Dev Workstation PC Build

A Complete 15-Chapter Build Course

From first principles to a fully configured development machine

Platform chosen: Intel LGA1700 (13th Gen) · B760 chipset · DDR4

CPU: i7-13700K · 16 cores (8P+8E) · 5.4 GHz boost · 30 MB L3

RAM: 64 GB DDR4-3600 (reused) · GPU: RTX 3050 LP (reused)

PSU: Corsair TX550M 550W 80+ Gold (reused)

Chapters 1–13: Core build course · platform selection through software setup

Chapters 14–15: Bonus — KVM switch setup & multimeter diagnostics

Format: A4 · Dark-theme · Compatibility tables · Installation steps

Table of Contents

CHAPTER 1 OF 15

Planning Your Build

Chapter 1 — Planning Your Build

Before a single screw is turned, the plan is already doing most of the work. A well-planned build saves money, avoids incompatibility headaches, and produces a machine that genuinely fits your needs. This chapter walks through exactly how to think about your requirements, audit your existing hardware, and arrive at a clear, confident parts list before chapter two begins.

> **Your build at a glance:** You're upgrading from an aging Intel LGA1200 platform to a modern Intel LGA1700 system for development work, multi-monitor remote desktop sessions, and video. Several excellent components carry over — your GPU, PSU, 64GB RAM, and SSDs — keeping costs well below your £2,000 budget.

Defining Your Use Case

The single most important question in any PC build is: *what will this machine actually do?* Every component selection flows from the answer. A machine built for video editing has completely different priorities from one built for gaming, and a development workstation differs again.

Use case categories and what they prioritise

USE CASE	CPU	RAM	GPU	STORAGE
Gaming	Fast single-core	16–32GB	Critical — high spend	Fast NVMe
Video Editing / Rendering	Many cores	32–128GB	GPU acceleration helps	Fast NVMe, large capacity
Software Development	Multi-core, fast compilation	32–64GB+	Light — basic display	Fast boot, large data
Home / General Use	Mid-range	16GB	Integrated often fine	Standard SSD
Server / NAS	Efficiency	ECC preferred	Minimal	Capacity + redundancy critical

Your specific use case

Your workload sits firmly in the **software development** column with some nuances that matter for component selection:

- **Compilation and build tools** — benefits most from CPU core count and fast NVMe storage

- **Simultaneous remote sessions** — X2GO (Linux desktop via OpenVPN), RDP, WinSCP, Kitty/PuTTY all running at once. Each session needs CPU threads and RAM; network is the bottleneck here, not GPU
- **Three monitors** — requires a GPU with three simultaneous display outputs; your RTX 3050 LP has exactly this
- **Video playback** — handled comfortably by any modern GPU or even integrated graphics; no requirement for a dedicated gaming card
- **Not gaming** — this is significant: you don't need to spend £400+ on a GPU, and your existing card is entirely suitable

> **Key insight:** Because you're not gaming, the GPU is not the limiting factor in your budget. This frees up significant headroom that can go toward a faster CPU — which directly benefits compilation speed, IDE responsiveness, and running many remote sessions simultaneously.

Understanding Form Factors

Form factor describes the physical size standard of the motherboard — and because the case must fit the motherboard, and the motherboard determines which CPUs and RAM you can use, the form factor decision has a cascade effect on everything else. The three most common consumer form factors are:

Mini-ITX

170 × 170 mm

COMPACT

- 1× PCIe slot only
- 2× RAM slots (max 64GB)
- Limited M.2 slots
- Small, challenging build
- Usually premium priced

Micro-ATX

244 × 244 mm

YOUR CURRENT + VIABLE

- 2–4× PCIe slots
- 4× RAM slots (up to 128GB)
- Good M.2 options
- Fits most mid-tower cases
- Good value for money

ATX

305 × 244 mm

RECOMMENDED UPGRADE

- 4–7× PCIe slots
- 4× RAM slots (up to 128GB)
- Most M.2 slots (3–5)
- Best airflow options
- Easier to build in

Your existing Kolink Citadel is a Micro-ATX case, and Micro-ATX would work well for your build. However, since you're replacing the motherboard and potentially the case, ATX is worth considering — more M.2 slots (useful for adding an NVMe boot drive alongside your SATA SSDs), better long-term expansion, and generally easier to work inside. Chapter 2 covers the case decision in full.

Key Compatibility Concepts

Before selecting any component, there are five compatibility dimensions you must understand. Get any one of them wrong and the component simply won't work — or won't work well — with the rest of the build.

1 — CPU Socket

The physical interface between CPU and motherboard. A CPU and motherboard must share the same socket — they are not interchangeable. Major current sockets:

SOCKET	MANUFACTURER	CPU GENERATIONS	RAM	STATUS
LGA1200	Intel	10th, 11th gen	DDR4 only	Dead — your current platform
LGA1700	Intel	12th, 13th, 14th gen	DDR4 or DDR5*	Recommended — current
LGA1851	Intel	15th gen (Arrow Lake)	DDR5 only	Very new, limited choice
AM4	AMD	Ryzen 1000–5000	DDR4 only	Mature, limited future
AM5	AMD	Ryzen 7000–9000	DDR5 only	Current AMD platform

* LGA1700 boards come in DDR4 and DDR5 variants — not both on the same board. Choosing a DDR4 variant lets you reuse your existing 64GB DDR4-3600 RAM.

2 — Chipset

The chipset is a chip on the motherboard that controls communication between CPU, RAM, storage, and PCIe devices. It's paired to a CPU generation and determines which features are unlocked. For LGA1700 (Intel 12th/13th gen):

CHIPSET	CPU OVERCLOCKING	RAM OVERCLOCKING	PCIE LANES	BEST FOR
B660 / B760	No	Yes (XMP)	Fewer	Our build — great value, XMP for DDR4-3600
H670 / H770	No	Yes	Mid	Mid-range without OC need
Z690 / Z790	Yes	Yes	Most	Overclockers, enthusiasts

Since you're not overclocking the CPU, a **B660 or B760 DDR4 board** is the sweet spot — unlocks XMP for your DDR4-3600 RAM (which runs at 2133MHz by default without XMP enabled), saves £50–100 versus Z-series.

3 — RAM Generation (DDR)

DDR4 and DDR5 are physically different — the slots and notches are in different positions. You cannot put DDR4 in a DDR5 motherboard or vice versa.

	DDR4	DDR5
Your existing RAM	64GB DDR4-3600 ✓	Would need new RAM
Typical speed range	2133–5333 MHz	4800–8000 MHz
Real-world dev workload difference	Negligible — bandwidth not the bottleneck	
64GB kit cost (new)	~£90–120	~£150–200
Verdict for this build	Reuse existing — save £150+	No benefit for your workload

4 — PCIe (Peripheral Component Interconnect Express)

The slot standard that GPUs, M.2 NVMe drives, and expansion cards use. PCIe is backwards compatible — a PCIe 3.0 card works in a PCIe 4.0 slot and vice versa, just at the lower speed. Your RTX 3050 LP is PCIe 4.0 and will work in any modern LGA1700 board.

5 — Power Connectors

Modern motherboards use a 24-pin ATX power connector and a 4+4 or 8-pin CPU power connector. Your Corsair TX550M provides both. GPUs typically need 6-pin or 8-pin PCIe connectors — the RTX 3050 LP uses a single 8-pin (or 6+2 pin). All compatible with your existing PSU.

Your Existing Components — Full Audit

GRAPHICS CARD ✓ Keep

GeForce RTX 3050 LP 6G OC

Perfectly suited to your workload. Drives 3 monitors simultaneously (3× DisplayPort + 1× HDMI). The LP (Low Profile) form means it's shorter than a full card but uses the same PCIe slot — works in any case. Saves approximately £250–350 over a new equivalent.

POWER SUPPLY ✓ Keep

Corsair TX550M 550W 80+ Gold

Reputable semi-modular unit. 550W is sufficient: RTX 3050 LP draws ~75W, an i7-13700K draws ~125W under load — total ~280W peak leaves good headroom. The 80+ Gold rating means at least 87% efficiency. Saves ~£100.

MEMORY (RAM) ✓ Keep

Corsair Vengeance 64GB DDR4-3600 C18

Excellent kit at a great spec. DDR4-3600 is near the sweet spot for DDR4 — fast enough that real-world performance matches DDR5 for development tasks. Requires a DDR4-variant LGA1700 motherboard. Saves ~£150–200 over equivalent DDR5 replacement.

STORAGE ✓ Keep both

Samsung 870 EVO 2TB + WD Blue 1TB

Both are excellent SATA SSDs that connect to standard SATA ports on any motherboard. 3TB of fast SSD storage is generous. Consider adding a small NVMe M.2 drive (~£60) as a dedicated OS/boot drive for faster boot times, while these handle project data.

MOTHERBOARD ✗ Replace

MSI B560M PRO-E (LGA1200)

LGA1200 is a dead-end platform — Intel's 10th and 11th generation only. No modern CPU fits it. Must be replaced to upgrade the processor. New recommendation: MSI B760M or ASUS Prime B760-Plus DDR4 (ATX or mATX depending on case choice).

CPU ✗ Replace

Intel Core i5-10400 (LGA1200)

Since the motherboard is being replaced and LGA1200 doesn't exist on any modern board, the CPU goes with it. The i5-10400 is also showing its age — a 13th gen i5-13600K offers roughly double the multi-threaded performance for compilation workloads.

CASE ⚡ Optional Upgrade

Kolink Citadel Mesh Micro-ATX

Functional and has decent mesh airflow. If you choose a Micro-ATX motherboard, this case can stay. If you choose a full ATX board (recommended for more M.2 and expansion slots), you'll need a new ATX mid-tower case. Chapters 2 and 3 will help decide.

Budget Planning

A realistic budget has two parts: what you're spending, and what you're *not* spending because you're reusing components. Both matter.

ITEM	DECISION	ESTIMATED COST
GPU — RTX 3050 LP	Reusing existing	£0 (saved ~£280)
PSU — Corsair TX550M	Reusing existing	£0 (saved ~£100)
RAM — 64GB DDR4-3600	Reusing existing	£0 (saved ~£170)
SSD — Samsung 870 EVO 2TB	Reusing existing	£0 (saved ~£150)
SSD — WD Blue 1TB	Reusing existing	£0 (saved ~£70)
Motherboard (LGA1700, DDR4, B760 ATX)	New	£160 – £240
CPU (Intel Core i5-13600K or i7-13700K)	New	£220 – £350
CPU Cooler (LGA1700 compatible)	New — old cooler bracket won't fit	£45 – £90
Case (ATX mid-tower, optional upgrade)	New if ATX mobo chosen	£70 – £130
NVMe M.2 Boot Drive (500GB–1TB)	New — recommended addition	£55 – £80
Internal Blu-ray Drive	New — required	£45 – £80
Internal Card Reader	New — nice to have	£15 – £25
Windows 11 Pro	New licence required	£130 – £200
Estimated Total		**£740 – £1,195**

Budget tip: The £700–£1,000 you're saving by reusing components gives you the option to go up to the i7-13700K (16 cores, significantly faster for compilation) without breaking the budget. Chapter 4 will help you decide whether the extra ~£120 for the i7 is worthwhile for your specific workload.

Buffer: Always keep 10–15% of your budget unallocated. Prices fluctuate, you may find a better component at slightly higher cost, and shipping/accessories add up. On a £1,000 build, aim to spend £850–900 and keep £100–150 in reserve.

Tools You'll Need

A PC build requires surprisingly few tools. Most of the job is done by hand. Here's what to have ready before build day.

🪛 **Precision Screwdriver Set (magnetic, PH1 + PH2)** — ESSENTIAL — Search Amazon

The most-used tool in any build. Magnetic tip stops screws falling into the case. PH2 (Phillips #2) for most case screws and motherboard standoffs; PH1 (Phillips #1) for M.2 drives and tight spots.

⚡ **Anti-Static Wrist Strap**

Grounds you to the case, preventing electrostatic discharge (ESD) that can silently damage components — especially CPUs and RAM. A £5–10 strap is cheap insurance against writing off a £300 processor.

ESSENTIAL

Search Amazon

🧲 **Magnetic Parts Tray**

Keeps small screws and standoffs from rolling away mid-build. A dropped M.2 screw inside a case is a frustrating 20-minute search. A tray costs £5–10.

RECOMMENDED

Search Amazon

🌡️ **Thermal Paste**

Applied between CPU and cooler to fill microscopic air gaps and improve heat transfer. Most aftermarket coolers include a small tube — check your chosen cooler before buying separately. Arctic MX-4 or Noctua NT-H1 are well-regarded options.

RECOMMENDED

Search Amazon

💨 **Compressed Air / Dust Blower**

Useful for clearing dust from any components you're reusing (GPU, PSU, drives) before installing them. Also handy for clearing debris from awkward spots during the build.

RECOMMENDED

Search Amazon

🔦 **Small Torch or Headlamp**

Cases have dark corners — particularly behind the motherboard tray and near the bottom. A small LED torch or headlamp lets you read connector labels and check seating without straining. A phone torch works in a pinch.

NICE TO HAVE

Search Amazon

🧬 **Cable Ties / Velcro Straps**

Cable management inside the case affects airflow and makes future upgrades much easier. Velcro straps are reusable and easier to work with than zip ties. Most cases also include some mounting points and routing channels.

NICE TO HAVE

Search Amazon

> **Your build surface:** Work on a large, flat, non-carpeted surface — a kitchen table or desk is ideal. Avoid carpet (static build-up). Keep a clear area around you for boxes and manuals. Don't build on a glass table if you can avoid it — things slide off. A large anti-static mat is ideal but not essential if you're using a wrist strap.

Pre-Purchase Compatibility Checklist

Before ordering any component, run through this list. Each chapter will revisit these points in more detail, but this is the master reference.

CHECK	QUESTION TO ANSWER	YOUR BUILD
Socket match	Does the CPU socket match the motherboard?	Both LGA1700 — confirmed
Chipset support	Does the chipset support your chosen CPU generation?	B760/Z790 supports 12th & 13th gen
RAM type	Does the board match your RAM generation (DDR4/DDR5)?	DDR4 variant board — reuses your 64GB kit

CHECK	QUESTION TO ANSWER	YOUR BUILD
RAM speed	Does the board support your RAM's rated speed (XMP)?	B760 DDR4 supports XMP to 5333MHz — your 3600 is fine
Form factor	Does the motherboard fit inside the case?	Decide: Micro-ATX (keep case) or ATX (new case)
CPU cooler clearance	Does the cooler fit within the case's CPU cooler height limit?	Check chosen cooler height vs case spec — Chapter 5
GPU clearance	Does the GPU fit the case's maximum GPU length?	RTX 3050 LP is short — fits any case
PSU wattage	Is the PSU rated for the total system power draw + 20% headroom?	550W ample for RTX 3050 LP + 13th gen mid-range CPU
Storage connections	Does the board have enough SATA ports and M.2 slots?	Any B760 ATX has 4+ SATA + 2–3 M.2
Power connectors	Does the PSU provide the right connectors?	TX550M provides 24-pin, 8-pin CPU, PCIe — all correct
Monitor connections	Does the GPU have outputs matching your monitors?	RTX 3050 LP: 3× DP 1.4 + 1× HDMI 2.1 — covers all 3 monitors

Course Roadmap

Here's how the rest of the course is structured. Each chapter covers selection, compatibility, specs, assembly, testing, and reuse decisions for its component. Use the shorthand prompts (PC2, PC3...) to generate each chapter.

1. **Planning Your Build ← You are here**
   Requirements, form factors, compatibility concepts, budget, tools

2. **The Case**
   Form factor, airflow, clearances, cable management, your Kolink vs alternatives

3. **Motherboard**
   Chipset, VRM, I/O, DDR4 LGA1700 selection, replacing the B560M PRO-E

4. **CPU**
   i5-13600K vs i7-13700K, cores vs clock, upgrading from the i5-10400

5. **CPU Cooling**
   Air vs AIO, TDP ratings, clearance, mounting on LGA1700

6. **Memory (RAM)**
   DDR4 vs DDR5 deep dive, XMP profiles, keeping your 64GB kit

Next: Type **PC2** to generate Chapter 2 — The Case.

CHAPTER 2 OF 15

The Case

Chapter 2 — The Case

The case is the one component nobody notices when a build goes right — and the one everyone blames when it goes wrong. It shapes airflow, determines which motherboards fit, dictates your cooler height limit, and affects how enjoyable the build process itself is. It also holds your Blu-ray drive, which turns out to be a constraint with more impact on your choice than you might expect.

Key constraint for your build: You need an internal Blu-ray drive, which requires a **5.25" external bay**. The majority of modern cases released in the last three to four years have dropped this bay entirely in favour of cleaner aesthetics. This is the single most important filter when selecting a case and will rule out many otherwise excellent options.

What a Case Actually Does

It's tempting to treat the case as a box that everything goes into. In reality it does five distinct jobs, and a poor case undermines all of them:

- **Structural housing** — holds every component securely and in the correct spatial relationship to one another
- **Airflow management** — channels cool air over hot components and exhausts warm air out. Poor airflow raises temperatures by 10–20°C and reduces component lifespan and performance
- **Cable management** — a case with good routing channels, grommets, and tie-down points keeps cables out of the airflow path and makes future upgrades straightforward
- **Acoustic management** — some cases are designed to reduce fan and drive noise through sound-dampening panels; others prioritise airflow over silence
- **Expansion and access** — drive bays, PCIe slots, and front I/O ports determine what you can add now and in the future

Case Sizes and Motherboard Compatibility

Cases are categorised by the largest motherboard they can accommodate. A larger case can always fit smaller boards, but not the reverse.

CASE SIZE	FITS MOTHERBOARDS	TYPICAL USE	FOR YOUR BUILD
Full Tower	E-ATX, ATX, mATX, ITX	Workstations, server-adjacent, enthusiast	More than needed — large and expensive
Mid Tower	ATX, mATX, ITX	Most desktop builds — the sweet spot	Recommended — room to work, good expansion

CASE SIZE	FITS MOTHERBOARDS	TYPICAL USE	FOR YOUR BUILD
Mini Tower / mATX	mATX, ITX	Compact desktops, limited space	Your current case — viable but limiting
Small Form Factor (SFF)	ITX only	Ultra-compact, under-desk, HTPCs	Too restrictive — no 5.25" bay, cramped

Your decision point: If you choose a full ATX motherboard (recommended for more M.2 slots and expansion), you need a mid-tower case — your existing Kolink Citadel mATX case won't accommodate it. If you choose a Micro-ATX motherboard, the Kolink can stay and the choice becomes optional rather than forced.

Reading a Case Specification Sheet

Every case product page lists a set of specifications. Here is what each one means in practice and why it matters for your build:

MOTHERBOARD SUPPORT

e.g. ATX / mATX / ITX

Lists the form factors the case accepts. Your chosen motherboard must be on this list. A case that supports ATX also fits mATX and ITX boards (smaller boards in a bigger case is fine).

CPU COOLER HEIGHT

e.g. 160 mm / 170 mm

Maximum height of the CPU cooler (measured from motherboard surface). Tower air coolers are typically 150–168mm tall. Check your chosen cooler fits before buying either component. Chapter 5 covers this in detail.

GPU LENGTH CLEARANCE

e.g. 370 mm / 420 mm

Maximum graphics card length the case can fit with all drive cages in place. Your RTX 3050 LP is short (~200mm) so this is a non-issue for your build. Only critical for large gaming GPUs.

