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E Co m e Custom PC Issue 222

/ FROM THE EDITOR Hoping for a happier year

appy New Year, fellow PC-loving people. May your 2022 H be filled with exciting hardware launches, awesome new game releases and maybe, just maybe, some decent stock of PC kit at reasonable prices. We can always hope. If all goes well, there's some good stuff coming out this year. You can take a look at the hardware we're eagerly anticipating on p88, and Rick has a rundown of some new game releases to expect on p76.

Surely 2022 has got to be better than 2021 for PC hardware, hasn't it? Looking back over 2021 reveals a tough time for the PC business. At the start of the year, there was practically no stock of AMD's Zen 3 Ryzen 9 CPUs, and Intel's Core i9-11900K was so rare it was practically fictional. Meanwhile, the already limited stock of GPUs was being hoovered up by eBay scalpers and cryptocurrency miners, while demand was rocketing and manufacturing couldn't keep up.

The GPU situation sadly remains bleak, but I've been given some hope by the good supply setups that have been engineered elsewhere. You can now find stock of AMD's Zen 3 CPUs widely available, and stock of Intel's Alder Lake CPUs is also superb. All three of Intel's 12th-gen K-series chips are still in stock and keenly priced months after the launch, and while enthusiast-level DDR5 memory is practically non-existent, DDR4 memory is fine for Alder Lake.

This means you can read this month's motherboard Labs on p42, as well as our Alder Lake upgrade guide in Issue 221, and plan an awesome PC upgrade without having to worry about supply issues. That's something to cheer about in these times of severe silicon shortages, and there will be plenty more CPU launches coming this year.

My highlight of 2021 was our 'Beat the scalpers' feature, where we teamed up with Scan to make a DIY PC kit available at a reasonable price, and we'll continue to look for ways to serve our readers during these trying times. While I don't see an end to the GPU supply situation coming any time soon, you can rest assured that Custom PC will be here to guide you through your hardware buying decisions over 2022.



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RICHARD SWINBURNE / VIEW FROM TAIWAN

THREE-WAY GPU FIGHT

Three competitors will soon be scrapping in the low-end discrete GPU market, but the specs look mediocre, argues Richard Swinburne

his year, for the first time in years, we'll have three companies – AMD, Intel and Nvidia – vying for space in the low-end graphics card market. Nvidia already has its GeForce GTX 1650 and GTX 1660 variants, while Intel will be launching its Arc A380 and AMD will bring out the Radeon RX 6500 and 6400.

The performance of the Nvidia cards is well known, and none of the Intel and AMD GPUs are expected to set performance records, even at this level. However, for gamers who play at 1,920 x 1,080, the expanding competitive options could at least result in dropped prices. These cards will also offer a solid step up for anyone stuck using very old GPUs or integrated graphics.

If we purely consider the leaked specs – the Radeon RX 6500, with its rumoured 1,024 stream processors and small slice of Infinity Cache, should compete against the GTX 1650 Super, while the Radeon RX 6400 will go up against the entry-level GTX 1650 GDDR6.

The Radeon cards look set to be based on AMD's 7nm Navi 24 chip with RDNA 2 architecture, making them technically more

advanced than Nvidia's older TU116/117 chips. The latter are based on Nvidia's last-gen Turing architecture from 2019, so work performed per shader should be more effective on the Radeons, although ray tracing is going to be a non-starter at this level of performance with only 4GB of graphics memory. On the flip side, limited memory capacity could make these GPUs less useful for cryptominers than pricier cards, so their prices might remain close to MSRP.

However, the RX 6500 (Navi 24) has fewer stream processors and texture units than the previous RX 5500 (Navi 14) - 1,024 and 64 vs 1,440 and 88 respectively - and half the memory bus

bandwidth. The small amount of Infinity Cache will offset these limitations to some degree, but it has to make up a lot of ground. AMD appears to have become extremely conservative here, as the chip's specs are around half the capacity of the Navi 23 in the RX 6600.

Intel's movements into the graphics card market have been – generously speaking – slow and steady. Its first card, the DG1, launched in 2020 and was strictly limited to certain pre-made systems. However, we're now on the cusp of Intel's first gaming card launching in shops – the Arc A380.

It's expected to offer a similar count of 1,024 shaders to Navi 24, along with a 96-bit wide memory bus and 6GB of memory

capacity. On paper, two of those metrics are better than Navi 24, although Intel's Xe DG1 graphics didn't use a large internal cache, and it's currently not known if Arc will have one either.

The broader concern is the increasing gap between top and bottom cards. High-end specs and performance are increasingly climbing upwards (arguably primarily because of the increasing power budget),

while entry-level specs and performance growth is much, much slower.

This will mean increasing costs and time for game developers to support a wider range of graphics features and memory capacities, in order to cater for this increasing disparity each generation. The gap between the middle (not even top) and bottom of the graphics stack is now separated by around 8-10GB of graphics memory and half the TFLOPS. That's in addition to the fact that people are holding onto their older cards for longer, creating an extended range of graphics generations with different capabilities to support. **GPC**

High-end specs are increasingly climbing upwards, while entrylevel performance growth is much slower

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

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TRACY KING / SCEPTICAL ANALYSIS

PASSING THE TORCH

Tracy King enjoys the warm and fuzzy feelings of introducing a new generation of kids to gaming without judgement

His dad is also now playing

Peggle – a game so great

I named my cat after it

love writing the New Year column, it gives me a chance to look back on 12 months of opinions – overall, things change a lot while staying much the same. I've been a PC user since the early 1980s thanks to my dad's career in computing, and a proud gamer since I was old enough to press the BREAK key.

I've seen controversies come and go, debates about the influence or importance of technology and gaming in particular debated in Parliament, newspapers and by concerned parents everywhere. I've always felt grateful for having parents who could see that a child who can code, type and knows how computers work will always find

employment, and a child who has access to video games will never be bored. In this column I've debunked scaremongering articles about crime, highlighted the lack of evidence for 'gaming disorder', and pointed accusing fingers at those seeking to profit from the anxieties of parents.

But as I advance into middle age, spaffing my disposable income on tech and games, I don't factor this into my own life, because I don't have any children. I write about kids and gaming often, when headlines need debunking or politicians are talking nonsense, but it's all academic.

When parents ask for game recommendations for their kids, I reply with only my own experiences in mind. Until now. My godson is about to turn four and something incredible has happened. I was staying at his parents' house – a non-gaming household – and was relaxing while he watched some insufferable animated alien show.

Short of access to any other device, I started playing Peggle on my iPad. Suddenly I noticed him watching. He crept closer, utterly rapt and I found myself showing him how to play. Thereafter, he didn't stop talking about 'the funny game!' He hadn't played a video game before, and it was magic to see how quickly he grasped it. I suddenly knew how my parents felt in 1980 when I was four and they showed me Little Brickout on the Apple II.

The next time I visited, I took an old Xbox 360 and a copy of Peggle, and I'm delighted to report I have made not one but two new gamers (his dad is also now playing Peggle – a game so great I named my cat after it). I do have mild misgivings, not because four is too young to start gaming (it absolutely is not) but because his retro game

and old console are the beginning of what will probably be his most expensive hobby for life ('aunty' Tracy probably gets to pay for it all, of course).

He'll want to keep up with his friends, but hopefully I can convert him to PC in a few years and teach him to code just like

my parents did with me, so at least he'll have some control over his gaming hardware.

Shortly after this symbolic passing of the gaming torch, I read an article in the New York Times by a dad who had introduced his four-year-old daughter to gaming during lockdown. It's a sweet piece, and for a non-expert writer, he's surprisingly accurate about the (lack of) evidence for addiction or harm, which heartened me greatly.

If a major cultural influencer such as the New York Times can see that the future of childhood is gaming, the era of scaremongering about gaming looks like it might finally be coming to an end and kids of all ages can play games in peace. **CPG**

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

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INCOMING / NEWS

Incoming

SAMSUNG SAMPLES 24GHz GDDR6 MEMORY

Samsung has started sampling GDDR6 memory chips running at speeds of 2.5GHz (20GHz effective) and 3GHz (24GHz effective). The company's GDDR6 product page (**custompc.co.uk/GDDR6**) lists the two new chips, with 'Sample' written in the 'Product Status' column. The two new

MSI SHOWS OFF MOTHERBOARD TOUCH-SCREEN

MSI has given us a teaser of what's to come from its forthcoming MEG Z690 Godlike motherboard – a detachable touch-screen. In a video, MSI has shown off the screen sitting in a shroud next to the motherboard's DIMM slots. The screen shows off some MSI logos, and then goes into the menus.

Among the screen's features demonstrated in the video are a clear-CMOS button, along with plus and minus buttons for the CPU clock, and options for a safe boot and retrying an overclock, plus power and reset buttons.

While the bling factor is clearly a large part of the screen's appeal, we wonder if it might enable you to set up your PC, and check its status, without needing a monitor and GPU, which could be handy in the early stages of PC building.



chips have a density of 16Gb (2GB), and are organised into 32 512Mb blocks.

These speeds are faster than the 1219MHz (19.5GHz effective) speed of the GeForce RTX 3090's GDDR6X. As a point of comparison, the AMD Radeon RX 6900 XT's GDDR6 memory runs at 2GHz (16GHz effective).





Rumour control

WE PRESENT SOME OF THE LATEST UNCONFIRMED TECH GOSSIP. TAKE THESE STORIES WITH THE APPROPRIATE PINCH OF SALT

GEFORCE RTX 3090 Ti INCOMING

According to various online sources, including **videocardz.com**, Nvidia is planning to launch a new top-end GPU, called the GeForce RTX 3090 Ti, in early 2022, with availability expected on 27 January. According to the rumours, RTX 3090 Ti cards will have 10,752 CUDA cores (compared to 10,496 on the standard RTX 3090), while its 24GB of GDDR6X memory will run at 21GHz (effective) – a boost over the 19.5GHz (effective) memory used on the standard RTX 3090.

CHEAPER AMPERE GPUS COMING

According to regular tech leaker **@kopite7kimi** on Twitter, Nvidia has two new low-end GPUs based on its Ampere architecture in the pipeline. Apparently based on the same GA106 GPU as the RTX 3060, the new GPUs are said to come in both 4GB and 8GB options. According to **@kopite7kimi**, the 8GB version will have 2,560 CUDA cores, while the 4GB version will have 2,304.

BUDGET ALDER LAKE CHIPSETS ON THE WAY

A list of forthcoming Alder Lake motherboards has been leaked by Twitter user @momomo_us, with model numbers implying the use of new Intel chipsets called H670, B660 and H610. As with the Z690 line-ups, there are two entries for some of the model numbers, with the second one having a 'D4' or 'DDR4' suffix, showing that some B660 options could come in both DDR4 and DDR5 variants.

What's more, in a separate leak, **@momomo_us** also claims to have found details of the new chipsets' capabilities. According to the leak, both the H670 and B660 chipsets (but not H610) will allow memory overclocking, but not CPU overclocking, and will also support 4x PCI-E 4 NVMe SSDs.

Meanwhile, the H670 chipset reportedly also supports one 16x PCI-E5 slot or a pair of 8x PCI-E5 slots, while the other two chipsets only support a single 16x PCI-E5 slot configuration. According to the leak, all the chipsets can also support both DDR5 and DDR4 memory.

CORSAIR DDR5 HITS 6400MHz

Corsair has announced some new high-speed memory in its Dominator Platinum RGB DDR5 line-up, with two 32GB (2 x 16GB) kits running at 6200MHz and 6400MHz frequencies.

In addition to running at high speeds, the memory also supports Corsair's XMP Manager software, which is part of its latest iCUE suite. The software enables you to tweak the XMP 3 profile of your memory and save your new latency settings to the module from Windows.

Meanwhile, the lighting on the modules comes from 12 of Corsair's individually addressable Capellix LEDs. As with most DDR5 memory modules at the moment, there's no sign of stock as yet, but the 6200MHz kit is currently listed on Corsair's

website at £460 inc VAT, along with a 'Notify me when in stock' button.



NVIDIA QUIETLY RELEASES 12GB RTX 2060

Following months of speculation, Nvidia has rereleased its aging TU106 GPU in a new GeForce RTX 2060 variation with 12GB of memory, but without any fanfare. Along with the extra memory over its 6GB older brother, the 12GB variant also has four more streaming multiprocessors (SMs) enabled, giving it a total of 34. This gives it 2,176 CUDA cores, compared to 1,920 in the original RTX 2060, as well as 34 RT cores.

That's the same number of CUDA cores found in the RTX 2060 Super, but the Super variant also has a 256-bit wide memory interface paired with its 8GB of GDDR6 memory, resulting in a total memory bandwidth of 448GB/ sec compared to just 336GB/sec on the 12GB RTX 2060. Not surprisingly, there's no stock to be found anywhere, and it's unlikely the small bump in spec will make the 12GB RTX 2060 worth buying unless it's seriously affordable.

On the plus side, the extra memory will open up some new game options (the 6GB version wouldn't even run our Doom Eternal benchmark), but the RTX 2060 was generally a fair way behind currentgen GPUs when we recently tested it (see Issue 220, p50) – even its ray-tracing performance regularly dropped behind AMD's low-end RDNA2 GPUs.



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Letters

Please send us your feedback and correspondence to custompc@raspberrypi.com

You call a pie a pie

Congratulations on Issue 221! You have truly hit the jackpot in my opinion. I've been a subscriber of your fine magazine since the very first issue and your latest edition is probably the best ever. Every month, after receiving the latest edition of the magazine, I go through it and dog-earall the pages I want to read in depth. After going through the latest issue, I found there were dog ears on most of the pages-truly remarkable!

Every year, I base my mince pie purchase on your megatest, and I just love that you take mince pies as seriously as your computer hardware. I particularly liked the 'Graphics grand prix'. You're prepared to call a spade a spade, meaning the current crop of high-end graphic cards offer very little value for money, and you don't get a badge from CPC just for high performance and a strong feature set. Keep up the great work! As always, I'm eager to get my hands on the next issue. **BENJAMIN SIU**

Ben: Aw, thank you so much for your kind comments Benjamin - it makes us feel all warm and fuzzy to know when

When's the next issue out?

Issue 223 On sale on Thursday, 3 February

> we've got it right. We all love mince pies (except Rick, the weirdo), and take our Christmas treats seriously! And ves indeed, it's hard to recommend any of the current GPUs when they're so hard to find at normal prices.

Alder Lake questions

I'm writing in reference to Issue 220 about the new Intel Alder Lake CPUs. I for one have been a supporter of Intel CPUs for years, but in the past few years I've become disheartened by Intel's progress. AMD has been running the show with little response from Intel. I can't tell you how happy I was to see that Intel has at long last made that jump forwards.

From your great review, I can see that Alder Lake has a lot going for it. For starters, I like the idea of splitting the cores. The fact that Windows 11 already supports the split process shows the time that Intel has put into this feature. The memory support is another great step forwards. The fact it supports DDR4 and DDR5 means you don't have to break the bank when you first upgrade.

The real steal of the show, though, has to be the performance. The benchmarks you listed showed that the Core i7 can hold its own against the AMD Ryzen 9! These three CPUs really look like they mean the business.

I do have concerns, though. First off, how easy is to get them?



Alder Lake CPUs are in good supply, unlike DDR5 memory modules

We all know about the supply problems that have been plaguing the computer industry, and I feel there's still some way to go before it gets better. The next question is about motherboards. What boards will support Alder Lake to its full capability? It's GREAT to see Intel back in the race and in style. A Core i7-12700K for about £400? It looks like it's time for me to upgrade my rig.

ADAM BUCKENHAM

Ben: Alder Lake is indeed a triumphant return to form for Intel, although we have to thank AMD here for leading the competitive charge as well. The good news is that all the CPUs are generally still widely available. The bad news is that the same can't be said for DDR5 memory but, as you say, you can always use DDR4, and our tests have so far shown that there isn't a massive performance difference from using DDR4 instead of DDR5. As for motherboards, I think you're going to like this issue - have a look at our Labs test on p42.

We take mince pies as seriously as our computer hardware!





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SPEC

Intel compatibility LGA1700, LGA115x, LGA1200, LGA2066, LGA2011

AMD compatibility Socket AM4, AM3/+, TRX/4 Radiator size with fans (mm) 275 x 123 x 30 (W x D x H) Fans 2 x 120mm Stated noise 36dBA

ith a 'Z' at the front of its model number, the Kraken Z53 RGB White represents NZXT's flagship 240mm liquid cooler and it has a price to match. At £230 inc VAT, it's monstrously expensive. However, unlike some other pricey coolers, you get a few extras thrown into the mix in order to help justify that price tag.

First off are the cooler's two 120mm AER RGB fans, which have software-controlled lighting arrays, and the 7th-generation Asetek-derived pump has software control as well. There's a splitter cable that provides power to all of the kit via a SATA connector on your PSU, but it then splits off to connect the pump to the fans. A second cable connects the pump to a spare USB 2 header on your motherboard, enabling NZXT's CAM software to control it all.

> This does result in a mass of cable spaghetti, though, and it's compounded further by a separate RGB cable connecting to the fans to control the lighting. Needless to say, you'll need to spend some time tidying away all these cables and making sure none of them find their way into the fans. Thankfully, the situation is made a little easier by the RGB lighting control daisy-chaining between fans. On this dual-fan cooler, and the larger triple-fan Kraken Z73 RGB, only one RGB cable is required to control the lighting of multiple fans.

Meanwhile, the large pump section has tubes protruding out of one side, which makes it too large to fit on some motherboards with restricted CPU socket areas. These include the mini-ITX Asus ROG Strix Z690-I Gaming WiFi, although the Kraken 120 RGB's smaller pump did allow that cheaper cooler to fit on that board. You should have no such issues fitting the Kraken Z53 to most micro-ATX and ATX motherboards though – just have a look at the room around the CPU socket before you buy it.

The highlight of the cooler is undoubtedly the 2.36in display on the pump/waterblock unit, which can cycle through various data inputs, such as CPU and GPU temperature, coolant temperature, clock speed and load. You can also upload GIFs and customise the display's text, background and detail sections separately. It's not as snazzy as the display on Corsair's new coolers, such as the H150i Elite LCD we reviewed last month, but it's certainly a step forwards compared with NZXT's holographic displays.

That's all for show, of course, but what's more useful in terms of cooling is the software control for the Kraken Z53's fans and pump. They can be controlled separately, either using Silent or Performance profiles, a fixed speed or your own custom curve. You don't have to stick to using the CPU temperature input to control them either, as you also have the option of using the coolant temperature or even that of the GPU.



TEMPERATURE RESULTS

The difference between the Silent and Performance profiles is down to the fan or pump speed at lower temperatures, with the Silent profile seeing lower speeds and noise before ramping up to 100 per cent speed at around 60°C. The Performance profile will do the latter as well, but sits at higher speeds lower down the temperature range. You won't see any difference between the two profiles under sustained heavy loads with most CPUs, but the Silent profile might make your system quieter at low to medium loads.

The fan lighting isn't just found on the blades either, unlike the Corsair H150i Elite LCD – in this case, there are also illuminated rings that sit around the edge of the fan housing. There are eight individually tweakable LEDs on each fan, and you can pick from numerous presets, such as a rainbow mode or even colours changing according to CPU or GPU temperature. Sadly, the included hardware only features proprietary connectors though.

Out of the box, our sample wasn't compatible with Intel's new LGA1700 socket, but newer samples should be compatible. In any event, the LGA1700 adaptors are available for free from NZXT, or you can purchase the generic Asetek upgrade kit from UK retailers, such as **overclockers.co.uk**. Installation is just as simple as other Asetek coolers, with a backplate, mounting pins and thumbscrews. As usual, though, the thermal paste is pre-applied, so you'll need to protect it until you're ready to install the cooler.

Performance

The Kraken Z53's fans spun up to reasonably loud levels at their peak speed of 2,000rpm, but at idle, they were inaudible outside our test system. Dealing with a Core i9–12900K,

NZXT 32° Liquid

the Kraken Z53 RGB White managed an average CPU delta T of 50°C on the P-Cores and 41°C on the E-Cores, with the former being 4°C warmer than the Kraken X73 RGB and 7°C warmer than the Corsair H150i Elite LCD, but those are 360mm coolers, so this 240mm cooler isn't doing badly in comparison. Initially, the temperatures were even, but rose a few degrees towards the end of the test.

In our Socket AM4 system dealing with a Ryzen 7 5800X, the Kraken Z53 RGB again hit a CPU delta T of 50°C, placing it at the top of the stack of 240mm AlO liquid coolers, but a degree warmer than the latest 360mm models, such as the Thermaltake Toughliquid Ultra 360 and Corsair H150i Elite LCD.

Conclusion

With advanced RGB lighting and a pump display, as well as excellent cooling on both our test sockets dealing with the latest CPUs from AMD and Intel, the NZXT Kraken Z53 RGB is one of the most potent coolers available.

It's more flexible in terms of case compatibility compared with 360mm radiator models, but with full software control, you only lose a few degrees in terms of comparative temperatures.

You're paying a lot for the aesthetics though. NZXT's Kraken X53, which doesn't have the display or RGB fans, currently goes for under half the price, and the black Kraken Z53 without the RGB fans costs £210 and was spotted going for just £130 inc VAT in a recent sale at **scan.co.uk**.

Corsair's H100i Elite Capellix AlO liquid cooler also costs just £120 and can also be upgraded to use the same snazzy pump display as the H150i Elite LCD, as well as being available in both black and white versions. In short, the Kraken Z53 RGB is a fantastic cooler that looks great, but it's far too expensive.

ANTONY LEATHER

VERDICT

Great cooling and compact with full software control, but it's extremely expensive.



MINI-ITX CASE LIAN LIQ58/**£120** incvat

SUPPLIER overclockers.co.uk

t's always worth checking out the latest mini-ITX hardware, for the simple reason that manufacturers often take different approaches to solving the usual issues of limited space, whether they're dealing with motherboards or cases. Every now and then a really interesting design turns up, such as Lian Li's new Q58 case.

It comes in black or white, and it's a sandwichstyle mini-ITX case that uses riser cables to connect the motherboard and graphics card, which sit back to back. In addition to the colour options, you can also choose to have PCI-E 3 or PCI-E 4 riser cables, with the cheapest option being £120 and the most expensive one costing £155. This price range means the Q58 offers

SPEC

Dimensions (mm) 170 x 340 x 250 (W x D x H)

Material

Aluminium, steel, glass Available colours

White, black

Weight

4.5kg

Front panel Power, 1 x USB 3, 1 x USB

3.1Type-C, 1x audio Drive bays

4 x 2.5in, 1 x 3.5in

Form factor(s) Mini-ITX

Cooling

2 x 120/140mm roof fan mounts (fans not included), 1 x 120mm base fan mount (fan not included)

CPU cooler clearance 67mm

0/11111

Maximum graphics card length 320mm reasonable value compared with the likes of the NZXT H1 and Streacom DA2 V2, although it makes the Q58 a little more expensive than the Cooler Master MasterCase NR200P.

The Q58 has a similar design to the Raijintek Ophion Evo, but Lian Li has added its usual premium feel and flair. Each side section sports a pair of lateral panels, with the top section made from tempered glass and the bottom section made from perforated steel. These sections fold up and down respectively, opening up the interior like a set of double doors.

The benefits of this design approach are twofold. Firstly, it simply looks great – you could even lower one of the doors to show off your graphics card to your mates. Secondly, the fact that the lower panel is meshed results in an airflow boost to aircooled graphics cards and CPUs.

The case has a spartan exterior, with just a power button, audio port, and single USB 3.1 Type–C and USB 3 Type–A ports on the front panel. It's extremely compact too, measuring

just 17cm wide, 25cm tall and 34cm long, and our white sample looked extremely

clean and cute (yes, cute, I said it) on our test bench. It's not just the double-door panels that are interesting with this design either – it starts to get really interesting when you look at the interior, and the underside between the rubber-tipped case feet.

Lian Li has added a lower fan bracket to the bottom that extends downwards, allowing you to fit a 120mm fan to the underside, and while the company doesn't mention it, there's easily enough space to fit a 120mm radiator on top, especially if you use a slim fan and radiator. The case also features a brilliant hinged door at the rear with a combined 3-pin digital RGB and PWM fan hub mounted to it. This hub has three fan headers and three 3-pin RGB headers, and its placement here means it's kept out of space-limited areas of the case and is easily accessible too.

Meanwhile, the top panel pops off with no tools required, revealing a removable fan mount that can house a pair of 120mm or 140mm fans or corresponding radiators. There's 60mm of clearance between it and the motherboard tray too, giving you plenty of space for radiators and fans.

Out of the box, the Q58 is configured in SFX PSU mode, with the PSU mount located in the lower front of the case next to the motherboard. There's an extension cable running from the power socket to an external port at the rear of the case. However, the case also allows for ATX PSUs to be used, thanks to an included optional bracket. This sits in place of the fan bracket in the roof, taking up one of the fan mounts to cater for an ATX PSU instead.

The fact there are still two locations for 120mm fans and radiators, even with an ATX PSU installed, is important, as the case only has room for 67mm-high CPU coolers. It caters better for large graphics cards, with up to 320mm of clearance, and GPUs will benefit from having side ventilation too, unlike the design of a number of other sandwich-style cases.

If you go for SFX PSU mode, you'll also get space for a single 3.5in hard disk as well as three 2.5in SSDs, although the former will occupy one of the roof fan mounts. The single 2.5in bay at the front of the case features a tool-free mount with integrated power and data ports too, although the provided data cable that then runs to your motherboard is quite short – we had to re-route it in order to reach the SATA ports on our motherboard.

Lian Li has done a good job with cable tidying, providing numerous Velcro ties in the case as well as extras in the accessory box. As the lower half of the case is obscured by the mesh vents, most of the cables should be hidden from view too, whichever PSU you opt to use.



TEMPERATURE RESULTS





Performance

There are no fans included as standard, so we've added a 120mm Noiseblocker fan to at least see how the case performs with some airflow and, needless to say, we'd recommend you do the same. Out of the box, the CPU delta T was 53°C, which was on par with the Kolink Rocket Heavy, but warmer than the Cooler Master Master Case NR200P and Jonsbo A4. Adding an exhaust fan in the roof cut this temperature to 50°C, matching the NR200P.

The GPU delta T of 47°C with no fans was toasty compared with all other mini-UTZ cases we've tested, except the Phanteks Shift 2, so while the GPU's access to cool external air is definitely there, your card will still get hot if there's no fan to get rid of the warm air building up in the case. Adding a single roof exhaust fan lopped 4°C off that temperature, so whether you do it with an AlO liquid cooler or case fans, we'd definitely recommend boosting the Q58's stock airflow.

Conclusion

The Lian Li Q58 is a fabulous mini-ITX case, but while the Cooler Master MasterCase NR200P might be cheaper and less suave, it does offer a better cooling package out of the box. The Q58 is more of a blank slate, with better liquid-cooling support, and an intuitive, attractive and unique design. Kit it out with some sort of liquid cooling, and it's easily one of the most appealing mini-ITX cases available.

VERDICT

A gorgeous, unique case design but you'll need to add some extra cooling.

UNDERFLOOR COOLING

- Attractive
- + Unique design
- Good liquidcooling support

UNDERFLOOR RODENTS

- Average out-ofthe-box cooling
- SSD mount cables are short
- Limited CPU cooler height limit



PCI-E 3 M.2 SSD WD BLUE SN 570 / **£80** inc VAT (1TB, reviewed); **£50** inc VAT (500GB)

SUPPLIER scan.co.uk

BLUE SKY

- Excellent value
- Competitionbusting speeds
- Good endurance rating

BLUE SCREEN OF DEATH

- Poor write speeds with extremely large files
- PCI-E4SSDs have higher sequential speeds
- No 2TB option

SPEC

TTB
Formatted capacity 931GB
Heatsink
No
NAND
TLC
Controller
WD in-house
Endurance
600TBW (1TB)
Warranty
Five years

f you don't specifically need the massive sequential speeds of PCI-E 4 SSDs to deal with regular humongous file transfers, PCI-E 3 SSDs offer all the speed you need for less cash. Even here, though, there are some notable differences between models, but at the lower end of the spectrum, WD's Blue SSDs such as the Blue SN550 have been our favourites. The new Blue SN570 builds upon its predecessor with much faster speeds, but thankfully costs about the same amount of money.

WD BLUE" SN570 NVMe" SSD

At the top of the stack is the 1TB model that costs \pounds 80, but sadly no larger capacities are available. That's a bit of a shame, as an affordable but speedy 2TB drive could be very useful for users who need a lot of storage space, and such a drive would likely still leave you with change from £190 if the price of the SN550 is representative. The latter is a much slower SSD, though, despite costing about the same price.

While the SN570's basic design is similar to that of the SN550, being a DRAM-less SSD using an in-house WD controller with triple-level cell (TLC) NAND, the faster speeds are likely due to the move from BiCS 4 96-layer 3D TLC to BiCS 5 112-layer 3D TLC NAND. This move results in a peak stated sequential read and write speed of 3,500MB/sec and 3,000MB/sec, respectively while the older SN550

sits at 2,400MB/sec and 1,950MB/sec.

Those are some significant speed boosts given the similar pricing, and these speeds are similar to those found on the faster PCI-E 3 SSDs available. The absence of DRAM to reduce wear on the flash memory doesn't seem to impact endurance either. We're not looking at the huge TBW ratings of WD's Red SSDs, but at 600TBW for the 1TB model, you're not losing out compared with the competition. For example, Samsung's 1TB 980 has the same rating.

Suspecting we'd get slower write speeds with larger files, we threw a 100GB file at the SSD and, sure enough, after 15GB or so, the write speed plummeted to around 500MB/sec. However, even dealing with

many tens of gigabytes at once

WD Blue ** SN570 NVMe** SSD SOLID STATE DRIVE

is an extremely rare situation for most of us.

CrystalDiskMark's sequential tests saw the SSD hit numbers closer to the specifications, with a read speed of 3,549MB/sec and write speed of 3,195MB/sec.

Western Digital

The random 4K performance with a queue depth of 32 and four threads saw read and write speeds of 1,890MB/sec and 1,723MB/sec respectively, both of which are faster than the results from the Samsung 980 and WD Blue SN550. What's more, these speeds are faster than those of the ADATA XPG GAMMIX S50 Lite, which was one of our favourite affordable PCI-E 4 SSDs in our last Labs test. We didn't see the SSD's temperature rise above 53°C in our stress test either, and that's without any added heatsinks, so it runs relatively cool compared with many other SSDs too.

Conclusion

With a very reasonable price and performance that matches or betters more expensive SSDs, WD's new Blue SN570 is a fantastic SSD for the cash. It offers some of the fastest speeds

the PCI-E 3 interface has to offer, and the only area where it comes up short is when you're writing tens or hundreds of gigabytes at once – a job most of us rarely do. It's a shame there's no 2TB option, but if you're after a 500GB or 1TB PCI-E 3 M.2 SSD for under £100, this is the one to get.

ANTONY LEATHER

VERDICT

A fantastic, well-priced all-rounder, as long as you won't be writing massive files regularly.





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27IN GAMING MONITOR HPOMEN 27C / £499 inc VAT

SUPPLIER scan.co.uk

THE OMEN (1976)

- + Fantastic contrast
- Good colour accuracy
- + Curved, sleek design
- + 240Hz refresh rate

THE OMEN (2006)

- Ghosting and inverse ghosting present
- Tricky to build
- Expensive

SPEC

Screen size

27in Resolution 2,560 x 1,440 Panel technology VA

Maximum refresh rate 240Hz

Stated response time 1ms

Stated contrast ratio 3,000:1

Active sync AMD FreeSync Premium, Nvidia G-Sync compatible

Display inputs 1x DisplayPort 1.4, 1x HDMI 2

Stand adjustment Height, tilt

Extras

100 x 100mm VESA mount, 1 x USB Type-C 3.2 Gen 1 port, 2 x USB 3.2 Gen 2 ports

HDR standard VESA DisplayHDR 400

here's a lot to like about the spec list attached to HP's Omen 27c. This monitor's 27in panel has a 2,560 x 1,440 resolution, a 240Hz refresh rate that's compatible with both FreeSync and G-Sync, and a VA panel with a 1ms response time. It has a 1000R curve too, which does a great job at increasing immersion.

The panel has slim bezels and a diamond-shaped base, and the diamond-shaped section on the rear means the ports don't face downwards, so they're easy to reach. In terms of ports, the HP is equipped with single HDMI and DisplayPort connections alongside a USB Type-C port and two USB 3.2 Gen 2 connectors. There's also a robust joystick on the rear for controlling the responsive on-screen display.

In other practical areas, though, the HP is inconsistent. Its stand has 130mm of height adjustment and 25 degrees of tilt movement, but there's no swivel or pivot motion. It's awkward to build too – the stand attaches to the display with two downward-facing screws that are difficult to reach.

Comparatively, the Asus TUF Gaming VG27AQ arrives with its stand pre-attached, and the AOC AG273QZ has a tool-free assembly mechanism. Those rivals are more compelling in some other areas too – the Asus has an IPS display and Extreme Low Motion Blur (ELMB), albeit at 165Hz, and it now costs £279. Meanwhile, the £403 AOC monitor pairs its 240Hz refresh rate with a 0.5ms response time, but it uses TN technology.

The benefit of the HP's VA panel, however, is its high contrast. Out of the box, the HP produced a brightness level of $195cd/m^2$ and a black point of $0.06cd/m^2$. That latter figure is fantastic, and it means the panel supplies a contrast ratio of 3,250:1. That's superb, and it helps the HP to create incredible depth and vibrancy, with deep blacks.

Colour accuracy is good as well, with delta E and colour temperature figures of 1.58 and 6308K, although the panel only rendered a middling 88.6 per cent of the sRGB colour gamut. With its TN panel, the aforementioned AOC AG273QZ had poorer contrast, and the Omen's punchy image looks great in games and video, even if its gamut handling could be better.

As with other VA gaming panels we've reviewed lately, though, while the Omen can indeed refresh at 240Hz, there's visible ghosting. The OSD has



overdrive levels from 1-5 (there's no 0 option), but even at the lowest level you can see ghosting. At the top level, you could also see lingering ghosting when objects appeared on darker backgrounds and obvious inverse ghosting in lighter areas. The middle overdrive options supplied the best balance and eliminated inverse ghosting, but conventional ghosting never went away entirely.

These issues aren't terminal if you're playing single-player games, but they're not ideal for fast-paced esports gaming. Comparatively, the cheaper Asus TUF Gaming VG27AQ uses ELMB to do a better job of removing ghosting, even if it only runs at 165Hz.

Conclusion

HP's Omen 27c offers fantastic contrast, an immersive curve and good colour reproduction, resulting in great-looking

games. The 240Hz refresh rate provides crisp, fast motion in most scenarios too. It's a shame, then, that this screen can't eliminate all of its ghosting, especially for the relatively high price. That's the Omen's biggest weakness, and it means this display isn't really suitable for fast-paced esports gaming, even if it's great in most other situations.



VERDICT

Fantastic contrast and a 240Hz refresh rate, but its ghosting issues mean fast-paced esports fans should look elsewhere.