5.25" EXTERNAL BAYS

e.g. 0 / 1 / 2

The bay your Blu-ray drive needs. Many modern cases list zero here. This is your primary filter — if a case has no 5.25" bay, it's out of consideration for an internal optical drive.

3.5" INTERNAL BAYS

e.g. 2 / 4 / 6

For traditional 3.5" hard drives. Your external USB drives don't need these, but it's useful to have one or two if you ever want to add an internal HDD.

2.5" DRIVE BAYS

e.g. 2 / 4

For SSDs like your Samsung 870 EVO and WD Blue. Most cases mount these behind the motherboard tray. You need at least two dedicated 2.5" mounting points.

FAN MOUNT POSITIONS

e.g. Front 3×120mm, Top 2×140mm, Rear 1×120mm

Where fans can be installed and what sizes they accept. More positions = more airflow flexibility. Rear 120mm exhaust position is near-universal; front intakes and top exhausts vary by case.

RADIATOR SUPPORT

e.g. Top 240mm, Front 360mm

Whether an AIO (all-in-one liquid cooler) radiator can be mounted. If you choose a 240mm or 360mm AIO cooler in Chapter 5, the case must support it at one of the listed locations.

FRONT I/O

e.g. 2× USB-A 3.0, 1× USB-C, audio

Front panel ports. USB-C on the front panel requires a USB-C header on the motherboard. Useful for plugging in USB drives and headphones without reaching to the back of the machine.

PSU SHROUD

Yes / No

A panel that covers the PSU and bottom cable routing area, hiding the bulk of power cables from the main visible area. Greatly improves the look and organisation of the build. A strong indicator of a quality case design.

DUST FILTERS

Front, Bottom, Top

Removable mesh filters over intake fans. Reduce dust build-up inside the case. Look for ones that are easily removable without tools — you'll want to clean them every few months.

PANEL MATERIAL

Steel / Tempered Glass / Mesh

Side panels are often tempered glass (visual) or solid steel (quieter). Front panels are either mesh (airflow) or solid (quieter but restricts intake). For your development workstation, mesh front + tempered glass side is a common and practical combination.

Airflow Fundamentals

Air has to travel in a logical path through the case: enter cool, pass over hot components, and exit warm. Incorrect fan direction or placement creates hotspots that reduce performance and lifespan.

```
OPTIMAL AIRFLOW — ATX MID-TOWER

┌────────────────────────────────────────────┐
│ ↑ TOP EXHAUST (140mm fan, warm air leaves)  │
├────────────────────────────────────────────┤
│                                            │
│  CPU Cooler ──→ blows toward rear exhaust  │ → REAR EXHAUST
│                                            │ (120mm fan)
│  GPU ─────────→ exhausts from card vents   │
│                                            │
│                                            │
→ FRONT INTAKE (2–3×120/140mm fans, cool air) │
├────────────────────────────────────────────┤
│ PSU ←─ bottom intake, exhausts via rear    │
└────────────────────────────────────────────┘

Cool air in:  Front → Bottom
Warm air out: Rear → Top
Rule: air always flows from front/bottom intake toward rear/top exhaust.
```

Positive vs negative pressure

PRESSURE TYPE	HOW IT WORKS	PROS	CONS
Positive pressure	More intake fans than exhaust	Dust pushed out; less ingress through gaps	Slightly warmer in some configs
Negative pressure	More exhaust fans than intake	Can run cooler	Draws dust in through every gap; filters useless
Neutral / balanced	Equal intake and exhaust	Good temperatures, reasonable dust control	Depends heavily on case sealing

For a development workstation that you want to open infrequently and clean occasionally, **slight positive pressure** with filtered intakes is the practical optimum. A mesh-front case with two or three front intake fans and one or two rear/top exhaust fans achieves this easily.

What Makes a Case Good vs Bad

SIGNS OF A GOOD CASE

✓ Mesh or perforated front panel for airflow

SIGNS OF A POOR CASE

✗ Solid plastic front panel — restricts airflow severely

- ✓ PSU shroud hiding cables below the motherboard
- ✓ Cable routing grommets and tie-down points behind the mobo tray
- ✓ Removable, tool-free dust filters on all intakes
- ✓ At least 1 × 5.25" bay *(for your build)*
- ✓ Thick steel construction (0.7mm+ SECC steel)
- ✓ Solid tempered glass side panel with secure latch
- ✓ Front USB-C plus at least 2× USB-A
- ✓ Pre-installed fans included (saves extra spend)
- ✓ Good clearance behind mobo tray for cable routing
- ✓ Clearly labelled standoff positions (or pre-installed)
- ✓ Bottom-mounted PSU (better thermals, easier access)

- ✗ No dust filters, or filters you can't reach without dismantling
- ✗ Thin, flexible steel that rattles under fan vibration
- ✗ No cable routing space (less than 15mm behind mobo tray)
- ✗ Tempered glass held by friction only — drops if knocked
- ✗ Poorly fitted I/O shield cutout (requires filing)
- ✗ Drive bays that block front fans completely
- ✗ No PCIe slot covers (open to dust from day one)
- ✗ Front audio header with no separate mic/headphone jacks
- ✗ Glossy external plastic — scratches and fingerprints immediately
- ✗ Restrictive GPU clearance (under 300mm)
- ✗ No side panel thumb screws — requires a screwdriver every time

The 5.25" Bay Problem

Between 2018 and 2022, the PC case market largely abandoned the 5.25" external bay. The reasoning was aesthetic — without optical drives, the blank bay covers created a visually cluttered front panel. Manufacturers switched to cleaner, all-mesh or solid-front designs.

The result is that finding a *current*, well-reviewed mid-tower case with a 5.25" bay is genuinely harder than it was five years ago. Many otherwise excellent cases — the Corsair 4000D, NZXT H7, Fractal Meshify 2, Phanteks P400A — have zero 5.25" bays.

> **What to look for:** Search specifically for "ATX mid-tower case 5.25 bay" rather than general case searches. Filter results by that specification. Cases that retain the bay tend to be either (a) older but still sold designs, (b) cases aimed at content creators/prosumers, or (c) quieter/NAS-oriented designs that prioritise flexibility over aesthetics.

Alternative: External USB Blu-ray

If the ideal motherboard choice forces you toward a case with no 5.25" bay, an external USB Blu-ray drive is a practical alternative. They cost £40–70, require no internal bay or SATA/power connection, work with any USB port, and can be stored away when not in use. The trade-off is a cable on your desk and slightly slower transfer speeds than internal SATA (though for occasional Blu-ray use, speed is irrelevant).

Search Amazon — External Blu-ray

Your Existing Case — Kolink Citadel Mesh Analysis

SPECIFICATION	KOLINK CITADEL MESH	ASSESSMENT
Form factor	Micro-ATX	Limits you to mATX or smaller motherboards
CPU cooler height	~155 mm	Limits tower cooler height — check Chapter 5 carefully
GPU clearance	~305 mm	RTX 3050 LP (~200mm) fits with ease
5.25" external bays	0	No internal Blu-ray drive possible without modification
2.5" / 3.5" bays	2 × 2.5" + 1 × 3.5"	Enough for your 2 SSDs, no expansion room
Front panel	Mesh	Good airflow
Front I/O	2× USB-A 3.0, audio	No USB-C front panel
Pre-installed fans	1 × rear 120mm	Would need additional front intake fans
PSU shroud	Yes	Clean cable management
Build quality	Good for price	Solid budget-to-mid-range case

Verdict: The Kolink Citadel Mesh has no 5.25" bay, which means an internal Blu-ray drive is not possible. This forces a decision: either replace the case (choosing one with a 5.25" bay), or go with an external USB Blu-ray drive and keep the Kolink. If you also choose a full ATX motherboard, the case must be replaced regardless.

Recommended Cases for Your Build

All recommendations below include a 5.25" bay and support ATX motherboards. They are ordered by overall suitability for a quiet development workstation.

Fractal Design Define 7 — TOP PICK

Form factor	ATX / E-ATX / mATX / ITX
5.25" bays	2 × removable
CPU cooler height	185 mm
GPU clearance	315 mm
Radiator support	Front 360mm, Top 280mm

be quiet! Pure Base 600 — STRONG OPTION

Form factor	ATX / mATX / ITX
5.25" bays	2
CPU cooler height	190 mm
GPU clearance	430 mm
Radiator support	Front 240mm, Top 240mm

Front I/O	USB-A, USB-C, audio
Sound dampening	Yes — excellent acoustics
Pre-installed fans	2 × 140mm

£130 – £160

The gold standard for a quiet, well-built development workstation case. Excellent noise dampening (important if it sits on your desk), two 5.25" bays, outstanding cable management, and a modular interior that can be reconfigured. The Define 7 Compact saves £10–20 and offers the same quality in a slightly smaller footprint.

Search Amazon

Front I/O	2× USB-A, audio
Sound dampening	Yes
Pre-installed fans	2 × 140mm Pure Wings 2

£80 – £100

be quiet! is a German brand known for silent-running builds. The Pure Base 600 includes sound-dampening panels, two quality pre-installed fans, and two 5.25" bays. Slightly less refined internal layout than the Define 7 but excellent value. No front USB-C on the base model.

Search Amazon

Antec P110 Silent

BUDGET PICK

Form factor	ATX / mATX / ITX
5.25" bays	2
CPU cooler height	180 mm
GPU clearance	400 mm
Radiator support	Front 240mm
Front I/O	2× USB-A, audio
Sound dampening	Yes — foam lined panels
Pre-installed fans	3 × 120mm

£55 – £75

Good value option with sound dampening foam, two 5.25" bays, and three pre-installed fans. Build quality is a step down from Fractal/be quiet! and the interior layout is less refined, but it does the job cleanly. A reasonable choice if keeping costs tight.

Search Amazon

Tip: When checking any case on Amazon or a retailer, search the Q&A section for "5.25" or "optical drive" — real buyer questions often confirm whether the bay is genuinely usable or partially blocked by cable routing in practice.

Search All: ATX Cases with 5.25" Bay

Assembly — Installing Components Into the Case

The case is the first physical step of the build. Getting the case prepared correctly before any other components are installed saves frustration later. These steps are covered in full in Chapter 13, but understanding them now helps you evaluate how case-friendly your chosen enclosure actually is.

1 **Remove side panels and prepare the workspace**

Lay the case on its side (left panel facing up) on a stable surface. Remove both side panels. Most modern cases use thumb screws at the rear — no tools needed. Take stock of what's inside: fan mounts, drive cages, cable routing holes.

2

Install motherboard standoffs

Standoffs are small threaded brass posts that lift the motherboard off the case floor, preventing short circuits. Cases come with standoffs for ATX, mATX, and ITX — you only install the ones that match your board's mounting holes. Count the holes on your motherboard and install exactly that many standoffs — **no more, no fewer**. An extra standoff touching an undrilled area of the board will cause a short and prevent POST.

⚠ Most common mistake: installing standoffs in ATX positions when using a Micro-ATX board, or vice versa. Compare the board against the case layout diagram before installing any standoffs.

3

Install the I/O shield

The I/O shield is the metal plate that covers the rear port cutout — it comes with your motherboard, not the case. Press it firmly into the rectangular opening from inside the case until all four edges click into place. It must be fully seated before the motherboard goes in.

⚠ The I/O shield's metal tabs are razor-sharp. Work slowly and consider wearing thin gloves. If it doesn't click in fully, the motherboard rear ports won't align correctly.

4

Route PSU cables before installing the motherboard

Thread the 24-pin ATX power cable and the 8-pin CPU power cable through the case's cable routing channels **before** the motherboard is mounted. The CPU power connector sits at the top of the board near the cooler — routing its cable after the board is installed is very difficult in a tight case.

5

Install the motherboard

Lower the motherboard onto the standoffs, aligning the rear I/O with the I/O shield tabs and the mounting holes with the standoffs below. Insert all mounting screws finger-tight first, then tighten in a diagonal cross pattern — never fully tighten one corner before the others, as this bends the board.

⚠ If a screw goes in easily with zero resistance, a standoff is likely missing beneath that hole. Stop and check — a loose motherboard will vibrate and can short against the case.

6

Install the front panel connectors

The case's power button, reset button, and power/HDD LEDs connect to a row of small pins on the motherboard (labelled JFP1 or F_PANEL). These are the fiddliest connections in any build. Consult your motherboard manual for the exact pin layout — it varies by manufacturer. The most common arrangement: **Power SW, Reset SW, HDD LED (+ and -), Power LED (+ and -)**. LEDs are polarity-sensitive; if the LED doesn't light up, swap the connector 180°.

⚠ These connectors are tiny (1-pin or 2-pin each). Use needle-nose pliers or a pencil tip to seat them. Label them with sticky tape before disconnecting from the old case if you're transferring.

7

Mount drives and optical bay

2.5" SSDs slide into their trays and secure with small screws or clips — match the screw size to the holes (usually M3). The Blu-ray drive slides into the 5.25" bay from the front and is secured by screws on each side through the case wall. Connect SATA data and SATA power cables once positioned.

8

Cable management and fan headers

Bundle cables with velcro ties and route them through grommets behind the motherboard tray. Connect case fans to the motherboard's SYS_FAN or CHA_FAN headers (or to a fan hub if there are more fans than headers). Good cable management improves airflow measurably and makes the build far easier to work on in the future.

Testing the Case

The case itself has no electronic components to fail, but there are important physical checks to make before and after the build. Tick each one off before closing the side panels.

- [ ] **Standoff count check:** Count standoffs installed and compare to the number of mounting holes on your motherboard. They must match exactly. No more, no fewer.
- [ ] **I/O shield seating:** Looking from the rear, all port openings should be cleanly exposed with no shield tab protruding into a port. Press the shield firmly if any edge isn't flush.
- [ ] **Front panel connectors:** Power the system on and verify the power button works, the reset button works, and both LEDs illuminate. If the HDD LED stays dark, try reversing the connector (it's polarity-sensitive).
- [ ] **Fan direction check:** All case fans should draw air in from the front/bottom and exhaust from the rear/top. The label side of a fan faces the direction air is *expelled* — use this to confirm orientation before the case is closed.
- [ ] **Vibration check (post-boot):** With the system running, rest a hand lightly on the case. Minor vibration is normal; heavy rattling suggests a fan hitting a cable, a loose drive, or an unsecured side panel. Diagnose before the panel goes on.
- [ ] **Airflow check:** After a few minutes of operation, hold your hand near the rear exhaust fan — you should feel warm air flowing out. Cold exhaust means air isn't moving through the case correctly (wrong fan direction or blocked path).
- [ ] **5.25" bay fitment:** With the Blu-ray drive installed, open and close the tray several times to confirm the bay cover aligns properly and the tray extends without obstruction.
- [ ] **Side panels close cleanly:** Both panels should close flush with no bulging from cables. If a panel won't close, a cable is crossing the interior space — re-route it behind the motherboard tray.

Decision Summary for Your Build

SCENARIO	CASE DECISION	COST IMPACT
ATX motherboard + internal Blu-ray	New ATX case with 5.25" bay — Fractal Define 7 recommended	£130–160
Micro-ATX motherboard + internal Blu-ray	New mATX case with 5.25" bay — harder to find; be quiet! Pure Base 500 if available	£70–100
ATX motherboard + external USB Blu-ray	New ATX case (many good options) + USB drive	£100–150 + £50–70
Micro-ATX motherboard + external USB Blu-ray	Keep Kolink Citadel + USB drive	£50–70 for USB drive only

> **The motherboard chapter (PC3) will clarify which direction makes most sense** — once you see the ATX vs mATX motherboard options side by side, the case decision will become clearer. The case recommendation above is intentionally framed as options rather than a single answer for that reason.

Next: Type **PC3** to generate Chapter 3 — The Motherboard.

CHAPTER 3 OF 15

Motherboard

Chapter 3 — The Motherboard

The motherboard is the nervous system of the build. Every other component connects to it — the CPU sits in it, RAM slots into it, storage plugs into it, and the GPU draws power through it. Choose the wrong one and you limit what CPU you can use, how fast your RAM can run, how many drives you can fit, and what you can add later. Choose well and it quietly enables everything else to perform at its best.

> **What we're replacing:** Your MSI B560M PRO-E is an LGA1200 (Micro-ATX) board, compatible only with 10th and 11th generation Intel CPUs. That platform is discontinued — no new CPUs will ever fit it. This chapter selects its replacement and settles the DDR4 vs DDR5 question once and for all.

What a Motherboard Does

A motherboard performs four core functions:

- **Physical mounting** — provides sockets, slots, and ports for every component to attach to in the correct position relative to each other
- **Power distribution** — receives power from the PSU and regulates it down to precise voltages for the CPU, RAM, and chipset via the VRM (Voltage Regulator Module)
- **Communication** — manages the data lanes between the CPU, RAM, storage, GPU, and peripherals according to the chipset's routing rules
- **Configuration** — the BIOS/UEFI firmware lets you set boot order, enable XMP RAM profiles, monitor temperatures, and configure power settings before the OS even loads

The Platform Decision

The most important choice in selecting a motherboard is the **platform** — the combination of CPU socket and chipset generation. This decision locks in which CPUs you can use and which RAM type is supported. For a new build in 2024–2025, three platforms are worth considering:

Intel LGA1700 — DDR5 RECOMMENDED

Socket	LGA1700
CPU generations	12th, 13th gen
RAM	DDR5 — new RAM needed
Board price range	£160 – £240 (ATX, B760)

Intel LGA1700 — DDR4 RAM-SAVING OPTION

Socket	LGA1700
CPU generations	12th, 13th gen
RAM	DDR4 — keeps your 64GB kit
Board price range	£140 – £200 (ATX, B760)

Extra RAM cost	~£130–160 (64GB DDR5-5600)
Board selection	Widest — most current stock

- Mature, well-tested platform
- Widest board choice at every price point
- Excellent driver and software support
- DDR5 now affordable and future-proof
- More M.2 slots on typical boards vs DDR4 variants

- Requires new 64GB DDR5 kit (~£130–160)
- Socket will be replaced by LGA1851 for 15th gen+

Extra RAM cost	£0 — reuse existing
Board selection	Narrowing — fewer new models

- Saves ~£130–160 by reusing existing 64GB DDR4-3600
- DDR4-3600 is genuinely fast enough for dev workloads
- Slightly cheaper boards than DDR5 equivalents

- DDR4 boards increasingly hard to find new in 2025
- Fewer M.2 slots on some DDR4 board variants
- Less future-proof (DDR4 ecosystem declining)

AMD AM5 — DDR5 STRONG ALTERNATIVE

Socket	AM5
CPU generations	Ryzen 7000, 8000, 9000
RAM	DDR5 only — new RAM needed
Board price range	£160 – £250 (ATX, B650)
Extra RAM cost	~£130–160 (64GB DDR5-5600)
Platform longevity	AMD committed to AM5 through 2027+

- Longer platform lifespan — AM5 will support future Ryzen generations
- Excellent multi-thread performance for compilation
- Good value at the mid-range CPU tier

- Requires new 64GB DDR5 kit (~£130–160)
- Slightly higher board+CPU entry cost vs Intel equivalent
- Some dev tools and VMs have better Intel optimisation

The verdict for your build: The recommended platform is **Intel LGA1700 with a DDR5 board**. Here's why: DDR4 boards are becoming harder to source new and have fewer M.2 slots in the same price bracket. The cost difference — approximately £130–160 for a new 64GB DDR5-5600 kit — is modest given your overall budget, and your existing DDR4-3600 kit can be sold to offset some of this. DDR5 is the mainstream standard for the next several years. AMD AM5 is an excellent alternative and worth considering if the CPU chapter (PC4) points strongly toward a Ryzen option.

Chipsets Explained

The chipset is a chip on the motherboard that manages traffic between the CPU, storage, USB, PCIe lanes, and other peripherals. The chipset generation must match the CPU generation, and the chipset tier determines which features are unlocked.

Intel LGA1700 chipsets (relevant to your build)

CHIPSET	CPU OC	RAM OC / XMP	PCIE LANES	M.2 SLOTS (TYPICAL)	VERDICT
H610	No	No XMP	Fewer	1–2	Budget only — avoid for this build
B660 / B760	No	XMP / XMP 3.0	Good	2–3	Sweet spot — recommended
H670 / H770	No	Yes	More	2–3	Mid-tier, not much over B760 for your needs
Z690 / Z790	Yes	Yes + manual OC	Most	3–5	Worth it only if overclocking — adds £60–100

B760 is the current-generation B-series chipset for 12th/13th gen Intel. It supports XMP (the profile that tells the board to run your RAM at its rated speed rather than the JEDEC default), offers 2–3 M.2 slots on most ATX boards, and costs £30–60 less than Z790 without meaningfully sacrificing anything for a non-overclocking development workstation.

AMD AM5 chipsets (for comparison)

CHIPSET	CPU OC	RAM OC / EXPO	VERDICT
A620	No	Limited	Too restricted — avoid
B650	Limited	EXPO / XMP	AMD equivalent of B760 — recommended if going AM5
X670 / X670E	Yes	Full	Enthusiast tier — unnecessary for this build

Reading a Motherboard Specification Sheet

SOCKET

e.g. LGA1700, AM5

The physical CPU interface. Must match the CPU exactly — there is no adapter. Intel and AMD sockets are completely incompatible with each other.

FORM FACTOR

ATX / mATX / ITX

Physical size. Must fit your case. ATX (305×244mm) gives most expansion. Micro-ATX (244×244mm) is smaller with fewer slots. Your case decision from Chapter 2 is directly linked to this choice.

VRM — POWER PHASES

e.g. 12+1+1 phases

The Voltage Regulator Module delivers clean, stable power to the CPU. More phases = better power distribution = less heat and throttling under sustained load. For a non-overclocking B760 build with a 13th gen K CPU, 10+ CPU power phases is adequate.

RAM SLOTS

4 slots (2 channels)

ATX boards have 4 RAM slots, supporting dual-channel operation. Your 64GB kit (2×32GB) fills 2 slots in dual-channel configuration. Always populate matching slots (A2+B2 on most boards) for dual-channel unless the manual says otherwise.

MAX RAM SPEED (XMP)

e.g. DDR5-7600 OC

The highest RAM speed the board officially supports via XMP profile. DDR5's native JEDEC speed is 4800MHz — without XMP enabled in the BIOS, fast DDR5-5600 kits will run at 4800MHz. Always enable XMP after first boot.

M.2 SLOTS

e.g. 3× M.2 (Gen 4)

NVMe SSD slots. More is better — aim for at least 2 on an ATX board (one for the OS drive, one for additional fast storage). Note whether slots support PCIe Gen 3, Gen 4, or Gen 5 — Gen 4 is the practical sweet spot in 2024/25.

SATA PORTS

e.g. 4× SATA 6Gb/s

For your Samsung 870 EVO and WD Blue SSDs. Any modern board has at least 4 SATA ports. Check whether enabling certain M.2 slots disables some SATA ports (a common design trade-off on budget boards).

PCIE X16 SLOT

PCIe 5.0 x16

The primary slot for your GPU. All B760 boards have at least one full-length PCIe slot wired directly to the CPU for maximum bandwidth. Your RTX 3050 LP is PCIe 4.0 and works fine in any PCIe 4.0 or 5.0 slot.

REAR USB-A / USB-C

e.g. 4× USB-A, 1× USB-C

The ports on the rear I/O panel. For a dev machine with WinSCP, USB drives, dongles, and peripherals, more USB-A ports is better. USB-C 10Gbps or 20Gbps on the rear is a bonus. Check at least one USB-A port runs at USB 3.2 Gen 2 (10Gbps) speed.

ETHERNET SPEED

2.5GbE recommended

Your remote desktop sessions (X2GO, RDP) benefit from fast local network throughput. 2.5GbE is now standard on mid-range motherboards; 1GbE is the minimum. Check the NIC brand — Intel and Realtek 2.5G NICs are both reliable.

WI-FI / BLUETOOTH

Wi-Fi 6 / 6E + BT 5.x

Built-in wireless. Available in "WiFi" variants of most boards at ~£20–30 premium. For a wired desktop, it's optional — but convenient for Bluetooth peripherals (keyboard, mouse, headphones) even if the network connection remains wired.

FAN / PUMP HEADERS

e.g. 1× CPU_FAN, 4× SYS_FAN

PWM headers for connecting case fans and CPU coolers. Count them against your planned fan setup. If you have more fans than headers, a cheap fan hub (£10–15) splices multiple fans into one header. At least 4 system fan headers is comfortable for an ATX build.

FRONT PANEL USB HEADER

USB 3.2 Gen 1 + USB-C

Connects to the front I/O of your case. If your case has a front USB-C port, the motherboard needs a corresponding USB-C header (Type-E connector). Confirm this matches before buying — it's easy to overlook.

BIOS FLASHBACK

Nice to have

Lets you update the BIOS from a USB drive *without a CPU or RAM installed*. Useful if you buy a board that needs a BIOS update to support your CPU — without this feature, you'd need a compatible older CPU to perform the update first.

Understanding the VRM

The VRM (Voltage Regulator Module) is the cluster of components along the top and left edge of the motherboard that converts the 12V from the PSU down to the precise voltage the CPU needs (typically 1.0–1.4V) and distributes it across multiple phases to reduce heat and ripple.

```
MOTHERBOARD — VRM LOCATION

┌──────────────────────────────────────────────────┐
│ VRM phases (MOSFETs + chokes + capacitors)       │
│ ██████████████████████████████████████           │
├──────────────────────────────────────────────────┤
│ ██  ┌────────────┐  RAM slots ▓▓ ▓▓ ▓▓ ▓▓          │
│ ██  │    CPU     │                                │
│ ██  │   Socket   │  PCIe x16 ══════════════════   │
│ ██  └────────────┘                                │
│                  M.2 slots  [   ][   ][   ]      │
└──────────────────────────────────────────────────┘

VRM phases = more phases → cooler, more stable power delivery
For a 65–125W CPU on a B760, 10+ phases is sufficient.
Poor VRM causes thermal throttling under sustained all-core load.
```

For your build, the key is matching VRM quality to the CPU. The i5-13600K and i7-13700K both have unlocked multipliers (K-suffix) but on a B760 board the CPU runs to Intel's default power limits — the VRM workload is predictable. A board advertised with "12+1" or more CPU power phases from a mainstream brand (MSI, ASUS, Gigabyte, ASRock) at the B760 price tier will handle either CPU comfortably.

> **Watch out for:** Some budget boards claim high phase counts but use "doublers" — one driver chip running two phases simultaneously. A board with "6+6 true phases" often outperforms one with "12 phases (doubled)". Reputable tech reviewers (Hardware Unboxed, Gamers Nexus) publish VRM analyses for popular boards if you want to dig deeper before purchasing.

What Makes a Motherboard Good vs Bad

SIGNS OF A GOOD BOARD

- ✓ Strong VRM with heatsinks covering the phases
- ✓ XMP 3.0 support for DDR5 rated speed
- ✓ 3+ M.2 slots on an ATX form factor
- ✓ 2.5GbE ethernet (Intel or Realtek 2.5G NIC)
- ✓ USB-C on the rear I/O panel
- ✓ Front panel USB-C header (Type-E)
- ✓ BIOS FlashBack for CPU-free updates
- ✓ Good rear I/O coverage (6+ USB-A ports)
- ✓ Pre-installed I/O shield (saves fiddling)
- ✓ Clear BIOS with easy XMP toggle
- ✓ PCIe slot screw-latch (prevents GPU sag)
- ✓ M.2 thermal shields on all slots

RED FLAGS TO AVOID

- ✗ Only 1 M.2 slot on an ATX board
- ✗ H610 chipset — no XMP at all
- ✗ VRM with no heatsink on a K-series CPU board
- ✗ Only 1GbE ethernet in 2024/25
- ✗ USB 2.0 only front panel header
- ✗ Fewer than 4 SATA ports
- ✗ M.2 slots that disable SATA ports when used
- ✗ Only 2 fan headers on an ATX board
- ✗ Capacitors crowding the CPU socket area (cooler clearance)
- ✗ Poor BIOS reputation (check recent reviews)
- ✗ No XMP/EXPO support labelling — read carefully
- ✗ Flimsy PCIe slot without retention clip

Recommended Boards for Your Build

All recommendations below are ATX, LGA1700, and B760 chipset. Boards are presented in DDR5 and DDR4 variants side by side so you can compare the trade-offs directly.

DDR5 Boards (recommended path — requires new 64GB DDR5 kit)

MSI MAG B760 TOMAHAWK WIFI DDR5

TOP PICK

Socket / Chipset	LGA1700 / B760
Form factor	ATX
RAM	DDR5, 4 slots, up to 192GB, XMP 3.0
M.2 slots	3× (1× Gen 5, 2× Gen 4)
SATA ports	6
VRM	12+1+1 phases, large heatsinks
Ethernet	2.5GbE (Realtek)
Wi-Fi	Wi-Fi 6E + Bluetooth 5.3
Rear USB	4× USB-A 3.2, 1× USB-C 10Gbps
Front USB-C header	Yes (Type-E)
FlashBack	Yes

£185 – £220

The Tomahawk series has a strong reputation for solid VRM quality at a fair price. Three M.2 slots means a dedicated NVMe OS drive plus your two SATA SSDs plus room to grow. The included Wi-Fi 6E is useful for Bluetooth even on a wired network. Excellent BIOS with straightforward XMP activation.

Search Amazon

ASUS TUF Gaming B760-Plus WiFi D5

STRONG OPTION

Socket / Chipset	LGA1700 / B760
Form factor	ATX
RAM	DDR5, 4 slots, up to 192GB, XMP 3.0
M.2 slots	3× M.2 (Gen 4)
SATA ports	4
VRM	12+1 phases, heatsink covered
Ethernet	2.5GbE (Intel i225-V)
Wi-Fi	Wi-Fi 6E + Bluetooth 5.3
Rear USB	4× USB-A, 1× USB-C 10Gbps
Front USB-C header	Yes
FlashBack	No — check BIOS version for CPU support

£175 – £210

ASUS TUF boards are well-regarded for reliability and clear BIOS layout. The Intel 2.5GbE NIC is preferred by some over Realtek for driver stability in Linux environments — relevant given your X2GO Linux remote sessions. Only 4 SATA ports vs 6 on the Tomahawk, but sufficient for your 2 SSDs plus Blu-ray.

Search Amazon

DDR4 Boards (if keeping existing 64GB DDR4-3600 kit)

MSI MAG B760 TOMAHAWK DDR4

DDR4 PICK

Socket / Chipset	LGA1700 / B760
Form factor	ATX
RAM	DDR4, 4 slots, XMP 3.0 to 5333MHz
M.2 slots	2× (Gen 4)
SATA ports	6
VRM	12+1 phases
Ethernet	2.5GbE
Wi-Fi	No (separate WiFi variant available)
Front USB-C header	Yes

£155 – £185

The DDR4 sibling of the top pick. Same VRM and build quality, saves ~£30 on the board price plus ~£150 by reusing your existing RAM. Only 2 M.2 slots vs 3 on the DDR5 version — you'll use one for the OS NVMe drive, leaving one spare. Still plenty for your needs. Note: no built-in Wi-Fi on this variant.

Search Amazon

Gigabyte B760 AORUS Elite AX DDR4

DDR4 + WIFI

Socket / Chipset	LGA1700 / B760
Form factor	ATX
RAM	DDR4, 4 slots, XMP support
M.2 slots	2× (Gen 4)
SATA ports	4
Ethernet	2.5GbE
Wi-Fi	Wi-Fi 6E (AX variant)
Front USB-C header	Yes

£165 – £195

If you want DDR4 with built-in Wi-Fi, the AORUS Elite AX is a strong option. Gigabyte's BIOS (now called GIGABYTE UEFI) has improved considerably. AORUS boards generally have more visual lighting than the Tomahawk, though most RGB can be disabled entirely from the BIOS.

Search Amazon

🔍 Search All: B760 ATX DDR5 Boards 🔍 Search All: B760 ATX DDR4 Boards 🔍 Search All: B650 ATX AM5 Boards

Your Existing Board — MSI B560M PRO-E

SPECIFICATION	B560M PRO-E	ASSESSMENT
Socket	LGA1200	Dead platform — 10th/11th gen Intel only
Form factor	Micro-ATX	Limits to mATX or smaller cases
RAM type	DDR4 only	Can't be reused with a new CPU platform
Chipset	B560	No overclocking, limited to its generation
M.2 slots	1× M.2 (Gen 3)	Only one slot — no room to expand storage
SATA ports	4	Adequate but not generous
Ethernet	1GbE	Slower than current 2.5GbE standard
Verdict	Replace — platform is discontinued, no upgrade path exists	

Assembly — Installing the Motherboard

Important: Install the CPU, RAM, and M.2 NVMe drives onto the motherboard *before* placing it in the case. Working on a bare board on a flat surface is far easier than reaching into a case. Chapter 13 covers the full build sequence, but the pre-installation steps below are motherboard-specific.

1

Unbox and inspect on anti-static surface

Remove the motherboard from its anti-static bag and place it on the bag itself or a non-conductive surface. Inspect for bent pins in the CPU socket, damaged capacitors, or broken PCIe/RAM tabs. Wear your anti-static wrist strap throughout.

⚠ The CPU socket area on LGA1700 boards has a plastic protective cover. Remove this only when you're ready to install the CPU — never force it off and never touch the socket contacts.

2

Install the CPU (covered fully in Chapter 4)

LGA1700 is an Intel socket — the pins are on the motherboard, not the CPU. Lift the socket lever, align the CPU's golden triangle marker with the socket's corresponding triangle, lower it in without force, and close the lever. Chapter 4 has the full detail.

✓ Do this before fitting RAM — the CPU lever requires some pressure and can flex the board. It's safer with the board flat on a desk.

3

Install RAM in the correct slots

For 2 sticks in a 4-slot board, check your manual for the dual-channel configuration — usually slots A2 and B2 (the 2nd and 4th slots from the CPU). Push each stick straight down until both retention clips click. The notch in the stick ensures it can only go in one way. **Never force RAM** — if it needs excessive force, the stick is not aligned.

⚠ Installing RAM in the wrong slots (e.g. A1+B1 instead of A2+B2) still works but disables dual-channel mode, halving memory bandwidth. Check the manual silkscreen or the coloured slots for the correct pairing.

4

Install M.2 NVMe drives

Remove the M.2 slot heatsink (if present — usually 2 screws). Insert the NVMe drive at a 30° angle into the slot, press it flat, and secure with the single small retaining screw. Replace the heatsink. The drive will not operate above its rated temperature without the heatsink — don't skip it.

⚠ The M.2 retaining screw is one of the smallest in the build — use a magnetic screwdriver and a parts tray. Dropping it inside the case is a significant inconvenience.

5

Fit the I/O shield and mount the board in the case

Press the I/O shield (supplied with the motherboard — many modern boards have it pre-attached) firmly into the case's rear cutout. Lower the motherboard onto the standoffs, align the rear ports with the I/O shield, and insert all mounting screws in a diagonal cross pattern. Connect the 24-pin ATX and 8-pin CPU power connectors.

✓ Route the 8-pin CPU cable before mounting the board — it runs to the top-left of the board and is very difficult to connect after the cooler is installed.

6

Connect SATA, front panel, and fan headers

Plug SATA data cables from the board to your drives. Connect front panel connectors (power SW, reset SW, HDD LED, power LED — covered in Chapter 2). Connect case fans to SYS_FAN headers. Connect the front USB 3.0 header and the USB-C Type-E header if your case has a front USB-C port.

Testing the Motherboard

The first boot after installing a new motherboard is called POST — Power On Self Test. The board checks that all essential components are responding before handing control to the BIOS.

- [ ] **First POST:** Connect a monitor to the GPU (not the motherboard's rear video output) and power on. The board should POST and display the manufacturer's logo within a few seconds. If it doesn't, diagnostic LEDs on the board (CPU, DRAM, VGA, BOOT) indicate where it's hanging — consult your manual.
- [ ] **Enter BIOS:** Press the BIOS key at startup (usually Delete or F2). Confirm the CPU is correctly identified (e.g. "Intel Core i7-13700K"), the RAM size is correct (64GB), all M.2 and SATA drives are listed, and temperatures look sensible (CPU below 50°C at idle).
- [ ] **Enable XMP:** In the BIOS, find the memory profile setting (usually on the first or "OC" page). Enable XMP (Intel) or EXPO (AMD). Save and reboot. After boot, confirm RAM speed in BIOS or via CPU-Z — it should now show your rated speed (e.g. DDR5-5600) not the default JEDEC speed (DDR5-4800).
- [ ] **CPU-Z verification:** Boot into Windows and run CPU-Z (free download). The CPU tab should show your exact processor model. The Memory tab should show your XMP speed. The SPD tab should show both RAM sticks in slots 2 and 4.
- [ ] **Storage detection:** In Windows Disk Management (right-click Start → Disk Management), confirm all drives appear: NVMe OS drive, Samsung 870 EVO 2TB, WD Blue 1TB. If a drive is missing, check the SATA cable seating and whether the M.2 slot's SATA port sharing has disabled a port.
- [ ] **Fan headers working:** Check HWMonitor or the BIOS hardware monitor to confirm all connected fans show RPM readings. A fan showing 0 RPM is either disconnected, faulty, or connected to a header in DC (not PWM) mode.

- [ ] **Network detection:** Confirm the 2.5GbE NIC appears in Windows Device Manager and that your router/switch assigns it an IP address. Run a speed test or file transfer to confirm 2.5Gbps capability if your network switch supports it.
- [ ] **MemTest86 (optional but recommended for new RAM):** Boot from a MemTest86 USB stick (free download) and run at least 2 passes. This catches faulty RAM sticks before you spend hours troubleshooting strange crashes later. Takes 30–60 minutes for 64GB.

Diagnostic LEDs: Most quality B760 boards have 4 LEDs near the RAM slots labelled CPU, DRAM, VGA, BOOT. During POST they illuminate briefly in sequence. If the board stops at a particular LED, that component is the problem. A DRAM LED that stays lit means the RAM isn't seated — press both sticks firmly and try again.

Next: Type **PC4** to generate Chapter 4 — The CPU, where we'll decide between the i5-13600K and i7-13700K for your development workload.

CHAPTER 4 OF 15

CPU

Chapter 4 — The CPU

The CPU is the brain of the build — every instruction your code executes, every SSH session you open, every Docker container compiling in the background, every X2GO frame arriving over VPN is processed here. For a development workstation, the CPU choice has more impact on daily feel than any other component. A fast CPU makes compiling quick, IDE indexing snappy, and ten simultaneous tasks manageable. A weak one makes all of those painful.