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GAMING CHAIR NOBLECHAIRS ICON TX / £340 inc VAT

..... SUPPLIER noblechairs.co.uk

ICONIC

- + Smart design
- + Solid build quality
- + Decent overall comfort
- TX fabric ÷ feels great

ICONOCLAST

- Tilt system not balanced
- Pointless neck and lumbar pillows
- Raised front edge of seat
- Poor castors

n our recent gaming chair Labs, the noblechairs Hero Black Edition came out on top, earning points for its smart styling, build quality and features, but that prowess came at a high price of £420 inc VAT. That was down to its optional 'high-tech' faux leather upholstery, but also because it's a fairly large chair. The Icon, though, is a slightly more compact model and the new TX fabric option is cheaper too, resulting in this version coming in at £340.

The TX fabric might be cheaper than high-tech faux leather, or the real leather option, but in many ways, it's a better choice. It's soft and warm to the touch, and it looks superb in this anthracite grey colour, which is currently the only option. The fabric also offers more support than leather, as its higher friction means you don't slide down the chair.

The downside is the material's greater vulnerability to grot. You can use a carpet cleaner to keep it fresh, but it's a far cry from the wipe-clean ease of use of leather variants. Also, the slightly fluffed finish to the fabric leaves a very obvious bum print when you get up.

The shape of this Icon chair is much more akin to a standard office chair than the more bucket seat style used by most gaming chairs. Combine this shape with the simple grey fabric, unobtrusive stitched logo, and all-black arms, legs and wheels, and this chair is among the best options for doubling as a smart home office chair and chic-looking gaming throne.

The shape also helps with comfort, as the lack of shoulder wings means you don't feel at all hemmed in and hunched over. It also accommodates different sizes of sitters better than some chairs - our three testers of heights between 5ft 2in and 6ft 2in all found it worked for them.

However, the seat cushion isn't the most comfortable. It's a touch firm, and the front edge rises up slightly, so it can dig into the underside of your legs. This is a common problem with gaming chairs - and the lcon TX far from the worst - but the AKRacing chairs we've reviewed suffer less from this issue.

This chair doesn't include the built-in adjustable lumbar support of the Hero either, but instead comes with a lumbar cushion. As with many such cushions, we found it too large and firm to be comfortable, preferring the chair without it, and the same goes for the headrest cushion.

There are plenty of adjustment options, though, with handles on the right side for height adjustment and reclining the back of chair, and on the left for locking and unlocking the tilt system. The latter is easy to use and locks in any position, but its balancing isn't guite right. We couldn't get the chair



to just tilt back by leaning back, instead needing to prop up our feet - the heavier-backed Hero tilts back more easily (depending on the sitter's weight).

Meanwhile, the armrests slide forwards and back, in and out, and up and down, but don't rotate. Their padding is a very stiff foam plastic that's hard-wearing but not all that cushioning. One other slight disappointment is the castors, which don't roll all that freely. Finally, assembly is fairly easy, but the included right-angled Allen key/screw tool is a bit fiddly to use compared with a T-shaped tool.

Conclusion

The noblechairs Icon TX gets a lot right. It's a great-looking, robustly made chair with a shape that

will suit a variety of sitters. The TX fabric feels superb and the chair as a whole is reasonably comfortable too, although the tilt system could be better balanced. The fairly throwaway lumbar and headrest support cushions are disappointing when you're spending this much money on a chair though. EDWARD CHESTER



VERDICT

Great styling, robust build quality and decent fabric define this slimline gaming chair, although there are a few compromises.



TRUST BAYO / £30 inc VAT

SUPPLIER amazon.co.uk

rgonomic wireless mice that use a more upright position aren't new, but their relative rarity has tended to mean they demand a high price. However, the Bayo from Trust costs just $\pounds 30$ and offers the same core feature set as most such mice. Is it a bargain alternative to the Logitech MX Vertical?

Starting with the most important aspect of any such mouse, the Bayo's shape is indeed quite comfortable. It lacks the rubberised surface of the Logitech MX Vertical, but we still found it easy to grip and the contouring provides a pleasant, relaxed handhold.

The only way to really use mice such as this one is with a palm grip position, where you rest your whole hand on the mouse, while movements are large, and come from the wrist and shoulder. In contrast, many gaming mice rely much more on fingertip agility, but trying to use this mouse in that way defeats its purpose and results in a poor experience.

The four main buttons – left, right, back and forward – fall correctly under your forefinger, middle finger and thumb respectively while up top is a DPI button. Tap this with your thumb and it will cycle between five DPI levels (800, 1,200, 1,600, 2,000 and 2,400). There's also a scroll wheel between the left and right buttons.

It's a standard button configuration that works perfectly well, but the quality of the buttons and wheel is noticeably not on the level of more premium mice, lacking their snappy, precise feel. You also miss out on the fast, weighted scroll

SPEC

Weight 110a Dimensions (mm) 70 x 83 x 109 (W x D x H) Sensor Optical, 2,400 DPI Buttons 6 (left, right, scroll wheel, back, forward, DPI) Cable 1m, charge only **Battery life** Not stated Extras Dongle stowage on underside, RGB lighting

mium mice, lacking their snappy, out on the fast, weighted scroll wheel and sideways scroll wheel of the semi-ergonomic Logitech MX Master 3, but that mouse only has a roughly 20-degree angle compared to the 45 degrees of the Bayo and 57 degrees of the MX Vertical, so it isn't a direct comparison. On the left side is a translucent plastic strip that will light up in an array of RGB

with light up in an array of RGB lighting via a switch on the underside, which also has positions to turn on the mouse without lighting and turn off the mouse. It seems unnecessary to add RGB lighting to such a



cheap, productivity-focused mouse, but at least there's that hardware switch to turn it off.

There's also a sync button on the underside in case you lose sync with the included USB adaptor. In addition, there's a hole in which to stow the adaptor and three glide feet. However, the glides are a touch thin, so other parts of the mouse can drag on soft mouse mats, which is irritating.

Up front, meanwhile, is a USB Type-C port for charging the mouse. The area around the socket is wide enough to fit any cable, not just the included 1m cable, but the mouse won't work directly plugged into a PC.

Battery life isn't rated but it uses an 18650-type cell, rather than a custom unit, so replacement may be easier than with some mice if it fails.

Finally, the optical sensor tracks on most desktop surfaces (though not glass) but lacks the fine control of more accurate mice. It's adequate for desktop duties but not for gaming or fiddly tasks such as drawing.

Conclusion

For just £30, the Bayo delivers on its promise of being a cheap but capable ergonomic mouse. Its shape is comfortable, its functions all work adequately and it has basic modern conveniences, such as a wireless connection and USB Type-C charging. You'll get much better tracking, build quality and button feel with more expensive options, but if you just want a basic, comfy mouse for general desktop work, the Bayo does the job.

VERDICT

Rest those wrists with this cheap and mostly cheerful ergonomic mouse.

BAY OF BISCAY

- Comfortable ergonomic shape
- Convenient wireless connection
- + Very low price

BALEFUL

- Lightweight build quality
- Basic sensor
- No wired data connection









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- > 8GB GEFORCE RTX 3070 Ti
- > 1TB PCS PCIe M.2 SSD
- > 2TB SEAGATE BARRACUDA HDD
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GAMING MOUSE RAZER BASILISK V3 / **£70** incvat

SUPPLIER razer.com

LADDERS

- Brilliant contoured shape
- + Powerful sensor
- + Bright RGB lighting

SNAKES

- Bloated software
- Not the best for claw grippers

SPEC

Weight 101q

Dimensions (mm) $60 \times 130 \times 43 (W \times D \times H)$

Sensor

Razer Focus+ sensor, 26,000 DPI, 50g acceleration, 650 IPS

Buttons

11 (left, right, scroll wheel, back, forward, DPI, profile switch, DPI clutch)

Cable

1.8m, lightweight braided Extras

RGB lighting, smart

scroll wheel

he Razer Basilisk V3 is one of Team Green's latest entries into its extensive line-up of gaming mice. Compared to its predecessor, this V3 variant is a bit heavier, with a total weight of 101g as opposed to the V2's 92g. However, it retains the exact same shape and roughly similar design cues.

Its shape is marvellously contoured and ideal for righthanded gamers who prefer a palm grip – you can drape your hand over the entire plastic frame, and also rest your thumb in its dedicated thumb rest. The Basilisk V3 is also decent if you use a fingertip grip and just want to opt for pure speed.

Meanwhile, the hard plastic construction feels sturdy and hard-wearing. There are also some rubberised and padded side grips on the left and right, which help, alongside the contoured shape, making the Basilisk V3 one of the most comfortable mice available.

You'll also find plenty of RGB lighting at varying intervals across the body. There are 11 zones, which can be split into three main sections. The first zone is on the scroll wheel, with a pair of circles surrounding the usual plastic wheel, while the second is found on the Razer logo. Arguably the most impressive, however, is the third. On the Basilisk's underside is an entire strip of lighting that adds an underglow effect. It's just enough lighting to make the Basilisk V3 look smart without being gaudy.

It connects with a standard-issue 2m braided USB

cable that's flexible enough for making sweeping movements. As one of Razer's Speedflex cables, you also don't find any kinks once it's unravelled. Movement is also helped by the three 100 per cent PTFE glide pads on the bottom, with two up front and one larger one further back.

The Basilisk V3 is packed with buttons as well. There are 11 in total, including forward and backward buttons, a DPI button and a profile switch on the underside, which can be a little fiddly if you want to switch profile mid-game. The mouse's power is also reflected in its 26,000 DPI sensor and Razer's 2nd-gen optical mouse switches – the latter are quick and snappy, and the former offers superaccurate tracking, although we find most gaming mouse sensors are fine these days anyway.

In addition, Razer has completely rehashed the scroll wheel on the Basilisk V3, adding a slew of new

options that make it seem space age. The 'Smart-Reel Mode' can switch automatically between the usual tactile feel and more of a free-spinning mode that removes resistance, based on your scrolling speed. However, we found this annoying in use, and the wheel itself feels a little cheap – a notched scroll wheel would be more useful here.

Razer's Synapse 3 software is also on hand with the usual range of customisation options for changing DPI levels, programming buttons and the Chroma lighting. For the most part, it's all easy and convenient to execute, but Synapse is beginning to feel a little bloated with all the choices and third-party device integration, plus it requires an online login.

Conclusion

The Razer Basilisk V3 is a marvellous mouse for gamers who prefer to use a palm grip in games and want to drape their right hand over a comfortably contoured shape.

It's wonderfully comfortable to use, it performs well and it's packed full of features. Its weight is a little high, and there are a few other niggles, but it's otherwise a grand choice. **REECE BITHREY**

VERDICT

Comfortable shape, sharp looks, crisp lighting and a lot of power – there's a lot to love about the Basilisk V3.



84-KEY ELECTRO-CAPACITIVE KEYBOARD NIZ MINI 84 PRO/**£165** incvat

SUPPLIER keyboardco.com

f you're not used to mini keyboards, the Niz Mini 84 Pro has a strange layout. With its total of 84 keys, it looks like a squidged-up tenkeyless keyboard, but this slightly smaller form factor is

one of its biggest selling points. There's a bit of a learning curve if you're used to punching numbers on a numberpad, hitting the Home/End key cluster and using conventional cursor keys. However, if you're already used to TKL or 60 per cent keyboards, using the Mini 84 Pro is a doddle.

Its layout isn't the only odd feature though. Looking at the keyboard's sharp PBT keycaps from the top down, you'll notice it looks blank. Look a little further dowb, and you'll find that the Mini 84 Pro uses side-printed keycaps, which have been a staple of specialist manufacturers such as Filco for years. Again, this can take some getting used to if you aren't a touch-typist and need to look down at the keys, but it results in a very clean finish if you know your key locations.

This isn't necessarily a keyboard for gamers though – it will feel more at home in the hands of typists. It's all mounted in a sturdy plastic frame with some second-to-none build quality, along with a two-tone white and grey colour scheme that has a bit of a retro appearance.

The biggest reason for picking up a Niz Mini 84 $\mbox{Pro}\,\mbox{isn't}$

SPEC

Dimensions (mm)	tł
320 x 13 x 40 (W x D x H)	fi
Weight	Ν
780g	C
Format	t
84 keys	ir
Connections Bluetooth (via bundled receiver)	v
Switch type	g
Electro-capacitive	р
Switch life	
90 million key stroke	n
Backlighting	V
None	f
Extras	to
Keycap puller, Mac	ir
keys, extra springs	e
	_

looking PBT keycaps, hough, but what you ind under your fingers. Niz has used electroapacitive switches inside he Mini 84 Pro; these are n essence rubber domes with a spring on top that ets pushed down by a lastic actuator. It's a kind of halfmechanical switch that, vith its 45g actuation orce, feels very smooth to the touch and results n one of the best typing experiences we've found.

its quirky layout or cool-

If you're wanting a properly mechanical keypress, you won't find it here, but fans of Topre RealForce keyboards will feel right at home with the feel of the Niz Mini 84 Pro under their fingers.

Assuming you're comfortable with the layout, we didn't find we needed much of a period of acclimatisation to get used to the feel of these switches compared with standard mechanical models either.

You can immediately switch to this model from one of the usual slew of mini gaming keyboards and feel right at home immediately.

If a heavier key press is preferable, however, there are some extra springs bundled in the keyboard's box that can increase the weight of the keypress by 20g, bringing them more in line with Cherry MX Black switches in terms of force.

You also get a keycap puller in the box, along with some extra keys to swap into place if you're a Mac user. What's more, any keycaps with Cherry MX stems should be compatible with the Mini 84 Pro if you're looking to jazz up its looks with a different set of keycaps.

Conclusion

The Niz Mini 84 Pro is an absolutely fantastic typist's keyboard. Its smaller footprint features an intuitive and ideal layout if you want to save yourself some space. What's more, its build quality is unparalleled for such a small keyboard and its electro-capacitive switches feel snappy and light.

If you're looking for a brilliant, small-footprint keyboard that's built like a tank and feels great – it's not cheap, but it is brilliant.

REECE BITHREY

VERDICT

A marvellous mix of light switches, incredible build quality and sharp looks – a brilliant all-round package.

R-TYPE

- Amazing build quality
- Marvellous typing experience
- High-quality sideprinted keycaps

NOT MY TYPE

- Pretty expensive
- Light actuation force won't please everyone
- Heavy for a small keyboard



GAMING LAPTOP HPVICTUS 16/**£1,049** incvat

SUPPLIER overclockers.co.uk

P's new Victus brand offers a more affordable alternative to its high-end Omen line, and this £1,049 machine is one of the cheapest gaming laptops we've seen for ages. The low price doesn't mean cut-back silicon either. Nvidia's GeForce RTX 3060 has a peak limit of 95W in this rig, which is right in the middle of the GPU's thermal design power range, and AMD's Ryzen 7 5800H is a reliable performer that has a mid-range 45W thermal envelope.

Elsewhere, the HP has 16GB of dual-channel 3200MHz DDR4 memory and a 512GB Micron SSD. That drive offers solid read and write speeds of 3,258MB/sec and 2,784MB/

SPEC

CPU 3.2GHz AMD Ryzen 7 5800H

Memory 16GB 3200MHz DDR4

Graphics Nvidia GeForce RTX 3060 Laptop 6GB Screen 16.1in 1,920 x 1,080 IPS 144Hz

Storage

512GB Micro 2300 M.2 SSD Networking

Dual-band 802.11ax Wi-Fi, Gigabit Ethernet, Bluetooth 5.2

Weight 2.5kg

Ports

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

Dimensions (mm) 370 x 260 x 24 (W x D x H)

Operating system Windows 10 Home 64-bit

Warranty One year parts and labour return to base sec, but it will fill up quickly if you install a few games. Happily, there's a spare M.2 SSD bay on the inside.

The other notable component is the 16.1in screen, which is a little larger than a conventional 15.6in panel – a move that HP says improves immersion. That extra half an inch doesn't deliver transformative change, but it's noticeable and supplies a little extra room without the sheer size of a 17.3in machine. Elsewhere, the screen's specification is conventional – it's a 1080p IPS panel with a 144Hz refresh rate.

The Victus is available in white, black and dark blue designs, and our white sample looks eye-catching. Get hands-on, though, and the cost cutting is apparent. The machine weighs 2.5kg, so it's heavier than most rivals, and build quality is mediocre – the wrist rest rattles, and the desktop distorts if you put any pressure on the rear of the panel. You'll want a sleeve to keep this machine protected out of the house.

In terms of connections, you get three USB 3.2 Gen 1 ports and a Type-C socket that handles DisplayPort, plus an SD card

reader, HDMI 2.1 and Gigabit Ethernet, but there's no Thunderbolt and no quicker USB ports. There's a webcam, but it doesn't support Windows Hello, and you also get dual-band Wi-Fi 6 and Bluetooth 5.2. Meanwhile, the speakers have a punchy midrange, but the top end is tinny and they lack bass.

Ergonomically, the HP is fine but not brilliant. The keyboard has fast, snappy buttons that deliver crisp gaming action alongside a numberpad and a button to open the Omen gaming app. The cursor keys are small, though, and the Power button is sandwiched between the F12, Delete and Backspace buttons. That key requires more force to push than the unit's other buttons, but that's an awful location for it, as it's too easy to accidentally hit while gaming. The keyboard doesn't have LED backlighting either, and the touchpad rattles and pushes down too far.

PERFORMANCE

The HP might be a little rough around the edges, but its 95W RTX 3060 performs well. It played Assassin's Creed Valhalla and Cyberpunk 2077 with 99th percentile minimums of 40fps and 37fps, and the latter score increased by 3fps with Medium ray tracing and DLSS. Those results don't quite hit our frame rate targets, but they're good for a cheap gaming laptop – you'll only have to drop the settings a little to get smoother frame rates.

Meanwhile, the HP's Doom Eternal 99th percentile result of 94fps was bolstered by a 165fps average. That's fast enough to take advantage of the 144Hz display, which bodes well for performance in undemanding esports titles. HP's machine has a Performance mode that adds a few extra frames per second to games, and its Quiet mode retains enough pace for casual games and esports titles at sub-100fps frame rates.



BENCHMARK RESULTS



ASSASSIN'S CREED VALHALLA 1920 x 1.080, Ultra High settings, High AA HP Victus 16 40fps 58fps 0 30 60 90 CYBERPUNK 2077 1920 x 1.080, Ultra preset, no ray tracing HP Victus 16 37fps 48fps 0 0 30 60 90 METRO EXODUS 1920 x 1.080, Ultra settings, High RT, PhysX off, HairWorks off

HP Victus 16 28fps 47fps 120 0 30 60 90 120 99th Percentile Average

The Ryzen 7 5800H is a rock-solid bit of silicon too. Its benchmark results are consistently towards the top end of the speeds we expect from this chip, and its multi-threaded results are better than anything Intel can currently muster. This machine also has a battery that lasts for seven hours when handling everyday work tasks, although you can shave a couple of hours from that result for creative work and it only lasted for 90 minutes when gaming.

The GPU's delta T never rose beyond 44°C either, and the HP was quieter than most gaming laptops. The exterior remained warm rather than hot too. Noise levels were fine when we stress-tested the CPU as well, and the chip attained top single-core and multi-core speeds of 4.3GHz and 3.6GHz respectively – virtually identical to the chip's theoretical boost clocks. The only minor issue here is the processor's high delta T of 76°C during an all-core stress test, but it never caused instability.

The downside is the quality of the Victus' 16.1in display. The peak brightness of 240 cd/m² is poor, the delta E of 4.9 is mediocre and the screen only rendered 58.8 per cent of the sRGB gamut. These results leave the panel looking drab. The black point of 0.14cd/m² is good and it means you get a solid contrast ratio of 1,714:1, but that depth is wasted on a display with such a narrow colour gamut and an absence of brightness. You can play games on this panel, but they'll never look vibrant.

CONCLUSION

HP's machine delivers impressive gaming and computing power for a great price, and the 16.1in screen is a good size too. Battery life is good in some situations, and the Victus is never loud. It fails to impress in some areas though – the display has underwhelming quality, the keyboard has irritations, build quality is mediocre and connection options are average.

If you can stretch your budget, we recommend paying the extra £250 for the Lenovo Legion 5 on our Elite list, which currently goes for £1,299 at **currys.co.uk** and offers a faster RTX 3070 GPU, RGB-backlit keyboard, 165Hz screen and better USB connections in a stronger, lighter chassis. However, the HP Victus 16's decent performance for the price still makes it worth considering if your budget is limited to only just over a grand and you're aware of its shortcomings.

VERDICT

Good power and a big screen at a low price, but the HP suffers in several important areas.

VICTORIOUS

- + Solid performance
- + Great price
- + 16.1in display
- + Cool and quiet

DEFEATED

- Washed-out display
- Bad keyboard layout
- Mediocre build quality
- Uninspiring connection options



GAMING LAPTOP LENOVO LEGION 5 PRO/**£1,499** incvat

SUPPLIER cclonline.com

enovo's Legion 5 Pro is the upgraded version of our Elite-listed budget gaming laptop, so we've got high hopes for this mid-range machine. It gets off to a good start with its screen, which has an intriguing 16:10 aspect ratio. This gives you more vertical space than a 16:9 screen and its 16in diagonal also contributes to more immersive gameplay than a 15.6in display.

The taller aspect ratio makes it easier to browse the web and view documents too, and it has a crisp 2,560 x 1,600 resolution as well. The screen pairs this ambitious

SPEC

Memory

CPU 3.2GHz AMD Ryzen 7 5800H

16GB 3200MHz DDR4 Graphics Nvidia GeForce RTX 3070 Laptop 8GB

Screen 16in 2,560 x 1,600 IPS 165Hz G-Sync

Storage 1TB Samsung PM981a M.2 SSD

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

Weight 2.54kg

Ports

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

Dimensions (mm) 356 x 264 x 27 (W x D x H)

Operating system

Windows 10 Home 64-bit Warranty

One year parts and labour return to base

specification with great quality – the panel renders 95.9 per cent of the sRGB gamut with a delta E of 1.28 and a colour temperature of 6,244K, so you get a broad swathe of accurate colours, and the good contrast ratio of 1275:1 serves up decent depth and nuance.

The peak brightness level of 546 cd/m² is also vast – you'll have to turn it down indoors, but it does mean that the Legion remains usable in all lighting situations. This is an excellent display, and it also supports G-Sync at a 165Hz refresh rate – you'll only want to look further afield if you want a 4K panel or a 240Hz refresh rate.

On the inside, Lenovo has deployed a GeForce RTX 3070 GPU with a hefty peak thermal design power of 140W alongside AMD's familiar Ryzen 7 5800H. There's the usual 16GB of dual-channel DDR4 memory, and a 1TB SSD with reasonable speeds of 3,569MB/sec and 2,802MB/sec.

Meanwhile, connection options include dual-band Wi-Fi 6, Bluetooth 5.1 and Gigabit Ethernet, and Lenovo has done a good job with the port selection. The Legion 5 Pro has four USB 3.2 Gen 1 connections and two USB 3.2 Gen 2 USB Type-C ports that handle DisplayPort. One of those full-sized USB connections is always on, for device charging, while one of the USB Type-C ports also offers power delivery.

The Legion also has an HDMI 2.1 output and a webcam privacy shutter, and most of the ports are around the back to keep your desk tidy. The webcam doesn't support Windows Hello, though, and while the speakers are usable for games, they have a muddy mid-range output. You don't get a card reader either.

Move to the keyboard and you'll find concave keys with quiet, fast actuation that's good for mainstream gaming, and the sensible layout includes a numberpad. There's no RGB LED backlight, though, and the action is a tad soft – keen gamers will prefer a crisper experience. The trackpad disappoints too – it's positioned on the left of the laptop, so your wrist can easily catch it during gameplay.

Lenovo's Pro machine looks the part, though, with a sleek black finish used on the external aluminium panels and plastic interior. Build quality is good, although be aware that the Lenovo weighs 2.54kg and has an 870g power brick, so you'll notice it in your bag.

PERFORMANCE

When tested at our conventional 1,920 x 1,080 resolution, the high-end RTX 3070 delivered 99th percentile minimums of 48fps and 45fps in Assassin's Creed Valhalla and

SUPERHERO

- + Superb 16:10 display
- + Consistently fast components
- + Plenty of ports
- Sturdy chassis and comfortable keyboard

SUPERMARKET

- Mediocre battery life
- Noticeable fan noise
- Awkward trackpad
- Relatively heavy



Cyberpunk 2077. Those results are better than almost every laptop we evaluated in our recent Labs test – only Lenovo's own Legion 5 offered comparable pace.

That's a good start, and the Lenovo's solid performance continued at 16:10 resolutions: its 99th percentile results were only 1fps at 1,920 x 1,200. It starts to struggle when you run demanding games at the screen's 2,560 x 1,600 resolution, but it can still handle undemanding games fine, racking up an average of 152 fps in Doom Eternal. However, if you want to play tough titles at the Lenovo's native resolution then you'll need to reduce your settings.

Not surprisingly, the Ryzen 7 5800H is great and still better than any current equivalent Intel chip – it has ample power for mainstream content creation and multi-tasking, as well as single-threaded performance. The Lenovo's overall benchmark score of 204,593 is a mid-range result for a laptop with this chip because the CPU never quite attained its theoretical peak speeds, but performance isn't seriously hindered.

The Legion 5 Pro produces some noticeable fan noise when it's working, though, being marginally louder than many other RTX 3070 laptops. The noise isn't ruinously irritating, and the exterior is never hot, but the Legion isn't on the subtle end of the scale. Happily, the machine's Quiet mode is very hushed, but that option also has a corresponding drop in performance.



BENCHMARK RESULTS



Don't expect much from the battery either. During a games test, the Lenovo only lasted for one hour and twenty minutes, and when gaming, the GPU is reined in to 90W. The Lenovo also only lasted three hours when running work tasks. The laptop has a hybrid mode that uses the AMD CPU's integrated graphics to extend battery life, but that only added an hour of longevity to the work test.

CONCLUSION

This won't be the last gaming laptop to have poor battery life, though, and the Lenovo impresses in plenty of other departments. The 16:10, high-resolution screen has fantastic quality, the components are fast, and the chassis is robust and well connected. Its fans can get loud and the trackpad is disappointing, but those issues aren't dealbreakers or unique to this machine. There's an awful lot to like on this £1,499 laptop, from the powerful components to the large, impressive display, especially at this price.

VERDICT

A cracking display meets powerful components in an impressive machine for a reasonable price.



INTEL 2690 GAMING PC CYBERPOWER HYPER LIQUID INFINITY X129/**£3,999** incvat

SUPPLIER cyberpowersystem.co.uk

s its name suggests, CyberPower's Hyper Liquid Infinity comes in a huge case filled with an ambitious custom water-cooling setup. Two EK Quantum Kinetic pump/reservoir combo units dominate the front of the Corsair 7000D chassis, one of which is hooked up to a 240mm radiator in the roof, while the other flows into a 360mm unit behind those reservoirs.

SPEC

CPU Intel Core i9-12900K

Motherboard MSI Z690 Carbon WiFi

Memory 32GB Kingston Fury Beast 4800MHz DDR5

Graphics MSI GeForce RTX 3080 10GB

Storage 1TB Seagate FireCuda 530 M.2 SSD

Networking 2.5Gbps Ethernet, dual-band

802.11ax Wi-Fi, Bluetooth 5.2

Corsair 7000D

Cooling

CPU: EX Quantum Velocity2 waterblock, EK CoolStream 360 radiator with 3 x 120mm fans, EK TBE 200 D5 pump/reservoir, 3 x 120mm fans; GPU: EK Quantum Vector Trio waterblock, EK CoolStream 240 radiator with 2 x 120mm fans, EK TBE 200 D5 pump/reservoir; front: 4 x 120mm fans; rear: 1 x 120mm fan

PSU

Corsair RM850x 850W

Ports

Front: 4 x USB 3.1, 1 x USB 3.2 Gen 1Type-C, 1 x audio; rear: 5 x USB 3.2 Gen 2, 1 x USB 3.2 Gen 2x2 Type-C, 4 x USB 2.0, 1 x optical S/PDIF, 5 x audio

Operating system

Windows 11 Home 64-bit

Warranty

Five years labour with two years parts and six months collect and return

The 240mm unit cools the GPU via an EK Quantum Vector Trio waterblock, while the 360mm radiator chills the processor with a Quantum Velocity2 waterblock. Smartly, CyberPower has also chosen to cool the CPU with blue coolant and the GPU with green liquid, all with hard tubing.

Those colours indicate which components this machine uses. The CPU is Intel's latest Core i9-12900K, which has eight high-power P-Cores with base and boost speeds of 3.2GHz and 5.2GHz, and eight power-efficient E-Cores with base and boost clocks of 2.4GHz and 3.9GHz. CyberPower pairs this Alder Lake chip with 32GB of DDR5 memory running at 4800MHz, while a 1TB Seagate FireCuda 530 PCI-E 4 SSD delivers fantastic read and write speeds of 6,971MB/sec and 5,441MB/sec.

Meanwhile, graphics power comes from an Nvidia GeForce RTX 3080. Underneath the EK waterblock sits an MSI Suprim X LHR model, which raises the original clock of 1710MHz to 1905MHz. It's all powered by a fully modular Corsair RM850 PSU with 80 Plus Gold efficiency.

The motherboard comes from MSI too, and it's superb. It has four DDR5 slots with a top speed of 6666MHz, and its two top 16x PCI-E slots support PCI-E 5. The board has a monster five M.2 connectors too, four of which support 4x PCI-E 4, plus it comes equipped with 2.5Gbps Ethernet, Wi-Fi 6E and Realtek ALC4080 audio. At the rear, the MSI also has five USB 3.2 Gen 2 ports and

a Type-C socket that supports USB 3.2 Gen 2x2. There are four USB 2 ports as well, and no 1x PCI-E slots, but those are the only negatives.

It's all packed into a vast Corsair 7000D chassis, in a sturdy and tidy build. Around the back there's room for more fans and 2.5in drives, alongside easy access to the 360mm radiator. Both side panels have hinges, the roof and front panels pop free, and the case has four USB 3.2 Gen 1 ports and a Type-C connection on the front panel.

The case has no RGB LEDs, but CyberPower has used its cooling hardware, motherboard and power cables to supply illumination. The CyberPower looks great, although it's also a monster – it measures 600mm tall and 550mm long, it's extremely heavy and the motherboard is tricky to access. It's a setup that's overkill for most people, but it makes a serious statement if you want a really powerful PC.

You get a decent warranty as well, with CyberPower offering five years of labour coverage and two years of parts protection alongside six months of collect and return service.

PERFORMANCE

The RTX 3080 and i9–12900K deliver superb gaming speed. In Cyberpunk 2077 at 2,560 x 1,440, the CyberPower hit a 99th percentile minimum of 66fps, although that figure dropped to 34fps at 4K. Those figures are respectively 9fps and 2fps frames ahead of the last system we saw with an RTX 3080 – a rig with a smaller GPU overclock and an AMD processor.

BENCHMARK RESULTS



2560 x 1440 Vulkan Ultra Nightmare settings

CyberPower Hyper Liquid Infinity X129			241fps	371	ps
	0	100	200	300	400
3,840 x 2,160, Vulkan, Ultra Nightmare set	tings				
CubarDower Hunor Liquid Infinity X130		12460	2106		
CyberPower Hyper Eiguid Infinity X129		134rps	2101	200	
	U	100	200	300	400
2,560 x 1,440, Ultra preset, no ray tracing					
CyberPower Hyper Liquid Infinity X129			66fps	75fps	
	0	30	60	90	120
2,560 x 1,440, Medium ray tracing preset,	DLSS Ba	lanced			
CyberPower Hyper Liquid Infinity X129			70fps	80fps	
	0	30	60	90	120
3,840 x 2,160, Ultra preset, no ray tracing					
		0.44			
CyberPower Hyper Liquid Infinity X129		34rps 3/rp	IS		
2.040 ·· 2.160 Madium mutaning analytic		30	60	90	120
5,840 x 2,160, Medium ray tracing preset,	ULSS B	atanceu			
CyberPower Hyper Liquid Infinity X129		40fps 4	44fps		
	0	30	60	90	120
METRO EXODUS					
2,560 x 1,440, Ultra, HairWorks off, Advance	ed Phys	X off, High RT			
CyberPower Hyper Liquid Infinity X129		48fps		85fps	
	0	30	60	90	120
3,840 x 2,160, Ultra, HairWorks off, Advance	ed Phy:	X off, High RT			
CyberPower Hyper Liquid Infinity X129		32fps	50fps		
	0	30	60	90	120
	99th F	ercentile	Average		

.....

With Medium ray tracing and DLSS in Cyberpunk, the CyberPower's 99th percentile results increased to 70fps at 2,560 x 1,440 and 40fps at 4K. It's not quite powerful enough to cope with this level of demanding gaming at 4K, but it's amazing at 2,560 x 1,440. Likewise, the 99th percentile result of 48fps in Metro Exodus at 2,560 x 1,440 with High ray tracing is superb, with an average of 85fps, although the former drops right down to 32fps at 4K.

Sadly, Assassin's Creed Valhalla refused to run on this machine at the time of writing, with Intel's Scroll Lock DRM fix not able to help either. However, the Doom Eternal result shows how much power is on top for playing undemanding games at high frame rates. The CyberPower averaged 371fps



in this game at 2,560 \times 1,440, and 218 fps at 4K, so it can handle 240Hz screens fine.

CyberPower's Core i9-12900K fared well in our tests too. In our image editing test, the CyberPower's result of 78,810 was marginally ahead of the result from the Scan 3XS Vengeance Ti (see Issue 221, p34), and its video encoding score of 1,126,691 in our heavily multi-threaded Handbrake test is superb, matching the Scan and beating any current AMD AM4 CPU in all our RealBench tests. This Core i9 chip is a beast that will tackle any gaming or high-end content creation work.

There's undeniable power here, but CyberPower's rig includes ten fans and it's louder than most gaming and content-creation PCs, including the aforementioned Scan. The noise isn't ruinous, especially if you use a headset, play loud music or keep your PC beneath your desk, but this PC isn't subtle. Positively, the respective CPU and GPU delta Ts of 69°C and 52°C are good, the fan noise never varied, and the processor's single-core and multi-core peak boost speeds of 5GHz and 4.9GHz are solid.

CONCLUSION

The noise will put some people off this PC, and not everyone needs this level of water cooling or power – or a system that's this big. Scan's alternative is tempting too – it doesn't have the size or the water-cooling setup, but it's cheaper and faster in games. The CyberPower, though, is a superb choice for anyone who wants a high-end gaming and content-creation PC that looks the part thanks to its great water cooling and powerful internals.

MIKE JENNINGS

VERDICT

CyberPower's system offers great speed and water cooling inside a large, sturdy case, but it's expensive, loud and overkill for lots of users.

BUZZ LIGHTYEAR

- Fantastic gaming speed
- Excellent Intel CPU
- + Awesome custom water cooling
- Fully featured motherboard

EMPEROR ZURG

- Consistently loud
- Huge, heavy chassis
- Some tricky internal access
- Other PCs are faster in games



AMD APU GAMING PC WIRED2FIRE ULTIMA RYZEN GAMESTATION/**£669** incvat

SUPPLIER wired2fire.co.uk

ired2Fire's Ultima Ryzen Gamestation is the most ambitious system we've seen with an AMD Cezanne APU so far, because the Surrey-based firm has applied some judicious overclocking to attempt to boost the Ryzen 5 5600G's performance. The tweak is applied to the GPU's integrated graphics core, and sees its clock speed increase from 1900MHz to 2300MHz.