> **What we're replacing:** Your Intel Core i5-10400 (LGA1200, 6 cores / 12 threads, 4.3GHz max) is a solid older chip but belongs to a dead platform. The LGA1200 socket is gone — no new boards support it, no new CPUs will ever fit it. This chapter selects its replacement, and settles the "i5 vs i7, Intel vs AMD" question for your specific workload.

What a CPU Does

The CPU (Central Processing Unit) executes instructions — sequences of operations like add, compare, branch, and store — at extraordinary speed. Everything that happens on your computer is ultimately a stream of such instructions passing through the CPU. For a development workstation, the CPU is stressed by:

- **Compilation** — converting source code to binaries; naturally parallel, benefits strongly from more cores
- **IDE background indexing** — IntelliJ, VS Code, PyCharm continuously analyse and index your project while you type
- **Docker and containerisation** — each container can pin a core; more containers = more cores needed
- **Remote desktop decoding** — X2GO and RDP decode compressed video streams; sustained CPU load per active session
- **Virtual machines** — each VM gets its own vCPU allocation
- **Database processes** — local PostgreSQL, MySQL, Redis all consume CPU when queries run
- **Browser + dev tools** — Chrome with many dev tabs, Postman, Fiddler — all CPU consumers

Unlike gaming (which favours *single-core* clock speed), development workloads are a mix: some tasks (interactive typing, browser, IDE UI) favour single-core speed, while others (compilation, Docker builds, parallel test runs) reward *many cores*. The sweet spot for a dev machine is high IPC with a good core count — not the raw MHz number.

Understanding the Specs

CORE COUNT

e.g. 16 cores

Physical processing units. Each core can run an independent task. More cores = more things happening simultaneously without competition. Critical for dev workloads where compilation, Docker, IDE, and remote sessions all run at once.

THREAD COUNT

e.g. 24 threads

With Intel Hyperthreading (or AMD SMT), each physical core presents two logical threads to the OS. Useful for lightly-threaded tasks. Core count matters more; thread count is a secondary benefit.

P-CORES VS E-CORES

Hybrid architecture (Intel 12th/13th gen)

Intel's 12th and 13th gen CPUs have two core types: Performance cores (P-cores) for demanding single-threaded work, and Efficient cores (E-cores) for background tasks. Windows 11 automatically routes work to the right core type. Explained in detail below.

BASE CLOCK / BOOST CLOCK

e.g. 3.4 GHz / 5.4 GHz

Base clock is the guaranteed minimum frequency. Boost clock is the peak single-core speed under light load. For sustained all-core work (compilation), the CPU runs below boost — real-world all-core speed is between base and boost. Clock speed alone does not determine performance — IPC matters equally.

IPC (INSTRUCTIONS PER CLOCK)

Architecture-dependent

How much work gets done per clock cycle. Intel 12th/13th gen ("Alder Lake" / "Raptor Lake") delivered a major IPC jump over 10th/11th gen. Your old i5-10400 at 4.3GHz will lose to an i7-13700K at the same clock because of IPC — newer architecture = more work per tick.

TDP — PL1 / PL2

e.g. 125W (PL1) / 253W (PL2)

TDP (Thermal Design Power) is the base power limit (PL1). PL2 is the burst power limit Intel allows for short periods before throttling back to PL1. Your PSU and cooler must handle PL2 peaks, but sustained load runs at PL1. On a B760 board at defaults, the CPU respects Intel's spec limits — not boards with "enhanced" power profiles.

CACHE (L1 / L2 / L3)

e.g. 30MB L3

Ultra-fast on-chip memory the CPU uses to avoid fetching data from RAM. L3 cache (the largest, shared between all cores) is particularly important: more L3 means less time waiting for RAM. This is why the AMD Ryzen 7800X3D (with 96MB 3D V-Cache) is exceptional for gaming — but for compilation, L3 is less decisive than core count and clock speed.

SOCKET COMPATIBILITY

Must match motherboard exactly

Intel LGA1700 CPUs fit only LGA1700 motherboards. AMD AM5 CPUs fit only AM5 motherboards. There is no cross-compatibility. The socket also locks in which chipsets are supported — confirmed in Chapter 3.

INTEGRATED GRAPHICS

Intel UHD 770 (most 13th gen)

A graphics chip built into the CPU die. On Intel 13th gen, most models include one (the "F" suffix variants remove it). Not used when a discrete GPU (your RTX 3050) is installed, but useful as a fallback for diagnostics if the GPU ever fails.

Intel's Hybrid Architecture — P-cores and E-cores

Starting with 12th gen (Alder Lake), Intel moved to a hybrid CPU design that combines two very different core types on the same chip. This directly affects how your development workload is handled:

```
Intel Core i7-13700K — Die Layout (simplified)

┌─────────────────────────────────────────────────────────┐
│ P0  P1  P2  P3  P4  P5  P6  P7  │  E0  E1  E2  E3        │
│ ──────────────────────────────  │  ────────────  E4  E5  │
│ 8 Performance Cores             │  E6  E7                │
│ Hyperthreaded → 16 threads      │  8 Efficient Cores     │
│ High clock, high IPC            │  No HT → 8 threads     │
│ Up to 5.4 GHz boost             │  Lower power, lower clock │
├─────────────────────────────────────────────────────────┤
│                  Shared L3 Cache (30MB)                 │
├─────────────────────────────────────────────────────────┤
│          Intel Thread Director ← Windows 11             │
│      routes tasks to the right core type automatically  │
└─────────────────────────────────────────────────────────┘

Example: you are typing in IntelliJ (P-core handles UI)
```

```
    while a Gradle build runs in background (E-cores handle it)
    and an SSH session streams data (E-core handles low-load task)
```

What this means for your workload:

- **IDE, browser, interactive tasks** → automatically scheduled on P-cores for maximum responsiveness
- **Compilation, Docker build, test runner** → spread across all cores (P + E) for maximum throughput
- **Background X2GO / RDP stream decoding** → E-cores absorb this without competing with your foreground work
- **Requires Windows 11** for Intel Thread Director support — Windows 10 does not route correctly and wastes E-core potential

> **More cores, not just faster cores:** The i7-13700K has 16 cores total (8P + 8E) vs your current i5-10400's 6 cores. Running three simultaneous remote sessions plus an IDE plus a Docker build was forcing your CPU to context-switch aggressively. With 16 cores it can hand each task its own core with headroom to spare.

The Intel 14th Gen Warning

> **Avoid Intel 14th gen K-series (14600K, 14700K, 14900K) for a new build in 2025.** These chips have documented instability issues that caused reports of permanent CPU degradation across many builds — particularly the i9-14900K and i7-14700K. The root cause was boards applying excessively high voltages and power limits beyond Intel's official spec. Intel released a microcode update (0x12B) in August 2024 to address the worst cases, but it does not recover CPUs already damaged, and not all boards apply it correctly. For a reliable development machine that you're investing £200–350 into, this is a real risk not worth taking. The 13th gen i7-13700K performs virtually identically and does not have these issues at spec power limits on a B760 board.

Intel 13th Gen — The Lineup for Your Build

CPU	P-CORES	E-CORES	THREADS	BOOST	L3 CACHE	TDP (PL1)	PRICE (EST.)	VERDICT
i5-13400	6	4	16	4.6GHz	20MB	65W	£160–190	Strong value, but fewer cores than ideal for heavy dev multitasking
i5-13600K	6	8	20	5.1GHz	24MB	125W	£220–260	Strong budget pick — excellent IPC, good core count
i7-13700K ★	8	8	24	5.4GHz	30MB	125W	£280–340	Top pick — best balance of multi-thread power and value
i9-13900K	8	16	32	5.8GHz	36MB	125W / 253W MTP	£420–500	Overkill; high TDP, significantly more expensive for marginal dev gain

Head-to-Head: The Final Candidates

Intel Core i7-13700K
TOP PICK

Socket	LGA1700
Cores / Threads	16C (8P+8E) / 24T
Base / Boost clock	3.4 / 5.4 GHz
L3 Cache	30MB
TDP (PL1 / PL2)	125W / 253W
iGPU	Intel UHD 770
DDR4 support	Yes (with DDR4 board)
DDR5 support	Yes (with DDR5 board)

£280 – £340

The 8 P-cores handle your 3 concurrent remote sessions plus IDE without any of them competing. The 8 E-cores absorb compilation, Docker, background tasks. 30MB L3 is the largest in the 13th gen mid-range. This is the CPU that will make you forget your current machine ever felt slow. Well within PSU headroom at 125W sustained on a B760 board.

Search Amazon

Intel Core i5-13600K
BUDGET PICK

Socket	LGA1700
Cores / Threads	14C (6P+8E) / 20T
Base / Boost clock	3.5 / 5.1 GHz
L3 Cache	24MB
TDP (PL1 / PL2)	125W / 181W
iGPU	Intel UHD 770
DDR4 / DDR5	Both supported

£220 – £260

Saves ~£60–80 vs the i7. 14 cores is still a massive leap from your current 6. The 2-fewer P-cores do show under sustained heavy multitasking — if you regularly have Docker builds + full IDE + 3 remote sessions all pegged simultaneously, the i7 headroom is meaningful. For lighter multitasking, the i5-13600K is excellent value.

Search Amazon

AMD Ryzen 7 7700X
AM5 ALTERNATIVE

Socket	AM5 (new board + DDR5)
Cores / Threads	8C / 16T (no hybrid)
Base / Boost clock	4.5 / 5.4 GHz
L3 Cache	32MB
TDP	105W
iGPU	No (7700X) — 7700 has one
RAM	DDR5 only

£230 – £280

Strong single-core speed, great Linux/WSL compatibility, lower TDP. The 8 cores are all full performance cores with SMT — different from Intel's hybrid model. Fewer total threads than the i7-13700K for the same price, but well-regarded platform with long AM5 roadmap. Good choice if you prefer AMD or plan more Ryzen-optimised workloads.

Search Amazon

AMD Ryzen 9 7900X
AM5 HIGH-END

Socket	AM5 (new board + DDR5)
Cores / Threads	12C / 24T
Base / Boost clock	4.7 / 5.6 GHz
L3 Cache	64MB
TDP	170W
iGPU	No
RAM	DDR5 only

£290 – £360

12 full-performance cores at high clocks with a massive 64MB L3 cache. The most i7-13700K-comparable AMD option. The 170W TDP is notably higher than the Ryzen 7 7700X and demands a capable cooler. If going AM5 and wanting genuine competition with the i7-13700K in multi-threaded dev work, this is the chip to evaluate.

Search Amazon

PSU note — i7-13700K and your TX550M 550W: Under full all-core stress the i7-13700K hits ~180W sustained on a B760 board with PL1 set to 125W (the board's long-term power limit is respected but the PL2 burst window drives it higher briefly). Add the RTX 3050 LP at ~80W, drives, fans — your 550W PSU is operating at approximately 65–70% load under sustained peak, which is fine and actually near the ideal efficiency zone for an 80+ Gold unit. You do not need to replace the PSU for this CPU.

What to Look For (and Avoid)

SIGNS OF A GOOD CHOICE

- ✓ 8+ total cores for a heavy dev workstation
- ✓ Current-gen architecture (13th gen Intel or Ryzen 7000+)
- ✓ High boost clock (5.0GHz+) for single-thread responsiveness
- ✓ Confirmed socket match to your chosen motherboard
- ✓ Good IPC for the generation (check benchmarks vs your i5-10400)
- ✓ Reasonable TDP for your cooler budget
- ✓ K-suffix Intel = unlocked, but runs at spec on B-series boards — not a problem
- ✓ iGPU present — useful diagnostic fallback
- ✓ Brand-new, sealed box from reputable seller

AVOID THESE

- ✗ Intel 14th gen K-series (documented voltage/degradation issues)
- ✗ Any LGA1200 CPU (dead platform — same socket as your i5-10400)
- ✗ Any LGA1700 CPU below i5 tier (Celeron/Pentium for a dev machine is painful)
- ✗ Used / pulled CPUs without warranty
- ✗ i9-13900K unless you have a real use case — TDP is high and gains for dev are marginal
- ✗ Paying a premium for an F-suffix (no iGPU) when the non-F is similarly priced
- ✗ Cheap cooler bundles if buying a K-suffix — K CPUs don't include a stock cooler
- ✗ Mismatched socket to motherboard — always double-check both are LGA1700

Your Existing CPU — Intel Core i5-10400

SPECIFICATION	I5-10400	I7-13700K (NEW)	DIFFERENCE
Socket	LGA1200 (dead)	LGA1700 (current)	New platform with upgrade path
Architecture	Comet Lake (2020)	Raptor Lake (2022)	~30-40% more IPC per clock
Total cores	6 cores	16 cores	2.7× more cores
Threads	12	24	2× more threads
Max boost clock	4.3 GHz	5.4 GHz	+25% single-core clock
L3 cache	12MB	30MB	2.5× more cache
DDR5 support	No	Yes	Future-proof RAM path
PCIe generation	PCIe 3.0	PCIe 5.0	NVMe Gen 4/5 storage

SPECIFICATION	I5-10400	I7-13700K (NEW)	DIFFERENCE
Integrated graphics	UHD 630	UHD 770	Better iGPU fallback
Verdict	Replace — combined IPC + core count improvement makes this one of the most impactful upgrades you can make		

Installing the CPU

K-suffix CPUs do not include a cooler in the box. The i7-13700K ships as CPU only — no cooler, no thermal paste (some thermal paste is pre-applied to many coolers). You will need a separate LGA1700-compatible CPU cooler (covered in Chapter 5). Do not power on the system without a cooler installed — a CPU without cooling will hit thermal limits and power off within seconds.

1. **Prepare the board on a flat, non-conductive surface**

   With the motherboard out of the case and on its anti-static bag, locate the CPU socket. **Remove the black plastic protective cover** by lifting the socket retention arm — it will pop off. Keep this cover in case you ever need to transport the board without a CPU installed.

   ⚠ The LGA1700 socket has 1,700 delicate pins on the motherboard side (unlike AMD where the pins are on the CPU). A bent motherboard pin typically means an RMA. Never touch the socket contact area, never drop the CPU into the socket, and never force anything.

2. **Lift the retention arm and load plate**

   Push down slightly on the retention lever to disengage the hook, then swing it out and up. The metal load plate will lift as well. You'll see the empty socket with its grid of contacts exposed. This is the position for CPU installation.

3. **Align and place the CPU**

   Hold the CPU by its edges — never touch the gold contact pads on the underside. Look for the **small golden triangle marker** in one corner of the CPU package. Match this to the triangle marked on the corner of the socket. The CPU also has two notches on its sides that align with tabs in the socket for a single orientation. Lower the CPU straight down — it should fall into place under gravity with zero force.

   ✓ If the CPU doesn't drop in, it's oriented incorrectly — rotate 180° and try again. A properly aligned CPU seats with no pressure at all.

4. **Close the load plate and secure the retention arm**

   Lower the metal load plate over the CPU, then push the retention arm down and hook it back under the catch. This requires moderate force — the arm is designed to apply even clamping pressure to the CPU. You will hear a click when it fully engages. The CPU is now secure.

   ⚠ The arm will feel stiff — this is normal. Do not be tentative; if it's not fully clicked under the hook, it will appear closed but won't make reliable contact. Apply firm, steady downward pressure on the arm near the hook end.

5. **Apply thermal paste (if your cooler requires it)**

   Many coolers (especially tower coolers like the NH-D15 or Dark Rock Pro 5) come with thermal paste pre-applied to the base. If the cooler has a pre-applied patch of grey compound, you can mount directly — no separate paste needed. If the cooler base is bare metal, apply thermal paste to the centre of the CPU lid before mounting. See the thermal paste section below for the correct method.

   ✓ Remove the pre-applied paste protective film (if any) before mounting. It's transparent and easy to miss, but leaving it on will give catastrophically high temperatures.

Thermal Paste — Application Methods

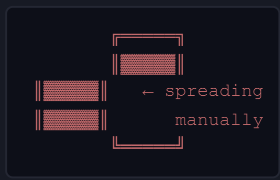
Thermal paste fills the microscopic gaps between the CPU lid and the cooler base, dramatically improving heat transfer. Too little = air pockets = high temps. Too much = overflow onto the socket = potentially catastrophic. The right amount applied correctly produces optimal results.

Centre Dot Method

✓ Recommended

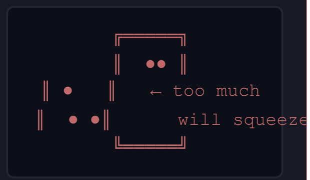
Thin Line Method

✓ Also works well



Spread Method

✗ Can trap air bubbles



Too Much

✗ Risk of socket contamination

- Aim for a pea-sized amount (3–4mm diameter) in the centre of the CPU lid
- The cooler mounting pressure spreads it evenly across the die area
- Most thermal pastes (Noctua NT-H1, Arctic MX-4, Thermal Grizzly Kryonaut) perform similarly — avoid cheap "silver" paste or generic included tubes from unknown cooler brands
- After first boot, retighten cooler mounting screws after the paste has settled (some pastes spread slightly with heat — covered in Chapter 5)

Testing the CPU

- [ ] **POST and BIOS identification:** On first boot, enter BIOS (Delete or F2) and confirm the CPU is correctly identified by name and core count. The BIOS will display e.g. "Intel Core i7-13700K @ 3.40GHz" and should show 24 logical processors. If it shows the wrong CPU or 0 cores, reseat the CPU (turn off, unplug, reopen socket).
- [ ] **CPU-Z — full identification:** Download and run [CPU-Z (free)](). The CPU tab should show: Name: Intel Core i7-13700K, Cores: 16, Threads: 24, Technology: 10nm, Core speed boosting above 3.4GHz under load. The Caches tab should show L3 = 30.0 MBytes.
- [ ] **HWMonitor — idle temperatures:** Download [HWMonitor (free)]() and check CPU temperatures at idle (desktop, no load). All cores should be below 45°C at idle in a reasonably ventilated case. If idle temps are above 60°C, the cooler is not seated correctly or thermal paste was applied incorrectly — remount before stress testing.
- [ ] **Prime95 stress test (Small FFTs — 10 minutes):** Download [Prime95 (free)]() and run "Small FFTs" for 10 minutes with HWMonitor open alongside. This is a worst-case load. Acceptable results: CPU temperature stays below 90°C on all cores, no throttling occurs (clock speeds remain consistent), no errors reported. If temperatures exceed 95°C, the cooler is not performing adequately — check mounting and thermal paste.
- [ ] **Cinebench R23 — benchmark score:** Download [Cinebench R23 (free)]() and run both Single Core and Multi Core tests. Expected scores for i7-13700K: Single ~2,000+, Multi ~30,000+. Compare to published results online — a significantly lower score suggests thermal throttling or incorrect power limit settings in BIOS.
- [ ] **Verify BIOS power limits:** In BIOS, check that the CPU is not running beyond Intel's specified PL1 (125W) without your explicit instruction. Some boards ship with "Performance Mode" or "Multi-Core Enhancement" enabled by default, which removes power limits and can push 13th gen CPUs toward the same conditions that caused 14th gen issues. On a B760 board, set the CPU to operate at Intel Default Settings if this option is available.

- [ ] **Real-world dev test:** Once the OS is installed, run a compilation of a large project (e.g. checkout a large open-source codebase and run a full build) while simultaneously opening your IDE and an X2GO session. The system should remain responsive throughout — if it feels sluggish or the build takes longer than expected, check for throttling in HWMonitor during the run.

Reuse vs Replace Summary

COMPONENT	KEEP OR REPLACE	REASON
i5-10400	Replace	LGA1200 — incompatible with all current platforms. No resale value against a new socket.
Intel Core i7-13700K	Buy new	Best fit for your workload — 16 cores, 5.4GHz boost, 30MB L3, confirmed B760 compatible
i5-13600K alternative	Buy new (if budget)	Saves ~£60–80. 14 cores is still a massive improvement. Consider if other budget areas are tighter

🔍 i7-13700K on Amazon 🔍 i5-13600K on Amazon 🔍 Ryzen 9 7900X on Amazon

Next: Type **PC5** to generate Chapter 5 — CPU Cooling, where we'll select the right tower cooler for the i7-13700K, covering LGA1700 mounting hardware, cooler height clearance, and validating temperatures under load.

CHAPTER 5 OF 15

CPU Cooling

Chapter 5 — CPU Cooling

The CPU generates heat proportional to its power draw — the i7-13700K can pull 180W+ under sustained load, enough to destroy itself in seconds without a cooler. The cooler's job is to move that heat away from the CPU lid, through a thermal interface, into a heatsink, and finally into the case air. Choose the right cooler and the CPU runs quietly at full speed indefinitely. Choose wrong and you get thermal throttling, high noise, and shortened component life.

New purchase required: Your i5-10400 included an Intel stock cooler (the round plastic-clip fan), which only fits LGA1200 and is underpowered for a 125W K-series CPU in any case. A new LGA1700-compatible cooler is needed for this build. The good news: a single quality air cooler lasts multiple CPU generations — it's a long-term investment.

How CPU Cooling Works

```
HEAT DISSIPATION CHAIN

CPU Die (silicon)        generates heat under electrical load
     |
     ▼ (soldered in 13th gen — excellent contact)
CPU Integrated Heat Spreader (IHS)  — the flat metal lid you see on top
     |
     ▼ (thermal paste fills microscopic gaps here)
Cooler Base (copper or aluminium)  — draws heat from the IHS
     |
     ▼ (heat pipes — liquid evaporates and recondenses at fins end)
Aluminium Fin Stack       — large surface area dissipates heat into air
     |
     ▼ (forced airflow from fan)
Case Air → Rear/Top Exhaust Fan → Outside the case

The thermal paste step is the only one you control during assembly.
Everything else is determined by the cooler you choose.
```

The **heat pipe** is the clever part: a sealed copper pipe filled with a small amount of fluid. The end touching the CPU base gets hot, the fluid evaporates and travels to the cool fin end, condenses back to liquid, and wicks back via a capillary structure. This happens thousands of times per second and is why modern tower coolers perform so well without any pumps or moving parts in the thermal path itself — only the fans move.

Air Cooler vs AIO Liquid Cooler vs Custom Loop

Air Tower Cooler

RECOMMENDED

TDP handling	150–250W (dual tower)
Moving parts	Fan(s) only
Failure modes	Fan failure only — no leaks
Lifespan	10–15+ years (fans replaceable)
Maintenance	None — dust every year or two
Noise at idle	Near-silent (quality coolers)
Cost	£40–110
RAM clearance	Check front fan vs tall RAM

A quality dual-tower air cooler like the Noctua NH-D15 or be quiet! Dark Rock Pro 5 easily handles the i7-13700K at spec power limits. No pump to fail, no tubes to leak, fans last decades, and the thermal performance is excellent. This is the right choice for a development workstation.

AIO Liquid Cooler (240mm / 280mm)

OPTIONAL ALTERNATIVE

TDP handling	200W+ (240mm), 250W+ (360mm)
Moving parts	Pump + fans
Failure modes	Pump failure, tube kink, slow leak
Lifespan	5–7 years typical (pump-limited)
Maintenance	None, but replace unit at 5–7 years
Noise at idle	Very quiet (pump + low-RPM fans)
Cost	£80–160
RAM clearance	Not an issue (cold plate is compact)

AIOs do have advantages: compact CPU mounting block means no RAM clearance issue, and they can look cleaner. However, for a reliability-first development workstation that you want running for many years without intervention, the added failure risk (pump burnout, slow coolant evaporation) tilts the decision toward air. If you have a strong preference for an AIO, the Arctic Liquid Freezer II 240mm is the standout value pick.

Custom Water Loop

SKIP FOR THIS BUILD

Performance	Best possible cooling
Cost	£300–600+
Complexity	Very high — leak testing required
Maintenance	Flush/refill every 1–2 years
For this build	Unnecessary — overkill

Custom loops are for enthusiast overclockers or those with very specific case aesthetics. Not appropriate for a development workstation where stability, simplicity, and reliability are the priorities. Skip entirely.

Reading a Cooler Specification Sheet

TDP RATING

e.g. 250W TDP

The maximum CPU power the cooler is rated to dissipate. The i7-13700K needs a cooler rated for at least 180W sustained. Aim for 220W+ for comfort margin and quieter operation (the cooler doesn't need to spin fans as fast when it has thermal headroom).

HEIGHT

e.g. 165mm — check case clearance

The physical height of the cooler from the motherboard surface. Must be less than your case's maximum CPU cooler height. The Fractal Define 7 (Chapter 2 top pick) allows 185mm — all recommended coolers below fit with room to spare.

FAN SIZE

120mm or 140mm

Larger fans (140mm) move the same air volume at lower RPM = quieter. Dual-fan setups use either 2×120mm or 2×140mm. 140mm dual fans are quieter at the same cooling level. 120mm fans can run higher RPM for the same noise budget.

HEAT PIPES

e.g. 6 heat pipes

More heat pipes = more thermal transfer capacity. Budget coolers have 2–4; flagship coolers have 6–8 large-diameter (6mm+) pipes. For the i7-13700K at 125–180W, 6 heat pipes is the comfortable target.

SOCKET COMPATIBILITY

Must list LGA1700

The cooler's mounting hardware must explicitly support LGA1700. Coolers from 2021 and earlier often supported LGA1151/1200 but not LGA1700. Check the product page carefully — "LGA17xx" means it covers LGA1700 and LGA1851. Some older popular coolers (e.g. original Noctua NH-D15) need a free upgrade kit for LGA1700 support.

RAM CLEARANCE

Critical for dual towers

The front fan on a dual-tower cooler sits very close to the first RAM slot. Tall RAM heatspreaders (40mm+) can prevent the front fan from being mounted at standard height. DDR5 non-RGB sticks are typically 36–38mm tall — usually fine. Tall RGB DDR5 can be 44–50mm and may require raising the front fan bracket above the RAM.

NOISE LEVEL (DBA)

e.g. ≤24 dBA at idle

Decibels (A-weighted) at a standard distance. Below 25 dBA is near-inaudible in a normal room. Quality air coolers from Noctua and be quiet! are consistently near-silent at idle. Under full Prime95 load they become audible but not intrusive. Check reviews for noise measurements — manufacturer specs are often optimistic.

MOUNTING TYPE

Screw-down backplate

Modern coolers use a backplate that sits behind the motherboard with threaded standoffs — far more secure than the old plastic push-pin design. Push-pin Intel stock coolers were notorious for uneven mounting pressure. All recommended coolers below use a proper screw-down backplate system.

LGA1700 Mounting — What Changed

Intel's LGA1700 socket (12th and 13th gen) has a different physical footprint from the older LGA1151/LGA1200 sockets. The screw hole spacing is the same as LGA115x horizontally but different in the other axis — meaning coolers designed for older Intel platforms **will not mount correctly on LGA1700** without an updated bracket.

> **Always verify "LGA1700" or "LGA17xx" is explicitly listed** on the product page under compatible sockets. Phrases like "Intel compatible" or "LGA1200 compatible" are not sufficient. If buying a cooler released before 2022, it almost certainly needs a new mounting kit for LGA1700 — check the manufacturer's website for a free upgrade kit before purchasing.

The LGA1700 socket is also shared with LGA1851 (Intel 15th gen Arrow Lake) at the same screw spacing — so a cooler labelled LGA1700/LGA1851 will work on 12th, 13th, and 15th gen boards, giving you future upgrade flexibility.

> **Noctua LGA1700 kits:** If you already own an older Noctua cooler (NH-D15 original, NH-U12S, etc.), Noctua offers free LGA1700 upgrade kits via their website. You only pay return postage. The **NH-D15 G2** (2023+) was redesigned from the ground up with LGA1700 as its primary target and needs no kit — it ships with LGA1700 hardware as standard.

Case Clearance — Will Your Cooler Fit?

Based on the cases reviewed in Chapter 2, here's how each recommended cooler fits:

Cooler	Height vs Case Max (185mm — Fractal Define 7)
Noctua NH-D15 G2 (167mm)	167mm ✓ 18mm spare · 185mm max
be quiet! Dark Rock Pro 5 (163mm)	163mm ✓ 22mm spare · 185mm max
DeepCool AK620 (160mm)	160mm ✓ 25mm spare · 185mm max

Arctic Freezer 36 (158mm) — 158mm ✓ 27mm spare — 185mm max

All four fit the Fractal Define 7 and be quiet! Pure Base 600 comfortably. The Kolink Citadel Mesh (165mm max) is marginal for the NH-D15 G2 — use DeepCool AK620 or Arctic Freezer 36 if keeping the original case.

Fan Direction — Getting It Right

```
╔══════╗
║ LABEL ║  ← sticker/model name side
║ SIDE  ║     faces the direction
╚══════╝     air is pushed OUT
    ↓
→ → AIR FLOWS → →
```

The Label Rule

The sticker/label side of a fan faces the direction air is expelled. If you want air pushed FROM the front fan INTO the fins, the label faces AWAY from the fins (toward the front of the case).

```
FRONT INTAKE                REAR EXHAUST
     ↓                            ↑
[FAN→]   [== FIN STACK ==]   [←FAN]
 push                          pull
 label   →→ airflow →→   label
 faces                         faces
 FRONT                         BACK
```

Dual Tower Fan Setup

Front fan: label faces toward front of case (pushes air in). Rear fan: label faces toward rear of case (pulls air through). Both arrows on the fan frame confirm airflow direction.

```
CASE FRONT → CASE REAR

[intake fans] → [CPU COOLER] → [rea

Cooler airflow must align with
overall case airflow direction.
Reversing the CPU cooler fan creates
a conflict zone → hot spots.
```

Case Airflow Alignment

The CPU cooler's airflow direction must work WITH case airflow. In a standard front-intake → rear-exhaust setup, the cooler should blow air toward the rear of the case.

What Makes a Cooler Good vs Bad

SIGNS OF A GOOD COOLER

- ✓ Explicitly lists LGA1700 in compatible sockets
- ✓ Screw-down backplate (not push-pin clips)
- ✓ Dual tower with 6+ heat pipes for a 125W+ CPU
- ✓ 140mm fans for quieter operation vs 120mm at same RPM
- ✓ TDP rating 220W+ gives thermal headroom
- ✓ Named brands: Noctua, be quiet!, Arctic, DeepCool
- ✓ Fan connector: 4-pin PWM (speed controlled by mobo)
- ✓ Low noise at idle (check reviews — under 25 dBA)
- ✓ Thermal paste included (or known good brand)
- ✓ Replacement fans available (futureproof)

RED FLAGS TO AVOID

- ✗ Push-pin plastic clips (uneven contact, falls out with age)
- ✗ No explicit LGA1700 support in spec sheet
- ✗ Single tower with 4 pipes for a 125W+ CPU — will throttle
- ✗ Unknown brand with no reviews
- ✗ TDP rating below 150W for the i7-13700K
- ✗ RGB-heavy, massive designs with thin fin stacks
- ✗ 3-pin DC fans (not PWM-controllable by the motherboard)
- ✗ Pre-applied thermal paste that's dried / cracked (old stock)
- ✗ Very cheap single-fan 120mm options (≤£20) for a 125W CPU

Recommended Coolers for the i7-13700K

Noctua NH-D15 G2

TOP PICK

Type	Dual tower, dual 150mm fans
TDP rating	330W (massive headroom)
Height	167mm
Heat pipes	8 × 6mm
LGA1700 / 1851	Yes — designed for LGA1700
Noise at idle	Near-silent (fans at 300 RPM)
Max fan RPM	1,500 RPM
Thermal paste	Noctua NT-H2 included

£95 – £115

Noctua redesigned the D15 from scratch for LGA1700 — the G2 uses larger 150mm fans and a revised mount optimised for the slightly warped LGA1700 package. It is simply one of the best air coolers ever made. The fans are Noctua's signature brown and beige (chromax.black version available for all-black aesthetics). With an i7-13700K at B760 default power limits, the NH-D15 G2 never needs to spin fast — the CPU stays cool and the cooler runs almost silently.

Search Amazon

be quiet! Dark Rock Pro 5

STRONG ALT

Type	Dual tower, dual fans (120+135mm)
TDP rating	280W
Height	163mm
Heat pipes	7 × 6mm
LGA1700 / 1851	Yes — included hardware
Noise at idle	Extremely quiet
Appearance	All-black, brushed top plate
Thermal paste	be quiet! DC2 Pro included

£80 – £100

The be quiet! flagship air cooler. Saves £15–25 vs the NH-D15 G2 with nearly identical real-world performance — within 1–2°C on the i7-13700K. The all-black aesthetic suits cases where the neutral brown Noctua fans feel out of place. Known for exceptional low-noise performance — be quiet! tune their fans specifically for quiet operation.

Search Amazon

DeepCool AK620

BUDGET PICK

Type	Dual tower, dual 120mm fans
TDP rating	260W
Height	160mm
Heat pipes	6 × 6mm
LGA1700 / 1851	Yes
Noise at idle	Quiet
Thermal paste	Generic included — consider upgrading

£40 – £60

Outstanding price-to-performance ratio — consistently recommended by reviewers as the best budget dual-tower. Runs 3–5°C warmer than the NH-D15 G2 under full load, which still puts it well within safe range for the i7-13700K at stock B760 settings. If budget is tighter elsewhere in the build, the AK620 is the place to save £40–50 without meaningful real-world penalty.

Search Amazon

Arctic Liquid Freezer II 240mm

AIO OPTION

Type	AIO liquid — 240mm radiator
TDP handling	~250W sustained
LGA1700	Yes — modern revision
RAM clearance	No issue (compact cold plate)
Radiator fan size	2 × 120mm
Case requirement	240mm radiator mount in case
Pump lifespan	~5–7 years typical

£80 – £105

Best-in-class AIO performance for the price — frequently outperforms more expensive branded AIOs. If you prefer an AIO over air cooling, this is the recommendation. The Fractal Define 7 supports 240mm, 280mm, and 360mm radiators in the top and front — check the case manual for mount positions. Note that the pump adds a constant low hum that some find more noticeable than air cooler fan noise at idle.

Search Amazon

Search All: LGA1700 Dual Tower Coolers

Optional: The LGA1700 ILM Temperature Fix

Intel's LGA1700 retention mechanism (ILM — Independent Loading Mechanism) applies uneven pressure across the CPU package, causing it to bow slightly. This reduces contact quality between the CPU lid and cooler base and typically adds 5–10°C to temperatures. An aftermarket replacement ILM solves this.

> **Thermalright LGA1700 Contact Frame** (approximately £8–12) replaces the stock Intel retention bracket with one designed for even contact pressure. Reviewers consistently measure 5–10°C drops in peak core temperatures using it. It's a cheap and proven modification. You simply swap the bracket before mounting your cooler — no tools beyond a screwdriver needed. Worth considering if chasing quiet operation, as lower temps mean the cooler fans run slower.

🔍 **Search Amazon: Thermalright LGA1700 ILM Frame**

> **Order of operations:** If you use the Thermalright frame, install it before mounting your cooler — it replaces the retention bracket that the cooler's backplate standoffs thread into on some designs. Check your cooler's manual to confirm the frame is compatible (it is with all four coolers recommended above).

Assembly — Mounting the CPU Cooler

> **Sequence note:** As mentioned in Chapter 3, the CPU and RAM should be installed on the motherboard before it goes in the case. The CPU cooler is the last thing to go on the board before it's mounted in the case (or immediately after, depending on your preferred build sequence). Some builders prefer to mount the cooler with the board still on the desk — easier access but awkward to hold steady. Others mount the cooler after the board is in the case. Either works; the steps below assume the board is in the case.

1. **Identify and lay out the mounting hardware**

   Open your cooler's box and find the LGA1700 mounting kit — it should be clearly labelled. You'll typically find: a backplate, standoff screws (that thread through the board holes), a cooler bracket or crossbar, and mounting screws. Lay everything out and consult the included manual before starting. Different coolers use slightly different assembly orders.

   ⚠ LGA1700 kits sometimes look identical to LGA115x kits at a glance but have slightly different standoff thread sizes or backplate hole spacing. Using the wrong parts produces uneven mounting pressure. Confirm the LGA1700 kit is in hand before proceeding.

2. **Install the backplate through the motherboard**

   Thread the standoffs (long screws or threaded posts) through the four mounting holes surrounding the CPU socket, through the motherboard, and into the backplate on the rear side. If your case has a cutout behind the CPU socket (most modern cases do), you can reach the backplate without removing the motherboard. Tighten finger-tight only — no tools yet.

   ✓ The Fractal Define 7 has a large rear cutout, so you can install the backplate with the board already in the case without any contortion.

3. **Apply thermal paste (if not pre-applied on cooler)**

   Check whether your cooler's base has a pre-applied grey thermal compound patch. If yes, skip this step. If the base is bare metal (polished copper or aluminium), apply a pea-sized dot of thermal paste to the exact centre of the CPU lid as described in Chapter 4. Do not spread it — the mounting pressure handles distribution.

   ⚠ If the cooler has a clear protective plastic film on the base, remove it. It's transparent and easy to miss. Leaving it on produces temperatures 30–40°C higher than expected and is one of the most common first-build mistakes.

4

Lower the cooler onto the CPU and align the bracket

For dual-tower coolers: position the cooler so that the fin stack and fans blow air toward the rear of the case. Lower it straight down onto the CPU lid. The cooler's mounting bracket should align with the four standoffs. For screw-mounted systems, hand-thread the mounting screws in — they go through the cooler bracket and thread into the standoffs below.

5

Tighten mounting screws in a diagonal (X) pattern

Tighten each screw a few turns at a time in a diagonal sequence: top-left → bottom-right → top-right → bottom-left. This ensures even pressure distribution across the CPU lid. Tighten until you feel firm resistance — do not overtighten (you could crack the PCB or damage the socket). The thermal paste should spread evenly across the CPU lid under this pressure.

✓ A properly tightened mounting feels firm but not strained. If you're using a screwdriver and it's becoming difficult to turn, stop — it's tight enough.

6

Check RAM clearance and mount the front fan

For dual-tower coolers, the front fan is typically not permanently attached to the heatsink — it's clipped on. Before clipping it, check that your RAM sticks (in slots A2 and B2) clear the fan when it's at its lowest mounting position. If the RAM heatspreader is close, raise the front fan to the next clip position on the heatsink (most allow 10–15mm of adjustment). The rear fan position can usually stay at the standard height.