Elsewhere, the graphics core is based on AMD's aging Radeon RX Vega architecture, rather than RDNA, with seven Vega compute units, equating to 448 stream processors.

SPEC

CPU

3.9GHz AMD Ryzen 5 5600G Motherboard

MSI B550M Pro-VDH WiFi

Memory 16GB ADATA XPG GAMMIX D10 4000MHz DDR4

Graphics AMD Radeon RX Vega 7

Storage 1TB Crucial P2 M.2 SSD

Networking

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

Case Cougar MG120-G

Cooling

CPU: ARCTIC Freezer 34 with 1 x 120mm fan; front: 1x 140mm fan; rear: 1x 120mm fan

PSU Kolink Classic 500W

Ports

Front: 1x USB 3.2 Gen 1, 1x USB 2, 2 x audio; rear: 4 x USB 3.2 Gen 1, 2 x USB 2.0, 1x PS/2, 3 x audio

Operating system

Windows 11 Home 64-bit

Warranty

Five years labour with two years parts and collect and return

It's business as usual on the CPU side too – the 5600G has six SMT-enabled Zen 3 cores with base and boost speeds of 3.9GHz and 4.4GHz.

With no graphics memory,

AMD's APUs have to use system memory, so Wired2Fire has sensibly paired this APU with fast dual-channel memory The 16GB of ADATA GAMMIX D10 DDR4 memory has been boosted from its default frequency of 3600MHz to 4000MHz.

Elsewhere, the Wired2Fire has a 1TB Crucial P2 SSD that delivered solid read and write speeds of 2,481MB/sec and 1,909MB/sec, and a Kolink Classic PSU with 80 Plus Bronze protection. The PSU isn't modular, but its 500W power rating will support a mid-range GPU upgrade.

Not surprisingly, the Wired2Fire has a modest micro-ATX motherboard, but the MSI B550M Pro-VDH WiFi does do a decent job of covering the essentials. It has four memory slots and two M.2 connectors, one of which has a heatsink. The board has one 16x PCI-E slot for a future graphics update alongside two 1x PCI-E slots.

However, bear in mind that the 16x PCI-E slot and the top M.2 connector can't use PCI-E

A unless you upgrade the processor, and the MSI only has entry-level Realtek ALC897 audio. There's Gigabit Ethernet and 802.11ac Wi-Fi too, but no Wi-Fi 6 support. Similarly, at the rear, you get four USB 3.2 Gen 1 connectors but no faster USB ports and no Type-C ports.

The hardware sits inside a Cougar MG120–G chassis. It's small, measuring just 400mm tall and 415mm deep, and it's equipped with a tempered glass side panel and a transparent front panel. On the inside, there's a PSU shroud and plenty of cable-routing holes, and at the rear, there's a 2.5in bay and two tool-free 3.5in caddies. It's a good entry-level mini tower, but the Wired2Fire has no RGB LEDs and there's some movement in the front and roof panels.

This PC has inevitable shortcomings due to its price, but it still compares well with rivals we've recently reviewed, both of which cost £699. The Stormforce Onyx used the same CPU without overclocking, and it had slower memory and a slower, smaller SSD alongside a motherboard and case with fewer features. PC Specialist's Lotus Elite R had better networking, faster USB ports and more motherboard features, but it also had a slower, smaller SSD and a similar case.


Wired2Fire's PC has a good warranty too – a five-year labour deal with two years of parts cover, and two years of collect and return service. Neither rival offers those five years of labour service, although Stormforce does provide three years of parts coverage.

PERFORMANCE

Wired2Fire's overclocking has an impact in game tests. This PC's best results came in Rainbow Six Siege, where it played the game at 1,920 x 1,080 with Low settings at a 99th percentile minimum of 94fps and an average of 114fps. The former score is 15fps better than either rival, and the latter is 18fps ahead.

That's a significant leap, and it means that you'll get more esports gaming pace from this PC. You'll be able to play most of today's top competitive titles at decent frame rates, even if you need to drop graphics settings in some games.

The Wired2Fire played Doom Eternal at 1080p with High settings with a 99th percentile result of 30fps, which is 6fps faster than the competition, and it maintained that gap at Low settings, where it delivered a 99th percentile result of 39fps and a 59fps average. The Ultima could only manage 29fps in Dirt 5 at Low settings, so it's clearly operating at its limits in that game, but that result was still at least 3fps faster than the competition.

While Wired2Fire's system has a noticeable leg up on rivals in single-player games, you'll still struggle with most titles unless you drop the quality settings – there's no getting round the fact that you'll still need a discrete GPU if you want to get the most out of those games.

In terms of CPU performance, the Wired2Fire's image editing score of 68,452 and Handbrake result of 523,196 both fell marginally behind the Stormforce and PC Specialist rigs, and Wired2Fire's machine only proved faster in the multi-tasking test.

That still represents reasonable power for everyday computing, though, and the APU's single-threaded score is close to the scores we see from AMD's mid-range desktop

BENCHMARK RESULTS



CPUs. The 8-core Ryzen 7 5700G and 6-core Ryzen 5 5600X are faster if you want to tackle tougher multi-threaded work, but the Ryzen 5 5600G will cover most people's needs.

Happily, Wired2Fire's rig had no thermal issues either. The APU remained cool and attained its stated speeds, including the GPU overclock, and the system was virtually silent in all situations. It's a better result than the Stormforce, which produced a high-pitched whine, and it proves that Wired2Fire's ARCTIC Freezer 4 cooler does a good job.

CONCLUSION

Wired2Fire's graphics overclock delivers a solid improvement in frame rates compared with other machines based on this APU, meaning this machine will do a better job with esports games and some single-player titles.

Elsewhere, the Ultima offers good memory and storage in a compact, accessible case alongside a basic motherboard. Compare it with the competition and it's undoubtedly a better deal.

This machine's rivals are slower in games, and sometimes offer poorer storage and case options. The Wired2Fire isn't perfect – not least thanks to that motherboard – but it's the best AMD Cezanne PC we've seen so far, and it's ideal for entry-level and esports gaming if you can't afford a machine with a discrete GPU at the moment.

MIKE JENNINGS

VERDICT

Faster than rivals in games and with good storage and memory. This affordable entry-level PC can handle basic gaming, but it could do with a better motherboard.

BATTLE STATION

- + Overclocked GPU
- + Good memory and storage
- Consistently quiet operation
- + Affordable price

PETROL STATION

- Discrete GPUs are much quicker
- Basic motherboard
- No RGB lighting



REVIEWS / CUSTOM KIT

Custom kit

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

JBL TUNE 125TWS / £39.99 incvat

SUPPLIER uk.jbl.com

The JBL Tune 125 earbuds are strange beasts, not in a scary Star Trek 2 way, but they're unusual nonetheless. You don't get noise cancellation, wireless recharging, waterproofing or a supplementary app to handle configuration, but the result is at least a streamlined pairing process.

However, the interface is purely reliant on different combinations of pressing the single button on each earbud, which makes configuration a struggle. Compounding this issue is the fact that the button on each earphone covers much of the area on which you push to get them in your ears, making them easy to press by accident, resulting in a load more button tapping to reverse what you've done. That's particularly irritating when the only feedback you get from the earphones is a power on or off noise and a flashing light.

The Tune 125TWS has some neat touches, such as the case, which recharges using a USB Type-C connector and carries 24 hours of extra



charge for the earbuds. The sound quality is also acceptable – it doesn't overcome the problems with the big buttons, but it's at least good enough to not be another problem in itself.

Khaaaaaan! eeeooo Khan't

UNIGEAR HAND WARMER

£20.99 inc VAT

SUPPLIER amazon.co.uk

The Unigear is a hand warmer that doubles as a power bank, which feels like a natural pairing given the propensity of power banks to run warm anyway. The device has a squashed-egg shape, is comfortably palm-sized and sits in a soft cloth bag, which makes it even comfier to use to fend off the cold. One button on the side tells you how much charge is left, while another adjusts the heat level, which goes from

 $35^{\circ}C-55^{\circ}C$ – the temperature and remaining capacity are shown on a clearly readable digital display.

The overall capacity of the Unigear is 5,200mAh, which is enough to recharge an average smartphone a couple of times, and translates to about eight hours of toasty hands. As a power bank, however, the Unigear is limited by having only one USB Type-C port, and although it's supplied with a standard USB adaptor, it's still rather clumsy to use with most current USB cables.

Bugs – – – – – – Snugs



NEWSEEGO EXTERNAL HARD DRIVE CASE / **£8.99** incvat

SUPPLIER amazon.co.uk

It's not easy to define the Newseego External Hard Drive Case – you could call it a laptop pocket, or a pocket for a laptop, but both imply that you're putting the laptop in the pocket, but in this case, the reverse is true. The Newseego is a pocket that attaches to the back of the screen on a laptop. Ostensibly (as implied by the name), this is a good place to store an external drive, so it isn't in the way, but it also works fine for cables, pens, earbuds or any of the other small items that might otherwise need to be stored elsewhere.

It's handy for a laptop that doesn't travel far, but for a laptop that's usually folded up in a regular bag for all its kit, adding a pocket to the chassis will disrupt the shape. The pocket attaches

by a sort of gummy tape that isn't immensely strong, but won't leave a residue either. The Newseego does its job well enough for a cheap price, even if it is a bit weird.

Pocket lint

POWERA CONTROLLER / £24.99 inc VAT

SUPPLIER amazon.co.uk

A chunky Xbox-a-like gamepad, the PowerA goes by the numbers and hits its marks adroitly. It has a detachable cable, using a Micro-USB plug to connect to the pad, so a replacement can be found easily enough if necessary. The supplied cable is 3m long, which is fine for a living room situation and almost excessive for a desktop, although it also has a Velcro loop on it to keep it tidy.

There's a 3.5mm headset port in the base too, which is handy. Visually, the PowerA has an array of styles – the default black one looks neat and on brand for an Xbox, but they're all clean, rounded and as comfy you want for a standard gamepad. The shoulder buttons have an even pull to them, which is good for driving games, and the thumb sticks are equally smooth in action, while the main button cluster works exactly as you would expect.

Alongside the Home button in the middle, you also get a share button that takes screenshots when running games through the



Windows Xbox app, which is a helpful addition. The PowerA doesn't go big on illumination, there's a single white light to show it's plugged in and that's your lot, and there's also no option to adjust the amount that it rumbles, but it rumbles plenty, which is good. It's a basic controller, but for under £25, the PowerA's smart choices and great fundamental elements make it a good shout.

.....

Too much

JBLTUNE225TWS / £39.99 inc VAT

SUPPLIER uk.jbl.com

The slightly larger of the two JBL Tune earbuds on test this month, the 225TWS have an extended downwards section that makes them sturdier and more comfortable, even if the fit isn't particularly snug. They also have a superior button design to the one on the 125TWS – the interface is still controlled by a single button on each earphone, but it's shaped with a downwards-pointing extension part, so you don't end up hitting the buttons when you try to put the earphones in your ears

Sound quality is good too, although the lack of noise cancelling means you're at the mercy of whatever background noises are going on around you. The battery life is a respectable five hours too, with 20 more stored in the case, which is recharged by a USB Type-C port.

The Tune 225TWS pares back any sort of control interface almost down to nothing – the earbuds switch on when you take them out of the case and switch off when you put them back into it. The pairing process isn't complicated, and the buttons on either side handle pause/play, answering calls and activating whichever voice assistant



runs on your phone. You can run one earbud in mono mode if you want to extend battery life. The JBL Tune 225TWS makes for a better option than the 125TWS and is pretty good all round.

Tune

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

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LABS TEST / Z690 MOTHERBOARDS

Alder Lake district

LABS TEST

Antony Leather tests eight brand-new motherboards based on Intel's Z690 chipset for its 12th-gen CPUs

How we test

his month we're taking a look at some shiny new Intel LGA1700 motherboards based on Intel's Z690 chipset, covering a range of price points, so you can pick the best foundation for your choice of 12th-gen Intel CPU. Our test kit includes a Core i5-12600K CPU and either 16GB of 3466MHz Corsair Vengeance RGB Pro DDR4 RAM or 32GB of 5200MHz DDR5 memory, as Z690 boards either support DDR4 or DDR5.

We test using Windows 11 on a WD Red SN750 SSD, along with a WD Black SN850 SSD to test the speed of M.2 ports. The latter is also used to test heatsink performance – we tap into the SSD's internal temperature sensor to see how well any M.2 heatsinks perform under load, using back-to-back runs of CrystalDiskMark's entire battery of tests.

We use the latest BIOS versions for the motherboards, and use an Nvidia GeForce RTX 3070 Founders Edition graphics card for game tests. All the motherboards are tested on a Barrow Rhopilema test bench with a full custom water-cooling system, including two 240mm radiators and a Laing DDC pump to eliminate any cooling bottlenecks.

We use RightMark's Audio Analyzer software to measure the dynamic range, noise level and total harmonic distortion of the on-board audio. Other tests include our RealBench suite of benchmarks, Far Cry 6, Cinebench R23's single and multi-threaded tests, and total system power consumption at both stock and overclocked speeds. Our scores are based on a weighted calculation, which includes performance, features and value, with the overall score being the sum of those three values.

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ASROCK Z690 PG RIPTIDE / **£199** incvat

SUPPLIER scan.co.uk

f you've been put off an Alder Lake upgrade by the eye-watering prices of Z690 motherboards, then the cheapest example in this month's Labs test costs £199, which is certainly far cheaper than most examples we've seen. However, ASRock has had to cut back the Z690 PG Riptide's features significantly to hit this price.

It's a reasonable-looking board, but the Gigabyte Z690 Gaming X is certainly more attractive. The latter has a large array of M.2 heatsinks, while the ASRock board only has one. Our PCI-E 4 SSD ran noticeably cooler in the Gigabyte board too, thanks to its larger heatsinks, peaking at 53°C instead of instead of the ASRock's 60°C. The VRMs

RIPTIDE

RIP OFF

- Cheap for a Z690 board
- PCI-E 5 slot and PCI-E 4 M.2 ports
- + Good overclocker
- Above-average M.2 and VRM temperatures

No integrated

I/O shield

 Mediocre onboard audio

SPEC

Chipset Intel Z690

CPU socket Intel LGA1700

Memory support 4 slots: max 128GB DDR4 (up to 4800MHz)

Expansion slots One 16x PCI-E 5, one 16x PCI-E 3, three 1x PCI-E 3

Sound 8-channel Realtek ALC897

Networking 1x Realtek 2.5 Gigabit LAN

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

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

Dimensions (mm) 305 x 244

were cooler too, at 55°C compared to 59°C for the ASRock board.

For us, though, the biggest difference is the lack of an integrated I/O shield. You'll have to play Russian roulette with your fingers to get the Z690 PG Riptide into the back of your case, while the Gigabyte Z690 Gaming X includes an integrated shield for just a little more

money. Both boards lack Wi-Fi, but have PCI-E 4 M.2 ports and 16x PCI-E 5 slots, and are also equipped with six 4-pin fan headers, plus both 3-pin digital and standard 4-pin RGB headers.

It's another win to Gigabyte in terms of USB ports, though, with an impressive count of nine Type-A ports, trumping the ASRock board by three ports. Should you wish to use integrated graphics, you get both HDMI and DisplayPort connections on the Gigabyte Z690 Gaming X, while the Z690 PG Riptide only has the former. Both boards are equipped with their own versions of USB BIOS FlashBack, but the ASRock board has an extra advantage by including a clear-CMOS button, as well as the full complement of audio outputs.

Gigabyte's software is also a little easier to use, though, and more granular. While neither board has thermal probe inputs, the Gigabyte board does at least allow you to pick from various temperature inputs to control your case fans – not just the CPU. Audio performance was a little disappointing as well, with the ASRock using the dated Realtek ALC897 codec, resulting in a –94dBA noise level and 94dBA dynamic range.

Despite the Gigabyte board having a more elaborate 16+1+2 power phase design than the ASRock, the Z690 PG Riptide's 13 phases still coped fine with our overclocked Core



i5-12600K, achieving the usual 5GHz on the P-Cores and 4GHz on the E-Cores with a vcore of 1.36V. This saw the video encoding score rise from 759,888 to 834,121 and the Far Cry 6 minimum 99th percentile from 96fps to 104fps. The load system power draw also rose from 248W to 297W, although the CPU was still fairly easy to cool.

Conclusion

The ASRock's price of £200 still seems hefty for this board, especially given the lack of features, but it's still more than capable of dealing with an overclocked Core i9-12600K and cutting-edge M.2 SSD. If possible, though, we recommend stretching your budget to get the Gigabyte Z690 Gaming X DDR4 at this price range.

VERDICT

.

A solid effort and decent overclocker, but it lacks features compared with similarly priced boards.



ASUS ROG MAXIMUS Z690 APEX / **£570** incvat

SUPPLIER scan.co.uk

hile the Asus ROG Maximus Z690 Apex has an eye-watering price tag, it's beautifully crafted and dripping with features. The most prominent of them is an extruded aluminium heatsink spelling ROG on the bottom-right corner of the PCB.

This section forms part of a massive heatsink that, rather strangely, only cools one PCI-E4M.2 port, and there are just two of these ports on the PCB in total.

While they sport Asus' new tool-free latches, which remove the need to deal with tiny, fiddly screws, the other boards have more M.2 ports on their PCBs. Thankfully, Asus also includes a dual M.2 port expansion card with an even bigger heatsink and a PCI-E 5 M.2 port. albeit with no PCI-E 5 SSDs available yet to enable it to stretch its legs.

This card comes in addition to a DIMM.2 vertical card next to the memory slots, which houses a third pair of PCI-E 4 M.2 slots. The ports on the PCB are cooled on both sides, but the expansion card offered the lowest M.2 SSD temperature, at just 55°C during our stress test. Lavish cooling is also provided for the 105A teamed 24-phase power delivery system

SPEC

Chipset Intel Z690

CPU socket Intel LGA1700

Memory support 2 slots: max 128GB DDR5 (up to 6600MHz)

Expansion slots Two 16x PCI-E 5, one 4x PCI-E3, one 1x PCI-E3

Sound 8-channel ROG SupremeFX ALC4080

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

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

Ports 6 x SATA 6Gbps, 1 x M.2 PCI-E 5, 4 x M.2 PCI-E4, 5 x USB 3.1 Type-A, 4 x USB 3,1xUSB3.1Type-C,1xUSB3.1Type-C header, 1x LAN, 3x surround audio out

Dimensions (mm) 305 x 244

too, with a trio of large heatsinks connected using a heatpipe.

There's a generous count of nine fan headers as well, along with watercooling flow sensors and temperature sensors that can pair up with Asus' EFI or AI Suite software to control your fans using coolant temperature. The Apex is very much geared towards custom water cooling and extreme

overclocking, with voltage readout points, slow mode and LN2 switches to name just a few features, although the board has shed two memory slots in order to accommodate the extra features.

Another of our favourite features is the PCI-E latch release. This sits next to the USB Type-C header, and pressing its button will release your graphics card - that's particularly useful since the heatsinks severely limit access to the slot once it's occupied. There are plenty of USB ports on the I/O panel too, as well as 2.5 Gigabit Ethernet and 802.11ax Wi-Fi. There's no Thunderbolt 4 support, but you can at least output up to 60W from the front panel USB Type-C header by hooking up a spare 6-pin PCI-E power connector to the port on the motherboard.

Overclocking was simple, with our Core i5-12600K only needing the default loadline calibration set in addition to a vcore of 1.38V to hit 5GHz on the P-Cores and 4GHz on the E-Cores. This saw the Cinebench R23 multi-

COMMODUS

Very expensive

Some software

incompatible with Windows 11

MAXIMUS

+ Loads of ports

Good M.2 and VRM cooling

overclocking

Great for water cooling and extreme No Thunderbolt 4



threaded score rise from 17,383 to 19,349. The Apex also has excellent audio, with a dynamic range of 118dBA and noise level of -118dBA, courtesy of the ROG SupremeFX ALC4080 codec and Savitech SV3H712 amplifier.

On the downside, there are currently some compatibility problems with Asus' motherboard software and Windows 11, including Fan Xpert and its Armory Crate installer software.

Conclusion

An all-round excellent performer, equipped with a fantastically premium design and oodles of features, the Asus ROG Maximus Z690 Apex is easily the most desirable board here, even if you won't be delving into extreme overclocking. The price is undeniably hideous, but if you can afford it, you won't be disappointed.

VERDICT

.

Devastating feature set, lavish design and an outrageous price tag.

FEATURES PERFORMANCE **OVERALL SCORE** 34/35 35/35 VALUE 23/30

ASUS TUF Z690– PLUS WIFI D4 / **£260** incvat

SUPPLIER box.co.uk

hile ASRock's cut-price Z690 PG Riptide's forces you to deal with a separate I/O shield, the Asus TUF Z690-Plus WiFi D4 offers a less potentially finger-dicing PC build experience, as its £260 price tag bags you an integrated shield and quite a bit more besides.

You get 802.11ax Wi-Fi thrown into the bundle, along with an extra fan header over the ASRock (seven vs six), a better EFI and software suite, albeit with some issues with Windows 11 compatibility, plus four PCI-E 4 M.2 ports, three of which are covered with heatsinks. This Asus TUF model is a more premium-feeling, smarter-looking motherboard too, which help to justify its higher asking price over the ASRock.

There are a few issues, though, especially when compared with the cheaper Gigabyte

TOUGH SKIN

TOUGH MEAT

+ Tool-free M.2 latches – Lacks features

- Good M.2 and VRM cooling
- + Excellent EFI
- Some software currently incompatible with Windows 11
- More expensive than competition

SPEC

Chipset Intel Z690
CPU socket Intel LGA1700)
Memory support 4 slots: max 128GB DDR4 (up to 5333MHz)
Expansion slots One 16x PCI-E 5, one 16x PCI-E 3, one 4x PCI-E 3, one 1x PCI-E 3
Sound 8-channel Realtek HD Audio
Networking 1 x Intel 2.5 Gigabit LAN, 802.11ax Wi-Fi
Cooling Seven 4-pin fan headers, VRM heatsinks, M.2 heatsinks
Ports 6 x SATA 6Gbps, 4 x M.2 PCI-E 4, 2 x USB 3.1 Type-A, 4 x USB 3, 1 x USB 3.1 Type-C, 1 x USB 3.1 Type-C, 2 x USB 2, 1 x USB 3.1 Type-C header.1 x LAN. 3 x surround audio out

Dimensions (mm) 305 x 244

boards we've also put to the test this month. The Asus TUF board only has four SATA ports, which is likely to be more than enough for most people, but might be limiting if you're planning to transplant a few hard disks and 2.5in SSDs from an older PC. It has a reasonable, but average, count of six Type-AUSB ports as well, which is trumped by both Gigabyte boards on test this month.

The Asus TUF Z690-Plus WiFi D4 doesn't support USB BIOS FlashBack either, which would enable you to update the BIOS without needing a CPU in the socket – handy if you buy this board at a later date with a brandnew CPU. Gigabyte's version of this feature is included on both the aforementioned Gigabyte boards, although they lack on-board overclocking and testing tools.

On the plus side, despite having a rather small M.2 heatsink, the Asus did manage to achieve the lowest M.2 temperature on test at just 51°C, thanks to its location and possibly also the thermal interface material used. This wasn't much cooler than the Gigabyte Z690 Gaming X DDR4, but was noticeably cooler than the 60°C achieved by the Gigabyte Z690 UD AX.

It's also great to see this TUF board coming with the awesome tool-free latches on the ports that are included on Asus' more expensive boards. The VRM temperature of 53°C was also slightly lower than the Gigabyte boards. All three also performed similarly in audio performance too, with a dynamic range of 95dBA and noise level of -95dBA for the Asus board.

Overclocking our Core i5-12600K was fairly painless on this board, and like other Asus



Z690 boards we've seen, we did need to add loadline calibration to get our 5GHz E-Core and 4GHz P-Core overclock stable at 1.36V. There wasn't much between the boards in our raw performance tests, but the overclock saw the Far Cry 6 minimum 99th percentile rise from 98fps to 104fps and the system score from 292,406 to 316,908, albeit with a 33W hike in system load power consumption.

Conclusion

The Asus TUF Z690-Plus WiFi D4 is a slightly more attractive package than the ASRock board, but it doesn't really offer anything notable over the cheaper competition from Gigabyte. In fact, it has fewer features in some areas, which means it just falls short of an award this month, despite its comparatively low price.

VERDICT

No significant issues, but nothing standout or award-worthy either.



GIGABYTE Z690 GAMING X DDR4/ **£210** incvat

SUPPLIER ebuver.com

s one of several Z690 boards available that comes in both DDR4 and DDR5 flavours, the Gigabyte Z690 Gaming X gives you the option of jumping on either bandwagon, albeit with specific versions of the board supporting one memory type or the other. We've got the DDR4 version in for review here, but if you're looking to go the DDR5 route for as little cash as possible, then that version actually costs about the same amount of money.

It's a good price too, with our DDR4 model retailing for £50 less than the Asus TUF Gaming Z690-Plus WiFi D4. What's more, we'd pick this board over the pricier Asus model for a few reasons. Firstly, we love the look of its hefty gunmetal grey heatsinks, which are also both large and numerous, covering all of the board's four PCI-E 4 M.2 ports as well as the 16 CPU power phases. These did a pretty decent job of cooling the VRMs and our PCI-E 4 SSD at 55°C and 53°C respectively.

Sadly, Gigabyte had to cut corners somewhere, so there's no Wi-Fi, meaning you'll need to a USB dongle or PCI-E card if you can't use a wired connection. We have few other complaints though. This budget board includes an integrated I/O shield, as

SPEC

Chipset Intel Z690

CPU socket Intel LGA1700

Memory support 4 slots: max 128GBDDR4 (up to 5333MHz)

Expansion slots One 16x PCI-E 5, two 16x PCI-E 3

Sound 8-channel Realtek ALC1220 HD Audio

Networking 1x Realtek 2.5 Gigabit LAN

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

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

Dimensions (mm) 305 x 244

well as a generous total of nine Type-A USB ports, in addition to a USB 3.2 Type-C port, HDMI and DisplayPort outputs, and 2.5 Gigabit LAN. You don't get the full complement of audio ports, but there's the added bonus of an optical S/PDIF output in addition to input and output audio jacks. You get six SATA ports as well.

While there are no thermal probe headers, Gigabyte's EFI and software does allow you to use temperature inputs other than the CPU to control individual fans. You can also use the software in Windows 11 as well, unlike

Asus' FanXpert software, and unlike MSI's software, the Gigabyte package allows you to view your VRM temperature within Windows too. For those purchasing the board in future, you also get Gigabyte's Q-Flash Plus feature (analogous to Asus' USB BIOS FlashBack), allowing you to update the BIOS without a compatible CPU.

Performance was generally fine, and we were able to hit our usual P-Core overclock to 5GHz and E-Core clock of 4GHz with a 1.36V vcore and loadline calibration enabled. This gave it a big performance boost, with the RealBench system score rising from 280,708 to 303,098 and the Cinebench R23 multi-threaded score going from 17,424 to 19,015.

The audio performance was disappointing, given that the Gigabyte uses Realtek's ALC1220 codec, which normally performs

PLATINUM

- + Attractive design
- + Plenty of ports
- + Good EFI and software
- + Very reasonable price



strongly. On this board, however, it could only perform similarly to the ALC897 codec used on the cheaper ASRock Z690 PG Riptide.

Conclusion

Gigabyte gets a lot right with the Gigabyte Z690 Gaming X DDR4, and we have absolutely no problem recommending it or its DDR5 counterpart for a budget-conscious Z690 system. It has a good balance of ports, it looks great and it trumps the Asus TUF Gaming Z690-Plus WiFi D4 in a number of areas. It's a shame about the disappointing audio performance from what's usually a good codec, but the Z690 Gaming X is otherwise a great Z690 board for this price.

VERDICT

Good value, great-looking and good balance of features.

FOOL'S GOLDAverage number of

- fan headers No Wi-Fi
- Mediocre on-board audio



GIGABYTE Z690 UD AX / **£205** incvat

SUPPLIER ebuyer.com

hile DDR5 memory doesn't make a huge overall difference to performance, and is more expensive than DDR4 even if you can find it in stock, we can sympathise with anyone wanting to jump on that bandwagon for futureproofing. Cheaper Z690 offerings often cater for DDR4, but you don't need to spend big to get DDR5 support. In fact, the Gigabyte Z690 UD AX comes in both DDR4 and DDR5 flavours, with the latter costing only just over £200.

That's around £30 more than the DDR4 version, but around the same price as the Gigabyte Z690 Gaming X DDR4, so should you save some cash with the DDR4 version or even opt for the latter board instead? The Z690 UD AX is certainly fairly plain-looking, with none of gunmetal heatsinks found on

AND MY AXE

+ Affordable

le 🗕

- + Plenty of USB ports
- 🕂 Wi-Fi
- GET THE AXE
 - Average audio performance
- DDR4-based equivalents are cheaper
- Only one M.2 heatsink

SPEC

Chipset Intel Z690
CPU socket Intel LGA1700)
Memory support 4 slots: max 128GB DDR5 (up to 6000MHz)
Expansion slots One 16x PCI-E 5, two 16x PCI-E 3, two 1x PCI-E 3
Sound 8-channel Realtek HD Audio
Networking 1 x Intel 2.5 Gigabit LAN, 802.11ax Wi-Fi
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 USB 3.1 Type-A, 4 x USB 3, 1 x USB 3.1 Type-C, 4 x USB 2, 1 x USB 3.1 Type-C header, 1 x LAN, 3 x surround audio out

Dimensions (mm) 305 x 244

Gigabyte's other board this month. In fact, only one of its three PCI-E 4 M.2 ports is equipped with a heatsink, which did a reasonable (but not stellar) job of cooling our PCI-E 4 M.2 SSD to 60°C.

On the plus side, you do get 802.11ax Wi-Fi, which its sibling lacks, and the rear I/O panel is largely the same too, with a USB 3.2 Type-C port and

generous count of nine Type-A USB ports, along with HDMI and DisplayPort outputs. The only back panel feature it's missing is an optical S/PDIF output for the audio – Gigabyte doesn't say which codec it uses for the audio, but we suspect it's a fairly dated one, given its mediocre performance in the audio tests.

Still, you get some beefy VRM heatsinks for the 16 power phases feeding the CPU, which kept them reasonably cool at 57°C. Plus, unlike the Asus TUF Gaming Z690-Plus WiFi D4, you get the full complement of six SATA 6Gbps ports. The board also supports Gigabyte's Q-Flash Plus, which allows you to update the BIOS without a compatible CPU. This could be useful if you buy the board in future with a new LGA1700 CPU. Overclocking and testing tools are nearly non-existent, though, except for a reset switch.

There's no built-in RGB lighting either, but you do get four RGB headers for both 3-pin and 4-pin LED strips. If you want to upgrade the audio, there are two more 16x PCI-E slots and two 1x PCI-E slots, although using the latter will obstruct the lower two M.2 ports. Meanwhile, the fan header count is reasonable at six, but every manufacturer except ASRock has more this month.

Like the Gigabyte Z690 Gaming X DDR4, we had to add a little loadline calibration as



well as our usual 1.36V vcore to get our Core i5-12600K to 5GHz on its P-Cores and 4GHz on its E-Cores, but once it then saw some sizeable gains in our benchmarks.

This overclock boosted the RealBench system score from 290,193 to 319,336 and the Cinebench multi-threaded score from 17,505 to 19,101. However, load power consumption rose by over 70W too.

Conclusion

If you're looking for a cheaper way to get on the DDR5 bandwagon then this is a great route. The Gigabyte Z690 UD AX has plenty of features and it overclocks well too. Its audio performance and M.2 cooling aren't charttopping, but it gets all the essentials right for a very reasonable price.

VERDICT

A brilliant way to get onto the DDR5 bandwagon without spending a fortune, assuming you can find a memory kit.



MSIMAG Z690 TOMAHAWK WIFIDDR4/**£246** incvat

SUPPLIER box.co.uk

aving picked up an Approved award in our recent standalone review, the MSI MAG Z690 Tomahawk WiFi DDR4 is certainly one of the better-looking sub-£300 DDR4 Z690 motherboards. It trades blows with the Asus TUF Gaming Z690-Plus WiFi D4, which costs about the same, but there's added competition in this Labs test.

The Gigabyte Z690 Gaming X DDR4 has a similar feature set, with all four PCI-E 4 M.2 slots equipped with heatsinks, but for some reason, our SSD got pretty toasty on the MSI board, hitting 63°C, which was 10°C warmer than the Gigabyte board. There's no way to see the VRM temperature in MSI's software, but using our IR probe, we measured them at 56°C, which is on par with the Gigabyte board. However, the latter's reading was retrieved through software, which often outputs results a few degrees warmer than our probe.

The board looks better than Asus and ASRock's similarly priced offerings this month

DYNAMIC RANGE **DEMONIC RAGE**

- + Attractive design
- +
- Pipped in some areas by cheaper boards
- Full M.2 heatsink array
- + Excellent audio
- Software lacks polish Average M.2 cooling

SPEC

Chipset Intel Z690
CPU socket Intel LGA1700
Memory support / slots may

128GB DDR4 (up to 5200MHz)

Expansion slots One 16x PCI-E 5, two 16x PCI-E3, one 4x PCI-E3, one 1x PCI-E3

Sound 8-channel Realtek ALC4080 HD Audio

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

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

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

Dimensions (mm) 305 x 244

in our opinion, and while there's no built-in RGB lighting, you do get the usual pair of 3-pin and 4-pin RGB headers. There are no overclocking or testing tools, though, except for a row of diagnostic LEDs next to the 24-pin ATX connector, although these can be tricky to read. On the plus side, you get more SATA 6Gbps ports than the Asus board, and eight fan headers - that's more than you get on both the Asus and Gigabyte boards.

It also beats the Asus

board when it comes to Type-A USB ports on the I/O panel, but both Gigabyte boards have more here, with nine each compared to the MSI's seven. The I/O panel also sports DisplayPort and HDMI outputs, a USB BIOS FlashBack button, 2.5 Gigabit Ethernet, 802.11ax Wi-Fi antennae connectors and a full complement of audio outputs. The latter are fed using Realtek's ALC4080 codec, which performed significantly better than any other sub-£300 motherboard on test.

We're still not keen on MSI's software. though, which in contrast to its EFI, is clunky and lacks the detailed settings of the software with Asus and Gigabyte's boards. We have no complaints with the EFI, though, which remains slick, well laid-out and easy to use. With our usual vcore of 1.36V applied, we hit 5GHz across all P-Cores with our Core i5-12600K and 4GHz on the E-Cores.

This provided a healthy boost in Far Cry 6, with the 99th percentile result rising from 97fps to 105fps and the Cinebench R23 multi-threaded score increasing from 17.393 to 19,346 too. The system score was boosted from 297,332 to 314,707 as well. This wasn't without its downsides, though, with load



system power consumption rising from 242W to 301W. Meanwhile, audio performance was excellent, with a dynamic range of 110dBA and noise level of -111dBA. which were both much better than the results from Asus, ASRock and Gigabyte's cheaper boards.