7

Connect fan cables to motherboard headers

The cooler fans have 4-pin PWM connectors. Plug them into the motherboard's CPU_FAN header (required — if no fan is detected here the board will trigger a warning or refuse to POST) and CPU_OPT header if a second fan is present. Route cables tidily and away from the fan blades using cable ties or clips.

⚠ Some boards detect a missing CPU_FAN connection and refuse to boot, showing an error like "CPU Fan Error." If you have a dual-fan cooler and only one CPU header, plug one fan into CPU_FAN and one into SYS_FAN — the system will still work correctly.

Testing the Cooler

Target temperature zones

< 40°C CPU idle — ideal	**40–55°C** CPU idle — normal	**< 80°C** Full load — excellent	**80–90°C** Full load — acceptable
90–95°C Full load — check mounting	**> 95°C** Remount — cooler issue		

- [ ] **Post-first-boot idle check:** Open HWMonitor before running anything else. CPU package temperature should be below 50°C at idle on the Windows desktop. If idle temperature is above 60°C before any load, the cooler is not seated correctly — shut down and remount before any stress testing.
- [ ] **Fans detected in BIOS:** In the BIOS hardware monitor page, confirm both cooler fans show an RPM reading (not 0). A reading of 0 RPM means a fan is either unplugged, connected to a header in DC-only mode, or faulty. PWM fans will report their actual speed even at low RPM.

- [ ] **10-minute Prime95 Small FFTs stress test:** Run Prime95 (Small FFTs) for at least 10 minutes with HWMonitor open. Monitor "CPU Package" temperature. With an NH-D15 G2 or Dark Rock Pro 5 on an i7-13700K at B760 default power limits, expect 75–85°C at peak. AK620 may hit 82–88°C. All acceptable. If you reach 95°C+ or see throttling (clock speed dropping below the expected sustained frequency), remount the cooler.
- [ ] **Noise assessment at idle:** After Prime95, let the system return to idle for 5 minutes. Sit quietly and listen. A quality air cooler at idle should be near-inaudible — you should hear the GPU fan and case fans more clearly than the CPU cooler. If the CPU cooler is the loudest component at idle, check whether the fan PWM curve in BIOS has been set aggressively.
- [ ] **Noise under compilation load:** Trigger a large compilation job (e.g. a full Gradle or Maven build of a large project) and listen. This is a real-world sustained load — CPU should run at 60–75°C (cooler than Prime95's unrealistic worst-case), and fan noise should increase only moderately. This is what daily usage actually sounds like.
- [ ] **Thermal paste spread check (optional):** After 2–3 weeks of use, if you want to verify paste coverage, you can remount the cooler and look at the paste spread on the CPU lid. It should cover a roughly rectangular area aligned with the CPU die. Uneven spread or very small coverage may explain higher temperatures. This is optional — if temperatures are within acceptable range, there's no need to remount.

Next: Type **PC6** to generate Chapter 6 — Memory (RAM), where we'll compare keeping your existing 64GB DDR4-3600 vs switching to a 64GB DDR5 kit, and cover the XMP configuration that makes a real speed difference.

CHAPTER 6 OF 15

Memory (RAM)

Chapter 6 — Memory (RAM)

RAM is the CPU's working space. Every application you open, every file you're editing, every Docker container running in the background, and every remote desktop stream being decoded occupies RAM. Run out and the OS starts swapping to disk — and the machine bogs down immediately. This chapter settles the DDR4 vs DDR5 question with real numbers, explains the single most commonly skipped configuration step (XMP activation), and gives you specific kit recommendations for each path.

> **Your existing kit:** Corsair Vengeance RGB RS 64GB (2×32GB) DDR4-3600 C18. This is a genuinely good kit — DDR4-3600 is the sweet spot on the DDR4 performance curve and 64GB is exactly right for your workload. Whether you keep it or replace it depends entirely on which motherboard platform you choose. Both paths are fully covered below.

What RAM Does

RAM (Random Access Memory) holds the data and instructions the CPU is actively working with right now. Unlike storage (SSD/HDD), RAM is volatile — it loses its contents when power is removed — but it's orders of magnitude faster than any SSD. The CPU can access RAM in nanoseconds; it would take microseconds to wait for the same data from even the fastest NVMe drive.

When you open an application, its code and data load from storage into RAM. When you switch to it, the CPU reads from RAM. When you run out of RAM, the OS uses a swap file on the SSD as overflow — and the speed difference is immediately noticeable: things that were instant become slow.

For your dev workstation, RAM is constantly consumed by:

OS baseline (Windows 11 + system processes)	~3–4 GB
IntelliJ IDEA / VS Code + project indexing	~2–6 GB
Chrome browser (multiple dev tabs)	~2–5 GB
Docker containers (3–5 running simultaneously)	~4–10 GB
Local database (PostgreSQL / MySQL / Redis)	~1–3 GB
X2GO + RDP remote sessions (2–3 active)	~2–4 GB
WinSCP, Kitty/PuTTY, OpenVPN client	~0.5–1 GB
Build process / compiler working set	~2–8 GB

Realistic peak (heavy multitasking) **16–41 GB**

64GB gives 23–48GB headroom above peak — enough that you will never hit the wall in normal use, and plenty of room to grow your Docker footprint or add a local VM.

Why not 32GB? With your workload — multiple remote sessions, Docker containers, and IDE indexing running simultaneously — 32GB runs close to its limit. Any large compilation or added container will start paging to disk. 64GB costs only marginally more as a kit and removes the problem entirely. 128GB is unnecessary and expensive at this price point.

Understanding the Specs

DDR GENERATION

DDR4 vs DDR5 — not interchangeable

DDR4 and DDR5 sticks have different notch positions, different pin counts, and different voltage requirements. They cannot physically fit in the wrong motherboard slot. A DDR5 board takes only DDR5 sticks; a DDR4 board takes only DDR4. The generation is determined entirely by your motherboard choice.

SPEED / DATA RATE

e.g. DDR5-5600

The number after "DDR5-" is the data transfer rate in MT/s (megatransfers per second). The physical clock is half this (DDR5-5600 runs at 2800MHz). Higher is generally faster — but only after XMP is enabled in the BIOS. Without XMP, the kit runs at its JEDEC default (typically DDR5-4800 regardless of what the kit is rated for).

CAS LATENCY (CL)

e.g. C40 or C36

Number of clock cycles between a memory request and the first data response. Lower CL is better — but only meaningful relative to the clock speed. A DDR5-6000 C36 kit has the same real-world latency as a DDR5-4800 C28.8 kit because the absolute latency (in nanoseconds) is what matters.

TRUE LATENCY (NS)

CL ÷ MHz × 2000

The real comparison metric. Formula: CL ÷ (data rate ÷ 2) × 1000 = ns. DDR4-3600 C18: 18 ÷ 1800 × 1000 = **10 ns**. DDR5-5600 C40: 40 ÷ 2800 × 1000 = **14.3 ns**. DDR5-6000 C36: 36 ÷ 3000 × 1000 = **12 ns**. Your existing DDR4-3600 C18 actually has excellent latency — one reason to keep it if using a DDR4 board.

XMP / EXPO PROFILE

Must be manually enabled in BIOS

XMP (Intel eXtreme Memory Profile) and EXPO (AMD Extended Profiles for Overclocking) are the profiles stored on the RAM stick that tell the motherboard to run it at its rated speed. Without enabling XMP/EXPO in the BIOS, DDR5-5600 runs at DDR5-4800. DDR4-3600 runs at DDR4-2133. This is the single most commonly skipped step in PC builds.

DUAL CHANNEL

2 sticks, correct slots

Running two sticks of RAM in the right paired slots (A2 + B2 on most boards) enables dual-channel mode, effectively doubling memory bandwidth. A single 64GB stick running in single-channel mode would perform significantly worse than two 32GB sticks in dual-channel. Always use a matched pair — never one stick alone.

CAPACITY (GB)

64GB = 2 × 32GB

Total RAM available to the system. 2×32GB = 64GB is the right capacity for this workload. Two sticks (vs four) leaves the remaining two slots free for a future 128GB upgrade if needed — though that's unlikely to ever be necessary for this use case.

VOLTAGE

DDR4: 1.35V / DDR5: 1.1V base

DDR5 runs at lower base voltage than DDR4 but requires a PMIC (Power Management IC) built onto the RAM stick itself — DDR5 manages its own power delivery rather than relying entirely on the motherboard. This is transparent to you as a user but affects compatibility between certain boards and RAM sticks.

XMP — The Step Everyone Forgets

```
WITHOUT XMP ENABLED                  WITH XMP ENABLED

DDR5-5600 kit → runs at DDR5-4800        DDR5-5600 kit → runs at DDR5-5600
DDR4-3600 kit → runs at DDR4-2133        DDR4-3600 kit → runs at DDR4-3600

DDR4 example:
JEDEC default    XMP speed        Bandwidth increase
DDR4-2133   →    DDR4-3600           +69% throughput

DDR5 example:
JEDEC default    XMP speed        Bandwidth increase
DDR5-4800   →    DDR5-5600           +17% throughput

XMP is not overclocking — it simply tells the board to run the RAM
at the speed it was designed and tested for. It is always safe to enable.
```

HOW TO ENABLE XMP AFTER FIRST BOOT

1. Restart and press **Delete** (or F2) to enter BIOS at the manufacturer splash screen
2. Find the memory/OC section — MSI: `OC` tab → AI OC Genie or `DRAM Frequency`; ASUS: `AI Tweaker` → `AI Overclock Tuner`; Gigabyte: `Tweaker`
3. Look for **XMP** or **XMP 3.0** (Intel boards) / **EXPO** (AMD boards). Change the setting from `Disabled` to `XMP Profile 1`
4. The board will display the new RAM speed (e.g. **DDR5-5600**). Confirm this matches your kit's rated speed
5. Press **F10** to save and exit. The board will reboot. If it fails to POST (three beeps or black screen), re-enter BIOS — it will have automatically reverted to safe settings. This is harmless; try XMP Profile 2 if available, or the next lower speed.
6. After boot, verify in CPU-Z → Memory tab: DRAM Frequency should show your rated speed ÷ 2 (CPU-Z reports the physical clock, not the effective data rate). DDR5-5600 shows as **2800 MHz**; DDR4-3600 shows as **1800 MHz**

Dual Channel — Always Use the Correct Slots

Installing RAM in the wrong slots produces single-channel operation — half the memory bandwidth. The performance impact is measurable in compilation and large file operations. Always check your motherboard manual for the dual-channel slot pairing. On most boards, the recommended pairing is slots **A2 and B2** (the 2nd and 4th from the CPU).

Correct configuration — 2 sticks, slots A2 + B2

← CPU

A1	A2	B1	B2
empty	32GB	empty	32GB
Ch A	Ch A	Ch B	Ch B

✓ Dual-channel — correct

Total: 64GB across 2 channels
Full memory bandwidth
Slots A1 + B1 remain free for future upgrade

Wrong configuration — 2 sticks in A1 + A2 (same channel)

← CPU

A1	A2	B1	B2
32GB	32GB	empty	empty

✗ Single-channel — wrong

Both sticks on channel A only
Half the memory bandwidth
Windows still shows 64GB total — easily missed

Your board's manual overrules everything. Most boards use A2+B2 for 2-stick dual-channel, but some use A1+B1. The slots are usually colour-coded (two slots in one colour = one channel). Check the silkscreen printing on the motherboard itself, or the first few pages of the manual. CPU-Z → Memory tab confirms dual-channel operation: it shows "Channel #: Dual" if configured correctly.

DDR4 vs DDR5 — The Full Comparison

DDR4 — Keep your existing kit		DDR5 — New kit required	
Your kit	Corsair Vengeance RGB RS 64GB DDR4-3600 C18	Recommended kit	G.Skill Trident Z5 or Kingston Fury 64GB DDR5-6000
True latency	10 ns (excellent)	True latency (DDR5-6000 C36)	12 ns (vs 10 ns for DDR4-3600)
Peak bandwidth (dual ch)	~57.6 GB/s	Peak bandwidth (dual ch)	~96 GB/s (DDR5-6000)
Extra cost	£0	Extra cost	~£130–160 for 64GB kit
64GB kit availability	DDR4 boards becoming rarer	64GB kit availability	Wide — mainstream standard now
Ecosystem future	Declining — DDR4 end of life approaching	Ecosystem future	DDR5 will remain mainstream for 5+ years
Intel sweet spot	DDR4-3600 is exactly right	Intel sweet spot	DDR5-5600 to DDR5-6000
Real-world dev performance	Fully adequate	Real-world dev performance	Comparable + higher bandwidth

The honest verdict: For your development workload, DDR4-3600 and DDR5-5600–6000 produce nearly identical day-to-day performance. Compilation is slightly faster on DDR5 in bandwidth-heavy scenarios. The real-world difference across a full working day is small. The DDR5 case is about future-proofing and board selection breadth — not a dramatic performance gain. If you choose a DDR4 board specifically to save ~£150 in RAM costs, you lose nothing meaningful in practice.

Your Specific Decision — Keep or Replace?

Keep: Corsair Vengeance RGB RS 64GB DDR4-3600 C18

IF DDR4 BOARD

Board required	B760 DDR4 variant (e.g. MSI MAG B760 TOMAHAWK DDR4)
Extra cost	£0
True latency	10 ns — excellent
Speed after XMP	DDR4-3600 (rated speed)
Capacity	64GB — right for this workload
RGB	Yes — can disable in Corsair iCUE or BIOS

Your existing kit is genuinely good — DDR4-3600 C18 is where DDR4 starts performing well on Intel platforms. No performance compromise keeping it. The only consideration: RGB DDR4 heatspreaders can be tall (yours are ~40mm). Check front fan clearance on the CPU cooler before installing — raise the front fan if needed.

Replace: New 64GB DDR5 Kit

IF DDR5 BOARD

Board required	B760 DDR5 variant (e.g. MSI MAG B760 TOMAHAWK WiFi DDR5)
Extra cost	~£130–160
Recommended speed	DDR5-5600 (min) → DDR5-6000 (sweet spot)
True latency (DDR5-6000 C36)	12 ns (slightly higher than DDR4-3600)
Bandwidth gain	~65% more than DDR4-3600
Sell existing DDR4	~£50–80 second-hand — offsets cost

Buying DDR5 future-proofs the memory subsystem for the life of this board. The net additional cost after selling the DDR4 kit is approximately £60–100. Specific DDR5 kit recommendations are listed below.

DDR5 Kit Recommendations (if choosing DDR5 path)

The sweet spot for DDR5 on Intel LGA1700 is **DDR5-6000 C36** — it offers the best balance of bandwidth, latency, and price. Aim for a kit explicitly listed as compatible with your chosen motherboard (manufacturers maintain QVL — Qualified Vendor Lists — on their product pages).

G.Skill Trident Z5 Neo 64GB DDR5-6000 C36 — TOP PICK

Configuration	2 × 32GB
Speed (XMP 3.0)	DDR5-6000
Timings	36-36-36-96
True latency	12 ns
Voltage	1.35V
Heatspreader height	~36mm (no RGB) or ~44mm (RGB)
Platform	Intel LGA1700 + AMD AM5 (EXPO too)

£145 – £165

G.Skill's flagship consumer DDR5 line with a 6000 MT/s frequency and tight C36 timings. The Neo variant supports both Intel XMP 3.0 and AMD EXPO — useful if you ever switch platforms. Available in a low-profile non-RGB variant (Neo Silenz) that keeps heatspreader height under 36mm, eliminating any CPU cooler clearance concerns.

Search Amazon

Kingston Fury Beast DDR5-6000 C36 64GB — STRONG ALT

Configuration	2 × 32GB
Speed (XMP 3.0)	DDR5-6000
Timings	36-38-38
True latency	12 ns
Heatspreader	Low-profile, ~33mm
XMP / EXPO	Both supported

£130 – £155

Kingston Fury Beast is widely available, well-regarded, and broadly compatible with B760 boards. The low-profile heatspreader (33mm) means no CPU cooler front-fan clearance issues whatsoever — a practical advantage over taller kits. Often undercuts the G.Skill by £15–20 at the same speed and timings.

Search Amazon

Corsair Vengeance DDR5-5600 C40 64GB — BUDGET DDR5

Configuration	2 × 32GB
Speed (XMP 3.0)	DDR5-5600
Timings	C40
True latency	14.3 ns (higher than DDR4-3600)
Price advantage	~£20–30 less than DDR5-6000

£115 – £140

Entry DDR5. The C40 timings at 5600 give higher true latency than your existing DDR4-3600 C18. In practice you won't notice the difference for dev work, but given the relatively small price gap to DDR5-6000 C36, the G.Skill or Kingston at 6000 C36 is a better value unless budget is tight. The Corsair brand and warranty are reliable.

Search Amazon

Search All: 64GB DDR5-6000 C36 Kits

Search All: 64GB DDR4-3600 Kits

What to Look For (and Avoid)

SIGNS OF A GOOD KIT

- ✓ Matched pair (2×32GB) — never a single 64GB stick
- ✓ XMP 3.0 (Intel) or EXPO (AMD) profile on the label
- ✓ DDR5-5600 minimum; DDR5-6000 C36 is the sweet spot
- ✓ Named brands: G.Skill, Corsair, Kingston Fury, Crucial Pro
- ✓ Listed on your board's QVL (Qualified Vendor List)
- ✓ Low-profile heatspreader if using a big dual-tower cooler
- ✓ DDR4 path: your existing kit is already good — keep it
- ✓ Heatspreader height under 40mm for safe cooler clearance

AVOID THESE

- ✗ DDR4 in a DDR5 board, or DDR5 in a DDR4 board (physically impossible anyway)
- ✗ Single 64GB stick — always loses bandwidth vs 2×32GB
- ✗ DDR5 below C40 at DDR5-4800 — barely faster than JEDEC default
- ✗ Unknown brands with no reviews or QVL presence
- ✗ Buying 4×16GB instead of 2×32GB — fills all slots, no upgrade path
- ✗ DDR5 kits above DDR5-7200 without checking your board's support
- ✗ Forgetting to check heatspreader height vs cooler clearance
- ✗ Skipping XMP activation — most common performance loss in new builds

Installing RAM

Anti-static: RAM is sensitive to static discharge. Wear your anti-static wrist strap or touch a grounded metal object before handling. Hold sticks by their edges — avoid touching the gold contact pads or the PCB.

1. **Identify the correct slots**

   Locate slots A2 and B2 on the motherboard (the 2nd and 4th slot from the CPU, usually colour-coded). Confirm dual-channel pairing in the motherboard manual if unsure. The correct slots are typically labelled or printed on the PCB silkscreen.

2. **Open the retention clips**

   Push the retention clips at each end of the target slots outward and away from each other until they click open. On some boards only one end has a movable clip (the other end is fixed); on others, both ends open. Do not force them — they swing outward freely when pushed correctly.

   ⚠ Some boards have very stiff retention clips on fresh-from-factory slots. A gentle but firm sideways push is correct. If a clip won't move, you may be pushing in the wrong direction (they open outward, not upward).

3. **Align the notch and lower the stick**

   Each RAM stick has a single notch (gap) along the gold contacts. This notch must align with the raised key inside the RAM slot. DDR4 and DDR5 notches are in different positions — this is why they cannot be inserted in the wrong type of slot. Lower the stick into the slot aligned along its entire length, not at an angle.

✓ DDR5 sticks are slightly longer than DDR4 and require more force to seat fully. This is normal.