Conclusion

If you need the best possible audio performance, Wi-Fi support and like the look of the MSI MAG Z690 Tomahawk WiFi DDR4, it's definitely worth considering. It overclocks well, has a good EFI and plenty of features. However, if Wi-Fi or high-guality audio isn't a necessity, Gigabyte's Z690 Gaming X DDR4 is much cheaper and just as good in most areas.

VERDICT

A well-rounded motherboard with great audio performance and Wi-Fi.



MSIMPG Z690 GAMING CARBON

SUPPLIER cclonline.com

SI's MPG Gaming Carbon range of motherboards has proved pretty popular among PC enthusiasts, with EK even teaming up with MSI to water-cool them for the Carbon EK X range of motherboards. As with many Z690 boards, though, while it looks like another solid effort on paper, the DDR5-based MPG Z690 Gaming Carbon WiFi will also set you back over £400, which isn't a small sum of money.

Thankfully, it does look fantastic, with a splash of RGB lighting on the I/O shroud and PCH heatsink, full M.2 port heatsink covers and some substantial VRM heatsinks too. You get a total of five PCI-E 4 M.2 ports as well and, iust like the MSI MEG Z690 Unify, the Gaming Carbon WiFi kept our M.2 SSD at a chilly 52°C under load, which was the second lowest M.2 temperature on test. The temperature of the VRMs was trickier to measure, as MSI's software lacks a VRM reading, but our probe measured them at 57°C, which is rather average but still miles away from any danger zone.

That price also bags you 802.11ax Wi-Fi and Realtek ALC4080, with the latter offering

SPEC
Chipset Intel Z690
CPU socket Intel LGA1700
Memory support 4 slots: max 128GB DDR5 (up to 6666MHz)
Expansion slots Two 16x PCI-E 5, one 16x PCI-E 3
Sound 8-channel Realtek ALC4080 HD Audio
Networking 1 × Intel 2.5 Gigabit LAN, 802.11ax Wi-Fi
Cooling Eight 4-pin fan headers, VRM heatsinks, M.2 heatsinks
Ports 6 x SATA 6Gbps, 5 x M.2 PCI-E 4, 5 x USB 3.1Type-A, 1 x USB 3.1Type-C, 4 x USB 2, 1 x USB

3.1Type-C header, 1x LAN, 3x surround audio out

Dimensions (mm) 305 x 244

the second best audio results on test. with a noise level of -121dBA and dynamic range of 116dBA. You get plenty of on-board features as well, including an LED POST code display and the ability to flash the BIOS without a CPU present, which could be handy if you buy this board at a later date with a future LGA1700 CPU.

Sadly, other

overclocking and testing tools are absent. although you do at least get video outputs, which can be useful for troubleshooting if you suspect your graphics card might be on the blink.

As with MSI's MEG Z690 Unify, it was a shame Thunderbolt 4 support hasn't made it to the party, but you get nine Type-A USB ports on the back, as well as a USB 3.22x2 Type-C port. The eight fan headers are welcome as well, but there are no thermal probe inputs here to allow you to control them using coolant temperature. However, you can at least alter the temperature input in the EFI to an input other than the CPU.

The software MSI provides isn't the best example on test either, and it's clunky and simplistic compared with Asus and Gigabyte's offerings. We suggest sticking to the EFI for the majority of your tweaking.

There were no issues overclocking our Core i5-12600K, and we hit the usual 5GHz P-Core and 4GHz E-Core frequencies with a vcore of 1.36V, with around 50W added to the load

CARBON

FOOTPRINT

Expensive

CARBON FIBRE

- Funky lighting
 - Great audio
 - performance
- Excellent FFI



power consumption as a result. However, the benefits were significant, with the Cinebench R23 multi-threaded score rising from 17,409 to 19,278 and the Far Cry 6 99th percentile result increasing from 99fps to 104fps.

Conclusion

Ultimately, the MSI MPG Z690 Gaming Carbon WiFi costs significantly more than MSI's MAG Z690 Tomahawk WiFi DDR4, which also has Wi-Fi and similar audio quality, but it only shaves £100 or so off the price of more droolworthy boards, such as MSI's own MEG Z690 Unify. That doesn't prevent the Z690 Gaming Carbon WiFi from being a decent motherboard, but it struggles to justify its price in this situation. If you really want a high-end board, put the extra money towards the MEG Z690 Unify.

VERDICT

A great motherboard with plenty of features and RGB lighting, although you have to pay a high price for it.



MSI MEG Z690 UNIFY / **£510** incvat

SUPPLIER scan.co.uk

f you prefer your motherboard to be free from RGB bling, and with a decidedly dark and moody theme, then you're in luck, as there's not an ounce of built-in lighting on the MEG Z690 Unify. You do get some RGB headers, including two 3-pin, one 4-pin and a single Corsair connector for hooking up that company's proprietary RGB hardware, such as waterblocks and pumps. Most of the PCB is covered in heatsinks too, including all five of its M.2 ports.

This cooling extends to both sides of the PCB, so it was no surprise to see the MEG Z690 Unify offer one of the lowest M.2 temperatures on test, with our PCI-E 4 M.2 SSD hitting 52°C. The VRMs couldn't be measured using MSI's software, but our IR probe returned a reading of 57°C, which is good, but not the coolest on test, despite the huge, heatpipe-equipped heatsinks. However, cooling is also aided by a large backplate, and cooling the 19+2 105A power phases won't be an issue with this board.

As you would expect, you get the full complement of overclocking and testing

SPEC

Chipset Intel Z690

CPU socket Intel LGA1700

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

Expansion slots Two 16x PCI-E 5, one 4x PCI-E 3

Sound 8-channel Realtek ALC4080 HD Audio

Networking 2 x Intel 2.5 Gigabit LAN, 802.11ax Wi-Fi

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

 Ports
 6 x SATA 6Gbps, 4 x M.2 PCI-E 4, 1

 x M.2 PCI-E 3, 7 x USB 3.1 Type-A, 1 x USB

 3.1 Type-C, 2 x USB 2, 1 x USB 3.1 Type-C

 header, 2 x LAN, 3 x surround audio out

Dimensions (mm) 305 x 244

tools here, including power and reset buttons. an LED POST code display, a clear-CMOS button and the ability to flash the BIOS without a CPU. You even get thermal probe inputs, which you can use to control the fan headers in the EFI. That's useful to fans of water cooling, although there's currently no way to do this in MSI's software, unlike the package with Gigabyte and Asus' similar boards.

We were a tad disappointed not to see Thunderbolt 4 support on the rear I/O panel, though, seeing as other Unify boards have supported Thunderbolt in the past, especially at this price. The accessories are also rather thin on the ground compared with those provided with the Asus ROG Maximus Z690 Apex, although the Unify does manage to cram a similar specification into the PCB, as it's not as focused on extreme overclocking as the Asus board.

The Unify also has the best audio performance on test, dual 2.5 Gigabit Ethernet ports and the I/O panel is equipped with nine Type-A USB ports, which is the joint highest on test. However, there are no video outputs.

Meanwhile, the EFI is up to MSI's usual high standards and it was easy to plumb in our usual settings to overclock our Core i5-12600K to 5GHz on its P-Cores and 4GHz on its E-Cores, although like many other

UNIFY

- + Attractive design
- + Great feature set
- + Excellent EFI



boards this month we did need to add loadline calibration too. This overclock provided a big boost to benchmarking, though, with the System score rising from 202,645 to 313,119 and the multi-threaded Cinebench score from 17,409 to 19,315.

Conclusion

A bit of a wolf in sheep's clothing, the MSI MEG Z690 Unify is a monster motherboard with a killer feature set. However, its price is just as eyebrow-raising and we were a tad perplexed by the meagre accessory and lack of Thunderbolt 4 support. It's still a fantastic board, though, and is slightly more appealing to mainstream users than the Asus ROG Maximus Z690 Apex. If you feel like splashing out, you won't be disappointed. **CPG**

VERDICT

A stunningly premium board that's dripping with features, but your wallet will need to feel very generous.



No Thunderbolt 4

Software is below par

No video outputs



Wireframe

Join us as we lift the lid on video games



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Z690 MOTHERBOARDS LABS RESULTS

GIMP IMAGE EDITING Stock speed

Asus TUF Gaming Z690-Plus WiFi D4		77,736
MSI MAG Z690 Tomahawk WiFi DDR4		77,230
Asus ROG Maximus Z690 Apex		77,147
ASRock Z690 PG Riptide		77,090
Gigabyte Z690 Gaming X DDR4		76,962
MSI MPG Z690 Gaming Carbon WiFi		76,328
MSI MEG Z690 Unify		76,129
Gigabyte Z690 UD AX		74,895
(30,000 60,0	00 90,000 120

MSI MPG Z690 Gaming Carbon WiFi	83,786
MSI MEG Z690 Unify	83,418
Gigabyte Z690 Gaming X DDR4	83,286
MSI MAG Z690 Tomahawk WiFi DDR4	83,097
Gigabyte Z690 UD AX	82,955
Asus TUF Gaming Z690-Plus WiFi D4	82,010
Asus ROG Maximus Z690 Apex	81,947
ASRock Z690 PG Riptide	81,478

HANDBRAKE H.264 VIDEO ENCODING Stock speed

MSI MAG Z690 Tomahawk WiFi DDR4					776,827	
MSI MEG Z690 Unify					765,028	
Asus ROG Maximus Z690 Apex					764,297	
ASRock Z690 PG Riptide					759,888	
Gigabyte Z690 UD AX					759,358	
Gigabyte Z690 Gaming X DDR4					758,926	
MSI MPG Z690 Gaming Carbon WiFi					758,686	
Asus TUF Gaming Z690-Plus WiFi D4					755,863	
(2	300,00	0	600,000	900,000	1,200,000

Overclocked

Gigabyte Z690 UD AX	844,522
Asus TUF Gaming Z690-Plus WiFi D4	844,403
Asus ROG Maximus Z690 Apex	844,225
MSI MAG Z690 Tomahawk WiFi DDR4	842,563
ASRock Z690 PG Riptide	834,121
MSI MPG Z690 Gaming Carbon WiFi	827,957
MSI MEG Z690 Unify	827,557
Gigabyte Z690 Gaming X DDR4	820,084

0 300,000 600,000 900,000 1,200,000

CINEBENCH R23 MULTI-THREADED

Gigabyte Z690 UD AX	17,505	
Asus TUF Gaming Z690-Plus WiFi D4	17,438	
Gigabyte Z690 Gaming X DDR4	17,424	
MSI MEG Z690 Unify	17,409	
MSI MPG Z690 Gaming Carbon WiFi	17,401	
MSI MAG Z690 Tomahawk WiFi DDR4	17,393	
Asus ROG Maximus Z690 Apex	17,383	
ASRock Z690 PG Riptide	17,323	
(0 10,000 20,000	30,000 40,000
Overclocked		
Asus ROG Maximus Z690 Apex	19,349	a
Asus ROG Maximus Z690 Apex ASRock Z690 PG Riptide	19,349	3
Asus ROG Maximus Z690 Apex ASRock Z690 PG Riptide MSI MAG Z690 Tomahawk WiFi DDR4	19,345 19,347 19,347	ı
Asus ROG Maximus Z690 Apex ASRock Z690 PG Riptide MSI MAG Z690 Tomahawk WiFi DDR4 Asus TUF Gaming Z690-Plus WiFi D4	19,345 19,347 19,346 19,325	
Asus ROG Maximus 2690 Apex ASRock 2690 PG Riptide MSI MAG 2690 Tomahawk WiFi DDR4 Asus TUF Gaming 2690-Plus WiFi D4 MSI MEG 2690 Unify	19,346 19,347 19,346 19,326 19,325 19,315) ; ;
Asus ROG Maximus Z690 Apex ASRock Z690 PG Riptide MSI MAG Z690 Tomahawk WiFi DDR4 Asus TUF Gaming Z690-Plus WiFi D4 MSI MEG Z690 Unify MSI MPG Z690 Gaming Carbon WiFi	19,344 19,347 19,347 19,326 19,325 19,315 19,278	i i
Asus ROG Maximus 2690 Apex ASRock 2690 PG Riptide MSI MAG 2690 Tomahawk WiFi DDR4 Asus TUF Gaming 2690-Plus WiFi D4 MSI MEG 2690 Unify MSI MPG 2690 Gaming Carbon WiFi Gigabyte 2690 UD AX	19,346 19,347 19,347 19,326 19,325 19,315 19,278 19,101	
Asus ROG Maximus 2690 Apex ASRock 2690 PG Riptide MSI MAG 2690 Tomahawk WiFi DDR4 Asus TUF Gaming 2690-Plus WiFi D4 MSI MEG 2690 Unify MSI MPG 2690 Gaming Carbon WiFi Gigabyte 2690 Gaming X DDR4	19,346 19,347 19,347 19,325 19,315 19,278 19,101 19,015	

HEAVY MULTI-TASKING

MSI MPG Z690 Gaming Carbon WiFi				307,257
Asus TUF Gaming Z690-Plus WiFi D4				307,093
MSI MAG Z690 Tomahawk WiFi DDR4				305,424
MSI MEG Z690 Unify				299,577
Asus ROG Maximus Z690 Apex				298,334
ASRock Z690 PG Riptide				296,246
Gigabyte Z690 UD AX				292,735
Gigabyte Z690 Gaming X DDR4				289,946

100.000 200.000 300.000 400.000

Overeidened	
Gigabyte Z690 UD AX	316,740
MSI MPG Z690 Gaming Carbon WiFi	312,310
MSI MEG Z690 Unify	311,653
Asus ROG Maximus Z690 Apex	311,613
Gigabyte Z690 Gaming X DDR4	309,024
ISI MAG Z690 Tomahawk WiFi DDR4	303,321
Asus TUF Gaming Z690-Plus WiFi D4	301,665
ASRock Z690 PG Riptide	298,553

100.000 200.000 300.000 400.000

SYSTEM SCORE Stock speed

Overclocked

MSI

Ası

1SI MAG Z690 Tomahawk WiFi DDR4	307,257
MSI MPG Z690 Gaming Carbon WiFi	307,093
MSI MEG Z690 Unify	305,424
Asus TUF Gaming Z690-Plus WiFi D4	299,577
Asus ROG Maximus Z690 Apex	298,334
ASRock Z690 PG Riptide	296,246
Gigabyte Z690 UD AX	292,735
Gigabyte Z690 Gaming X DDR4	289,946

100,000 200,000 300,000 400,000

Gigabyte Z690 UD AX	316,740
Asus ROG Maximus Z690 Apex	312,310
MSI MAG Z690 Tomahawk WiFi DDR4	311,653
Asus TUF Gaming Z690-Plus WiFi D4	311,613
MSI MPG Z690 Gaming Carbon WiFi	309,024
MSI MEG Z690 Unify	303,321
ASRock Z690 PG Riptide	301,665
Gigabyte Z690 Gaming X DDR4	298,553

100,000 200,000 300,000 400,000

CINEBENCH R23 SINGLE-THREADED Stock speed

MSI MPG Z690 Gaming Carbon WiFi		1,901
MSI MAG Z690 Tomahawk WiFi DDR4		1,899
MSI MEG Z690 Unify		1,897
ASRock Z690 PG Riptide		1,892
Asus ROG Maximus Z690 Apex		,892
Gigabyte Z690 Gaming X DDR4	1	,890
Asus TUF Gaming Z690-Plus WiFi D4		,888
Gigabyte Z690 UD AX	1	,884
	0 1,000 2,00	3.000 4.000
Overclocked		
Overclocked Asus ROG Maximus Z690 Apex		1,935
Overclocked Asus ROG Maximus Z690 Apex Gigabyte Z690 Gaming X DDR4		1,935 1,935
Overclocked Asus ROG Maximus Z690 Apex Gigabyte Z690 Gaming X DDR4 MSI MEG Z690 Unify		1,935 1,935 1,935
Overclocked Asus ROC Maximus Z690 Apex Gigabyte Z690 Gaming X DDR4 MSI MEG Z690 Unify Asus TUF Gaming Z690-Plus WiFi D4		1,935 1,935 1,935 1,934
Overclocked Asus ROC Maximus Z690 Apex Gigabyte Z690 Gaming X DDR4 MSI MEG Z690 Unify Asus TUF Gaming Z690-Plus WiFi D4 MSI MPG Z690 Gaming Carbon WiFi		1,935 1,935 1,935 1,934 1,931
Overclocked Asus ROC Maximus Z690 Apex Gigabyte Z690 Gaming X DDR4 MSI MEG Z690 Unify Asus TUF Gaming Z690-Plus WiFi D4 MSI MPG Z690 Gaming Carbon WiFi ASRock Z690 PG Riptide		1,935 1,935 1,935 1,934 1,934 1,931 1,929
Overclocked Asus ROC Maximus Z690 Apex Gigabyte Z690 Gaming X DDR4 MSI MEG Z690 Unify Asus TUF Gaming Z690-Plus WiFi D4 MSI MPG Z690 Gaming Carbon WiFi ASRock Z690 PG Riptide Gigabyte Z690 UD AX		1,935 1,935 1,935 1,934 1,934 1,931 1,929
Overclocked Asus ROC Maximus Z690 Apex Gigabyte Z690 Gaming X DDR4 MSI MEG Z690 Unify Asus TUF Gaming Z690-Plus WiFi D4 MSI MPG Z690 Gaming Carbon WiFi ASRock Z690 PG Riptide Gigabyte Z690 UD AX MSI MAG Z690 Tomahawk WiFi DDR4		1,935 1,935 1,935 1,934 1,934 1,931 1,929 1,929

Stock speed

nahawk WiFi DDR4				83,097	
abyte Z690 UD AX				82,955	
Z690-Plus WiFi D4				82,010	
aximus Z690 Apex				81,947	
ck Z690 PG Riptide				81,478	
(0	30,000	60,000	90,000	120,000

Z690 MOTHERBOARDS LABS RESULTS



M.2 SEQUENTIAL READ PERFORMANCE (MB/SEC) CrystalDiskMark 32-queue-depth

Gigabyte Z690 UD AX								6,993
MSI MPG Z690 Gaming Carbon WiFi								6,986
Asus TUF Gaming Z690-Plus WiFi D4							e	5,984
Asus ROG Maximus Z690 Apex							e	6,974
MSI MAG Z690 Tomahawk WiFi DDR4							е	6,971
Gigabyte Z690 Gaming X DDR4							6	6,957
ASRock Z690 PG Riptide							6	6,956
MSI MEG Z690 Unify							6	6,952

2,000 4,000 6,000 8,000

M.2 SEQUENTIAL WRITE PERFORMANCE (MB/SEC)

CrystalDiskMark 32-queue-depth

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Gigabyte Z690 UD AX				5,273	
MSI MAG Z690 Tomahawk WiFi DDR4				5,255	
Asus TUF Gaming Z690-Plus WiFi D4				5,249	
Asus ROG Maximus Z690 Apex				5,224	
ASRock Z690 PG Riptide				5,223	
MSI MPG Z690 Gaming Carbon WiFi				5,223	
MSI MEG Z690 Unify				5,214	
Gigabyte Z690 Gaming X DDR4				5,208	
()	2,000	4,000	6,000	8,000

LOWEST M.2 TEMPERATURE (°C)



AUDIO NOISE LEVEL (DBA) RightMark Audio Analyzer, 24-bit/192kHz



AUDIO DYNAMIC RANGE (DBA)



AUDIO TOTAL HARMONIC DISTORTION (PER CENT)

			Laura da b	
	0 0.0020 0	0.0040 0.0080	0.001	0.00
digus yre 2000 00 mr			0.0000	
Gigabyte 7690 LID AX			0.0095	
Gigabyte Z690 Gaming X DDR4			0.0094	
MSI MEG Z690 Unify		0.0047		
ASRock Z690 PG Riptide		0.0046		
MSI MPG Z690 Gaming Carbon WiFi		0.0043		
Asus TUF Gaming Z690-Plus WiFi D4	0.0025			
	0.0010			
MSI MAG 7690 Tomahawk WiFi DDPA	0.0019			
Asus ROG Maximus Z690 Apex	0.0014			
3				
RightMark Audio Analyzer, 24–0	DIT/ 192KHZ			

TOTAL SYSTEM POWER CONSUMPTION (W)

Idle		,		
Gigabyte Z690 UD AX	93	116		
MSI MPG Z690 Gaming Carbon WiFi	100	123		
MSI MAG Z690 Tomahawk WiFi DDR4	103	118		
Asus TUF Gaming Z690-Plus WiFi D4	108	116		
Asus ROG Maximus Z690 Apex	110	127		
MSI MEG Z690 Unify	115	122		
Gigabyte Z690 Gaming X DDR4	111	118		
ASRock Z690 PG Riptide	112	125		
(D 100		300	60
		_	Lower is	better
	Stock speed	Over	clocked	
Load				
Gigabyte Z690 UD AX		231	308	
MSI MPG Z690 Gaming Carbon WiFi		237	288	
MSI MAG Z690 Tomahawk WiFi DDR4		242	301	
Asus TUF Gaming Z690-Plus WiFi D4		0.00		
Acus ROC Maximus 7600 Apox		242	281	
ASUS ROO Maximus 2090 Apex		242	281 284	
MSI MEG Z690 Unify		242 246 246	281 284 302	
MSI MEG Z690 Unify Gigabyte Z690 Gaming X DDR4		242 246 246 248	281 284 302 310	
MSI MEG Z690 Unify Gigabyte Z690 Gaming X DDR4 ASRock Z690 PG Riptide		242 246 246 248 248	281 284 302 310 297	
MSI MEG Z690 Unify Gigabyte Z690 Gaming X DDR4 ASRock Z690 PG Riptide) 100	242 246 246 248 248	281 284 302 310 297 300	60
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LABS TEST

Air to the throne

Andy Makin puts seven of the latest airflow-focused ATX cases to the test, with prices between \pounds 90 and \pounds 118 inc VAT

How we test

o test the performance of cases, we use real, overclocked hardware to provide a realistic and repeatable stress test. We've updated our case test rig to take advantage of the latest and more demanding hardware, so we're revisiting some of our previously reviewed cases. Our test platform consists of an AMD Ryzen 7 5800X overclocked to 4.4GHz on all cores using a vcore of 1.25V. This is coupled with a SilverStone AR-03 CPU cooler with its fan fixed to 60 per cent speed.

Our other main heat output is a PNY RTX 3070 XLR8 graphics card that also has its fan fixed to 50 per cent speed. The rest of the system consists of a Gigabyte X570 Aorus Pro motherboard and Corsair RM850x power supply. We also use up to four 120mm be quiet! Light Wings 1700rpm fans, where needed.

We use the smallfft test in Prime95 with AVX disabled to load the CPU to 100 per cent (**mersenneforum.org**) and the Unigine Superposition stress test (1080p, high settings, full-screen) to load the graphics card (**unigine.com**). We leave these tests running for 15 minutes to fully warm up the case, then average temperature readings are taken over the next five minutes. We record the CPU and GPU temperatures using hwinfo64 (**hwinfo. com**) and the ambient temperature is recorded using an external calibrated thermometer. We subtract the ambient from the component temperature to give a delta T reading, which we can use to test in normal conditions across several days and varying temperatures.

Initial testing is done with only the fans included with the case. We also test with one, then two additional fans added to those cases that can accommodate them. This gives cases that don't include fans a fighting chance in our tests and provides a meaningful picture of real-world performance. For cases that include fans it also shows whether it's worth adding extra fans.

Where fan controllers are included with a case, we test at the highest and lowest fan speeds to gauge the impact of different fan speeds on cooling. If no controller is provided, the case fans are run at maximum speed. All cases are also tested for cooling performance at a noise level of 35dB, with the CPU and GPU at their fixed speeds and the case fans slowed down until the desired volume is reached.

We score each case using weighted calculations for their cooling, design, features and value, to give an overall score.

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BE QUIET! PURE BASE 500DX / **£97** incvat

SUPPLIER overclockers.co.uk

hen we first tested the 500DX back in Issue 202, we were impressed by its styling, features and performance. Armed with our new much more demanding test rig, though, does it still hold up? Well, we're still fans of the design, especially when it comes to this white version with orange lighting.

There are three LED strips, with two running down the front with an opaque acrylic panel diffusing the light. The LED strips are connected through a 'pin-to-pad' mechanism, so the front panel isn't caught up on cables. The third strip is in the main chamber, casting light across all the components below. The lights can be controlled by the on-board controller, or via a standard 3-pin SV ARGB header. A black panel at the top houses one Type-A and one Type-C USB port to the left of a large trapezoidal power button, with separate audio jacks and a button to control the RGB LED strips to the right.

The front fan mount is recessed into the case and isn't connected at the top and bottom, so it isn't particularly rigid, but this could work in your favour if you're trying to fit a radiator that's

SPEC

Dimensions (mm) 232 x 450 x 463 (W x D x H) Material Steel, plastic, glass Available colours Black, white Weight 8.49kg

Front panel Power, 1x USB 3.2 Gen1, 1x USB 3.2 Gen2 Type-C, 1x headphone out, 1x mic in

Drive bays 5×2.5 in, 2×3.5 in

Form factor(s) ATX, micro-ATX, mini-ITX

Cooling 2 x 120/140mm front fan mounts (1 x 140mm fan included), 1 x 120/140mm rear fan mount (140mm fan included), 1 x 120/140mm roof fan mount (140mm included)

CPU cooler clearance 190mm

Maximum graphics card length 369mm

slightly thicker than normal. It's just tall enough to take a 360mm radiator, but the roof mount is only certified for a 120/140mm model. Meanwhile, the rear mount takes both 120mm and 140mm fans and radiators.

The inside is quite cramped though. You'll likely need to remove both the rear and roof fans when installing the motherboard. With the cable cover sitting proud and the flat rear panel pushing the rear fan mount forwards, there's little room to manoeuvre.

The cable cover also incorporates two 2.5in drive mounts, which are orientated so that all the SATA cables go through a hole in the middle of the panel, which is then hidden by a plastic cover. The mount works well, but the cable cover is tight, with just a 20.5mm gap – you'll need to use flat ribbon cables.

Meanwhile, the power supply attaches to a bracket outside the case, with the PSU then sliding into place from the rear. It's a slightly awkward procedure, especially as the bracket didn't quite match up with the case on our sample, requiring the PSU screws to be loosened to wiggle it all into place.

Once all our gear was installed, cable management was a breeze. Four Velcro straps down the centre secure most wires in place, with ample tie points elsewhere. There are clever touches too, such as cable tie points at 90 degrees to each other to secure the EPS cable to the bottom of the motherboard tray.

D GENERATION X

- Stunning in white, stealthy in black
- Attractive integration of RGB
- + Good build quality



- noise performance140mm fans struggle
 - to overcome mesh
- Cramped

Given be quiet!'s prowess in low-noise cooling, it was surprising to see the 500DX near the bottom of the 35dB charts. Even with the fans set to 100 per cent speed, it didn't perform well, being 4°C off the pace on CPU temperatures and 5°C on GPU temperatures, all while being the third loudest case on test. However, adding a fourth fan in the lower front mount improved GPU temperatures by 8°C.

bequiet

Conclusion

The 500DX disappoints in one area it should be dominant – noise. With our newer, more demanding test rig, once under load, this case is loud. Its interior is also a little cramped, but it still deserves praise for its good looks and easy cable management.

VERDICT

A stylish if slightly cramped case, although it's let down by high noise levels under load.



CORSAIR 4000D AIRFLOW / **£90** incvat

SUPPLIER corsair.com

e were previously a smidge underwhelmed by the 4000D Airflow (see Issue 207) thanks to its modest design and features. However, its true capabilities have come to light with our new test rig inside it. First, though, what's immediately striking about this case is the colour matching between the plastics and painted steel, which is exceptional. In our white review sample, the white with grey accents and the odd little flourish of Corsair yellow go so well together, and there are little details all over the case that make it feel a cut above the competition.

Less class-leading is the front panel, with just single Type-A and Type-C USB ports, and a combined audio jack, with no adaptor provided to split the latter. The power button has a satisfying resistance to it though.

Meanwhile, the glass side panel is secured with a combination of push pins and thumbscrews on the rear edge, to give it a clean look. The rear panel feels a little flimsy, though, as it doesn't have much in the way of reinforcement. The motherboard tray has a fair amount of wobble too, owing to the enormous CPU socket and cable cutouts.

The Corsair's cable cover looks good as well, but there are some niggles here. The gap between the motherboard tray and cover is tight, and requires the 24-pin cable to bend around on itself in a very short distance. It's fine with flat ribbon cables, but the bundled cables on Corsair's own PSUs struggle. It can be moved forwards by 20mm for more room, but this creates a more visible gap a the back.

PIRATE SHIP

+ Looks great

- + Quiet stock fans
- Great cooling performance

PEDALO

- PSU cables obstructed by cable channels
- Tight cable cover gap
 - Drive cage needs refinement

The pre-fitted cables are very neatly managed, but the plastic trays to which they're attached with Velcro aren't so good at accommodating the rest of the system's cables, instead just getting in the way. Thankfully, there are plenty of other cable tie points located all over the motherboard tray.

One neat design touch is at the top of the motherboard tray. The cable cutouts start in the motherboard tray, but continue when the sheet bends backwards, providing ample room for the EPS and fan cables.

There are also two 2.5in drive sleds mounted on the back of the motherboard tray, which can alternatively be mounted on top of the PSU shroud. Under the shroud is a cage that will take two 2.5in or 3.5in drives. The plastic sleds in the drive cage are quite loose, though, and have no vibration dampening, causing quite a racket with spinning storage media (as we found in our feature on p80).

SPEC

Dimensions (mm) 230 x 453 x 466 (W x D x H)

Material Steel, plastic, glass

Available colours Black, white

Weight 7.85 kg

Front panel Power, reset, 1x USB 3, 1x USB 3.1 Type-C, 1x combined audio jack

Drive bays 2x 2.5 in, 2x 2.5 / 3.5 in

Form factor(s) E-ATX (up to 277mm) ATX, micro-ATX, mini-ITX

Cooling 3 x 120 / 2 x140mm front fan mounts (1 x 120mm fan included), 1 x 120mm rear fan mount (120mm fan included), 2 x 120/140mm roof fan mount

CPU cooler clearance 170mm

Maximum graphics card length 360mm

The 4000D Airflow is one of the more water-cooling-friendly cases we've tested too, taking up to a 360mm radiator in the front and a 280mm one in the roof. It also features a built-in vertical GPU mount, but don't use it with an air-cooled card, as there's no room for the fans to breathe.

The two AirGuide fans included with this case do a great job cooling our new rig at low noise levels, being quiet enough to run at nearly full speed for the 35dB test, coming first overall in that test and being the quietest at full speed at 35.9dB.

Conclusion

The case that started Corsair back on a fine run of form is still one to beat. It has the looks, performance and build quality to match any competitor in its price range. It's not packed with dazzling features, but it's a solid workhorse of a case that's relatively quiet too.

VERDICT

Stylish, quiet and with excellent cooling. What more do you want?



KOLINK UNITY CODE X / **£108** incvat

SUPPLIER overclockers.co.uk

ou only need to take a quick look at the Kolink Unity Code X to see that it's modelling itself as a cheaper alternative to the Lian Li O11 Dynamic. However, at £108, it's not that cheap compared to the O11's £130 price. The Kolink does include a decent vertical GPU mount though. It's hefty with very little flex to it, and the mounting for the riser has two long standoffs in inch-long slots, accounting for any riser you care to use.

On a surface level, this case does look the part too, with its completely glass front and side panels meeting in a pillarless corner. Its twin-chamber design that has the motherboard and graphics card on show, and the PSU and drives mounted on the backside of the motherboard tray, also makes for an inherently tidy-looking system.

However, the fit and finish is rough and the design overlooks or skimps on many little details. The backs of the expansion slot covers are rough (watch your fingers), while the fan vents too have little peaks all over them. There's also very little actual

SPEC

Dimensions (mm) 280 x 440 x 427 (W x D x H)

Material Steel, plastic, glass

Available colours Black

Weight 7.4kg

Front panel Power, 1 x USB 2, 1 x USB 3, 1 x headphone jack, 1 x mic jack, RGB controller button

Drive bays 3 x 2.5in, 2 x 3.5in

Form factor(s) ATX, micro-ATX, mini-ITX

Cooling 1 x 120mm rear fan mount (120mm fan included), 3 x 120mm floor fan mount, 3 x 120mm side fan mount, 3 x 120mm roof fan mount

CPU cooler clearance 165mm

Maximum graphics card length 400mm



ventilation. Two of the panels are made from solid glass, and the other ventilated panels use oblong cuts that are 20 x 3mm in size, with a 4.5mm gap on the long side and 5.5mm between the end of one and the start of the next one – the panels are mostly solid. You only get one fan included too.

Meanwhile, the front has a plastic cover section with an RGB LED strip down the righthand side. It looks okay, but again it lacks the finesse of alternatives. What's more, when we took it out of the box, one of the connections had come loose.

There's also a vertical bar in the back for mounting one 2.5in and two 3.5in drives, but if you do mount a 3.5in drive, its connectors will obstruct the side fan mount, so you can't then mount fans or a slim radiator in the back. The bar can be moved rearwards, but then you can't use the drive mount there, as the PSU gets in the way. You also can't mount the PSU before attaching the drive mount.

You do get ample spare space above the PSU for general cable stuffing and hiding away extras such as fan controllers, but there's not much in the way of cable-routing

UNITY

- Sturdy vertical
 GPU mount
- + Pleasant power button
- + Goodlooks

FLASH PLAYERPSU cables obstructed

- by cable channels
- Poor stock airflow
- Bizarre design choices

features, such as channels or cable ties. What's more, access to the top and bottom of the motherboard from the front is poor. There's a small hole immediately above the EPS plug, but not much else. At the bottom, it's even worse – the only access comes from a hole in a PSU support cutout.

The biggest problem with this case, though, is airflow. Our CPU failed to pass successfully through a 20-minute Prime95 run without getting a fatal error until three fans were added – and only just. You won't want to run this case in its stock configuration.

Conclusion

The inclusion of only one fan limits this case's cooling, but even with several more, it's not a great case for air cooling. It should fare better with a full custom loop, and it's a good-looking case if you like the style of the O11 Dynamic that it mimics, but the price difference isn't big enough.

VERDICT

If you want a Lian Li O11 Dynamic, buy a Lian Li O11 Dynamic.



LIAN LI LANCOOL II MESH RGB / **£97** incvat

SUPPLIER overclockers.co.uk

he Lancool II Mesh looks like the offspring of the P400A and H510, with its angled nose and split side panels. It looks massive among the other cases on test. That's not because it's particularly big by usual standards – it's just that the size of mid-tower cases has generally shrunk elsewhere since the demise of the 5.25in bay.

The Lancool has glass panels on both sides, with the lower quarter being a separate steel panel, and the front is a ventilated panel. To open the glass panels, you have to open the lower ones first. With all the doors open, it looks a bit like a Lamborghini with its 'scissor doors' open, which is cool, but having to open the lower section every time you want to access the interior gets tiresome.

While the glass doors can be lifted off their hinges, the metal panels are permanently attached to their hinges, so the only way to removed them is by unscrewing the hinges from the case. That's a shame, as they do get in the way of your hands during the process of building a PC.

Behind the rear glass panel sit two steel cable covers. It's a little odd to put glass back there, where most of the gear behind it will be covered up. You still get a view of the two 2.5in drive sleds behind the motherboard, though, so it's not just cables and a motherboard tray. Plenty of cable tie points, Velcro straps and cable ties are also included. With 25mm of clearance, cable management should be a doddle, but that's sadly not quite the case.

DON'T MESH WITH THIS

.

- + Very well built
- Lots of features and expandability
- + Good performance

A BIT MESHY

- Rear cable covers only hinder management
- Side panels can't be tightly secured
- Stock fans are loud and whiny

The two covers demand that all cables are strapped down tightly in exactly the right spots, or they bulge outwards a little and the glass door won't close. As the doors are only held on with magnets, they offer no assistance when cramming gear into the case.

The Lancool does have an extensive drive bay collection, though, with 6 x 2.5 in or 3 x 2.5/3.5 in bays. The drive cage is particularly good, with solid trays and the option of a hot swap board if you so desire.

There's also a mounting plate behind the CPU socket to which you can attach fan controllers, although there's not much depth on offer. The Corsair iCue Commander Pro we used barely fitted. If a cable strayed in front or behind it, the cover wouldn't shut properly.

Meanwhile, the front fan mount is removable, with four different depths available to suit different radiator thicknesses and fan arrangements. The front supports up to 360mm radiators and the roof can take a 240mm model. In the roof there are two sets of fan mounts – one central and the other offset to give more radiator clearance. On top of the PSU shroud there are also two mounting plates that can be used for SSDs, or removed entirely to mount two 120mm fans.

The LEDs in the stock fans are pretty and bright, but the fans themselves are loud, and the noise has an annoyingly high pitch that's difficult to ignore. While it did well in the 35dB test, coming third overall, it came dead last at stock settings, hitting 40.3dB.

Conclusion

The Lancool II Mesh is built like a tank and will make a killer build, but its cable management requires effort and patience, and its fans are rather loud too.



SPEC

Dimensions (mm) 229 x 478 x 494 (W x D x H)

Material Steel, plastic, glass

Available colours Black, white, silver

Weight 12kg

Front panel Power, 2 x LED Control buttons, 2 x USB 3, 1 x USB 3.2 Type-C (optional), 1 x combined audio jack

Drive bays 6 x 2.5in, 3 x 2.5/3.5in

Form factor(s) E-ATX (width under 280mm) ATX, micro-ATX, mini-ITX

Cooling 3 x 120 or 2 x 140mm front fan mounts (3 x 120mm RGB fans included), 1 x 120mm rear fan mount, 2 x 120/140mm roof fan mount, 2 x 120mm PSU shroud mount

CPU cooler clearance 176mm

Maximum graphics card length 384mm

VERDICT

A very capable case, but its fans are loud and cable management can be fiddly.



NZXTH510 FLOW / £90 incvat

SUPPLIER scan.co.uk

Ithough we only looked at the H510 Flow last issue, our new test setup warrants an immediate reassessment to see if it still holds up. Ever popular thanks to its swish styling, the H510 is back with a ventilated front panel to give its airflow a boost. The new panel's ventilation comes in large round holes in a steel panel, with a fine plastic mesh immediately behind.

It should provide plenty of airflow and it doesn't dull the looks of the H510. The plastic-framed mesh can also be removed for cleaning. The glass side panel sits with its lower edge inside the lower quarter panel, with two push pins along the top edge and a thumbscrew at the rear to keep it firmly in place. This allows the glass to be uninterrupted and sit perfectly flush.

The H510 Flow is very compact, but it still has a fair amount of storage space, with mounts for up to three 2.5in drives and three 3.5in drives, although not at the same time. However, that compactness adversely affects cable management, with the EPS cables being very awkward to get up and over the motherboard tray. The rear plastic cable guides can also get in the way, and while the

SPEC

Dimensions (mm) $210 \times 428 \times 460$ (W x D x H)

Material Steel, plastic, glass

Available colours Black, white

Weight 6.6kg

Front panel Power, 1x USB 3.2, 1x USB 3.2 Type-C, 1x combined audio jack

Drive bays $2 \times 2.5/3.5$ in, 2×2.5 in

Form factor(s) ATX, micro-ATX, mini-ITX

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

CPU cooler clearance 165mm

Maximum graphics card length 369mm

24-pin cable gets its own plastic channel with Velcro straps, it's a tight squeeze with the thickly bunched cables of many PSUs. Other cable

management is a bit sparse. You can make a neat job of it, but when you start adding SATA cables and braided

extensions, it gets cramped. You end up bunching the cables at the bottom of the cable bar, and the side panel needs a firm push inwards as you close it. Thankfully, a hole in the PSU shroud for PCI-E power cables means fewer cables going behind the motherboard tray.

That cable bar has become a signature or NZXT, and its interpretation of the idea is a good one. Above the top PCI-E slot, the bar expands outwards to give more space for bulky 24-pin cables, and also incorporates mounts for custom loop reservoirs. It's a shame there's not room for much else when it comes to water-cooling gear, though, with it only accommodating 280mm front and 120mm rear radiators.

Performance out of the box is excellent, with the NZXT registering the lowest stock GPU temperatures on test by nearly 3°C. It's no slouch on the CPU either. At maximum fan speed, the NZXT produced the third best delta T on test of 68.9°C, and the third lowest volume (36.5dB).

With the stock front fan installed in the lower of the two fan slots, it favours GPU

I'LL BE FANNED

- + Good stock cooling
- + Timeless clean design
- + Best implementation of cable bar
- I'LL BE DAMNED
 Limited water-cooling
- capability
- Cable channels hinder rather than help
- Cramped in places

cooling, while adding a second front fan can bring CPU temperatures down to 63.8°C. However, this had an adverse effect on our GPU, with its core temperature increasing by 5°C. With a single extra fan, it's best placed in the roof to aid exhausting the hot air, with the CPU still dropping a few degrees but without sacrificing GPU temperatures. Putting additional fans in both slots again hurts the GPU temperature.

Conclusion

With the H510 Flow, NZXT has taken a proven popular design and added a generous amount of airflow. It's well built, with beautifully flush panels on all sides, but cable management can be awkward and cramped. This isn't helped by the bulky plastic cable channels, but you can get a good result with a little planning and perseverance.

VERDICT

One of the best-looking cases is also now one of the best cases for air cooling.



PHANTEKS ECLIPSE P400A DRGB/**£93** incvat

SUPPLIER overclockers.co.uk

hanteks has set up the P400A DRGB with a mesh front panel and no secondary filter, plus a trio of 120mm RGB fans mounted behind the front fan rails, giving them plenty of room to breathe, along with space for a 360mm radiator. The case includes a controller for the RGB fans, but they can also be hooked up to a motherboard or other RGB controller.

On the right side, under the lip at the top of the case, you'll find the reset button, with subtle markings, so you know where it's located without being too obvious. There's also a central power button on the top surface, with two USB 3.2 Gen 1 ports and separate audio jacks on the left edge of the case. As all the front I/O connections are attached to the top panel, it stays put when you remove the front panel, which is a welcome touch.

The glass window is secured with a thumbscrew in each corner, with the tell-tale holes in the side rails showing it to be a case that's been converted for a glass panel. The rubber grommets that sit within the holes in the glass don't do a great job of keeping it

SPEC

Dimensions (mm) 210 x 470 x 465 (W x D x H)

Material Steel, plastic, glass

Available colours Black, white

Weight 7kg

Front panel Power, reset, 2 x LED control buttons, 2 x USB 3.2, 1 x stereo jack, 1 x mic jack

Drive bays 2×2.5 in, $2 \times 2.5/3.5$ in (plus optional four more)

Form factor(s) E-ATX (up to 272 mm wide), ATX, micro-ATX, mini-ITX

Cooling 3 x 120 or 2 x140mm front fan mounts $(3 \times 120 \text{ mm fan included}), 2 \times 120/140 \text{ mm roof}$ fan mounts, 1 x 120mm rear fan mount (fans not included)

CPU cooler clearance 160mm

Maximum graphics card length 420mm

secure until screwed shut though. The glass panel also doesn't sit very flush, with the front edge jutting out beyond the front panel. The case feels quite flimsy in places too, and our callipers reveal the steel to be just 0.7mm thick, and that's with a decent layer of paint.

The 3.5 in hard drive cage under the PSU shroud has two tool-less sleds with vibration dampening, and the 2.5 in sleds behind the motherboard are also mounted on rubber grommets. Four additional trays that attach to the front of the motherboard tray can be purchased separately.

If you want a 360mm radiator up front, with both the radiator and its fans behind the fan rails, it will mean sacrificing the hard drive cage. It can't take a radiator in the roof due to the fan mount's central location either. CPU cooler height is also a little low at 160mm, but it can house 420mm graphics cards.

Sadly, cable management is severely lacking in the P400, with just a central column of cable tie points with three Velcro straps, forcing you to put all your cables into one large awkward bunch down the side of the motherboard. In a way, it makes it easier, as all the cables come to the middle where they're strapped down, but it's not very pretty and it can result in the side panel bulging.

Not much care has been taken with the fan locations either, with one fan crushing another fan's PWM cable so much that it didn't spin upon first booting up. Even when released and working, the fan cables are left to dangle.

FULL MOON

- + Good cooling
- Potential large hard drive capacity
- Included RGB controller



The P400A DRGB is a capacious case when it comes to storage and its cooling is decent too. However, it has some shortcomings in the cable management department and is a little too basic in some other areas.

VERDICT

COOLING

26/30

DESIGN

A decent performer if you don't mind a little noise, but it lacks finesse, especially when it comes to cable management.

FEATURES

15/20

VALUE

OVERALL SCORE

TOTAL ECLIPSEA touch loud at full tilt

- Very basic cable management
- Fit and finish wanting



Despite the shortcomings in layout, though, the case performs well enough, topping the CPU chart and sitting in the middle for GPU temperatures, although it's quite loud at maximum speed, hitting 39dB. It's not an unpleasant noise – it's just the sound of rushing air. In our noise-normalised 35dB test, the P400A's cooling performance sits in fourth place. Additional fans have minimal impact on temperatures.

60

THERMALTAKE DIVIDER 300 TG AIR / **£110** incvat

SUPPLIER scan.co.uk

he Divider 300 looks like a stylistic head scratcher at first, thanks to its angled side panel. However, once it's set up, you realise the line of sight from where you'd usually be ogling your expensive new hardware is through that clear front corner. It's odd, but a bit of variety is very much welcome in a sea of similar squares.

The triangular side panel comprises two separate pieces. They can be removed independently, although it's recommended that you remove the steel first, as the glass has a tendency to spring off. The steel section also slopes inwards, as though it's struck in the centre. This has allowed Thermaltake to add a small vent for additional fresh air. It does cut into CPU cooler clearance, with official support for air coolers that are only up to 145mm tall.

Meanwhile, the front panel is perforated with T-shaped holes, which look striking with illumination behind them. Behind the panel sits a removable mesh filter and front fan mount, although it only has one position, unlike the Lian Li. Above this areas sit the power and reset buttons, two USB 3 ports, one USB 3.2 Gen2 Type-C port, and separate headphone and microphone jacks.

When the panels are removed, the case is light yet sturdy, with no play in the chassis. This case is the only one on test with a side fan mount too (on the rear/right panel), with two 120mm fan mounts to go with the three 120mm or two 140mm mounts up front, a 120/140mm mount in the roof and a 120mm mount in the rear. The side mount will take a

AIRFLOW

+ Uncomplicated cable

- management
- Plenty of cooling performance on tap
- Built like a brick outhouse

AIRHEAD

- Struggles at lownoise settings
- Roof could easily house more cooling gear
- CPU cooler height and GPU width limited

240mm radiator too, but not at the same time as one in the front.

When not in use, the side fan mount houses a 2.5in drive tray with space for three drives, with a further two behind the motherboard and a 3.5in cage underneath the PSU shroud. This has only one position but can be removed entirely if needed.

That side fan mount eats into the space behind the motherboard tray, though, so you only have the room directly behind the motherboard for cables. However, there's 33mm of depth here, so cable management is relatively easy, with cable tie points where you need them.

The case's party trick is a rotating PCI-E bracket, so you vertically mount a graphics card well away from the side panel, with a secondary bracket included to secure the riser to the PSU shroud.

The Divider 300 didn't do well in our 35dB test thanks to sound leaking through gaps in it. The small side vent in particular unleashes graphics card fan noise. With its fans at maximum speed, it claws back some lost ground, while also being one of the quietest cases on test at 36.5dB. When adding just a single fan, using it in the roof as an exhaust best balanced CPU and GPU temperatures.

Conclusion

The Divider is easily the most interestinglooking case on test, and in a good way. Thermaltake, once the butt of copycat jokes, continues to push the envelope in case design. There's nothing miraculous or revolutionary, but it's different and well made. It's openness costs it a little in lownoise scenarios, but its free-flowing airways don't need much air to get going. **GPC**



SPEC

Dimensions (mm) 220 x 461 x 475 (W x D x H)

Material Steel, plastic, glass

Available colours Black, white

Weight 8.18kg

Front panel Power, reset, 2 x USB 3, 1 x USB 3.2 Gen2 Type-C, 1 x headphone jack, 1 x mic jack

Drive bays 5 x 2.5in, 2 x 2.5/3.5in

Form factor(s) ATX, micro-ATX, mini-ITX

Cooling 3 x 120 or 2 x 140mm front fan mounts (1 x 120mm fan included), 1 x 120mm rear fan mount (120mm fan included), 1 x 120/140mm roof fan mount 2 x 120mm side fan mount

CPU cooler clearance 145mm

Maximum graphics card length 390mm (without front radiator)

VERDICT

An interesting-looking, well-built case, although it gets hot at low-noise settings.



How we test

MOTHERBOARDS

TEST PROCESSORS

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



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

All CPUs are cooled by a Corsair Hydro-X water-cooling loop with two XR5 240mm radiators, an XD3 RGB reservoir and an XC7 RGB waterblock. We test with our RealBench suite and Far Cry 6 on Windows 11. We also test each board's M.2 ports, and record the noise level and dynamic range of integrated audio using RightMark Audio Analyzer.

PROCESSORS

TEST MOTHERBOARDS

Intel LGA1700

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

Common gear includes a 2TB Samsung 970 Evo SSD and Nvidia GeForce RTX 3070 FE graphics card. For LGA1700 CPUs, we use 32GB (2 x 16GB) of Kingston Fury 5200MHz DDR5 RAM and a Thermaltake Toughliquid Ultra 360 CPU cooler. For other systems, we use 16GB (2 x 8GB) of Corsair Vengeance RGB Pro 3466MHz RAM and a Corsair Hydro-X water-cooling loop, with two XR5 240mm radiators, an XD3 RGB reservoir and an XC7 RGB waterblock.

We use the latest version of Windows 11 with security updates, plus the latest BIOS versions and drivers. We record results at stock and overclocked speeds, and tests include our RealBench suite, Cinebench, Far Cry 6 and Dirt 5.

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

MONITORS

We test image quality with an X-Rite iDisplay Pro colorimeter and

DisplayCal software to check for colour accuracy, contrast and gamma, while assessing more subjective

details such as pixel density and viewing angles by eye. For gaming, we test a monitor's responsiveness subjectively and then also use Blur Buster's excellent ghosting UFO test to check the sharpness of the display in high-speed motion.

CPU COOLERS



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

For the Intel LGA1200 system, we take an average reading across all eight cores, and for the LGA1700 system, we take an average reading across both the P-Cores and E-Cores. AMD's CPUs only report a single temperature reading, rather than percore readings, so we list what's reported in Core Temp.

TEST KIT

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

INTEL LGA1700

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

INTEL LGA1200

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

AMD AM4

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

GRAPHICS CARDS

We mainly evaluate graphics cards on the performance they offer for the price. However, we also consider the efficacy and noise of the cooler, as well as the



GPU's support for new gaming features, such as ray tracing. Every graphics card is tested in the same PC, so the results are directly comparable. Each test is run three times, and we report the average of those results. We test at 1.920 x 1.080.2.560 x 1,440 and 3,840 x 2,160.

TEST KIT

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

GAME TESTS

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

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 Frame View.

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.



USTOMPC AWARDS

outstanding if you have money to spend.

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Some products are gloriously over the top. They don't always offer amazing value, but they're

EXTREME ULTRA

PREMIUM GRADE







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

Premium Grade products are utterly desirable,

offering a superb balance of performance and

features without an over-the-top price.

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.

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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.

RYZEN

8-core system with integrated graphics

8-core CPU, basic gaming

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

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
СРИ	AMD Ryzen 7 5700G	scan.co.uk	#218 p20	£290
CPU COOLER	AMD Wraith air cooler included with CPU	N/A	#218 p20	£0
GRAPHICS CARD	AMD Radeon RX Vega 8 integrated into CPU	N/A	# 218 p20	£0
MEMORY	16GB (2 x 8 GB) Corsair Vengeance LPX Pro 3200MHz (CMK16GX4M 2B3200C16)	scan.co.uk	#218 p78	£63
MOTHERBOARD	Asus TUF B450M-PLUS II (micro-ATX)*	awd-it.co.uk	# 218 p78	£75
STORAGE	500GB WD Blue SN750 (M.2 NVMe)	scan.co.uk	# 222 p20	£50

Total £478

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

1,920 x 1,080 gaming

6-core CPU, 1080p gaming

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



COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	Intel Core i5-11400F	scan.co.uk	# 215 p16	£150
CPU COOLER	ARCTIC Freezer 7 X	scan.co.uk	# 202 p20	£19
GRAPHICS CARD	AMD Radeon RX 6600 XT	overclockers.co.uk	# 220 p53	£500
MEMORY	16GB (2 x8 GB) Corsair Vengeance LPX Pro 3200MHz (CMK16GX4M 2B3200C16)	scan.co.uk	# 204 p74	£63
MOTHERBOARD	MSI MAG B560 Tomahawk WiFi (ATX)	scan.co.uk	#215 p18	£155
STORAGE	1TB WD Blue SN750 (M.2 NVMe)	scan.co.uk	# 222 p20	£80

Total £967

UPGRADES				
SWAP GRAPHICS CARD	Nvidia GeForce RTX 3060 Ti	cclonline.com	# 220 p55	£699
SWAP STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	# 215 p43	£117
SWAP CPU COOLER	SilverStone Hydrogon D120 ARGB	amazon.co.uk	# 217 p43	£51

2,560 x 1,440 gaming system

10-core CPU, 1080p and some 2,560 x 1,440 gaming

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



Total £1,445

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

Mid-range gaming system

INTEL (R) CORET is

SRL4T

X1310990 @



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

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

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	Intel Core i7-12700K	overclockers.co.uk	# 220 p18	£380
CPU COOLER	NZXT Kraken X53 (240mm AIO liquid cooler)	scan.co.uk	#221 p76	£120
LGA1700 Adaptor	Asetek Premium Retention Kit LGA1700	overclockers.co.uk	#221 p76	£4
GRAPHICS CARD	Nvidia GeForce RTX 3070 Ti	cclonline.com	# 220 p43	£949
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3200MHz DDR4 (CMW16GX 4M2C3200C16)	scan.co.uk	#221 p76	£70
MOTHERBOARD	MSI MAG Z690 Tomahawk WiFi DDR4	box.co.uk	#222 p48	£246
STORAGE	1TB ADATA XPG GAMMIX S50 Lite	cclonline.com	#215 p43	£117

Total £1,886

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

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Core component bundles cont ...

4K gaming system

12-core CPU, 4K gaming

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



COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
CPU	Intel Core i7-12700K	overclockers.co.uk	# 220 p18	£380
CPU COOLER	NZXT Kraken Z53 (240mm AlO liquid cooler)	amazon.co.uk	#221 p76	£173
LGA1700 ADAPTOR	Asetek Premium Retention Kit LGA1700	overclockers.co.uk	#221 p76	£4
GRAPHICS CARD	Nvidia GeForce RTX 3080 Ti	ebuyer.com	#221 p48	£1,620
MEMORY	16GB (2 x 8GB) Corsair Vengeance RGB Pro 3200MHz DDR4 (CMW16GX4M2 C3200C16)	scan.co.uk	# 221 p76	£70
MOTHERBOARD	MSI MAG Z690 Tomahawk WiFi DDR4	box.co.uk	# 222 p48	£246
STORAGE	1TB WD Black SN850	box.co.uk	#215 p49	£140

Total £2,633

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

Content creation system

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

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

COMPONENT	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
СРИ	Intel Core i9-12900K	scan.co.uk	# 220 p16	£595
CPU COOLER	NZXT Kraken X73 (360mm AIO liquid cooler)	scan.co.uk	#221 p76	£140
LGA1700 Adaptor	Asetek Premium Retention Kit LGA1700	overclockers.co.uk	#221 p76	£4
GRAPHICS CARD	AMD Radeon RX 6600 XT	overclockers.co.uk	# 220 p53	£500
MEMORY	32GB (2 x 16GB) Corsair Dominator Platinum RGB 5200MHz DDR5 (CMT32GX5M2 B5200C38W)	corsair.com/uk	#221 p76	£325
MOTHERBOARD	MSI MEG Z690 Unify	scan.co.uk	# 222 p50	£510
STORAGE	2TB WD Black SN850	scan.co.uk	# 215 p49	£320

Total £2,394

UPGRADES				
SWAP GRAPHICS CARD	Nvidia GeForce RTX 3080 Ti	ebuyer.com	#221 p48	£1,620
ADD SECONDARY STORAGE	4TB Western Digital Blue	overclockers.co.uk	# 166 p54	£78

Mini PCs

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

Micro-ATX

Motherboards

		And the second s			
Mini–ITX					
Motherboards					
CATEGORY	NAME	SUPPLIER	ISSUE	PRICE	
Intel Z690 (LGA1700)	Asus ROG Strix Z690-I Gaming WiFi	scan.co.uk	# 220 p22	£375	
Intel Z590 (LGA1200)	Gigabyte Z590I Vision D	scan.co.uk	# 214 p18	£280	
AMD B550 (AM4)	Asus ROG Strix B550-I Gaming	scan.co.uk	# 206 p44	£197	
Cases					
CATEGORY	NAME	SUPPLIER	ISSUE	PRICE	
ALL-PURPOSE	Cooler Master MasterBox NR200P	scan.co.uk	# 206 p18	£100	
TOWER	Ssupd	overclockers.co.uk	#219	£105	

PRICE CATEGORY NAME SUPPLIER AMD B450 Asus TUF #218 £75 awd-it.co.uk (AM4) B450M-PLUSII p76 AMD 8550 MSI MAG B550M #204 ebuyer.com £115 (AM4) Mortar p42 Cases PRICE NAME SUPPLIER #218 Kolink Citadel BUDGET overclockers.co.uk £63 Mesh RGB p26

Other components

V2

PREMIUM

Meshlicious

Streacom DA2

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

quietpc.com

p18

#214

p51

£203

ATX cases

				and the second s
CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET RGB	Antec DF700 FLUX	scan.co.uk	# 214 p26	£75
SUB-£100 AIRFLOW	Corsair 4000D Airflow	corsair.com/uk	# 222 p56	£90
СОМРАСТ	Fractal Design Meshify 2 Compact	scan.co.uk	#215 p20	£100
HIGH AIRFLOW	Fractal Design Meshify 2	scan.co.uk	# 212 p45	£130
MID-RANGE	Phanteks Eclipse P600S	overclockers.co.uk	# 202 p44	£140
SUB-£150	Fractal Design Define 7	overclockers.co.uk	# 204 p18	£140
PREMIUM	Phanteks Enthoo Evolv X	overclockers.co.uk	# 187 p24	£215

Networking

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET ROUTER	Belkin RT3200-UK	currys.co.uk	# 216 p52	£130
ROUTER	Asus RT-AX68U	scan.co.uk	# 216 p51	£170
MESH ROUTER	Asus AiMesh AX6100	amazon.co.uk	#196 p54	£338
WI-FI ADAPTOR	TP-Link Archer TX3000E	overclockers.co.uk	# 196 p58	£50
DUAL-BAY NAS BOX	Synology DS220j	laptopsdirect.co.uk	# 200 p22	£178
DUAL-BAY MEDIA NAS BOX	Synology DS218play	laptopsdirect.co.uk	# 174 p34	£200
2.5 GIGABIT DUAL-BAY NAS BOX	QNAP TS-231P3	ebuyer.com	# 212 p25	£293

Monitors



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

Up to 25in

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
241N, 144Hz, IPS, 1,920 X 1,080, F, G	AOC 24G2U	box.co.uk	# 214 p28	£197
251N, 240Hz, IPS, 1,920 X 1,080, F, G	Acer Predator XB253Q	amazon.co.uk	# 209 p57	£310
251N, 360Hz, IPS, 1,920 X 1,080, F, G	Asus ROG Swift PG259QN	overclockers.co.uk	# 212 p20	£549

Up to 28in

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
271N, 144Hz, IPS, 1,920 x 1,080, F, G	AOC 27G2U	overclockers.co.uk	# 201 p53	£230
271N, 240Hz, IPS, 1,920 X 1,080, F, G	Asus TUF Gaming VG279QM	overclockers.co.uk	# 209 p60	£340
271N, 144Hz, IPS, 2,560 x 1,440, F, G	Asus TUF Gaming VG27AQ	overclockers.co.uk	# 201 p54	£389
271N, 240Hz, TN, 2,560 x 1,440, F, G	AOC AG273QZ	overclockers.co.uk	# 202 p27	£480
271N, 240Hz, IPS, 2,560 X 1,440, F, G	Alienware AW2721D	dell.com	# 212 p21	£606
281N, 144Hz, IPS, 3,840 X 2,160, F, G	AOC U28G2XU	amazon.co.uk	# 221 p29	£583

Over 28in

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
31.51N, 60Hz, VA, 4K, F	iiyama ProLite XB3288UHSU	scan.co.uk	# 205 p43	£385
321N, 165Hz, IPS, 2,560 X 1,440, F, G	LG UltraGear 32GP850	overclockers.co.uk	#220 p38	£450
341N, 144Hz, IPS, 3,440 x 1,440, W, F	iiyama G-Master GB3461WQSU	scan.co.uk	#206 p53	£460
341N, 144Hz, IPS, 3,440 x 1,440, W, F, G	LG UltraGear 34GN850	currys.co.uk	#206 p55	£949
381N, 144Hz, IPS, 3,840 X 1,600, W, F, G, HDR	LG UltraGear 38GN950	currys.co.uk	#208 p30	£1,499
321N, 144Hz, IPS, 3,840 X 2,160, F, G, HDR	Asus ROG Swift PG32UQX	scan.co.uk	#218 p54	£3,299

Non-gaming

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
271N, 75Hz, IPS, 2,560 X 1,440, F	LG 27QN880	ebuyer.com	# 210 p26	£395

Peripherals and audio

Gamin				
CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET TKL	SteelSeries Apex 3 TKL	currys.co.uk	# 221 p59	£50
OPTICAL ESPORTS	Asus ROG Strix Scope RX	ebuyer.com	#209 p43	£113
MECHANICAL MMO	Corsair K95 RGB Platinum	scan.co.uk	# 164 p26	£180
PREMIUM MECHANICAL	Corsair K70 Mk.2 Low Profile	scan.co.uk	# 193 p56	£150
PREMIUM TKL MECHANICAL	Corsair K70 RGB TKL	scan.co.uk	# 214 p31	£140
LUXURY MECHANICAL	Ducky Shine 7 RGB	overclockers.co.uk	# 212 p53	£175
WIRELESS MECHANICAL	Razer BlackWidow V3 Pro	overclockers.co.uk	#208 p60	£230

Gaming mice					
CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)	
BUDGET GAMING	Corsair M55 RGB Pro	box.co.uk	# 200 p24	£35	
FIRST-PERSON SHOOTER	Glorious PC Gaming Race Model O	overclockers.co.uk	#215 p57	£50	
ммо	Razer Naga Trinity	amazon.co.uk	# 186 p52	£49	
AMBIDEXTROUS	Razer Viper 8K	currys.co.uk	# 215 p59	£58	
WIRELESS	Razer Viper Ultimate	amazon.co.uk	# 217 p54	£65	
PREMIUM WIRELESS	Razer Deathadder V2 Pro	ebuyer.com	#210 p28	£125	
ULTRA LIGHTWEIGHT	Roccat Burst Pro	scan.co.uk	# 211 p28	£48	
PREMIUM LIGHTWEIGHT WIRELESS	Logitech G Pro X Superlight	currys.co.uk	# 217 p52	£112	

Peripherals and audio cont...

Game	3346			
CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
RACING WHEEL	Logitech G29 Driving Force	currys.co.uk	#202 p50	£299
GAMEPAD	Microsoft Xbox One Wireless Controller	currys.co.uk	#191 p56	£55
PREMIUM GAMEPAD	Razer Wolverine V2 Chroma	razer.com	# 221 p30	£149
BUDGET FLIGHT STICK	Logitech Extreme 3D Pro Joystick	currys.co.uk	# 207 p52	£37
FLIGHT STICK	Thrustmaster T.16000MFCS HOTAS	scan.co.uk	# 207 p56	£140

Gaming headsets

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)		
BUDGET STEREO	Roccat Elo X Stereo	scan.co.uk	# 210 p56	£40		
STEREO	Epos Sennheiser GSP 300	amazon.co.uk	# 210 p54	£70		
WIRELESS	Corsair Virtuoso RGB Wireless	ebuyer.com	# 204 p50	£155		
PREMIUM WIRELESS	Razer BlackShark V2 Pro	scan.co.uk	# 211 p26	£200		

Speakers

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

Non-gaming keyboards

CATEGORY	NAME	SUPPLIER	ISSUE	PRICE (inc VAT)
WIRELESS 84-KEY ELECTRO-CAPACATIVE	Niz Mini 84 Pro	keyboardco.com	# 220 p29	£165
WIRELESS TKL MECHANICAL	Keychron K2 Version 2	keyboardco.com	# 208 p57	£84
TKL MECHANICAL	Filco Majestouch Convertible 2 Tenkeyless	keyboardco.com	# 203 p55	£140
BUCKLING SPRING MECHANICAL	Unicomp New Model M	keyboardco.com	# 219 p26	£129

PCs and laptops



Pre-built PC systems

CATEGORY	NAME	СРИ	GPU	SUPPLIER	ISSUE	PRICE (inc VAT)
AMD APU PC	Wired2Fire Ultima Ryzen Gamestation	AMD Ryzen 5 5600G	Integrated AMD Radeon RX Vega 7	wired2fire.co.uk	# 222 p36	£669
BUDGET GAMING	CyberPower Infinity X115 GT	Intel Core i5-11400	Nvidia GeForce RTX 3060	cyberpowersystem.co.uk	# 217 p32	£1,360
4K GAMING	Scan 3XS Vengeance Ti	Intel Core i9-12900K	Nvidia GeForce RTX 3080 Ti	scan.co.uk	# 221 p34	£3,499
WATER-COOLED ALDER LAKE	CyberPower Hyper Liquid Infinity X129	Intel Core i9-12900K	Nvidia GeForce RTX 3080	cyberpowersystem.co.uk	# 222 p34	£3,999
DREAM PC	Scan 3XS Barracuda	Intel Core i9-10980XE OC to 4.3GHz	Nvidia GeForce RTX 3090	scan.co.uk	# 145 p58	£14,615

Laptops

CATEGORY	NAME	CPU	GPU	SCREEN	SUPPLIER	ISSUE	PRICE (inc VAT)
BUDGET GAMING	Lenovo Legion 5 Pro	AMD Ryzen 7 5800H	Nvidia GeForce RTX 3070 Laptop	16in, 2,560 x 1,600 IPS 165Hz G-Sync	currys.co.uk	# 222 p32	£1,499
ULTRA PORTABLE GAMING	Razer Blade 14	AMD Ryzen 9 5900HX	Nvidia GeForce RTX 3070 Laptop	14in 1,920 x 1,080 IPS 144Hz	scan.co.uk	# 220 p40	£2,120
ULTRA PORTABLE GAMING + EGPU DOCK	Asus ROG Flow X13 GV301	AMD Ryzen 9 5980HS	Nvidia GeForce GTX 1650 Max-Q (laptop) / RTX 3080 Laptop (dock)	13.4in 1,920 x 1,200 IPS 120Hz	cclonline.com	# 219 p28	£2,656
PREMIUM RTX GAMING	Asus ROG Strix Scar G733QSA	AMD Ryzen 9 5900HX	Nvidia GeForce RTX 3080 Laptop	17.3in 1,920 x 1,080 IPS 360Hz	scan.co.uk	# 217 p28	£2,600





RICK LANE / INVERSE LOOK

GOING STRAIGHT

When mainstream gaming is dominated by huge open worlds, a big-budget linear game is a rare treat, says Rick Lane

The 14-year-old me would

have read this column and

thought I'd lost the plot

arvel's Guardians of the Galaxy (see p72) is a spectacular, story-driven sci-fi adventure that's not unlike an Uncharted game on PC. Indeed, its commitment to linearity is unusual in a time when nearly every major singleplayer game has an open world in some form, funnelling the player along a strict and definitive path for the duration of its 20-hour story.

This may seem like an odd structural choice for a game set in space, not least when games such as Elite Dangerous and No Man's Sky have made open-ended space simulators more popular than ever. Yet rather than feeling like a shortcoming, this game's linearity was one of its features that I enjoyed the most.

Go back 20 years and I would have killed to have single-player games with the scale and openness of Assassin's Creed Valhalla or Far Cry 6. I vividly recall the joy of playing The Elder Scrolls IV: Oblivion for the first time, being able to push beyond the buildings

immediately surrounding me and freely explore. It's fair to say that the 14-year-old me would have read this column and thought I'd lost the plot.

However, the proliferation of open-world games has brought me to a couple of realisations. Firstly, very few open worlds succeed in making the most of the space they offer, lacking either the storytelling chops or systemic depth to prevent the game from feeling repetitive or derivative. Over the past ten years, only a handful of open-world games have given me sufficient reason to explore their fullest depths, such as Skyrim and The Witcher 3. With the rest, I'll explore until the mechanics run dry, then beeline through the main quest to see the story.

Moreover, sometimes it's nice when you don't need to worry about where you need to go or what the game expects from you in order to enjoy it. Player agency is an important component of games, but an overabundance of choice or content can be stressful, especially if you have limited free time. We use stories to relax, and sometimes it's more relaxing to be told a story designed to be experienced in a specific way, rather than having it chopped up and dispersed across a huge map. Guardians of the Galaxy is a fine example of the advantages of linearity. It offers a spectacular vista or a sparky conversation

around every corner, while the combat and occasional dialogue choices are just enough to make you feel like you're having an impact on what's happening. It's a game with confidence and clarity of vision – at no point during play did I think it would have benefited letting me choose where

to go or what to do.

We often think of open-world games as an advancement over linear design, and that games should be pushing to be more expansive. However, each approach has its own distinct appeal. While open-world games enable a greater sense of agency, linear games allow you to switch off a little bit more of your brain, settle into a routine and enjoy the experience more easily. You can press ahead knowing all the best bits of the game lie directly in front of you, safe in the knowledge that if you keep going in that direction, you will eventually see the end.