4

Press firmly until both clips click

Apply even, firm downward pressure along the entire length of the stick using both thumbs — one near each end. The stick must go in all the way simultaneously, not end-by-end. You will hear and feel two clicks (one from each retention clip) when it's fully seated. **Partially seated RAM is the most common cause of DRAM LED errors and boot failures.**

⚠ RGB DDR4/DDR5 heatspreaders feel very solid — don't be surprised by how much pressure is needed to fully seat the stick. If you hear only one click, check the other end — one clip may not have engaged.

5

Verify both sticks are flush and both clips engaged

Visually confirm that the top of each stick is at the same height as the other (no tilt), and that both retention clips are closed and snug against the ends of the stick. Give each stick a gentle side-to-side wiggle — it should feel completely solid with no movement.

6

Check CPU cooler front-fan clearance

If you've already mounted the CPU cooler, confirm that the front fan clears the heatspreader on the nearest RAM stick. There should be at least 2–3mm of gap. If the heatspreader touches or is very close to the fan, raise the front fan one bracket position on the heatsink (most dual-tower coolers allow this adjustment).

Testing RAM

- [ ] **BIOS detection:** On first boot, enter BIOS and check that the total installed RAM is reported correctly (e.g. 64.0 GB). If only 32GB is shown, one stick is not seated — power off, reseat, and retry. If 0GB or a DRAM LED lights up, check both sticks are in the correct slots and fully seated.
- [ ] **Enable XMP in BIOS and verify:** Follow the BIOS steps shown earlier in this chapter. After enabling XMP and rebooting, confirm in CPU-Z (Memory tab): **NB Frequency / DRAM Frequency** should show half the rated speed (DDR5-6000 → 3000 MHz in CPU-Z; DDR4-3600 → 1800 MHz). The Channels field should read **Dual**.
- [ ] **CPU-Z SPD tab:** Click the SPD tab in CPU-Z. Select Slot 2 and Slot 4 from the dropdown. Each slot should show your RAM stick's full details (manufacturer, part number, serial, XMP profiles). Empty slots (1 and 3) should show no data. Confirm both sticks are from the same kit (matching serial number prefix).
- [ ] **Windows memory:** Open Task Manager → Performance → Memory. Confirm: Used should be 3–5 GB at idle (OS baseline), Speed should show the XMP-activated data rate (e.g. 6000 MT/s or 3600 MT/s), Slots used should show 2 of 4.
- [ ] **MemTest86 (strongly recommended for new RAM):** Download MemTest86 from memtest86.com, write it to a USB drive using Rufus, and boot from it. Allow at least 2 full passes. A single pass on 64GB takes approximately 45–60 minutes. Look for PASS: 2/2 with 0 errors. Any errors indicate a faulty stick — identify which one by testing each alone.
- [ ] **Windows Memory Diagnostic (quick check):** Type "Windows Memory Diagnostic" in Start → "Restart now and check for problems." Windows will run a basic memory test during reboot and report results. Less thorough than MemTest86 but catches obvious faults in under 10 minutes. Run this if MemTest86 is too slow to wait for right now.
- [ ] **Bandwidth benchmark — AIDA64 (optional):** AIDA64's free trial includes a memory bandwidth test. DDR5-6000 in dual channel should achieve ~80–96 GB/s read bandwidth. DDR4-3600 in dual channel should achieve ~55–60 GB/s. Significantly below these numbers suggests single-channel operation or XMP not activated.

Next: Type **PC7** to generate Chapter 7 — Storage, where we'll cover adding a new NVMe Gen 4 boot drive, keeping your existing Samsung 870 EVO and WD Blue SATA SSDs, and how to partition and organise a multi-drive setup for a dev workstation.

CHAPTER 7 OF 15

Storage — NVMe, SATA & HDDs

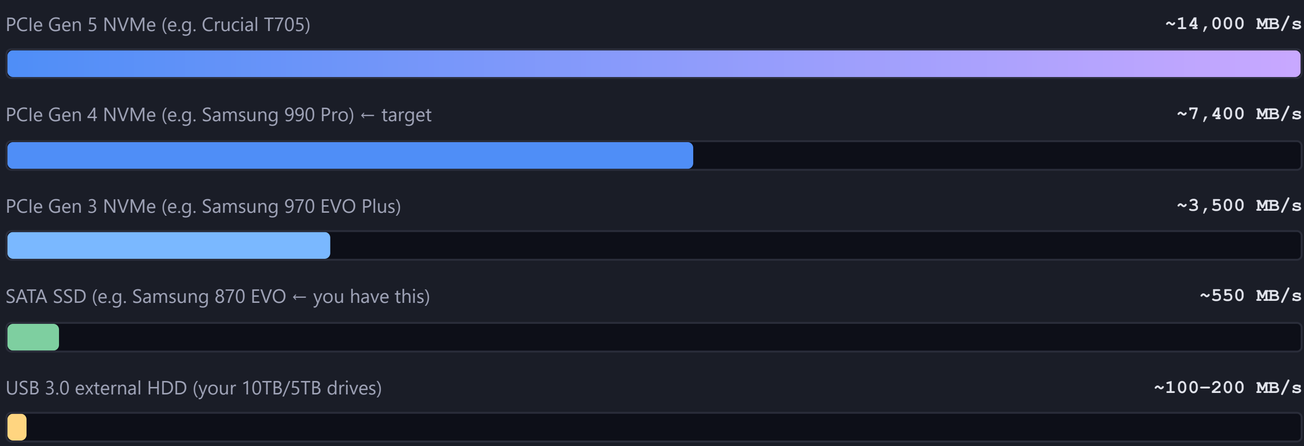
Chapter 7 — Storage

Storage holds everything that persists when the power goes off — your OS, your code, your tools, your data. Unlike RAM (Chapter 6, which forgets everything on shutdown), storage is permanent. For a development workstation, storage speed directly affects how fast your IDE opens, how quickly compilation reads and writes object files, how snappy Docker image pulls feel, and how long Windows boot takes. You have two excellent SATA SSDs worth keeping, and one gap to fill: a fast NVMe boot drive.

Your existing storage (all kept): Samsung 870 EVO 2TB SATA SSD, WD Blue SA510 1TB SATA SSD, and three external USB hard drives (10TB + 5TB + 5TB). These all transfer to the new build with no changes. The main addition is a new NVMe M.2 boot drive, which this chapter selects and sizes.

The Storage Speed Hierarchy

Not all storage is equal. Here is the real-world sequential read speed of each storage type — the speed at which large files (OS install, Docker layers, VM images) are read from the drive:



All sequential read. Random read (small files — git, compilation) follows a similar pattern but with smaller absolute differences. Gen 4 NVMe is 13× faster than SATA for large sequential reads.

Gen 5 is not the answer. PCIe Gen 5 NVMe drives run extremely hot (some require active cooling), cost significantly more than Gen 4, and the extra speed is only perceptible during large file transfers. For a dev workstation where the bottleneck is compilation logic and I/O pattern (many small files), not sequential throughput, Gen 4 is the rational sweet spot. The jump from SATA (your current boot drive scenario) to Gen 4 NVMe is dramatic. The jump from Gen 4 to Gen 5 is marginal.

Understanding the Specs

INTERFACE / PROTOCOL

NVMe (PCIe) or AHCI (SATA)

NVMe (Non-Volatile Memory Express) is a protocol designed for flash storage — low latency, high parallelism, uses PCIe lanes directly. AHCI is the older protocol designed for spinning hard drives and used by SATA SSDs. NVMe is dramatically faster for everything a dev workstation does. Your new boot drive should be NVMe.

FORM FACTOR

M.2 (NVMe) or 2.5" (SATA)

M.2 is a slot on the motherboard — no cables, no bay needed. Most NVMe drives use M.2 2280 (80mm long). Your Samsung 870 EVO and WD Blue are 2.5" form factor and go into drive bays with SATA data and power cables. Both types connect to the new motherboard.

PCIE GENERATION

Gen 4 = sweet spot

Gen 3 NVMe: ~3,500 MB/s. Gen 4: ~7,400 MB/s. Gen 5: ~14,000 MB/s. B760 boards have both Gen 4 and Gen 5 M.2 slots (primary slot is usually Gen 4 or Gen 5 depending on the board). A Gen 4 drive in a Gen 5 slot runs at Gen 4 speed — fully supported and backwards compatible.

SEQUENTIAL READ / WRITE

e.g. 7,400 / 6,900 MB/s

Speed for large contiguous reads and writes (OS install, Docker image pull, VM creation). The headline marketing spec. Important, but less representative of daily dev feel than random 4K performance. Drives within the same PCIe generation are often within 10% of each other here.

RANDOM 4K READ / WRITE

Most important for dev

Speed for reading/writing tiny 4KB blocks — the pattern of compilation, git operations, IDE indexing, database queries, and most real dev I/O. Gen 4 NVMe drives typically achieve 800K–1,000K IOPS random 4K read, vs ~100K IOPS for SATA SSDs. This is where the day-to-day difference is felt.

DRAM CACHE

Prefer drives with DRAM

A small DRAM chip on the drive stores the mapping table (FTL — Flash Translation Layer) so the controller can find data instantly. DRAM-less drives (HMB — Host Memory Buffer) borrow a slice of your system RAM instead, which is slower under sustained random I/O. For an OS/dev drive with constant small-file access, DRAM cache gives more consistent performance.

CAPACITY

1TB or 2TB for boot drive

1TB: Windows 11 (~30GB) + tools (~50GB) + active dev projects + Docker images (~100–300GB total) = comfortable. 2TB: same, but room for WSL2 distro images, multiple large active projects, and local VM disks without thinking about it. The price jump from 1TB to 2TB Gen 4 NVMe is typically only £20–35.

TBW (TERABYTES WRITTEN)

300–600 TBW per 1TB

Total data you can write before NAND cells statistically degrade. A dev workstation writing 30–50GB/day would exhaust a 600 TBW drive in ~33 years. In practice drives are replaced every 5–7 years for other reasons. TBW is rarely a concern with any brand-name Gen 4 NVMe — just avoid very cheap no-name drives with suspiciously low TBW ratings.

Your Existing Storage — Keep or Replace?

Samsung 870 EVO 2TB — KEEP

Interface	SATA 6Gb/s
Form factor	2.5" SATA
Sequential read	560 MB/s
Capacity	2TB — generous
TBW rating	2,400 TBW (exceptional)
DRAM cache	Yes
Recommended use	Data, archives, VMs, large projects

One of the best SATA SSDs ever made. 2,400 TBW endurance is far above typical consumer SATA SSDs. Keep it as secondary data storage — it will serve reliably for many years. Connect to a SATA port on the new motherboard with the included data cable.

WD Blue SA510 1TB — KEEP

Interface	SATA 6Gb/s
Form factor	2.5" SATA
Sequential read	560 MB/s
Capacity	1TB
TBW rating	400 TBW
DRAM cache	HMB (no dedicated DRAM)
Recommended use	Secondary data, personal files, backups

Solid mid-range SATA SSD. No dedicated DRAM (uses HMB), but for secondary data storage this is completely adequate — sustained random I/O is not the use case here. Keep it as tertiary storage or a dedicated drive for personal files, downloads, and archive.

NVMe Gen 4 M.2 Boot Drive — BUY NEW

External HDDs (10TB + 5TB + 5TB) — KEEP — NO ACTION

Interface	PCIe Gen 4 NVMe
Form factor	M.2 2280 (no cables)
Sequential read	~7,000–7,400 MB/s
Recommended capacity	2TB (preferred) or 1TB
DRAM cache	Yes — required for OS drive
Slot	M.2 slot 1 (primary PCIe Gen 4 slot)
Estimated cost	£65–90 (1TB) / £100–140 (2TB)

This is the only new storage purchase needed. Installing Windows on an NVMe Gen 4 drive transforms the experience — boot times drop to under 15 seconds, IDE launch is near-instant, and compilation I/O completes before you notice it. Specific recommendations follow below.

Connection	USB 3.0
Total	20TB external archive
Action needed	None — plug into new build's USB-A

USB storage transfers transparently to the new build. Plug into any USB-A 3.0+ port on the rear I/O panel. No drivers or reconfiguration needed. Suitable for long-term backups, media archives, and cold storage of old projects.

Drive Organisation Strategy

With three internal drives and three external drives, a clear organisation strategy prevents confusion and maximises the benefit of each drive's characteristics. The fast NVMe handles everything that needs to be fast; the SATA SSDs handle everything that needs to be large and accessible; the externals handle cold storage.

Drive C: — NVMe Gen 4 (M.2 slot 1) — **2TB recommended**

- Windows 11 Pro
- IDEs (IntelliJ, VS Code, PyCharm)
- Active dev projects
- Docker Desktop + images
- Node.js / Python / Java runtimes
- Git repositories (current)
- WSL2 virtual disk
- Databases (PostgreSQL data dir)
- Browser profiles + dev tools

Drive D: — Samsung 870 EVO 2TB (SATA) — **2TB**

- Archived dev projects
- VM disk images (.vmdk / .vhdx)
- Large datasets / training data
- Video captures / screen recordings
- Software installers
- Overflow Docker volumes

Drive E: — WD Blue SA510 1TB (SATA) — **1TB**

- Personal documents
- Downloads
- Music / personal media
- Internal backups of C: data
- Game installs (if any)

External HDDs — USB (10TB + 5TB + 5TB) — **20TB total**

- Full system backup (Macrium / Veeam)
- Long-term project archives
- Raw video / photography
- Cold storage
- Offsite rotation copies

Docker data root: By default Docker Desktop stores images and container data in `C:\ProgramData\Docker`. Docker images for a typical dev setup (multiple services, databases, runtimes) can easily reach 50–100GB. Move the Docker data root to a dedicated folder on the NVMe drive via Docker Desktop → Settings → Resources → Advanced → Disk image location. Do this before pulling images, not after, to avoid a slow migration.

Recommended NVMe Boot Drives

All recommendations below are PCIe Gen 4, M.2 2280, with DRAM cache. Available in 1TB and 2TB — 2TB is strongly recommended given the minimal price difference and your multi-container dev workload.

Samsung 990 Pro 2TB

TOP PICK

Interface	PCIe Gen 4 × 4, NVMe 2.0
Sequential read	7,450 MB/s
Sequential write	6,900 MB/s
Random 4K read	1,600K IOPS
DRAM cache	Yes (LPDDR4)
TBW (2TB)	1,200 TBW
Warranty	5 years
Heatsink	Available as heatsink variant

1TB: £70–90 / 2TB: £110–140

Samsung's current flagship consumer Gen 4 NVMe. Samsung controllers and NAND are manufactured in-house — exceptional reliability track record, consistent firmware updates, and Magician software gives excellent drive health monitoring, performance benchmarking, and secure erase. The 990 Pro fixed the earlier 980 Pro's thermal throttling issues. First choice for a build that will run for 5+ years.

Search Amazon (2TB) Search Amazon (1TB)

WD Black SN850X 2TB

STRONG ALT

Interface	PCIe Gen 4 × 4, NVMe 2.0
Sequential read	7,300 MB/s
Sequential write	6,600 MB/s
Random 4K read	1,200K IOPS
DRAM cache	Yes
TBW (2TB)	1,200 TBW
Warranty	5 years
Heatsink	Available as heatsink variant

1TB: £70–85 / 2TB: £110–135

Western Digital's flagship Gen 4 NVMe — the same drive recommended for PlayStation 5 expansion, which required a drive that could sustain maximum throughput indefinitely under console workloads. Performance is essentially identical to the Samsung 990 Pro. If the Samsung is out of stock or costs more, this is a direct equivalent. WD Dashboard software provides health monitoring.

Search Amazon (2TB)

Seagate FireCuda 530 2TB

ALT + HEATSINK

Interface	PCIe Gen 4 × 4, NVMe 1.4
Sequential read	7,300 MB/s
Sequential write	6,900 MB/s
Random 4K read	1,000K IOPS
DRAM cache	Yes (DDR4)
TBW (2TB)	2,550 TBW — highest here
Warranty	5 years
Heatsink	Usually includes heatsink variant

1TB: £65–80 / 2TB: £105–130

Phison E18 controller — the same silicon used in several top-tier Gen 4 drives. The FireCuda 530's 2TB variant has an exceptionally high TBW rating of 2,550 TBW — over double the Samsung at the same capacity. Irrelevant in practice (you'll never reach it), but it's a confidence indicator of the NAND quality. Often slightly cheaper than the Samsung 990 Pro for equivalent specs.

Search Amazon (2TB)

Crucial T500 1TB / 2TB

BUDGET GEN 4

Interface	PCIe Gen 4 × 4, NVMe 1.4
Sequential read	7,400 MB/s
Sequential write	6,500 MB/s
DRAM cache	Yes
TBW (2TB)	600 TBW
Warranty	5 years

1TB: £55–70 / 2TB: £85–110

Crucial (Micron's consumer brand) with an Innogrit controller and Micron NAND. Saves £15–25 over the Samsung at broadly similar sequential specs. Real-world random I/O is slightly behind the flagship drives, but for a dev workstation this is barely perceptible. Good choice if you want to spend the savings elsewhere in the build.

Search Amazon (2TB)

Search All: Gen 4 NVMe 2TB with DRAM

What to Look For (and Avoid)

SIGNS OF A GOOD STORAGE DECISION

- ✓ PCIe Gen 4 NVMe for the OS/boot drive
- ✓ DRAM cache on the primary OS drive
- ✓ 2TB for boot drive — headroom for Docker + projects
- ✓ Named brands: Samsung, WD Black, Seagate FireCuda, Crucial
- ✓ 5-year warranty on NVMe drives
- ✓ TBW ≥ 300 TBW per 1TB capacity
- ✓ Use motherboard M.2 heatsink on the NVMe drive
- ✓ Separate drives for OS and data (isolation + easier reinstall)
- ✓ Keep existing SATA SSDs — no need to replace them

MISTAKES TO AVOID

- ✗ Booting Windows from a SATA SSD when M.2 slots are available
- ✗ PCIe Gen 5 NVMe — runs hot, costs more, marginal gain
- ✗ DRAM-less drives as the OS boot drive (fine for data, not boot)
- ✗ Single huge drive for everything — OS failure = data risk
- ✗ Skipping the motherboard M.2 heatsink — NVMe drives run hot under load
- ✗ Buying a cheap no-name NVMe with no verifiable TBW rating
- ✗ Connecting SATA drives without checking M.2 slot SATA-port sharing
- ✗ Leaving Docker data in the default location before pulling images

Assembly

Installing the NVMe M.2 drive (boot drive)

1. **Remove the M.2 heatsink from slot 1**

   The primary M.2 slot on most B760 boards has a heatsink held by one or two small Phillips screws. Remove them and lift the heatsink away. Set it aside — you'll reattach it after fitting the drive. The thermal pad on the underside of the heatsink is pre-applied; do not remove the protective film until just before you reinstall it.

   ✓ If your motherboard ships with a thermal pad film on both the heatsink and the PCB below the slot — remove BOTH films. Some builders miss the PCB-side film, which insulates the drive from the heatsink and produces higher temperatures.

2. **Insert the NVMe drive at 30°**

   M.2 NVMe drives insert at a 30° upward angle (not flat). Align the drive's gold contacts (notched edge) with the slot's key, then slide it in firmly until the contacts are fully inserted. The drive will sit at a 30° angle above the board, supported by the slot on one end and unsupported at the other.