DEVELOPER Ubisoft/ PUBLISHER Ubisoft

hile Ubisoft's Assassin's Creed series has thrived under its gradual transformation into an RPG, Far Cry feels increasingly burdened by all the bells and whistles Ubisoft keeps adding to it. There's a huge amount of stuff in Far Cry 6, and much of it obscures the series' core loop of sneaking into a base and making stuff explode.

Set on the tropical island of Yara, you play a former military conscript turned guerrilla fighter named Dani, who becomes embroiled in the fight against Yara's dictator Antón Castillo after Castillo's goons murder a bunch of Dani's friends. From here, you embark on a revolutionary tour of Yara, bringing together several rebel factions as you dismantle Castillo's military infrastructure and take the fight to the despot.

Far Cry 6's attempts to represent guerrilla fighting mechanically are mixed. Yara is threaded with 'guerrilla trails', pathways through its jungles and mountains traversed with a mixture of platforming, rock-climbing and newly introduced horseback riding. While fun to navigate, these trails are undermined by the fact that you can travel via the main roads freely as long as you keep your weapon holstered.



Elsewhere, Far Cry 6 introduces a bunch of ad hoc weapons intended to reflect your guerrilla resourcefulness. 'Resolvers' are special weapons crafted from junk that include a powerful revolver and shield combination, and a composite bow that fires huge metal spikes.

Added to the weapon options are 'Supremos', which are special abilities deployed from a backpack such as a massive barrage of mortars. Frankly, all these weapons feel out of place in the game's otherwise authentically represented world, while the 'Press to win' nature of the Supremos is fundamentally at odds with Far Cry's emphasis on creative, player-driven gunplay.

Such silliness aside, the game's combat is as dynamic and entertaining as ever for a Far Cry game, with the combination of enemy reinforcements, vehicles, animal companions and other factors producing battles that escalate in incredibly satisfying ways.

What's more, although the broader story is nothing special, the individual campaign missions are frequently spectacular and imaginative. The tutorial section closes with an assault on two huge naval frigates, with you ziplining from one to the other as helicopters and smaller gunboats pepper both ships with bullets.

There's some admirable craft in Far Cry 6, which makes it all the more frustrating that it has so many ideas that simply don't fit with its formula heaped onto it, including a basebuilding mechanic that inexplicably switches you into thirdperson view, and a tasteless cock-fighting minigame based on Tekken. There's a great first-person shooter hidden in Far Cry 6; you just need to do some digging to find it.

FAR-SIGHTED

- Great mission design
- + Fun, dynamic combat

CRYING SHAME

- Toothless story
 New features don't really work
- Just too much going on

/ VERDICT

Far Cry may be suffering from an identity crisis, but this sixth entry is still capable of producing some fantastic FPS fun.



Marvel's Guardians of the Galaxy/£49.99 inc VAT

DEVELOPER Eidos Montreal / PUBLISHER Square Enix

STAR-LORD

- Excellent storytelling
- Incredible visuals
- Wonderful companion characters

STAR-BORED

- Mechanically uninspired
- Combat undermined by weak shooting

t's hard not to feel a little aggrieved by Marvel's Guardians of the Galaxy, a game that exists instead of the third entry in Eidos Montreal's excellent Deus Ex trilogy. Bandai Namco's desire to make the most of the Marvel licence is understandable, but yet another superhero tie-in seems like a poor substitute for one of the best game series of all time.

Or at least, it would, were it not for the fact that playing Marvel's Guardians of the Galaxy is so much darned *fun*. Eidos Montreal has produced a single-player adventure that's bursting with action, spectacle, humour and, above all, character. Although it's mechanically a little underwhelming, Guardians is comfortably one of the best-written

games of the year, matching its cinematic counterpart in both irreverence and heart.

That said, Eidos Montreal's game bears no relation to James Gunn's film. The game has an entirely new take on the Guardians, with its own perspective on the characters and a new tale to tell. In Eidos' story, the Guardians have recently formed after a long and bloody war, and together are seeking ways to make money in the aftermath of the conflict.

Hitting on a scheme to sell a monster to a warlord named Lady Hellbender, they trespass into the war's leftover Quarantine Zone to locate such a beast. What they discover instead is a force that threatens to destroy the entire galaxy, and they must work together to find a way to prevent it.

> Structurally, Guardians of the Galaxy relies heavily on the Uncharted template, with interesting thirdperson platforming and extended combat. Frankly, Guardians of the Galaxy isn't as

 ΠD
good as Uncharted either. We'll discuss the combat later, but the platforming feels rough and imprecise compared with Uncharted's hyper-slick movement.

Star-Lord's jet-boots, for example, play a central role in the game's jumping puzzles, but they're underpowered for the job. Not only does this make them unsatisfying to use, but you're also constantly falling short of platforms, which feels clumsy rather than exciting.

Fortunately, Guardians makes up for this in its approach to narrative. For starters, Eidos Montreal nails the Guardians' respective personalities. Star-Lord is cocky and wisecracking, but genuinely decent and heroic beneath. Rocket is incredibly caustic and often unreasonable in a way that's both funny and frustrating in equal measure. However, the highlight of the group is Drax, whose literal interpretation of everything is superbly handled by the Eidos writing team, making him both the funniest and most empathetic character in the game.

Thematically, Guardians centres around teamwork and family. As Star-Lord, your leadership of the team involves making certain choices, which can affect team morale and slightly alter the flow of the story. A simple example sees you needing to cross a chasm, whereupon Drax suggests throwing Rocket across it, so he can lower the bridge on the other side. If you do this, Rocket is understandably displeased, which can affect events later in the level. The Guardians' sparky relationships form the heart of a superb sci-fi adventure.

Visually, the game is also stunning, perhaps the bestlooking game of the year. It uses vibrant colours and clever geometric design to create planets and other environments that truly feel alien. The Quarantine Zone, for example, is eerily beautiful, with the viscous pink matter that binds its derelict spaceships together giving this highly dangerous place a deceptively picturesque atmosphere. When you arrive at the backwoods space station of Knowhere, Eidos Montreal really starts showing off, presenting a vast and knotty urban cityscape that rivals Cyberpunk 2077 for grotty futurism.

The game also makes the most of the Guardians as a group. Although you only play as Star-Lord, the Guardians are nearly always with you during play. Remarkably, having four NPCs travelling with you doesn't result in them being annoying or obstructive. The way they move with you through environments is slick and natural, while their running commentary on the surrounding environments and events-





at-large is entertaining – you genuinely miss it in the handful of moments when Star-Lord is alone.

As both a story-driven adventure and a visual experience, Guardians is undoubtedly one of the highlights of the year. That said, mechanically, it's surprisingly weak for a game from a developer lauded for its immersive sims. Your three main interactions are rudimentary platforming, some light puzzling where you order your companions to open up new pathways, and combat. We've already discussed the first, while the second amounts to pressing a button to get Gamora to cut through some wires or get Drax to move a heavy object.

As for combat, the system broadly does a decent job of representing the Guardians' chaotic teamwork. During combat, you can order your teammates to perform special moves that damage either health or stamina – depleting the latter opens enemies up to powerful attacks.

At certain points you can also order your team to 'Huddle up', giving them a motivational speech and hitting the button on your Walkman, firing them up with some classic 1980s tunes, such as Starship's We Built this City or Relax by Frankie Goes to Hollywood.

The results are pleasingly dynamic, with the fluidity of the combat bolstered by the team-based animations into which the Guardians seamlessly slip. Sadly, it's all undermined by the fact that Star-Lord's main weapon is rubbish. His twin energy guns have no sense of impact, and whittling away at enemy health bars with these puny pistols isn't much fun. Also, while the Huddle mechanic is great in theory, stopping mid-combat for a motivational speech kills the momentum of the fight, and it would be better served as a straightforward power-up where the music kicks in and instantly gives your team a boost.

Fortunately, the team abilities and general spectacle of the combat help support the weaker core, just as the storytelling and sense of adventure carries the lightweight mechanics of the main game. Guardians of the Galaxy isn't rounded enough to be an outright classic, but it's still one of the most entertaining games we've played this year, and a masterclass in scripted storytelling.

/ VERDICT

Marvel's Guardians of the Galaxy isn't Eidos Montreal's smartest or most innovative game, but it's one of the studio's most entertaining.



Back 4 Blood / £49.99 incVAT

DEVELOPER Turtle Rock / PUBLISHER Warner Bros

ack 4 Blood is a cooperative shooter heavily inspired by Left 4 Dead. It sees four players team up across a series of campaigns where they battle through hordes of zombies to complete various objectives. Yet where Left 4 Dead prioritised simplicity and character, Back 4 Blood is more interested in long-term multiplayer gaming, adding features such as a loot system and a cardcollecting metagame.

Your survivors are now named 'Cleaners', while the zombies are known as 'The Ridden'. Otherwise, though, it's the same affair of working through abandoned towns and creepy backwoods via a series of safehouses, while an unseen Al director deploys regular and special zombies to prise your team apart. It feels weightier than Left 4 Dead, the larger arsenal of weapons is a welcome addition (particularly the excellent revolvers and single-shot rifles) and the zombies splatter in sufficiently satisfying ways.

The key difference in Back 4 Blood is an emphasis on evolution and intensification. As you play through four campaigns, your zombie foes change over time, becoming



faster, tougher and gaining new abilities. To counter this, Back 4 Blood introduces 'survivor cards', from which you can build your own deck.

These could hold a bunch of random abilities that you like, or you could direct them towards a particular build, such as team healing and support, melee combat, or making the most of specific weapon types such as shotguns. At first, the system is a little confusing, not least because the starter deck only has a few actually interesting cards. Over time, however, gaining new cards and tweaking your build becomes much more engaging.

Back 4 Blood's own progression tracks along a similar arc. The initial campaign missions are uninspired affairs that involve traversing nondescript industrial yards. After a couple of hours, though, the missions become more interesting. The second chapter has some fantastic highlights, such as an enormous jumble of cargo ships and other vehicles known as The Clog.

However, sometimes Back 4 Blood's approach to design works against it. The 'Special Ridden' are nowhere near as distinctive as Left 4 Dead's Special Infected, a problem compounded by their constantly changing look and abilities. Similarly, the longer campaigns don't have the same thematic consistency as Left 4 Dead, and the individual levels don't flow into one another as coherently.

Consequently, Back 4 Blood's undead adventure is less memorable than Left 4 Dead, lacking its style and pizzazz. The card system is well thought-out and the campaigns feature some brilliant moments, but it's unlikely to engender the fondness of the game that inspired it. **RICK LANE**

BACK 4 BLOOD

- + Slick and satisfying zombie combat
- Card system works well
- Campaigns have some standout levels

NOT 2 GOOD

- Confusing initial hours
- Lacks personality of Left 4 Dead

/ VERDICT

A solid followup to one of the best cooperative games of all time, but it can't match the highs of its spiritual predecessor.



Inscryption / £16.79 inc VAT

DEVELOPER Daniel Mullins Games / PUBLISHER Devolver Digital

nscryption is a dark, devious and delightful game that sees you trapped in a backwoods cabin with a strange, shadowy figure, playing a twisted card game upon which your life may depend. There are several layers to Inscryption's play. At its core is the card game itself, wherein you and your shrouded opponents take turns to play cards of different animals.

Playing a card from your hand comes at a cost, which may be blood gained from sacrificing other cards, or bones collected from animals fallen in battle on either side. Your goal is to deal +5 more damage to your opponent than they deal to you, tipping the scales on the left of the screen, so they touch the table.

The sacrifice system leads to tough decisions as you ponder whether to risk scrapping two weaker animals to play a stronger card such as the Wolf, while the +5/-5 damage system results in tense back-and-forth battles. Further compounding your choices is the fact that each animal has a unique ability, such as the adder's poison, which will instantly kill any enemy it bites, and the stinkbug's ability to reduce rival cards' damage output by 1.

Yet this is merely the beginning of Inscrpytion's ingenuity. The card game folds into a light tabletop RPG themed around a journey through a forest, with your mysterious foe playing the Dungeon Master. In this part of the game, you'll have opportunities to gain new cards and upgrade existing ones, while facing your opponent in various battles, including highly challenging boss encounters, each with a different theme and insidious mechanical twist.





At any point outside of battle you can also stand up and walk around the cabin, which is filled with locked cabinets, encoded safes and other bizarre objects. As you progress through your opponent's game, you'll slowly learn how to unpick the puzzle of the cabin itself, simultaneously pushing the story forwards and putting more powerful cards in your hand.

Visually, Inscryption boasts an oppressive, moody colour scheme and a coarse texture lent by big, crunchy pixels. Meanwhile, the writing is both funny and frightening, with lots of weird touches such as cards that talk directly to you, offering you hints and commenting on events.

The story also constantly surprises, with big twists in the main plot and emerging from the game itself. The only real issue is that Inscryption's punishment of failure is quite harsh. Lose two matches and you're sent back to the start. There are both story and mechanical reasons for this, but a few hard save points along the way wouldn't have gone amiss. Otherwise, Inscryption is unusual, clever and superbly designed – it's a dark masterpiece of virtual card gaming.

INSCRIBE

- Great central card game
- Fascinating escape-room metagame
- Brilliant presentation

PROSCRIBE

 Losing is very costly

/ VERDICT

The shocking card game at the heart of Inscryption is only the start of its twisted genius.



GAMES OF 2022

Rick Lane reveals some of the PC gaming highlights scheduled for release this year

Ithough 2021 proved to be a surprisingly strong year for gaming, the impact of the pandemic on the game industry has seen many of its biggest games releases slip into 2022. While unfortunate for those hoping for more games to occupy them during lockdown, the delays mean 2022 is set to be a bumper year for PC gaming. Here are five of the most exciting titles launching in the next 12 months.

Elden Ring

Japanese developer From Software has undoubtedly been one of the most influential developers of the past decade, thrilling millions of players with its enigmatic and challenging games such as Dark Souls, Bloodborne and Sekiro: Shadows Die Twice.

The studio's latest venture is Elden Ring, which combines the formula that made From's games so celebrated with an open world on the scale of The Witcher 3. Whereas previous From games only offered a limited amount of exploration, Elden Ring's massive fantasy realm is freely traversable, letting you venture wherever you want using a magically summoned horse that can jump up mountains like a giant flea. Elden Ring also features a story partly scribed by A Song of Ice and Fire author George R.R. Martin, so expect a world that's even richer and nastier than From's previous work.

Will the added freedom of Elden Ring dilute the spatial puzzling of From's work, or simply offer the same environmental conundrums on a much larger scale? We'll find out when the game launches soon.





Company of Heroes 3

Relic's third entry in the Company of Heroes series is shaping up to be one of the most ambitious strategy games in years. The sequel still centres around real-time World War 2 battles that blend spectacular visuals with fast-paced tactics. However, instead of being structured around a linear sequence of missions, Company of Heroes 3 offers a dynamic, open-ended campaign similar in structure to Total War.

The campaign sees you assume the role of UK and US forces as they battle through Italy and North Africa, commanding your army via a top-down strategy map. From here, you'll order companies to capture towns and key military targets such as air bases. You can use clever tactics and support abilities such as naval barrages to soften up enemies before engaging them in battle, or even wipe them out entirely and save your infantry for other engagements.

Should your grander strategies fail, you'll need to get tactical by diving into a real-time battles that reflect your position on the campaign map. Here, you can take advantage of a new tactical pause feature to plan ahead and queue up orders, as well as marvel at the most advanced destruction tech in the series to date.

Redfall

From Arkane Studios, creator of Dishonored and Prey, Redfall is a co-operative shooter in which you defend a small American town from an invasion of vampires. You play as one of four different characters – telekinetically empowered Layla Ellison, gadget orientated Devinder Crousley, sharpshooter Jacob Boyer or combat engineer Remi de la Rosa.

The game aims to blend the chaotic action of Left 4 Dead with the creative systems design for which Arkane



is known. Each character has unique supernatural abilities, which can be combined to take advantage of the environment and get an edge on enemies. For example, Layla can use her telekinetic abilities to lift Jacob onto a rooftop, where he can get a better view of the battlefield and pop vampire skulls from afar.

Total War: Warhammer III

The conclusion to the Total War: Warhammer trilogy sees players take control of the armies of Chaos for a colourfully apocalyptic finale. Total War: Warhammer III will let you control one of four demonic armies, among the most spectacular and diverse forces seen in the series so far.

You'll be able to march a fiery path of destruction as the infernal armies of Khorne, who scorn missiles and magic in favour of hyper-aggressive melee units. Alternatively, you could control the pestilent minions of Nurgle, transforming cities into disease-ridden organic hives whose effects change as the seasons pass.

Also playable are the god of excess Slaanesh and the master of manipulation Tzeentch, each with their own unique armies and campaign mechanics.







Warhammer III also introduces several broader new features to Total War's epic strategy. 'Survival battles' are huge, bespoke encounters where your forces will square off against waves of enemies, slaughtering foes by the hundred while summoning fortifications and reinforcements to keep you in the fight.

The sequel also sees an overhaul of the game's siege mechanics, and the introduction of giant, elemental bears. It's shaping up to be the most spectacular and dynamic Total War yet.

Starfield

Bethesda's first game in six years also introduces its first completely new universe in a quarter of a century. This sci-fi RPG has been in the works for a long time, but has finally been given a release date of November this year.

However, there's still relatively little info on what Starfield will be like to play. We know it's a large-scale sci-fi RPG, described by Bethesda CEO Todd Howard as 'Skyrim in space'. We also know that it centres around a faction of explorers known as Constellation, that Howard has summarised as 'NASA meets Indiana Jones meets the League of Extraordinary gentlemen'. Starfield also runs on a brand-new engine, known as Creation Engine 2, which can be experienced from either first or thirdperson perspectives.

That's more or less it for hard facts, but it's likely the game will feature some form of space flight or space combat, given the emphasis on spacecraft in both the trailers and available concept art. It's also reasonable to expect to be able to explore various terrestrial environments in the game, such as planets, space stations and possibly even larger spaceships.

The big question is how the game will evolve mechanically over Skyrim and Fallout 4. The latter struggled to offer much that was new or innovative to the Bethesda template, so here's hoping that Starfield can bring some new ideas as well as a new engine and theme.

GAMES / VIRTUAL REALITY

REALLTY CHECK

Rick Lane sees if hand tracking tech can cope with the demands of serious air guitar, and looks at Facebook and Google's VR plans



NEWS GOOGLE REORGANISES VR PROJECTS

Facebook isn't the only VR innovator to see major changes lately. Google has undergone an internal reorganisation to bring several VR-orientated projects into one team, known as Google Labs. This team isn't directly related to the Google Labs of the 2000s, which was responsible for several major Google services such as Gmail.

It's being headed by Google veteran Clay Bavor, who previously oversaw the launch of Google's ill-fated Daydream VR platform. Originally launched in 2016, Daydream was abandoned three years later due to a disappointing reception to both its smartphone-based VR tech, and its dedicated headset, the Lenovo Mirage Solo.

That team is now being integrated with several other projects, including Project Starline (pictured), which is essentially an advanced 3D screen intended to make remote video communication feel like you're speaking to someone in the same room. Also being incorporated is Google's startup innovator Area 120, which has launched multiple offshoot technologies, including Avera Al and Orion WiFi.

NEWS FACEBOOK ANNOUNCES METAVERSE

In a move that has significant ramifications for VR, Facebook has undergone a complete rebrand, renaming itself Meta and realigning the company's long-term goals towards creating a more immersive Internet.

At the core of this strategy is the Metaverse, the company's vision for a digital universe that blends VR, AR and 2D video to create a persistent online world. The Metaverse is intended to be a workspace, social environment and place for entertainment and gaming. Imagine the Oasis from Ernest Cline's Ready Player One, although hopefully without the giant stacks of caravans.

Facebook's plans for the Metaverse are currently woolly, with the company looking at



five to ten years to realise the project. There have also been accusations that the rebrand is a cynical move to distract from Facebook's ongoing controversies regarding its use and abuse of personal data, including recent claims made by former employee Frances Haugen that Facebook was profiting from 'making [online] hate worse'.

Whether or not plans for the Metaverse are ever realised, the announcement does have immediate consequences for the future of VR. Firstly, the Oculus brand is to be slowly phased out, with the Quest line of headsets becoming known as Meta Quest.

Secondly, Meta could spell the end of having to log into your Quest using a Facebook account. Mark Zuckerberg stated that 'we're working on making it so you can log into Quest with an account other than your personal Facebook account'.

That said, it isn't clear what will replace the Facebook login, and whether it will be any better than having your whole social media profile tied to your VR headset.



DEVELOPER AnotherWay / **PUBLISHER** Vertigo Games

Unplugged would be one of the best VR games around, were it not for its overambitious demands on imperfect technology. This stylish rhythm game channels the late noughties magic of Guitar Hero, but replaces that series' plastic peripherals with an exclusively virtual instrument. It's ingeniously designed and undeniably fun, but it expects too much from the Quest's built-in hand tracking systems.

The game kicks off with you sat in the back room of some dank underground bar, when a poster of Steel Panther guitarist Satchel comes to life and starts teaching you how to play guitar. From this surreal introduction, you embark on a sequence of increasingly challenging gigs, playing set lists from Unplugged's 23 licensed songs.

As a technological feat, Unplugged is seriously impressive. The game exclusively uses the Quest's hand tracking system to play, requiring no controllers whatsoever. Instead, you use one free hand to strum the strings, while moving your other hand up and down



the five frets along the neck (the game caters for both left and right-handed players).

Above each fret is a sequence of coloured buttons corresponding to the number of fingers you must 'press down' in order to correctly strike the next chord in the song's sequence. This is represented by a track that arcs out elegantly from the guitar neck.

There's a surprising amount of nuance to this game of VR-enhanced air guitar. Alongside needing to think about hand and finger positioning, there are 'vibrato' chords where you hold down your fingers and move your hand rapidly from left to right.

There are also chords where you don't need to strum, simply pressing down your left hand to play, and solos, which you perform by wriggling your fingers as fast as possible to boost your score. Accurate playing will send the game's virtual audiences into a frenzy, while poor performance will see the crowd pelting the stage with cans and beer bottles.

While the tracklist is small compared with Guitar Hero, it includes some fantastic songs, including the Hives' 'Hate to Say I Told you So' and the Offspring's 'The Kids Aren't Alright'. Satchel also makes for an entertaining guide through the game.

That said, there are some problems. Feedback-wise, the game struggles to compensate for the lack of a physical peripheral. Neither your virtual guitar nor the songs respond sufficiently to your mistakes. Moreover, because the game focuses mainly on your fret hand, it can be easy to lose track of where your strumming hand should be positioned.

In addition, although Unplugged's implementation of hand tracking is by far the best we've seen, the game's demands on it can exceed its capabilities. Even on the easiest difficulty setting, some of the tracks are very challenging, and the hand tracking just doesn't feel up to that level of nuance.

Still, Unplugged is undoubtedly one of the best rhythm games for VR, second only to Beat Saber for the entertainment it offers, and it arguably has a more ambitious and innovative design. It just needs to rein in the challenge a little so that it tracks better with the Quest's nascent hand tracking capabilities.

ROCK 'N' ROLL

 Innovative concept
Great use of hand tracking tech

+ Bangin' choons

Innovative, stylish and with an excellent soundtrack,

you can get to being a rock

Unplugged is the closest

star without smashing

up your bedroom.

VERDICT

- tracklist
 - Hand tracking sometimes struggles

ROCK BOTTOM

Slightly anaemic





CUT DOWN THE RACKET COMING FROM YOUR SYSTEM

hether you like your PC to only ever been seen and not heard, or if you're just hoping to stop your PC drowning out your gaming sessions, there's plenty of reason to want to reduce the noise emanating from your machine, and there are many ways to achieve just that. In this guide, we'll take you through the main causes of PC noise and how to reduce them. From the blast of fast fans to the rattle and hum of hard drives, all PC noise can be curtailed, taking your PC from a cacophonous case to a whispering wonder.

THE TEST SETUP

To highlight the difference made by various methods of sound reduction, we've taken a fairly standard modern PC to use as our benchmark. Housed in a mid-sized Corsair 4000D case, the system has an AMD Ryzen 9 5900X coupled with 16GB of 3200MHz Corsair Vengeance DDR4 RAM, a 1TB WD Black SN750 M.2 SSD, a 4TB Seagate Barracuda Pro hard drive, an Asus ROG Strix B550-E Gaming motherboard, a Zotac Gaming GeForce RTX 2070 Super Amp Extreme graphics card and a Corsair RM750 power supply.

That PSU has a fan that only spins up when under load, which is essential for a quiet PC – such PSUs are near ubiquitous but it's worth double checking when buying. The graphics card is cooled by its huge and surprisingly quiet triple–fanned cooler, but we've also run some tests with a Zotac GTX 1080 Ti Mini card that's far louder, in order to highlight some methods you can take to reduce extreme graphics card cooler noise. Our wider tests are all performed with the Zotac RTX 2070 card's stock cooler.

We've coupled the CPU with a Cooler Master Hyper 212 Evo V2 air cooler, a Corsair H60 120mm AIO cooler and a Cooler Master



The toasty, 12-core Ryzen 9 5900X is at the heart of our test system

MasterLiquid 240L 240mm AIO cooler to test the three main CPU cooling options available. Most of our wider tests are performed with the Cooler Master Hyper 212 Evo V2.

This is a powerful PC, but a fairly nonextravagant one. Most obviously, we've chosen not to dabble in water cooling here, as the complexity, cost and general scope for customisation is so much greater that it becomes harder to generalise.

The PC was set up at default settings, with the CPU and GPU not overclocked, using the standard fans for the CPU and GPU coolers, and the standard fan profiles in the UEFI used for the CPU cooler and case fans. The hard drive was also mounted in the standard case mounts. We tested each of the changes we've made below in isolation (where practical), recording an overall sound level for the whole PC at each step of the process. We also recorded CPU and GPU temperatures and clock speeds for each step to gauge its effect on cooling.

We tested for noise using a decibel meter mimicking a normal sitting position, at a distance of 20cm back from a desk and 50cm above it. The PC was set to one side of the desk a further 50cm to the side of the decibel meter.

For idle tests, the PC was left at the Windows desktop. Meanwhile, for our load testing, we ran the Prime95 smallfft test to load the CPU, running it with 24 workers (loading up all virtual cores on the CPU), 12 workers and 6 workers, to simulate less CPU-intensive workloads. At



The Corsair 4000D comes with two fans and has a swappable front panel that can be solid or mesh

despite drives generally being well hidden in the depths of a PC. If you're still using a mechanical hard drive, then this is a great place to start your silencing.

With our hard drive mounted using the hard plastic mounts provided in our Corsair 4000D case, our recorded idle sound was 33.5dB while the drive was busy accessing data and 32.2dB while just spinning, but this dropped all the way to 31.2dB with the drive off completely.

IF YOU'RE STILL USING A MECHANICAL HARD DRIVE, THEN THIS IS A GREAT PLACE TO START YOUR SILENCING

the same time, we ran the Unigine Heaven benchmark to load the GPU. The noise floor for our test room was 30.5dB – a long way from the quietest room, but typical of the noise level in most homes without any particularly obvious background noise sources.

HUSH THOSE HARD DRIVES

It may seem like an odd place to start your pursuit of PC silence, but during our testing the most obvious noise emanating from our PC when idle was the hard drive. The sheer force being exerted as the spindles spin, and the read/write heads flick back and forth means the sound from hard drives really reverberates, That difference may not sound like a lot but you really do notice the background thrum of the drive spinning away. What's more, depending on how the hard drive was sitting, it could get much louder if the drive made firmer contact with the metal of the case – a bit of jiggling was required to stop it reverberating quite so much.

So what's the solution to howling hard drives? Well, some cases come with mounts that have rubber rings surrounding the pins that slip into the screw holes on the hard drive. Or you can get similar rubber rings that surround the mounting screws you use to affix the drive. These definitely help to reduce

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FEATURE / CUSTOMISATION



Resting or mounting hard drives on thick foam will absorb the worst of their vibrations

the worst rattles, but aren't the most effective solution, as the rubber tends to be too thin and stiff to significantly absorb vibrations.

Instead, your best bet is one of three options. First, just get rid of your hard drives. SSDs are cheap enough that they can be a viable choice even for bulk storage, so if noise is a concern, it's by far the easiest option. Alternatively, you can make sure your drives are slower-spinning, less performance-focused models that top out at 5,400rpm rather than 7,200rpm.

Secondly, make sure your system is set up so that your drives are powered down as often as possible, assuming the drive is being used only as a secondary backup/bulk data drive – you really shouldn't still be using a hard drive as a system drive.

Start by disabling indexing for the drive – right-click on the drive in File Explorer, hit Properties then untick the 'Allow all files...'



Rubber grommets for mounting hard drives are an improvement on plain screws or hard plastic hard drive mounts

button at the bottom of the popup. This turns off Windows' regular background checking of files that it uses to speed up its desktop search facility. Turning off indexing will make searches slower but it will greatly reduce background access of the drive. Plus, if your drive is only used for occasional backup purposes, this shouldn't be a major problem.

By default, Windows will also wait 20 minutes before powering down a hard drive

set the hard drive on a 1cm-thick slab of foam resting on the base of the case.

Bear in mind that hard drives do get hot – we've done this with a single drive in a drive bay with room for airflow around the drive, but you won't want to bunch several drives together with just foam slabs separating them. This one change immediately dropped our access noise to 32.8dB and spinning noise to 31.6dB, and subjectively, it really took the edge off the incessant low-level hum reverberating from our PC.

PROPERLY PLACE YOUR PC

There are few more effective ways of reducing your disturbance from PC noise than simply moving it further away from your ears. We compared the noise from our test PC in its default position on the desk, to it being sat on the floor just to the right of the desk, and the sound dropped from 31.2dB to 30.9dB at idle and from 36.3dB to 34dB under load. That's with no penalty to system temperatures or performance. You just have to reach a little further to plug in any peripherals and you won't be able to gaze at your pretty PC parts.

Whether you put your PC on the floor or leave it on your desk, though, there's one simple step you can take to reduce the noise from your PC, again without affecting its performance in any way, and that's to place it on a soft surface.

THE MOST IMMEDIATELY EFFECTIVE WAY TO SORT HARD DRIVE NOISE IS TO ISOLATE IT FROM THE CASE WITH SOME SOFT MATERIAL

after it has been accessed, but if you go to Power Options in the Windows Control Panel, select your current power plan and then click on 'Change advanced power settings – there should be an option to turn off your hard drives after a certain amount of time. Change this to one minute to ensure your drives power down as soon as possible, just note that this is a universal setting, not per drive.

The most immediately effective and easiest way to sort hard drive noise, though, is to isolate it from the case with some soft material. Depending on how much you move your system, you may need to come up with a more secure version involving zip ties to secure your hard drive to your case, but to get an idea of noise, we simply removed the drive tray and Whether that's the carpet in your room, one of those full-sized desktop mouse mats or a dedicated sheet of foam, adding some degree of vibration isolation between your whole PC and any hard surface on which it's resting can greatly reduce noise by eliminating contact between hard surfaces – just think of the difference it makes if you have a vibrating phone on a glass table as opposed to a sofa. Some cases do come with rubber feet, which can reduce the worst rattles but generally they aren't soft enough to significantly reduce vibration transmission.

We tested our PC on its desk as normal and with a layer of 1cm foam sat underneath it. As with hard drives, be cautious about airflow here, as many cases (especially those with solid front panels) rely on vents in the bottom of the case as an airflow intake. Leave the feet on your PC case, and make sure there's a gap between the foam and any vents on the bottom of your case.

With our default Hyper 212 Evo V2 cooler installed, we could just about measure a consistent 0.1dB reduction in noise with the foam when the system was idle, and in person the change was clear. The noise level was identical under load with the PC on the desk, but that was to be expected given the overwhelming volume of the fan noise.

Meanwhile, with the PC on the bare wooden floorboards next to the desk, we measured no difference at idle but under load there was a 0.1dB difference. Switching to using the AIO cooler on our CPU, the noise from the water pump was significantly impacted by the undercase foam. It dropped by 0.2dB under load while on the desk and on the floor.

These findings tally with our overall impression that foam and other vibration reduction works best for low-frequency, energetic vibrations from hard drives and pumps, while it's less impactful for fan noise. With the hard drive in its hard plastic tray, you could really hear its hum being conducted through the case to the desk and floorboards, so eliminating this rumble earlier by adding foam under the drive reduced the worst offender for conducted noise. That's also why you shouldn't place your PC, or any other noisy equipment, on bare floorboards upstairs, as the sound will conduct through to the ceiling below.

The addition of a layer of foam under your PC case helps to reduce vibrations from hard drives and pumps reverberating through your desk



The difference in noise between solid front panels with side ventilation and fully ventilated front panels is quite noticeable

If you really want to go the whole hog, the ideal stand for your PC would be a dense hard substance, such as a thick piece of MDF sat atop a thick (1in or so) layer of highdensity foam.

The slab's weight reduces its ability to be moved/vibrated by the vibrations in your case, plus it provides a stable surface into which your PC's feet won't sink, while the foam absorbs any vibrations that do make it through the board. Providing a hard surface for your PC





when placed on carpet is also a good idea, as it will prevent case feet marks and ensure any air intakes aren't blocked.

SEAL THE FRONT PANEL

Next we compared the difference between using an open/mesh-fronted case vs a solidpanelled front, as well as taking the whole side panel off the case. The Corsair 4000D case came in particularly useful here, as its front panel pops off and you can buy either the solid panel or mesh panel separately.

Starting with the front panel options, our tests showed a very small advantage to the solid panel when it came to noise reduction. When idle, the solid panel hit just 31.2dB, while the mesh panel let through 31.5dB, while under load, the solid panel hit 36.3dB compared to 36.5dB for the mesh panel. The difference was definitely noticeable from in front of the case, with the solid panel slightly muffling/ deflecting the internal sounds.

Internal temperatures were in the mesh panel's favour though. While the CPU stayed rooted at 90° C under load, the GPU temp dropped from 68° C with the solid panel to 66° C with the mesh panel.

The placement of the one default front fan directly in line with the graphics card meant that

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a slight increase in air flow to this fan reduced GPU temperatures.

Next we tried removing the side panel, which in this case is glass rather than metal. Not surprisingly, removing it had a profound effect on sound levels across the board, drowning out the effects of the front panels. Without a side panel, idle noise was 31.8dB while load noise was 38.1dB. Both are significant jumps, and the difference is very obvious. However, removing the side panel also had a significant effect on cooling. Again, the CPU didn't budge but the graphics card dropped as far as 63°C.

Either way, side panels are your friend with noise reduction. This also explains why small form factor systems can be a challenge to cool quietly, and why fantastic-looking, ultracompact open air 'cases' may look the part but can be a challenge if noise is a concern.

UEFIFAN CONTROL

Adjusting fan speeds is perhaps the oldest and most well-known approach to reducing PC noise. Whether it's through simple BIOS/ UEFI fan speed curve changes, through dedicated hardware fan controllers or via the latest software-controlled fan hubs, dropping fan speeds and optimising your fan layout is a surefire route to PC tranquillity.

The first place to start with fan control is to jump into your motherboard's UEFI via whatever route it normally specifies – generally hitting Del or F2 at boot-up.

Then head over to the fan control section if it has one. Here you'll be able to specify how each fan attached to your system's

You can take manual control of fan speeds in your motherboard's UEFI motherboard runs, although not the fans on your graphics card or PSU.

Generally, there will be profiles for a silent mode, a standard mode and a performance mode, each of which will ramp up the speed of the fans slightly differently as the temperature of the CPU increases. If you have a liquidcooling system and motherboard that gives you the option, it's also worth changing the input here to the coolant temperature, rather than the CPU temperature.

You can also specify custom profiles to more finely control what each fan is doing. You can choose whether a fan is running in pulse width modulation (PWM) mode or DC mode, which you can generally determine by whether the fan has a 4-pin plug (PWM) or 3-pin plug (DC). Most cases come with cheaper DC fans – as was the case with our 4000D – and generally, DC fans have more limited control options in the UEFI and can't be made to run as slowly as PWM fans.

For our tests, we initially set the CPU cooler and two case fans to a default 'standard' mode in the UEFI, then compared this with the optional 'silent' mode and quickly came up against two limitations. Firstly, all the default modes start spinning up the fan too quickly – our CPU idles at or around 30°C and both profiles started turning up the fan at this speed. This didn't affect our idle sound tests, but it was noticeable how only small loads could ramp up the fans earlier than needed.

The second issue with these default modes is that the Ryzen 5900X runs very hot, even under moderate load, when its Precision Boost Overdrive (PBO) mode is enabled. Load up just a few cores to 100 per cent and it will report that it's running at 90°C. This in turn makes





Quite basic air coolers can tame even the latest CPUs, but you'll need to spend more on a larger cooler to keep your PC quiet

the default fan profiles crank the fans to 100 per cent. Even with just six workers running in Prime95, the reported package temperature was still 90°C. The upshot is that there was no difference between any of the default fan profiles for our setup at load. Note, though, that this situation won't necessarily hold for slower CPUs with fewer cores.

For our custom profiles, then, we ensured fans didn't start ramping up their speed until 40°C, and then experimented with maxing out the CPU and case fan speeds at 80 per cent and 60 per cent speed. For initial reference, with the fans all hitting full speed under load, our CPU was hitting 90°C, the GPU was hovering at 68°C and the CPU's clock speed was around 4.3GHz. The resultant noise level was 36.3dB. These figures all stayed identical when reducing the workload to 12 and six threads on the CPU.

Implementing a drop to 80 per cent case fan speed, but still keeping the CPU running at up to 100 per cent, resulted in a huge drop in noise level to just 33.1dB under load. Clearly, those case fans aren't quiet when running at full whack. However, we also then noticed



240mm (and larger) AIO coolers are ideal for allowing fans to run slowly and quietly, although pump noise can still be audible when your PC is idle



an immediate change in the maximum clock speed the CPU would reach (though not the reported temperature). It topped out at 4.25GHz with six threads running, 4.1GHz with 12 threads and just 4GHz with 24 threads.

Dropping the CPU fan speed to 80 per cent resulted in the peak clock speed continuing to drop. Clearly, the Cooler Master Hyper 212 Evo V2 is at its limit trying to cool this CPU without the aid of case fans blasting air at it.

Rvzen 95900X to throttle down to 4.3GHz under the same settings, the two AIO coolers didn't drop below 4.35GHz and the ML240L hit as high as 4.45GHz with only six threads loaded on the CPU. These coolers also helped to reduce GPU temperatures by keeping the ambient temperature of the case lower.

Engaging our custom fan profiles resulted in the noise level of both coolers plummeting. With the case fans and CPU fans set to 80

SHEER HEATSINK SIZE AND GENERAL CPU **COOLER CAPACITY IS A CRUCIAL CONSIDERATION FOR A QUIET PC**

CPU COOLERS

If your system is anything like our test system, and it has a CPU that hits high temperatures easily, a CPU cooler upgrade can reduce overall system noise. By spreading the heat over a large radiator, all-on-one liquid coolers can be ideal here, particularly 240mm and 360mm models. With a large radiator and several large fans, you can then run the fans at low speeds and still get decent cooling.

To see how different coolers fared, we installed a 120mm AIO cooler, the Corsair Hydro Series H60, and a 240mm AIO cooler, the Cooler Master MasterLiquid ML240L V2 RGB, into our system. What was immediately striking was that neither option actually reduced the reported temperature of our CPU, such is the intensity at which this processor runs when PBO is enabled. Moreover, both options made a right racket using default fan curves - the H60 hit 39dB while the ML240L V2 RGB hit 40dB (we used the fans supplied with each cooler).

However, the more powerful coolers did allow for the CPU's clock speed to ramp up slightly. While the Hyper 212 would prompt the per cent, the ML240L's noise dropped to just 33.7dB while the H60 dropped to 33.2dB. However, we again saw the smaller cooler the H60 – struggling, resulting in a drop in CPU frequency. It dropped to 4GHz under full load and 4.125GHz under half-load, topping out at 4.35GHz with just six threads running. In contrast, the ML240L didn't miss a beat and the CPU's clock speed didn't drop at all.

Dropping further still to 60 per cent, fan speeds saw the CPU throttle further and further with the H60 and Hyper 212, but the ML240L again had no problem keeping this toasty CPU cool, and it did so while hitting just 33.1dB. Finally, dropping all the fans to 40 per cent speed saw the ML240L starting to struggle under full load, with the CPU hitting 4.2GHz. but it put out just 32dB. It's likely that an upgrade to a 280mm or 360mm cooler would give you more headroom here.

All of which goes to show that sheer heatsink size and general CPU cooler capacity is a crucial consideration for a quiet PC. With enough mass (and conducting fluid or heatpipes) to draw heat away from your components, you can keep fan speeds low to gently waft away the heat.

GRAPPLE WITH YOUR GRAPI-IICS CARD

The noise output from graphics cards can vary wildly depending on the heat output of the GPU and the cooler to which it's attached. For instance, the Zotac RTX 2070 card we've used for most of our testing has an enormous heatsink that's 6cm longer than a standard ATX motherboard and takes up two and a half PCI-E slots.

As such, its GPU temperature never peaked above 68°C and its cooler remained impressively quiet under load, only really becoming a noise concern once just about every other measure had been taken to quiet our system. As a point of reference, it only raises total system noise to 32.3dB under isolated load.

Reducing the maximum fan speed can keep noise in check, even when your components are at their hottest



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Weirdly, though, the fans don't fully turn off when the card is idle, so there's a slight background woosh all the time. It's low enough to still be below the noise from most other components (until they were quietened down) but certainly noticeable in person. In contrast, plenty of modern graphics cards come with fans that turn off completely when idle but can be far louder when under load.

Whatever card you own, though, there are options for taking control of their noise output, if you're willing to do a bit of tinkering. As Antony Leather explored in his in-depth guide in Issue 215, it's relatively easy to modify a graphics card cooler to use conventional case fans. You just need to remove the existing plastic shroud and fans from on top of the heatsink, then attach some case fans to the cooler with cable ties. How easy and how effective this will be varies depending on the card, but we've had great success with it on several cards.

On our Zotac RTX 2070, it was a ten-minute job to undo a few screws, unplug the fan cables then tie on a couple of 120mm case fans and plug them into a fan controller (more on which in a moment). With this setup, we were able



potentially take the edge off peak or idle fan speeds. Moreover, these apps also enable you to experiment with reducing clock speeds and power limits in order to keep temperatures under control.

BY THE END OF OUR TINKERING WE WERE ABLE TO ENSURE THAT OUR SYSTEM WAS PRACTICALLY INAUDIBLE

to set the fans to stay turned off when idle and so drop idle noise to zero. Under load, the new fans could keep the card cooler or quieter than the stock fans as required, depending on the speed we chose.

If you're not willing to risk damaging your graphics card by modifying it, you can always jump into the likes of MSI Afterburner or Zotac Firestorm to take some control of your card's stock fans.

Generally, the range of fan control is quite limited in these apps (if your fan spins at idle, this can't be disabled via software) but you can



Crude but effective, a couple of case fans, some cable ties and a fan controller can sort out graphics card noise

UNDERCLOCKING

If motherboard fan control, foam padding and cooler modifying still isn't doing enough to keep your PC quiet, or you have ample performance, so don't always need your PC running at full whack (or you're using a laptop that can't easily be physically modified), one of the best ways to reduce heat and noise is reducing the clock speed or voltage of your CPU and GPU.

For GPUs, this is easy to perform with software such as MSI Afterburner, while for CPUs, you can either use software, such as Ryzen Master, the software that comes with some motherboards or you can use the UEFI. For CPU control, most changes generally require a restart, which does limit their usefulness – it's a pain to have to restart just to switch between a quiet desktop setup and a loud gaming mode.

However, for GPUs, you can generally change these settings on the fly using software profiles. You can have one for general

Software such as MSI Afterburner can enable you to control GPU fan speed and underclock your card

desktop, one for intense desktop work, such as Photoshop or video editing, one for gaming (or specific games) and one for (say it quietly) crypto mining, if you're into that sort of thing.

As well as the general ability to take control of your hardware, this approach also allows you to work round the extreme heat output of products such as the Ryzen 5900X. Simply turning off PBO in Ryzen Master resulted in our CPU temperatures pottering along in the high 70s or 80s, depending on which cooler we were using.

The downside is reduced performance, with clock speed dropping from 4-4.4GHz to 3.8-4GHz, depending on which cooler was used. Assuming that your graphics card is the main limit for game performance in your machine (which is usually the case), though, those last few hundred megahertz of CPU speed can probably be sacrificed for a quieter life.

FAN CONTROLLERS

If you're still finding your PC's fans are too loud, or you can't get enough control of them, investing in a dedicated fan controller is your next best bet.

They come in all sorts of shapes, sizes and levels of capability, from lowly single-fan, in-line DC resistors to sophisticated, multi-fan, USB-controlled hubs that can control every fan in your system, respond to additional thermal probe inputs and even control your RGB lighting. Fan controllers such as Corsair's iCUE Commander Pro let you control fan speed via software, and include their own temperature probes

To compare the sort of control you can get from dedicated controllers with the more basic abilities of UEFI fan control, we hooked up a Corsair iCUE Commander Pro to our system. This unit costs £60 inc VAT and has six fan connections, along with connectors for two RGB strips and four temperature probes.

Hooking up the iCUE Commander Pro to our system enabled us to take full control of all the fans that came with the CPU coolers and the case. The advantage is threefold. Firstly, it allowed us to completely shut off our fans when idle, totally eliminating any fan noise, bar the GPU (without modification). It also enabled us to use more parameters to fine-tune fan control, such as using GPU temperature or information from the included temperature probes that could be stuck to the motherboard or other parts of the system.

By setting up the system in this way we were able to drop the idle fan noise to zero, while taking full control of the balance between noise and system temperatures under load. The figures reflect the same minimum and maximum results we achieved with our motherboard control system, but we were able to switch fan profiles on the fly, plus this system makes it much easier to fine-tune your fan settings.

Before you purchase a fan controller such as this one, though, you'll want to check which types of connectors are used by your fans, and whether they're compatible with your chosen controller. We originally intended to use the newer Corsair iCUE Commander Core XT for our comparisons, for example, but found it doesn't control 3-pin fans, rendering it useless with the fans included with Corsair's own 4000D case.

UPGRADE YOUR FANS

If the stock fans with your case and coolers can't be tamed, there's one last resort, which is to invest in some premium case fans. For our system, we swapped out the two case fans and the default fans for the coolers and replaced them with Corsair ML120 Pro fans.

Available for £25 each or £65 for three, these fans don't come cheap, but along with digitally controllable RGB lighting, they also include rubber isolated screw mounts to reduce vibration passing from the fan to the case. They also have a low RPM range and use magnetic levitating bearings to eliminate bearing noise.

The effect was immediate, with these fans proving whisper-quiet and dropping idle noise to just 30.6dB while load noise hit just 31.5dB regardless of which cooler we used and which fan profile we chose. The maximum speed of these fans is low enough that fan curves don't matter much.

However, what this swap did highlight is the importance of the interplay of case fans with CPU and GPU coolers. Our PC may have been whisper-quiet, but CPU clock speed dropped a lot with the new slower fans when we were using our Hyper 212 and 120mm AIO coolers, hitting just 3.7GHz.

It required the radiator capacity of the ML240L to wick enough heat away from our CPU for it to maintain a high clock speed under load with the quieter fans. Adding a second fan at the front of the case, in line with the CPU cooler, did help considerably with the less powerful coolers, though, bringing the maximum clock speed back up to 3.85Hz under a full 24-thread load, and 3.95GHz with a six-thread load.

CHILLING CONCLUSION

There are several main takeaways from our descent into din deadening. The first is that a lot of noticeable noise, particularly when

a machine is idle, comes down to physical contact. Isolating hard drives, pumps, fans and even your whole case with foam or soft rubber reduces vibrations being passed on and amplified by the panels of your case or the surface of your desk.

Secondly, mass matters when it comes to CPU and GPU coolers. Our air cooler and 120mm AIO liquid coolers lacked the cooling capacity to allow heat to be slowly dissipated at low fan speeds. Meanwhile, the ML240L and massive Zotac GPU cooler meant these components could cope with slow-spinning fans gently wafting air across them to keep cool. Skimping on the cooler size for either component means fans have to spin fast and loud to get rid of the heat.

Finally, fan and clock speed control are your friends. Taking the time to really experiment with the speed of each individual fan in your system – and sometimes ensuring certain fans never hit their peak speed – will keep your system noise-balanced. Meanwhile, unless you absolutely need it all the time, underclocking your CPU is well worth it for everyday use.

At the start of our silencing mission, our system was putting out as much as 33.5dB at idle, while under load it was belting out between 36.3dB and 40dB.

By the end of our tinkering, we were able to ensure that our system was practically inaudible (other than the pump noise from the AIO CPU coolers), thanks to our fan controller turning off all the fans and us swapping from hard drives to SSDs. Once under load, our quietened system's peak noise measured just 32dB. **CPC**



Upgrading to premium fans can reduce noise

2022 the road ahead

With 2021 being dominated by supply chain issues across the tech industry, **Edward Chester** takes a look at what lies ahead for 2022

INTEL GRAPHICS

022 is set to be a year of big hardware launches, with all the major component players releasing significant new upgrades. However, potentially the biggest of the lot is the entrance of Intel into the discrete graphics card market, with its Intel Arc product line. Having tried and failed several times to step into the space before, this latest attempt finally looks like it's set to offer a genuinely competitive product, even if rumours suggest it won't topple Nvidia from the gaming performance top spot.

We went into as much detail as we know at this point regarding Intel Arc in Issue 219, but the short version is that the brand-new Xe architecture on which it's based will support the same core features as modern Nvidia cards. As such, you'll get full DirectX 12 Ultimate hardware acceleration, including variable rate shading, mesh shading and ray tracing. Notably, the cards will also sport dedicated matrix processing units (called XMX units) akin to Nvidia's Tensor cores, which AMD's current RDNA2 architecture don't include.

These matrix units have many uses but the most well-known one so far for gaming has been with Nvidia's Deep Learning Super Sampling (DLSS) technology. DLSS is used to upscale games from a lower render resolution to a higher output resolution to reduce overall processing requirements, without reducing image quality as much as traditional upscaling techniques. It uses information from previous frames to inform the output of the next frame, and this comparison is greatly accelerated by Nvidia's Tensor cores.

With Arc, Intel will also be bringing this sort of capability to market with its Xe Super Sampling (XeSS) software, but while DLSS is restricted to Nvidia's Tensor cores, XeSS will be cross-platform and will even work on cards without matrix units, instead utilising conventional GPU cores to perform the required calculations.

Another reason AMD will be feeling the pinch is that Intel Arc's ray-tracing units are more capable than those of its RDNA2 architecture, at least on paper. While Arc and Nvidia Ampere ray-tracing units support acceleration of ray traversals, bounding box intersections and triangle intersections, RDNA2 lacks ray traversal acceleration.

However, Intel won't be able to avoid the ongoing issues with supply. Although the new

cards look set to be among the first products to be made using TSMC's latest 6nm node (a refinement of the 7nm process used on current AMD and Nvidia cards), there's little reason to suspect that all the overarching supply chain issues the industry has faced won't also affect Intel's cards. Likewise, pricing may be a moot point when supply inevitably instantly dries up.

Still, three players in the GPU market is a time to celebrate, and we won't have long to wait – the first batch of cards are set to arrive in the first quarter (Q1) of 2022, making for quite an exciting start to the year.

AMD UPDATES

Big changes can be expected across the board from AMD this year, with updates for both its

Intel's new Arc graphics cards are due at the start of the year, with the first GPU codenamed Alchemist





CPUs and GPUs set to introduce several never before seen technologies.

First up is an update to the company's Zen 3 CPUs. These chips are set to be largely the same as existing Zen 3 designs in terms of the core architecture and manufacturing process, as well as the socket, chipset and memory they'll use (they're expected to slot right into existing AM4 motherboards). However, they will incorporate a new 3D V-Cache die stacked right on top of the processor dies.

According to AMD, the new cache can provide up to a 15 per cent increase in performance, which will go a long way towards bridging the performance gap that opened up between AMD's current Zen 3 chips and Intel's chart-topping Alder Lake CPUs.

It's not yet known if a fully refreshed line-up will be announced with the new technology, or whether just one or two of the top-end processors will get the 3D V-Cache treatment. However, with Intel's mid-range, 6-core (six P-Cores, that is) Core i5-12600K proving such a hit for gaming performance, it would make sense for AMD to also give some of its midrange CPUs a performance boost from 3D V-Cache too.

Currently, we only know to expect the new 3D V-Cache CPUs to arrive in the first half of 2022 (with rumours suggesting around April), but it's reasonable to assume they'll arrive sooner rather than later, as by the end of the year we expect to see AMD's second big hardware release, Zen 4.

While the 3D V-Cache update isn't expected to see major architectural changes, Zen 4 is a much more comprehensive overhaul. It will usher in a new core design, a new AM5 CPU socket, a new 600-series chipset, add DDR5 memory support and be built using TSMC's newest 5nm node, rather than its current 7nm process. competitor to Nvidia's DLSS upscaling technology end of the year, not much is known about the

Intel Arc will include support for XeSS, a direct

details of the new architecture but there are some key features we can expect to see.

Most notably, RDNA3 is expected to introduce a multi-chip module (MCM) design to consumer graphics. As with its chipletbased CPU design, AMD is expected to split up its GPU into several smaller dies that work

AMD is expected to split up its GPU into several smaller dies that work together to complete graphics processing tasks

Although moving from 7nm to 5nm doesn't sound like all that large a change, it amounts to some big changes in key parameters. Transistor density will nearly double, moving from around 90 million transistors per square millimetre (MTr/mm²) to just over 170 MTr/ mm². Potential clock speed also increases by 15 per cent, or you could save a substantial amount of power draw (and heat output) by maintaining the same clock speed.

The final piece of the puzzle for AMD's big desktop PC releases this year will be its RDNA3/Radeon RX 7000-series graphics cards. Set to arrive much more towards the together to complete graphics processing tasks. AMD has already showed off this approach with its Instinct MI200 GPU for high-performance computing, codenamed 'Aldebaran', but this chip isn't going to be used to make gaming graphics cards.

From a macro level, this is the same principle of how SLI and Crossfire worked, but instead of splitting tasks between different cards, or between separate GPUs on the same card, the separation here will be within the GPU itself. In theory, this should mean that a computer doesn't see multiple GPUs, reducing potential compatibility issues for game programmers.

FEATURE / ANALYSIS



AMD's Instinct MI200 chip for high-performance computing is the first official multi-chip module (MCM) GPU, but it won't be used for gaming graphics cards

As well as this compatibility advantage over previous multi-GPU setups, an MCM approach should also reduce manufacturing costs, as the likelihood of there being a catastrophic manufacturing error is much lesser per die for smaller dies than bigger dies, potentially increasing yields. Whether that results in meaningfully cheaper and more readily available graphics cards is another story, but the theory is sound.

Along with its new chip design, the RDNA3 architecture is expected to introduce a matrix processing unit for machine learning calculations. This will bring AMD's offering into line with both Intel's new Arc GPUs and Nvidia's existing 3000-series GPUs, while enabling hardware acceleration of any future DLSS-like upscaling technology AMD uses. Similarly, RDNA3 is expected to bring in support for hardware accelerated ray traversal in ray tracing, again bringing AMD's offering into feature parity with Intel and Nvidia. Moreover, this addition – along with any other ray tracing unit improvements – should greatly increase the ray-tracing performance of RDNA3 GPUs over RDNA2 models. While RDNA2 can do ray tracing, performance is slow enough that it often proves unplayable, even at modest resolutions, so AMD needs to do plenty of catching up in this sphere.

Set to launch at some point in late 2022, this new GPU is rumoured to pack a whopping count of 18,432 CUDA cores

NVIDIA AND ADA LOVELACE

What will be Nvidia's response to both AMD and Intel's big graphics moves? First is a refresh of the company's RTX 3000-series cards as early as January, topping out with the introduction of an RTX 3090 Ti. Being seen as a 'Titan-class' card, it's rumoured to use the full GA102 GPU that's also at the heart of the RTX 3090, which gives it 10,752 CUDA cores – 256 more than the RTX 3090.

It's also expected to be coupled with 24GB of 21GHz (effective) GDDR6X memory. It's also

RTX 4000-series GPUs are reportedly codenamed Ada Lovelace, and the top-end AD102 GPU looks like it's going to be a monster if the rumours hold true.

set to be Nvidia's first PCI-E5 graphics card,

and comes with a new power connector that

can deliver the wattage required to meet its

Ti is expected to be an RTX 3070 Ti 16GB, giving buyers the option of a RAM-doubled

Looking further ahead sees us delving

those rumours certainly make for eyebrow-

raising reading. Nvidia's next-generation

deeper into rumour territory. However.

version of this card.

400W TDP rating. Also joining the RTX 3090

Set to launch at some point in late 2022, this new GPU is rumoured to pack a whopping count of 18,432 CUDA cores. Such a large leap between isn't GPU generations isn't impossible – the RTX 3090 more than

AMD's Zen 3 CPU update is expected to introduce 3D V-Cache technology, where an extra cache die is stacked on the CPU die



A PACKAGING BREAKTHROUGH FOR HIGH-PERFORMANCE COMPUTING

AMD 3D V-CACHE PROTOTYPE PICTURED





The already colossal GeForce RTX 3090 is rumoured to be getting an update in early 2022, unlocking the full 10,752 CUDA cores of its GA102 GPU

doubled the CUDA core count of the RTX 2080 Ti – but it's still very much a rarity. This also goes to highlight just why AMD is likely going to take the multi-die route (which Nvidia is also purportedly pursuing with its flagship datacentre GPUs).

Nvidia's Ada Lovelace GPUs are expected to be built on the same 5nm TSMC process as AMD's chips, so it will be able to take advantage of the same performance/power consumption benefits. However, thanks to the massive increase in transistor count that will be required to build all those CUDA cores, the GPU's total power consumption is still expected to rocket. While the RTX 3090 has a total graphics power (TGP) rating of 350W, the new card could hit 600W.

THE BEST OF THE REST

It's fair to say DDR5 has had a slow start, with stock almost impossible to obtain at the moment and performance not being a huge leap over DDR4. However, as 2022 unfolds, we'll see stock levels improve, speeds increase and greater support arrive with the likes of AMD's Zen 4 platforms.



DDR5 has been slow to get off the ground but will become more ubiquitous throughout 2022

Likewise, PCI-E 5-capable motherboards, SSDs and graphics cards will roll out, although the impact of this new interface is likely to be totally unnoticed by most people in general use. Its doubling of bandwidth over PCI-E 4 isn't relieving a bottleneck for any standard PC components right now, although a bit of futureproofing is always good.

Outside the PC case, trends in most peripherals are set to be quite iterative. More mainstream gaming mice are going wireless, removing that final convenience hurdle, and we're seeing even full-sized mechanical keyboards embrace the convenience of a removable USB Type-C cable.

Monitors are also settling into a new norm, with 144Hz 4K screens now readily available and relatively affordable.

However, we hope to see more affordable screens using the latest mini-LED backlight technology, bringing true HDR visuals to a lower price point.

Wi-Fi 7 is also on the horizon, bringing support for 320MHz transmissions (double the 160MHz of 802.11ax/Wi-Fi 6), the use of higher modulation orders, option 4096-QAM support (up from 1024–QAM in Wi–Fi 6) and the allocation of multiple resource units.

Multi-link operation will also allow for data to be transmitted between devices that support multiple bands (2.4GHz, 5GHz and so on) across all those bands at once, rather than only one at a time as is currently the case. Hardware is likely to be expensive at launch – if Wi-Fi 6 is representative – and won't arrive till late in the year, if it arrives at all before 2023.

SUPPLY STRAIN

What's unfortunately likely to continue being the big story of 2022, just as for 2020 and 2021, is the problems the industry is facing with silicon supply. By and large, we're no longer talking about the logistical woes and other overarching issues affecting supply that resulted from Covid. Now, it's just a case of silicon chip producers running at capacity.

From Apple iPhone production and chips for cars, through to all the components for the PC industry, demand is colossal at the moment and everyone is having to wait in line for a smaller piece of the production pie.

Several industry leaders have warned that supply struggles will persist for at least the first half of 2022. The one big unknown and potential pressure release, at least as far as the astronomical price of graphics cards is concerned, is that cryptocurrency mining may start to settle down as the likes of Ethereum become less viable to mine. It's certainly no guarantee, but we can at least hope for it as we boldly step into another new year.

TSMC claims that its 5nm process node can result in up to a 15 per cent improvement in performance, but it's going to be in huge demand



N5 Leads Industry to Start Volume Production

- N5 offers 15% faster speed, 30% less power and 1.8X logic density over N7
- N5 product D0 performance is progressing ahead of N7
- N5P extends additional 5% speed gain and 10% power enhancement over N5



CUSTOMISATION / HOBBY TECH



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 Clockwork Pi DevTerm

he DevTerm is an unusual beast for a number of reasons, not least of which is its design. Inspired by 1980s portable computers, in particular the TRS-80 Model 100, the DevTerm is from a bygone era, yet it combines vintage technology with some of the latest innovations.

The second major project from Clockwork Pi, after the modular build-it-yourself GameShell Linux-based hand-held console (reviewed in Issue 184), the DevTerm builds on the company's strengths. Like the GameShell,

it's a modular Linux-based gadget. It also maintains the GameShell's overall design paradigm, including a push-close two-part injection moulded housing held in place by two clever plastic fasteners.

Where the GameShell looked like a Nintendo Game Boy, though, the DevTerm looks like the aforementioned Model 100, or like something the late Sir Clive Sinclair would have signed off if he'd decided to take a break from black devices. The upper half of the device is dominated by an ultra-wide IPS display; the lower half by a compact keyboard.

> And we do mean 'compact'. While the DevTerm might look like a Model 100 or Cambridge Computers Z88, it's built to a much smaller scale. With an area of just 210 x

The top-end A6 models are based on a customdesigned RK3399 system-on-module A thermal printer is built in, with a removable paper cartridge to ease transportation

155mm, that clever 65 per cent keyboard is cramped and makes touch-typing a real challenge.

Before you can type anything, of course, the device has to be built. Like the GameShell, it's a relatively straightforward process that takes no more than an hour, despite the instructions missing a couple of steps. You'll also have to provide your own batteries – a pair of 18650 lithium-ion units housed under a removable panel at the back. When fitted with two batteries rated at 3,400mAh, our test unit ran





Some assembly is required – the DevTerm is a kit of parts that takes around an hour to build

a video playback test for three hours and 49 minutes before switching off.

Battery life, though, can be variable, and not just because of the quality of the batteries you pick. There are multiple versions of the DevTerm, from a base model that accepts a Raspberry Pi Compute Module 3 system-onmodule, to the top-end A-604 with a custom SOM based on the 6-core Rockchip RK3399 with 4GB of RAM (as reviewed).

The RK3399 is known for being a highperformance device, but you'd be forgiven for being disappointed with the DevTerm out of the box. A peer into the configuration reveals why – of the promised two 1.8GHz Cortex-A72 and four 1.4GHz Cortex-A53 cores, only the smaller A53 cores are activated, and clocked down to 1GHz to boot.

A tool for enabling and disabling the cores at a range of speeds is provided, and allows for the full performance to be unlocked – until you hit the thermal throttle point, which happened within seconds during a thermal torture test.

The design includes a small blower fan, which pushes air across the SoC, while the A6 models also get a small heatsink, but these



additions aren't enough to keep the SoC cool under sustained full load. The fan is very quiet, at least, and the stock four-cores-at-1GHz setting keeps the system cool enough for the fan to rarely activate.

You're unlikely to buy a DevTerm for its performance though. Its appeal is the unusual form factor – that wide 1,280 x 480 double-VGA screen, and its on-board thermal printer – complete with a removable cassette for 58mm paper rolls. Having it slowly churn out this month's column for posting to the editor was an undeniable pleasure, if one that required considerable patience.

The hardware is high quality, despite the display in our sample skipping the first four rows of pixels, but the software is still a work in progress. The bundled Linux distribution has a few rough edges, including non-functioning suspend-to-RAM and stability issues in the top performance mode. It's also built upon the shifting sands of the Armbian project, in which any given update may break established features, thanks to a cavalier approach to development and a lack of adequate test infrastructure.

The DevTerm is a novelty, admittedly, and the cramped rubber-dome keyboard, combined with the slow response of the



The DevTerm is a lot smaller than you'd think from pictures, and much smaller than a TRS-80 Model 100

If you long for the days of sticking a portable PC in your briefcase, the DevTerm is for you

tiny trackball, means you're likely to move to a bigger device before the batteries run out. The game controls are a weak point too – the D-pad is made up of four distinct buttons with enough travel to make a smooth transition through a diagonal, to make a Hadoken or Dragon Punch for example, impossible.

That said, it's a very attractive and definitely usable novelty – this month's entire Hobby Tech section was written entirely on the DevTerm, with only a handful more typos than usual, then printed on the thermal printer for submission by post for a true refresher on the state of technology journalism circa the mid-1980s (**Ed:** I can confirm this happened!)

The DevTerm is available to buy from clockworkpi.com starting at \$219 US (around £163 ex VAT) for a base model designed to accept a Raspberry Pi Compute Module 3. 3D printable files of all the plastic parts are also available for download free of charge.

Gareth wrote this month's Hobby Tech section on the Dev Term, and then submitted the printout to Ben by post





REVIEW HcX Floppy Disk Emulator

loppy disks once ruled the world of computing. Holding more data and transferring it more quickly than cassette tapes, with the added benefit of random access, having a floppy drive (or two) was the height of luxury. Today, though, floppy drives are a rarer sight – and disks are beginning to rot, rendering data inaccessible.

Devices such as the KryoFlux (reviewed way back in Issue 131) aim to assist preservation, turning drives into USB devices capable of sampling and recording the magnetic flux reversal timings. This creates an accurate image of the disk itself, rather than the data stored upon it. Once you've got such an image, though, you need a way to manipulate it, and that's where the HcX Floppy Disk Emulator comes in.

Created by Jean-François Del Nero, the HcX is a hardware device designed to emulate a physical floppy drive for a vintage computing system. The software that comes with it, though, doesn't require the hardware emulator, and offers a range of features of considerable interest to software preservationists or digital archaeologists.

The strongest feature in HcX is the track viewer, also known as the Visual Floppy Disk – you load a disk image and click Track Analyzer to see the disk in incredible detail. A preservation-grade stream file from a KryoFlux is ideal for this, as it contains

SOCard HxC Floppy Emulator settings HFE file interfacemode SD HxC Floppy Emulator Us e settinos 1 Backlight standby **UI Sound** Auto Device standby Head step sound Double Step SD HxC Floppy Emulator ce setting Scroll text speed Load last loaded flopp Drive A Drive B Mode From HFE Disable drive selector ٠ From HFE \$ Force loading STARTUPA.HFE to drive A at power Force loading STARTUPB.HFE to drive B at power up Indexed Mode 2 drives emulation
Drive B input as Drives Motor ON Enable indexed mode AUTO BOOT Mode / File Selector software startup Load config file Enable auto boot mode Enable index Pre increme Save config file Ok Force loading AUTOBOOT. HFE at power up

information about the disk's surface, although an image file can also be selected.

The default view shows you the tracks represented as a line graph, which you can replace with a scatter plot for more detail. Each sector in the track is then decoded and highlighted green for valid and a light red for invalid, including CRC failures. By default, the tool highlights tracks in ISO FM, MFM and Amiga MFM formats, although additional decoders can

Tools are included for handling external hardware, including HcX and Pauline emulators

be activated for Apple, Commodore 64/128, Membrain, Heathkit, DEC RX02, Northstar and other formats.

Hover the cursor over any recognised and decoded sector and you'll see details, including checksums, size, sector number and a hex dump of the contents. For disks of unknown format, this provides an easy



way to glance at the contents and skim for anything recognisable.

The software's other visualisation mode takes a rather more literal approach, mapping the sectors to a physical floppy disk – either an enlarged 'dummy disk' designed to fit any size of real-world media or a true-to-life 3.5in, 5.25in or 8in disk. As in the default view, sectors here are analysed and marked in green where valid. In this view, though, it's possible to find the exact location of the damaged area on a given disk – if you load a stream file, you can even see the rough shape of this damage.

One disk being examined in the tool proved to have a damaged area that showed up as two red'splodges' on the disk viewer. Using the visualisation, it was possible to find the damage on the physical disk and attempt to clean the area with isopropyl – a process that succeeded in a clean, green, error-free read after three clean-and-dump cycles.



The raw loader lets you specify custom disk geometry, if you have an unusual format to load

There are still more strings to the HcX bow. Raw disk images, including KryoFlux stream files, can be loaded with custom geometries – another powerful way to retrieve data from unusual or even outright unknown disk formats.

Once loaded, disk images can be exported in a range of formats, including Amiga Disk Files (ADFs), Dragon 32/64 VDK files and raw ISO sector images. The latter can even be fed through tools such as TestDisk to recover deleted files, although getting an image mountable in DOSBox from more unusual disks – such as the triple-format Amiga/IBM/ST disks on the front of Public Domain magazine in the 1990s – can be a challenge.

One particularly handy feature is the DOS disk browser. For operating systems that don't easily allow for ISO files to be mounted and explored, this browser allows the user to easily browse a disk's contents and even retrieve files. You can even write new ones to the image by dragging and dropping from the host operating system.



BMP file (disk)(*.bmp) XML file(*.xml) NSI file(*.nsi) H8D file(*.hsd) QD file (Quickdisk HxC Floppy Emulator file format)(*.qd) All Files (*) Custom Filter

Disk images can be exported in a range of formats, including Dragon 32/64 VDK files

Other features do require additional hardware though. There's a control interface for the Pauline floppy disk emulator, configuration settings for the SD card and USB versions of the HcX Floppy Emulator, and even the ability to dump a physical disk if you have a floppy drive connected. For the latter, though, a KryoFlux is the better tool – if, admittedly, a relatively expensive one.

If you're a KryoFlux user, the HcX software is a must-have tool. If you're more used to simply consuming disk images that other people have dumped it's still worth a look, especially for visualising the layout of unusual disk formats,

> or learning exactly how the magnetic flux reversals translate into the data on the disk.

The HcX Floppy Emulator is available for free download from hcx2001.com, or it can be installed on Linux via Flatpak (flathub.org).

The analysis tools are top-notch, and great for learning just how disk encoding works



REVIEW Hex Loader

t's hardly rare to see a piece of media receive a tie-in game, but a ZX Spectrum tie-in is more unusual these days. For Hex Loader, though, it's very much on-brand. Written by Dan Whitehead, illustrated by Conor Boyle, and lettered by Jim Campbell, it's the story of a struggling game developer set in the mid-1980s, and it rapidly shifts into the supernatural in a wholly original story that intertwines science and magic.

Presented in greyscale, bar the covers, the book builds a world that will be familiar to readers of a certain vintage, where kids barely out of school toil away in bedrooms and offices above kebab shops, with dreams of being the next Matthew Smith and making a fortune from a successful game such as Manic Miner.

A key plot device is Combat Wombat, a ZX Spectrum game written by the main character. Without giving too much away, the game's

The greyscale art is well-presented, and the story is engrossing, if a little short



main character plays an important role in what unfolds, but the game itself is also supplied as a tape image suitable for use with any Spectrum emulator. Combat Wombat is a genuine playable game tie-in for a computer that, while undeniably successful, was officially discontinued nearly 30 years before this graphic novel hit the shelves.

The game itself is playable, if basic. The player is put into the shoes of the titular Combat Wombat, an anthropomorphic wombat crossed with Rambo, and given the job of walking and jumping across a series of screens, gunning down anything in their way. Even by Spectrum standards the graphics are simple, but it's amusing enough for a play or two – save it until after you've read the book to avoid mild spoilers though.

The graphic novel, meanwhile, is excellent. The core world it builds is believable, particularly for anyone who experienced the game industry in the 1980s, and its shift into a Shadowrun-esque story in which hacking and hex-casting sit side by side is handled wonderfully.

Also expertly handled is the underlying coming-of-age story. However, the anticonsumerism 'modern art is a bit silly aspect' is far from subtle. It involves a comically evil man



Blending the worlds of magic and ZX Spectrum games programming, Hex Loader is a real trip

in a sharp suit literally trying to delete creativity from the world in order to trick people into buying any old tat, including on-demand Polaroids of a woman thinking and a literal dirty coffee cup.

At just over 150 pages, Hex Loader won't take long to read, and you're not likely to play Combat Wombat for more than a few minutes. For those with a real Spectrum, there's even a printable cassette case insert should you write the game to tape – complete with ageappropriate wear.

It's a thoroughly entertaining if short read, which is likely to appeal to readers who like an off-the-wall story, just as much as those who remember being that would-be Matthew Smith themselves. Hex Loader is available from **buysmallpress.com** for £5 as a digital DRM-free PDF download or £10 in print (both prices include appropriate VAT). **CPC**



A tie-in ZX Spectrum game is a neat inclusion, but relatively simple even by the standards of the era

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MODDING / OPINION



ANTONY LEATHER'S

Customised PC

Case mods, tools, techniques, water-cooling gear and everything to do with PC modding

RGB lighting finally gets easier

t's amazing to think that RGB lighting didn't exist in the PC ecosystem just a few years ago. If you wanted to add some illumination to your PC before then, you'd need to use external kits powered directly from your PSU, usually comprising LED strips. If you're as old as I am, you might even remember cathode lighting too.

Single-colour LED strips were revolutionary when it came to lighting up your PC, and I still use them often. However, they're not very flexible in terms of colour matching and can often be a shade out compared with the rest of the hardware or lighting I'm using. That's where RGB lighting comes in handy, as you have millions of colours from which to choose. For me, that's more important than funky rainbow lighting effects, and it can be achieved with the latest digitalcontrol tech, which gives you control over the colour and brightness of individual LEDs.

These days you don't even need to use separate power adaptors and cables for your lighting. You can wire your LED strips straight to your motherboard. First, 4-pin connectors that control an entire strip of LEDs entered the fray, then we got more intelligent 3-pin digital technology that allows you to control individual LEDs. Of course, a lot of the best technology involved lighting controllers tied to proprietary ecosystems, which has posed some significant issues.

Using one of these controllers locks you into one manufacturer's hardware, and any attempts to open it up in software, such as Corsair controlling Asus motherboard lighting, and MSI motherboards including headers for Corsair's RGB hardware, haven't always worked well, despite good intentions. RGB lighting now extends to nearly every component, including power cables

You'll find plenty of forum posts on these issues, and it's fairly clear that while this is a good idea, it still has problems. Notably, RGB software from motherboard manufacturers often appears to be even more hated than their software for fan control and overclocking.

I'm still a big fan of RGB lighting, though, and for a few reasons. If it's done well, it can complement any PC, especially if there are other coloured elements to your build. If you've spray-painted your PC then RGB lighting can help to illuminate the paint or complement it.

Memory modules always look great if they have RGB lighting, and some of the motherboards I've seen have fantastic-looking RGB lighting displays too. There are some ongoing issues, though, as far as compatibility goes. My pet hate is proprietary connectors. What's most annoying here is the fact that the underlying cables and the way the hardware works is exactly the same. Take off the connector, solder on another one from another manufacturer or hook it up to your motherboard, and the lights will work. It's just a product of manufacturers greedily tying you to their own hardware.

It's no surprise, then, to find adaptor kits for sale on eBay and Amazon that convert these proprietary connectors to standard 3-pin or 4-pin connectors. What's more, buying into these closed systems means you can't expand them with hardware from other manufacturers, or even



components with standard 3-pin and 4-pin connectors.

Thankfully, there are signs that this situation is changing. Manufacturers such as Phanteks and Corsair – two of the main culprits as far as proprietary RGB connectors go – are now offering converters with some of their latest gear, which enable you to connect their hardware to standard RGB headers and vice versa. RGB lighting isn't just for fancy rainbow effects – it can help to complement your PC's colour scheme as well

Corsair's excellent iCUE software to control a range of components, or using your current RGB controller to synchronise all your lighting gear, even if it has proprietary connectors. Add third-party adaptors and RGB software that (for the most part) works well and is more mature than a few years ago, and getting all your RGB gear in sync is about to become much easier.

It might soon finally be possible

to get the best of both worlds, using

Corsair is now shipping adaptor cables such as this one with some of its hardware



Hands on with be quiet! Light Wings RGB fans

peaking of RGB lighting, be quiet! sent me its new RGB fans this month. The new Light Wings RGB fans feature digital RGB lighting and come in 120mm and 140mm sizes, as well as low and highspeed flavours, available individually and in triple packs. The low-speed models peak at 1,500rpm for the

Light Wings RGB fans are available individually, or in packs of three with a 6-channel hub



140mm versions and 1,700rpm for the 120mm versions, while stepping up to the high-speed models sees those speeds rise to 2,200rpm and 2,500rpm respectively.

The triple pack includes a SATApowered, 6-channel RGB hub, but the fans themselves include daisychained 3-pin RGB cables, with male and female connectors on each fan, allowing you connect multiple fans to just one lighting connector. The triple pack is definitely the set to buy, despite the fact it includes the hub. This is thanks to the pricing of £23 inc VAT per individual fan, but only £60 for the triple pack, so the latter saves you money anyway.

The fans feel extremely well made, using a rifle bearing and antivibration mounts, although it's a little bit of a shame that there's no way to daisy-chain the 4-pin PWM cables. Meanwhile, the RGB lighting looks stunning, although it's only the ring around the fans that illuminates and not the blades. Even so, the fans look great and the 1,700rpm models I used were extremely quiet yet still shifted a lot of air. Even better, you can control them using standard 4-pin RGB connectors, either directly or using the hub included with the triple pack. **CPC**



The RGB lighting looks stunning, although it's only the ring around the fans that illuminates and not the blades

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How to Boost your GPU cooling

Antony Leather shows you how to reduce your graphics card's temperatures by replacing the thermal paste on its cooler

TOTAL PROJECT TIME / 3 HOURS

raphics card coolers are far better than they were a few years ago, with powerful fans and large heatsinks used to beat the heat in those lengthy gaming sessions. They ensure your graphics card can run cool and quiet, even under heavy sustained loads. However, while the cooler might be up to scratch, cheap thermal paste and thermal pads have regularly been found to hinder cooling, and haven't even been installed properly at the factory.

This can see your graphics card run much hotter and prevent the cooler from doing its job as well as seeing its fans spin up to higher speeds. Using high-performance thermal paste and thermal pads can dramatically cut temperatures and as long as you're comfortable to dismantle your graphics card, it's relatively easy to apply them too. If you can't afford to get an upgrade at the moment, you can at least ensure your current card is running at its absolute best too.

TOOLS YOU'LL NEED





1 / GOOGLE PCB PHOTOS

Identify the areas of your graphics card that are cooled with thermal pads before you start, so you can order enough pads of the right size to replace the stock ones. Google for your make and model of graphics card to see if someone else has dismantled it. The cooling configurator on **ekwb.com** sometimes has PCB images too.



2 / ORDER CORRECT THERMAL PADS If the first step proves unsuccessful, proceed to step 6 and dismantle your card, so you can buy enough thermal pads – we recommend the Gelid ones we're using here. These pads come in a variety of sizes and thicknesses, so you'll need to match the ones used on your card.



3 / CONSIDER USING LIQUID METAL PASTE We'll be using liquid metal paste in order to get the best performance, but you can also use standard paste that's non-conductive. The former can offer lower temperatures, but you'll need to carry out the steps below to ensure it's safe.



4 / INSPECT GPU AREA

Check the area around the GPU core in the image of your graphics card's PCB. This is likely to have exposed components, in which case they'll need to be insulated if you use liquid metal paste, as this paste can run when it gets hot. Again, if you can't find photos, you'll need to dismantle your card first.



5 / TEST GRAPHICS CARD

To see the results, run Unigine Valley (benchmark.unigine.com/valley) to load your card, with GPU-Z (techpowerup.com) recording the temperature of the GPU core and memory after ten minutes. Set a fixed fan speed such as 50 per cent using MSI Afterburner (msi.com), so you can stop automatic fan control skewing the results.



6 / **REMOVE SCREWS**

Remove the screws on the graphics card's rear side to begin dismantling it. Use a small pot to contain them, as they'll be easily lost. You'll very probably need a micro screwdriver to deal with some of them.



7 / DETACH CABLES

Once all the screws have been removed, detach any power and lighting cables you can see on your card. Most of them should be accessible now, but some may have to wait until you lift the heatsink.



8/ USE A HAIRDRYER

.....

If the heatsink proves tricky to remove, it can help to use a hairdryer from a foot away on a high heat and fan setting. This warms the card, and in turn warms the thermal paste and pads, making it easier to remove the heatsink.



9 / LIFT AWAY HEATSINK Go ahead and lift the heatsink away from the PCB, but do it gently and watch out for any cables that need to be detached.



10 / DETACH SLOT BRACKET

You may need to remove the expansion slot bracket at the end of the card in order to fully dismantle it. This is easy to do, as the bracket will only be held in place by a few screws.



11 / REMOVE THERMAL PADS

With the key parts separated, remove any thermal pads that are located on the VRMs and memory chips, taking note of any size differences, so you can replace them with pads of the same size and thickness.



12 / CLEAN SURFACES

With the pads removed, use thermal paste cleaner or isopropyl alcohol, plus a microfibre cloth, to clean the surfaces of the GPU core, memory and heatsink. Pads can leave behind a residue, so be sure to clean the areas that were underneath the pads too.



13 / REMOVE OTHER PADS

Now inspect the heatsink and backplate. Remove any remaining thermal pads on these parts, and clean the contact areas here too. If the backplate is metal yet lacks thermal pads by default, it's worth adding some pads above the rear of the memory modules and GPU core.



14 / AIR-DUST HEATSINK

Now is a great time to clean your heatsink, as it can pick up dust and detritus over time, even if your case is well protected against it. An air duster is great for this job, but do it outside, as a lot of dust can be ejected if your card is particularly dirty.



15 / POLISH GPU CONTACT

The part of the heatsink that makes contact with the GPU core can often benefit from being polished if it's become tarnished. Use a metal polish such as Autosol with a microfibre cloth to buff it to a shine, then use thermal paste cleaner to prepare it afterwards.



16 / CUT NEW PADS TO SIZE

Use scissors to cut the new thermal pads to size, mirroring the shapes of the original pads with the same thicknesses. Be sure to identify any small chips or other components that need pads as well.



17 / FIT PADS TO MEMORY AND VRMS

Remove one side of the protective film on the thermal pads and place the pads onto the memory and VRMs. Press them in place, as this will help them stick to the surface and not move around.



18 / USE NAIL VARNISH

If you plan to use liquid metal paste, you'll need to insulate the area around the GPU core in order to prevent short circuits should the paste run when it gets hot. Apply a thin layer of nail varnish (clear top coat) over the area immediately around the core– at least 10mm.



19 / APPLY LIQUID METAL PASTE

Now you can apply your thermal paste. You only need a very small amount – half the size of a grain of rice will be ample to cover the GPU core whether you're using liquid metal or normal thermal paste. You can see a guide to applying liquid metal paste in Issue 221 (custompc.co.uk/221).



20/ SPREAD PASTE OVER GPU

Liquid metal paste needs to be rubbed into the GPU core using the included applicators. It will start to bind with the surface, eventually covering it. If you're using a standard ceramic thermal paste, you can leave it to spread on its own using the pressure from the heatsink.



21 / REASSEMBLE AND TEST GRAPHICS CARD Finally you can reassemble your graphics card. We found the GPU core temperature on our card fell from 75°C to 58°C under load with the new liquid metal paste applied, and the peak fan speed after five minutes was 300rpm lower than before our tweaking as well.

How to Fit an M.2 heatsink

Don't have any M.2 heatsinks with your motherboard? **Antony Leather** shows you how to fit a heatsink to an M.2 SSD

BTOTAL PROJECT TIME / 30 MINUTES

hile many motherboards include heatsinks for M.2 SSDs as standard these days, there are plenty that don't have them. You don't always find heatsinks on current boards at the budget end of the scale, and high-end older boards often don't have them either, as they came out before the latest high-speed drives started getting toasty. Some of the latest PCI-E 4 SSDs, such as Samsung's 980 Pro, don't come with heatsinks as standard either.

Of course, if you're using an older motherboard that only supports PCI-E 3, then adding a heatsink to your drive will largely be an aesthetic choice. However, a heatsink can still help to prevent your drive from throttling under heavy sustained loads if there's not much airflow in your system.

While an M.2 heatsink isn't technically an essential, you'll want one if you're using a new super-fast PCI-E 4 SSD and, let's face it, they also look good. There's nothing wrong with highlighting the fact you have a shiny new, super-fast SSD by giving it a custom heatsink to stand out. And if you're using a bog-standard SSD with a boring white sticker on it then adding a heatsink will add a touch of flair to your otherwise blandlooking drive. M..2 heatsinks are easy to fit, they look great and they can prevent some fast, hot-running SSDs from throttling too.

TOOLS YOU'LL NEED



M.2 heatsink overclockers.co.uk



1 / LEAVE THE STICKER ON

Leave the sticker on the SSD, so you can sell or return it later – you'll still see a decent temperature drop with the heatsink, and you'll be less likely to damage the SSD. Before you fit the heatsink, check its maximum temperature using HWMonitor (**cpuid.com**), while running two CrystalDiskMark (**crystalmark.info**) tests back to back.



2 / TEST-FIT THERMAL PADS

Follow the instructions on how to mount the heatsink. These may involve using clips or bands to hold it in place, as well as trimming the pads. Do a practice installation first, while keeping the thermal pads' protective layers still in place, so you can get a feel for how the assembly clips together.



3 / INSTALL HEATSINK

Remove the protective layers on one side of the pads, apply them to the heatsink and then remove the protective layers on the other side. Follow the instructions to use the correct thickness for your SSD – it needs to be a tight fit to make good contact. Finally, rerun the tests from step 1 to see how cool your SSD now runs. **CPG**

WIN A 240Hz IIYAMA GAMING MONITOR



We've got a brilliant super-fast gaming display up for grabs this month, thanks to the monitor gurus at iiyama. The iiyama Gold Phoenix G-Master GB2590HSU-B1 is packed with the latest technologies, including FreeSync Premium. Its 24in IPS panel features a 240Hz refresh rate and a stunning 0.4ms MPRT response time, making sure your equipment will never hold you back.

The fast IPS panel guarantees highfidelity and displays vivid battleground scenes with outstanding colour accuracy, all while providing a stunning 0.4ms moving picture response time (MPRT). With its support for FreeSync Premium, the Gold Phoenix can also synchronise its fast refresh rate with your graphics card's frame rate. It guarantees low input latency and low frame rate compensation, putting an end to any tearing or stuttering issues at virtually any frame rate.



SUBMIT YOUR ENTRY AT CUSTOMPC.CO.UK/WIN

Competition closes on Friday, 4 February 2022. Prize is offered to participants in the UK aged 13 or over, except employees of Raspberry Pi Ltd and Foundation, 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 ontacted by email to arrange delivery. Any winners who have not responded 60 days after the initial email is sent will have their prize revoked.

Retrotech GEFORCE FX

Ben Hardwidge readies his hairdryer in preparation to revisit Nvidia's GeForce FX 5800 Ultra 'dust buster' card

A Gainward GeForce FX 5800 Ultra 'dust buster'. Photo credit: Dmitriy 'H_Rush', vccollection.ru



group of Nvidia's top marketing gurus gather together to decide how to cool their latest top-end graphics card. We could be the Harley Davidson of graphics cards,' suggests Steve Sims, senior product manager. 'When people buy a Harley or a Porsche one of the things they're looking for is that distinct noise that it makes,' concurs Dan Vivoli, vice president of marketing.

The video of the meeting, titled 'The Decibel Dilemma' then cuts to a dentist using a drill, and other clips of Nvidia's GeForce FX 5800 Ultra graphics card being used in humorously noisy situations. It's pictured being used as a hairdryer, part of a coffee grinder and on the end of a leaf blower.

Having realised that the criticism of the noise from its latest FX Flow cooler isn't going to go away, Nvidia has decided to put its hands up and own the situation with a comedy video, based on ideas contributed from the PC enthusiast community. It's preserved for posterity on YouTube (**custompc.co.uk/DustBuster**) if you want to see it for yourself. It's difficult to imagine a tech manufacturer having a similar delf-deprecating sense of humour now – Nvidia has, after all, just rereleased the RTX 2060 at the end of 2021 with a completely straight face, naturally with no stock.

FX FLOW

Was this card's cooler really that bad? I was one of the reviewers who tested some of the first samples of the GeForce FX 5800 Ultra for PC Pro magazine in early 2003, and I can tell you that the comparison with a hairdryer wasn't far off. There was a very sudden contrast with the quiet noise the cooler made when it was idle in Windows and the wind tunnel-like sound it made when the tiny fan spun up during our gaming benchmarks.

You could hear it all the way from the other side of the lab, provoking lots of laughter from the staff working for the other tech mags at Dennis at the time. The solid wall of noise could be likened to a hairdryer, but it also had a high-pitch whir – combine a dentist drill with a hairdryer and you'll have an idea of how it sounded.

A large copper plate covered the memory and GPU on the front, linked to a copper heatsink by three heatpipes. Photo credit: Dmitriy'H_Rush', vccollection.ru We criticised the noise from the blower-style coolers AMD used on its 1st-generation Navi cards a couple of years ago, but that noise was nowhere near as ridiculous as the racket from the FX 5800 Ultra.

Nvidia had got it so wrong that the only way to beat the comedians was to join them in laughing at itself. How did it happen?

Nvidia's new GeForce FX 5800 Ultra saw Nvidia taking a new approach to cooling. Up until this point, most (although not all) graphics cards had occupied a single expansion slot bracket and only required a single fan on the GPU itself. Nvidia's new GPU architecture prompted the company to take a new approach to cooling.

The move to the new GeForce FX architecture, codenamed Rankine, saw Nvidia moving to TSMC's 130nm manufacturing process in a chip clocked at 500MHz, and also using GDDR2 memory clocked at 500MHz (1GHz effective). Nvidia wanted a cooling setup that could tame the comparatively hot-running hardware and its solution to this cooling problem was called FX Flow.

The idea was to cool the whole lot with one small fan, using a concentrated airflow system. A large copper plate covered the memory and GPU on the front of the card, which was linked to a copper heatsink by three heatpipes. A small fan then pulled air from the top vent on the card's backplate, going across the heatsink to cool the GPU and memory plate.

The air was then directed (by the same fan) out the bottom vent on the card's backplate, with a plastic shroud forcing the system to direct the airflow in this way.

Meanwhile, a second copper heatsink was attached to the memory chips on the back of the card. You can see how it all worked in the great photos of a Gainward GeForce FX 5800 Ultra card on this page, kindly provided Dmitriy 'H_Rush' from **vccollection.ru**

Combine a dentist drill with a hairdryer and you'll have an idea of how it sounded

It was a sound design in theory, and Abit had already demonstrated a similar cooling system on its OTES-branded graphics cards. With this method, Nvidia would ensure that the hot-running components were kept cool, and that any hot air dumped inside your case was kept to a minimum. The main problem was that the tiny fan had to run at a very high speed to ensure that it worked properly, and the noise was horrendous, gaining it the nickname of the 'dust buster' among enthusiasts.

BUT WAS THE GPU ANY GOOD?

Nvidia's joke marketing video did one good job for the company, which was to focus attention on the cooling system, rather than the GPU. Even the discussion at the beginning of the video describes the GeForce FX 5800 Ultra as 'the most powerful graphics card on the planet',

A small fan pulled air from the top vent across the heatsink to cool the GPU and memory plate. Photo credit: Dmitriy 'H_Rush', vccollection.ru

RETRO TECH / ANALYSIS

which was stretching the truth at best. It was definitely more powerful than the GeForce 4 Ti cards that preceded it, but it was also up against some seriously powerful competition from ATi (before it was bought by AMD).

Before we get into the details, let's step back and take a look at the graphics landscape at this time. DirectX 8 had introduced us to the potential for programmable shaders – small programs that could be run directly on a GPU by its dedicated pixel and vertex processors, sometimes called pipelines. We still use pixel and vertex shaders today, but they're now processed by all-purpose stream processors, rather than dedicated pixel and vertex processors.

There was clearly a lot of potential here – you could see it in the beautiful Nature section of the 3DMark2001 benchmark, but games that supported DirectX 8's shader model were few and far between. It was supported by Nvidia's GeForce 3 and GeForce 4 Ti chips, as well as the Radeon 8500, but it was rarely used at the time. It's for this reason that cheaper GPUs, such as the Radeon 7500 and GeForce 4 MX, had no support at all for shaders and were

ATi had got to Shader Model 2 long before the launch of GeForce FX

available to buy at the same time. For context, the Nintendo Wii still had no shader support when it was released in 2006.

There were some notable games that supported early shaders, such as The Elder Scrolls III: Morrowind and Unreal Tournament 2003, but the vast majority of games still used fixed function pipelines. That situation started to change over the next year, with the launch of more high-profile titles such as Doom 3 and Half-Life 2, as well as the launch of DirectX 9 and Shader Model 2, which introduced a more flexible shader model.



Shader Model 2 massively increased the number of pixel shader instruction slots from 8+4 to 32+64, and it upped the texture instruction limit from four in Pixel Shader 1.3 to 32 in Pixel Shader 2. Likewise, the number of vertex shader instruction slots doubled from 128 to 256, with the ability to execute a maximum of 1,024 vertex instructions in Vertex Shader 2, compared to just 128 in Vertex Shader 1.1.

The problem for Nvidia was that ATi had got to Shader Model 2 long before the launch of GeForce FX. ATi's Radeon 9700 had eight pixel processors and four vertex processors. It didn't use all the latest tech – it came with 128MB of DDR memory and was built on a 150nm process, but it had a single-slot cooler that didn't make an awful noise and it beat Nvidia in the Shader Model 2 arms race by several months.

To make matters worse, ATi launched an update, the Radeon 9800 Pro, in the same time frame as the GeForce FX launch in early 2003. Based on the same Rage 8 architecture, it upped the GPU clock speed from the 9700's 275MHz to 380MHz, and increased the memory frequency from 270MHz (540MHz effective) to 340MHz (680MHz effective). Nvidia later mocked its cooler design in a comedy marketing video, showing it being used with a hairdryer, coffee grinder and leaf blower



The GPU was supported by 128MB of GDDR2 memory, but it was attached to a 128-bit interface. Photo credit: Dmitriy 'H_Rush', vccollection.ru
A plastic shroud directed the hot out of a hole at the bottom of the backplate. Photo credit: Dmitriy 'H_ Rush', vccollection.ru

When the GeForce FX 5800 Ultra finally launched in March 2003, the battle was already over before it had begun. It launched with four pixel processors, compared to the Radeon 9700's eight, and three vertex processors, compared to four on the 9700. It could barely compete with the GPU that had come out nine months beforehand, let alone ATi's latest 9800 Pro.

LIMITED BANDWIDTH

Of course, comparing the number of shaders isn't an apples-to-apples likeness on paper, due to the underlying differences in architecture, and that applies just as much today as it did then. For starters, unlike ATi's GPUs at that time, GeForce FX supported the superior Shader Model 2a, which was even more powerful than Shader Model 2. The GeForce FX 5800 Ultra also had the benefit of using the latest GDDR2 memory, with a top effective clock speed of 1GHz compared to 680MHz on the 9800 Pro.

However, despite ATI's card's using slower memory, they were attached to a much wider interface. With a 256-bit wide interface at its disposal, the Radeon 9800 Pro had a total memory bandwidth of 21.76GB/sec from its 680MHz (effective) DDR RAM.

Comparatively, the GeForce FX 5800 Ultra only had a 128-bit wide interface so, despite its faster memory, it only had a total memory bandwidth of 16GB/sec.

Basically, Nvidia's choice to pair its GDDR2 memory with a tight interface largely negated the point of using it. That was a big deal – you could get away with slower

BENCHMARK RESULTS





shader performance in a world where few games used programmable shaders, but restricted memory bandwidth opened up ATi's lead in real-world gaming tests as well.

SAVING GEFORCE FX

Once Nvidia had nursed its wounds from the reaction to its disappointing GPU and comical cooler, the company then had to make the best of the situation, as the GeForce FX architecture was all it had. A year later, it would be back on top with its superb GeForce 6000-series GPUs, but in the

There was no getting away from the hard fact that GeForce FX stank

meantime it had to make GeForce FX work.

The 5800 Ultra was largely abandoned by the industry, and Nvidia brought out the GeForce FX 5900 series of GPUs. Like the ATi competition, these cards went back to using DDR memory, but with a 256-bit wide interface. In the case of the top-end FX 5950, the memory was clocked at 475MHz (950MHz effective) and had a 475MHz GPU clock.

Nvidia also tweaked the cooler design. The FX Flow model was largely abandoned at this point, with many card manufacturers using their own traditional cooler designs for the GeForce FX 5900 XT and 5900 Ultra, squeezing cards into a single-slot design with a single cooling fan.

This wasn't enough to save GeForce FX from embarrassment though. In our first issue, we conducted a Labs test of Radeon 9800 Pro and GeForce FX 5900 Ultra cards, which at that time sat in the £300-£400 price bracket, with the Nvidia cards generally costing more. We've reprinted a selection of the results here for a laugh and, as you can see, the Radeon 9800 Pro was either much faster or the same speed as the GeForce FX 5900 Ultra in our tests at the time.

This pattern was generally repeated across the board, with the GeForce FX 5200 and 5600 failing to match the performance of ATi's equivalents at the time. There was no getting away from the hard fact that GeForce FX stank. Even with a wider memory interface and a quieter cooler, the cards simply couldn't keep pace with the comparatively priced competition from ATi.

Bizarrely, GeForce FX 5800 Ultra cards now fetch decent

prices among collectors, thanks to their rarity and the story that surrounded them at the time.

If you were unlucky enough to buy one and still have it lurking in a drawer, it might be worth sticking it on eBay. **CPC**

THANKS

We would like to say a big thank you to Dmitriy 'H_Rush' who very kindly shared these fantastic photos of a Gainward GeForce FX 5800 Ultra with us for this feature. You can see more of his extensive graphics card collection at **vccollection.ru**

Readers' drives

Avengers **GamerPC Build**

Avengers fan Eric Montalvo built this simple but effective tribute to his favourite superheroes, using some action figures, a load of RGB lighting and some glow-inthe-dark vinyl stickers



/MEET THY MAKER

Name Eric Montalvo **Aae** 56 **Occupation** Building Location Williamsburg

Main uses for PC

Likes Gaming, playing my

Dislikes Politics. aubergines, voghurt and people who talk too much

EFF: So how did this project start? What inspired you to make an Avengersthemed PC?

Eric: I needed a new PC, as my old one was slowly going out of date-it worked but I wanted something faster. I'm a Big Marvel and Avengers fan, and everything in my room and in my life is about Iron Man and The Avengers. I even have a huge Avengers sticker on the rear window of my truck - everyone knows me as the Iron Man. I have Marvel stuff everywhere, so I figured I'd build a PC with an Avengers theme.

GPG: What sort of look were you hoping to achieve?

Eric: As I said, I'm a huge Marvel fan, and I was looking to recreate the look in the movie Avengers: Infinity War, when they were on Titan and Wakanda.

GPG: That's an interesting layout for the motherboard.

Eric: Yes, the Segotep Phoenix case I used comes in this configuration, and I wanted to have the window on the right, and this layout for the motherboard and graphics card. I found it unique and wanted the glass side on the right, so I can see it while sitting at my desk. I added



EPE: How did you make the lightup Avengers logos?

Eric: They're just vinyl stickers that I purchased from Amazon. There's one for the side window and one for the front panel. They glow in the dark, which works well with the lighting behind them – they light up and glow, showing all the colours as the lights change.









motherboard and MSI's Dragon Center software.

EPE: What hardware specs did you choose and why?

Eric: I chose the 10th-generation Intel processor and MSI motherboard for what it had to offer. I like the idea of the NVMe SSD drives and was able to put

SPECS

CPU Intel Core i7-10700KF
Case Segotep Phoenix ATX Black Mid Tower
GPU Asus GeForce Dual GTX 1050 Ti 4GB Dual-Fan Edition
Storage 1TB Sabrent Rocket PCI-E 4, 512GB Sabrent Rocket PCI-E 3
Memory 32GB (2 x 16GB)
Teamgroup T-Force Delta RGB DDR4 White
Motherboard MSI MPG Z490
Gaming Carbon WiFi
PSU 850W Pystar ES850
Cooling ID-COOLING Auraflow
240mm all-in-one liquid cooler

The stickers glow in the dark, which works well with the lighting behind them, as they light up and glow

The lighting on the front panel is controlled with a remote that comes with the motherboard. I can change it to any colour I want or have multiple flashing colours – I just like it being blue.

For the rest of the lighting, I just surfed through the options that the motherboard had to offer, and decided to set it up to complement the Marvel action figures, and give it that 'Avengers' look. The lighting is all controlled by the them on this motherboard. They are fast and instant when clicking and starting programs.

GPD: Where did you get the figures, and how are they stuck down?

Eric: I purchased the action figures from Amazon and just stuck them down with double-sided tape that I had from work.

EFF: What do you use this PC for? Eric: Gaming and general home



use. I actually have it plugged into my 65in 4K TV for gaming, watching online movies and net surfing.

GPG: Did you come across any difficulties?

Eric: The only difficulty I had was connecting up all the lights – I had to order a multiport adaptor in order to get all the light strips and RGB lighting for the fans all connected.

GPG: How long did it take you to complete this build, from start to finish?

Eric: It took a weekend to build it – I kept making adjustments to the build in order to achieve the finished look.

GPG: Are you completely happy with the end result, or do you wish you'd done some of it differently in retrospect?

Eric: I'm very pleased with the end result of this build. I only wish that I was able to get hold of a newer graphics card for it, but you just can't find them anywhere – thank goodness I had the Asus GeForce GTX 1050 Ti card from my previous PC build. **ere**

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

The Corsair Hydro X Series XD3 RGB Pump/ Reservoir Combo features a highperformance 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

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 highefficiency micro-cooling fins, which



efficiently draw heat away from your CPU, lowering operating temperatures and allowing for maximum overclocks. You can choose a version for Intel or AMD CPU sockets.

Corsair Hydro X Series XR5 240mm Radiator

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

CORE i4, ANYONE?

James Gorbold asks what's in a name when it comes to fairly representing the specs of our components

That doesn't excuse the poor,

damn right misleading

branding of these processors

ntel's 12th-gen Core CPUs, codenamed Alder Lake, have dominated the pages of **Custom PC** for the past three issues. This shouldn't come as a surprise really, as the CPUs received such positive reviews in Issue 220. Their combination of brutal multi-threaded power, along with strong single-threaded and gaming performance, makes them a top upgrade at the moment.

There's going to be more Alder Lake gear coming too, with more CPUs and additional motherboard chipsets. It wouldn't normally be worth pontificating about Intel fleshing out the rest of its CPU range. After all, we're already well aware of how the new hybrid architecture performs,

how much power the chips draw and how much they cost. And while none of these fundamental elements has changed in the second wave of Alder Lake processors, there's one significant change that has me scratching my head.

I'll start with the good. After the first wave of six premium K-series 12th-gen CPUs, Intel has launched 13 new value-focused S-series chips. The second wave comprises enthusiast Core i9, high-end Core i7, mid-range Core i5 and entry-level Core i3 12th-gen CPUs, plus some entry-level Pentium and Celeron CPUs as well. While there's not much to excite us about the latter, it's good to see Intel using its latest architecture throughout the whole stack.

The two new Core i9 S-series CPUs, the 12900 and 12900F, make perfect sense, having the same configuration of eight P-Cores and eight E-Cores as the Core i9 K-series chips – they just run at a lower clock speed and cost a fair bit less money. The two new Core i7s S-series CPUs – the 12700 and 1200F – follow the same pattern, mirroring the configuration of eight

P-Cores and four E-Cores as the Core i7 K-series models, once again running at a slower frequency and costing less money. However, when it comes to the Core i5 range, the S-series

models are very different beasts from the K-series chips. Whereas the Core i5-12600K has six P-Cores and four E-Cores, the new Core i5 CPUs – the 12600, 12500, 12400 and 12400F – don't have any E-Cores. While this change doesn't make an appreciable difference to gaming performance, the extra, power-efficient E-Cores make a massive difference to performance when multitasking or in multi-threaded content creation.

> I'm therefore not convinced that it's fair to brand them as Core i5 chips when there are two other CPUs from the same family that offer substantially more performance. The S-series models are of course a fair bit cheaper than the K-series ones, but nowhere else in the range is that pattern of different

core configurations within a family repeated. It's unique, and uniquely baffling, to the Core i5 range.

Now, I realise that this decision is largely down to manufacturing, as it's cheaper and easier to build a CPU without any E-Cores, plus there's a fair number of Alder Lake dies that have faulty E-Cores and selling them as Core i5 S-series chips is a good way to use them up. However, that doesn't excuse the poor, damn right misleading branding of these processors.

I realise that little old me typing away at the back of **Custom PC** isn't enough to make Intel change its mind, but even so, I reckon calling these new chips 'Core i4', or at least resurrecting the old SX moniker (calling them Core i5 SX CPUs) would make more sense than branding them as fully fledged Core i5s. Who's with me? **CPE**

James Gorbold has been building, tweaking and overclocking PCs ever since the 1980s. He now helps Scan Computers to develop new systems.



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