   ⚠ The key notch on the NVMe drive prevents it from being inserted backwards, but a slightly misaligned insertion can damage pins. If it doesn't go in smoothly, do not force it — realign and try again.

3

Press flat and secure with the retaining screw

Press the free end of the drive flat toward the board. A small retaining screw or clip (M.2 standoff supplied with the motherboard) secures the end of the drive. Some boards use a small screw into a threaded standoff; newer boards use a screwless clip mechanism. Either way: secure the drive flat to the board before reinstalling the heatsink.

⚠ The M.2 retaining screw is tiny and often falls into the case interior during installation. Use a magnetic screwdriver and keep a parts tray handy. Losing this screw means the drive will pop out of position under vibration.

4

Remove heatsink thermal pad film and reattach heatsink

If you haven't already, peel the protective film from the thermal pad on the underside of the heatsink. Lower the heatsink squarely onto the drive and retighten the heatsink screws — finger-tight, then a half-turn more. The thermal pad compresses slightly under the heatsink weight; this is normal and correct.

Connecting the SATA SSDs

1

Check M.2 slot SATA port sharing — before connecting SATA cables

Some motherboards disable a SATA port or two when an M.2 slot is in use, due to shared PCIe lanes. Check your board's manual — there is usually a compatibility table showing which SATA ports remain active based on M.2 slot occupation. On B760 boards with 6 SATA ports, populating M.2 slot 1 with an NVMe drive typically has no effect on SATA availability, but verify for your specific board.

2

Mount the 2.5" SSDs in the case drive bays

The Fractal Define 7 has multiple 2.5" and 3.5" drive bays behind the PSU shroud and on the rear of the case. Screw each 2.5" SSD into a drive tray or bay using the four screws from the side. The drives can also be mounted to SSD brackets or tool-free sleds depending on the case.

✓ In the Fractal Define 7, the 2.5" drive bays on the rear of the motherboard tray are ideal for SATA SSDs — they hide behind the board and keep cables tidy.

3

Connect SATA data cables: drive → motherboard

SATA data cables are thin, 7-pin, L-shaped at one or both ends. Connect one end to the SATA port on the drive and the other to a SATA port on the motherboard. Route cables through grommets for tidiness. SATA cables are keyed — they only connect in the correct orientation and click into place.

⚠ SATA data cables are not usually included with the drives themselves — they come with the motherboard (typically 4 cables). If you have more drives than included cables, buy additional SATA data cables (very cheap — £3–5 for a two-pack).

4

Connect SATA power cables: drive → PSU

SATA power cables come from the PSU (your Corsair TX550M is semi-modular — attach the SATA power cable to the PSU). One SATA power cable typically daisy-chains 3–4 drives. Connect one branch to each drive's wide 15-pin SATA power connector. These are keyed and cannot be connected backwards.

Testing Storage

- [ ] **BIOS detection:** Enter BIOS after first power-on. All installed drives should appear in the Storage/Boot section. The NVMe drive typically shows as "M.2 PCIe Gen 4 — [model name]". SATA SSDs appear in the SATA port list. If a drive is missing: check the heatsink screw/clip on M.2, check SATA data cable seating, and verify the SATA port isn't disabled due to M.2 slot sharing.

- [ ] **CrystalDiskInfo — health check (after OS install):** Download CrystalDiskInfo (free). Open it and confirm all drives show **Good** health status and green icons. Check the Power On Hours for your existing SATA SSDs (gives an idea of how much life they've had). S.M.A.R.T. warnings here indicate a drive that needs attention before use.
- [ ] **CrystalDiskMark — speed benchmark:** Download CrystalDiskMark (free). Run the default test on each drive. Expected results: NVMe Gen 4 sequential read ~6,000–7,400 MB/s; SATA SSD sequential read ~500–560 MB/s. Significantly below these numbers on the NVMe drive may indicate it's running in the wrong slot (Gen 3 instead of Gen 4 — check BIOS to verify the slot's PCIe mode).
- [ ] **Windows Disk Management:** Right-click Start → Disk Management. All three internal drives should appear. The NVMe (C:) will already have Windows installed. The two SATA SSDs appear as unallocated or with their previous partitions. Initialise and format any unallocated drives here (GPT partition style → NTFS → assign a drive letter).
- [ ] **Samsung Magician (if using 990 Pro or 870 EVO):** Samsung Magician provides detailed health monitoring, firmware updates, and a performance benchmark specific to Samsung drives. Run the Diagnostic Scan on the 870 EVO — it checks all sectors and confirms the drive is fully healthy. Also use it to verify the 990 Pro's firmware is current.
- [ ] **NVMe temperature check under load:** In HWMonitor (or CrystalDiskInfo), note the NVMe drive temperature during a sustained large file copy (e.g. copying 20GB between the NVMe and a SATA drive). Gen 4 NVMe drives run hot — 50–70°C under sustained load is normal. Above 80°C suggests the motherboard M.2 heatsink is not making good contact — check that the thermal pad film has been removed and the heatsink is fully seated.

Next: Type **PC8** to generate Chapter 8 — Graphics Card (GPU), covering your existing RTX 3050 LP, confirming it handles 3 monitors at the right resolutions, and what upgrade options look like if you ever want more GPU headroom.

CHAPTER 8 OF 15

Graphics Card (GPU)

Chapter 8 — Graphics Card (GPU)

The GPU drives your displays, decodes video, and handles anything that benefits from thousands of small parallel compute cores. For most developers, the GPU is the least critical performance component — but it's the first thing you notice when it's wrong. A dead output means a dark monitor. An unsupported resolution means a blurry display at 165Hz. This chapter confirms your existing RTX 3050 LP is the right call for now, explains the low-profile form factor quirk in an ATX case, and gives you a clear upgrade path if your workload ever grows beyond it.

Verdict up front: Keep the RTX 3050 LP 6G OC. It drives all three of your monitors at full resolution and refresh rate, handles video playback with hardware decode, keeps remote desktop sessions smooth, and draws only ~75–80W — comfortably within your PSU's budget. No GPU purchase is needed for this build.

What a GPU Does — For a Developer

GPUs serve several distinct functions, and not all of them matter equally for a development workstation:

Display output — driving monitors
Critical — GPU must match your display setup

Video decode (YouTube, Blu-ray, streaming)
Important — hardware decode offloads CPU, smooth 4K

Remote desktop (X2GO, RDP frame decode)
Moderate — GPU helps decode the compressed stream

IDE / UI rendering
Low — any modern GPU handles this trivially

3D gaming
Varies — RTX 3050 LP handles older/lighter titles

AI / ML inference (local models)
Limited — 6GB VRAM caps model size

For your workload — development, video playback, remote desktop, no gaming — the GPU is almost always idle. Its main job is to drive three monitors and hardware-decode video when you play it. Neither task requires significant GPU power.

Your GPU — GeForce RTX 3050 LP 6G OC

NVIDIA GeForce RTX 3050 LP 6G OC

✓ KEEP — FULLY ADEQUATE FOR THIS BUILD

GPU chip	NVIDIA GA107 (Ampere)	Form factor	Low Profile (LP) — see notes below
VRAM	6GB GDDR6	Display outputs	3× DP 1.4 + 1× HDMI 2.1 (typical)
Memory bus	96-bit	Max simultaneous displays	4
PCIe interface	PCIe 4.0 × 16	Hardware video decode	H.264, H.265, AV1

TDP	~75–80W	Hardware video encode	NVENC (H.264, H.265)
External power	None / 1× 6-pin (card dependent)	CUDA cores	2,048

Check your card's exact outputs before buying cables: LP variants of the RTX 3050 vary by manufacturer. Most have 3× DisplayPort 1.4 + 1× HDMI 2.1, but some have 1× HDMI + 2× DP + 1× DVI. Open GPU-Z (free) on your current machine to see the exact output count, or look up your specific card's model number. The output count matters for connecting all three monitors — confirmed in the section below.

Three-Monitor Compatibility — Confirmed

The RTX 3050 supports up to 4 simultaneous displays. Your three 27" monitors are well within this limit, and DisplayPort 1.4 (present on the RTX 3050) has sufficient bandwidth for all three at their native resolutions and refresh rates.

MONITOR 1

27" Samsung (~2015) — 60Hz

Likely resolution	1920×1080 (FHD)
Refresh rate	60Hz
Suggested connection	HDMI 2.1 or DP 1.4
Bandwidth needed	~3.6 Gb/s — trivial

✓ Fully supported at 60Hz

MONITOR 2

27" Samsung (~2019) — 60Hz

Likely resolution	1920×1080 or 2560×1440
Refresh rate	60Hz
Suggested connection	DisplayPort 1.4
Bandwidth needed	Up to ~6.9 Gb/s (1440p@60) — fine

✓ Fully supported at 60Hz

MONITOR 3

27" Samsung (2024) — 165Hz

Likely resolution	2560×1440 (QHD) or 1920×1080
Refresh rate	165Hz
Required connection	DisplayPort 1.4 (DP 1.2 also fine for 1080p)
Bandwidth needed	~17.8 Gb/s (1440p@165) — DP 1.4 = 32.4 Gb/s

✓ DP 1.4 handles 1440p@165Hz with headroom

HDMI vs DisplayPort for the 165Hz monitor: HDMI 2.1 can also handle 1440p@165Hz, but HDMI 2.0 (which older monitors have) is limited to 1440p@144Hz or 1080p@240Hz. Check your 2024 monitor's input labels — if it has HDMI 2.1, either output works. If it only has HDMI 2.0, use DisplayPort to guarantee 165Hz. **DisplayPort is always the safe choice for the high-refresh monitor.**

Adapters: If a monitor only has HDMI inputs and your RTX 3050 LP has used up its HDMI output, use a **DisplayPort to HDMI adapter** — specifically an *active* adapter (passive adapters are unreliable at high resolution). HDMI to DisplayPort adapters generally do not work (signal direction matters). Active DP→HDMI adapters are ~£8–15 and reliable.

Low Profile Card in a Full-Size ATX Case

```
BRACKET HEIGHT COMPARISON

Full-height ATX slot   Low Profile (LP) card     Result in ATX case

┌──────────────────┐   ┌──────────────────┐     ┌──────────────────┐
│                  │   │ DisplayPort ×3   │     │ DisplayPort ×3   │
│ 111mm tall slot  │   │ HDMI             │     │ HDMI             │
│                  │   ╞══════════════════╡     ╞══════════════════╡
│                  │   │ ~68mm LP bracket │     │   LP bracket     │
│                  │   └──────────────────┘     │   ends here      │
│                  │                            │                  │
│                  │   Only fills 68mm of       │  ~43mm gap ←     │
│                  │   the 111mm opening        │  open to air     │
└──────────────────┘                            └──────────────────┘

✓ GPU works perfectly — PCIe slot is electrically identical regardless of bracket height
⚠ Gap in rear panel — minor dust ingress point; cover with a blanking plate if preferred
Some LP cards ship with both LP and full-height brackets — check your box
```

The electrical connection is between the GPU's PCIe connector and the motherboard slot — this is completely unaffected by bracket height. The gap in the rear panel is cosmetic and minor. In a well-filtered case like the Fractal Define 7, the positive pressure airflow means dust does not actively enter through gaps; it is pushed out. If the gap bothers you, metal slot cover blanks cost about £2–3 for a pack of ten.

> **Check your box for a second bracket:** Some LP GPU manufacturers include both a low-profile (68mm) and a full-height (111mm) bracket in the box. If your card came with both, you can swap to the full-height bracket now that you're moving to an ATX case — it will perfectly fill the slot and look cleaner. The bracket is held by two Phillips screws on the card's rear edge.

PCIe Compatibility — RTX 3050 LP in a B760 Board

SPEC	RTX 3050 LP	B760 MOTHERBOARD	RESULT
PCIe generation	PCIe 4.0	PCIe 5.0 primary slot	Backwards compatible — runs at PCIe 4.0 speed
Lane width	× 16	× 16 (CPU-connected)	Full bandwidth — no bottleneck
Physical slot	Standard length	Full-length PCIe slot	LP card fits in any full-length slot
Power draw	75–80W (slot only / 6-pin)	Slot provides 75W standard	No PSU connector needed on many variants
Driver support	NVIDIA Ampere — ongoing	Any modern Windows/Linux	Full driver support from NVIDIA

A PCIe 4.0 GPU in a PCIe 5.0 slot operates at PCIe 4.0 speed — exactly what the card was designed for. There is no compatibility issue and no performance penalty. The PCIe standard is fully backwards and forwards compatible: any card works in any same-or-newer slot.

Honest Limitations — What to Know

The RTX 3050 LP is the right GPU for this build today. But knowing its limits helps you recognise when an upgrade makes sense in the future:

- **6GB VRAM** — sufficient for dev work, video playback, and light inference. If you begin running local LLMs or training ML models, 6GB limits the model size you can load on the GPU. The smallest useful Llama 3 8B model in 4-bit quantisation requires ~5–6GB, which leaves almost no headroom.
- **Limited gaming performance** — the 6GB frame buffer and lower shader count means demanding modern games at 1440p run at reduced settings. This is irrelevant to your stated use case but worth noting if priorities shift.
- **No AV1 encode** — RTX 3050 (GA107) has AV1 decode but not AV1 encode (that arrived with Ada Lovelace / RTX 4000 series). AV1 hardware encode is increasingly useful for video streaming and screen recording. Not relevant for your current workflow.
- **Single fan / LP cooler** — the LP variant runs its single fan harder than a dual-fan full-size card under the same load. Under sustained GPU load (rare for dev work) it may be audible. Under typical dev + video workload it is near-silent.

Upgrade Path — If Your Needs Change

These GPUs are worth considering when the RTX 3050 LP no longer meets your requirements. All are full-size (standard height) cards that fit comfortably in the Fractal Define 7:

RTX 3050 LP 6G (current) — NOW

VRAM	6GB GDDR6
TDP	75–80W
AV1 encode	No
3-monitor@165Hz	Yes

Already owned

Ideal for current dev + video + remote desktop workload. Upgrade only if you hit the VRAM limit with AI/ML work, want serious gaming, or need AV1 encode.

RTX 4060 8GB (Ada Lovelace) — STEP UP

VRAM	8GB GDDR6
TDP	115W
AV1 encode	Yes
Perf vs 3050 LP	~2.5–3× faster

~£240–270

Right upgrade if you start gaming seriously or want AV1 screen recording. 8GB VRAM helps with small local LLMs. Good value step from the 3050 LP without a dramatic price jump.

Search Amazon

RTX 4060 Ti 16GB — AI / ML

VRAM	16GB GDDR6
TDP	165W
AV1 encode	Yes
Local LLM headroom	70B models (quantised)

~£380–420

Only worth it if running local AI models becomes a primary use case. 16GB VRAM enables running Llama 3 70B in 4-bit, Stable Diffusion XL at full quality, and other models that 6–8GB can't handle. Overkill for pure dev work.

🔍 Search Amazon

What Makes a Good Dev GPU

WHAT MATTERS FOR A DEV MACHINE

- ✓ Enough outputs for all monitors (3+ for your setup)
- ✓ DisplayPort 1.4 for any 144Hz+ monitor
- ✓ Hardware video decode (H.264, H.265, AV1)
- ✓ Low TDP — your PSU and CPU need the budget
- ✓ Stable, long-term driver support (NVIDIA/AMD mainstream)
- ✓ PCIe 4.0 or newer — works in any modern board
- ✓ VRAM matched to actual use case (6GB is fine for dev)
- ✓ Quiet at idle — most dev work barely touches the GPU

COMMON GPU MISTAKES FOR DEV

- ✗ Paying for RTX 4090 performance for a dev-only machine
- ✗ Using integrated graphics when a discrete GPU is available
- ✗ Connecting the 165Hz monitor via HDMI 2.0 instead of DP
- ✗ Skipping GPU drivers after install — Windows installs a basic display driver, not the full CUDA/NVENC driver set
- ✗ Not checking max simultaneous display count before buying
- ✗ Using HDMI-to-DP adapters (they don't work) instead of DP-to-HDMI
- ✗ Plugging monitors into the motherboard's rear video output instead of the GPU
- ✗ Forgetting to remove the PCIe slot protection cover before inserting the card

Installing the GPU

1. **Identify the primary PCIe x16 slot**

   On a B760 ATX board, the top full-length PCIe slot (closest to the CPU) is the primary x16 slot wired directly to the CPU with full bandwidth. Always install the GPU here. Lower slots are wired through the chipset with reduced bandwidth — fine for other cards but not ideal for the GPU.

2. **Remove the expansion slot covers from the case**

   Remove the metal slot covers (blanking plates) from the rear of the case that correspond to the PCIe slot positions the GPU will occupy. The RTX 3050 LP is typically a single-slot card, so remove one cover. Retain the thumbscrews or screws — you'll use them to secure the GPU bracket.

   ⚠ LP cards are thinner than standard cards. The LP bracket may not align perfectly with the case's screw holes, depending on the case. The Fractal Define 7 uses thumb screws that should accommodate LP bracket thickness without issue.

3

Unlock the PCIe slot retention clip

The end of the PCIe x16 slot has a small plastic retention clip. Push it away from the slot (outward) to unlock it before inserting the GPU. On some boards the clip is a simple lever; on others it's a push-button. The GPU cannot seat fully without this clip unlocked.

✓ Some boards have a "Quick Release" mechanism — the clip swings open when you press a button near the slot end. Check the board manual if it's not obvious.

4

Align and insert the GPU

Hold the GPU by its edges (avoid touching the PCB components or the gold PCIe contacts). Lower it toward the slot with the output ports aligned to the case's rear opening. The PCIe connector on the card must align with the slot. Press down evenly and firmly along the card's length until the retention clip clicks into place. The card should be fully horizontal with no tilt.

⚠ The RTX 3050 LP is short and light — it seats with less resistance than a full-size card. If you feel significant resistance, check alignment. Forcing a misaligned card can bend the PCIe slot or break the connector.

5

Secure the bracket to the case

Fasten the GPU bracket to the case chassis using the thumbscrew or screw from the removed slot cover. Tighten firmly — a loose GPU bracket allows the card to shift slightly over time and can cause intermittent display issues. The LP bracket should align with at least one screw hole; if it doesn't quite reach, check that the card is fully seated in the slot.

6

Connect PCIe power (if required)

Some variants of the RTX 3050 LP require a single 6-pin PCIe power connector from the PSU; others draw all power through the PCIe slot itself (75W max from slot). Check the edge of your card — if there is a 6-pin or 8-pin connector, plug in the corresponding cable from the Corsair TX550M. If there is no connector, no cable is needed.

⚠ Never power on a card that requires an external power connector without one attached — the card will either fail to POST or run in a severely limited power mode.

7

Connect monitors to the GPU outputs (not the motherboard)

Plug all three monitor cables into the GPU's rear output ports — not into the HDMI or DP ports on the motherboard's rear I/O panel. When a discrete GPU is installed, the motherboard's video outputs are disabled by default (the iGPU is bypassed). Connecting to the wrong ports gives a blank screen.

✓ Connect the 165Hz monitor to a DisplayPort output. The other two can use HDMI or DisplayPort — whichever matches the monitor's available inputs.

Installing NVIDIA Drivers

Windows will install a basic Microsoft display driver automatically, giving you a functional desktop. However, the full NVIDIA driver package is needed for hardware video decode, CUDA support, NVENC encoding, and proper power management (without it, the GPU may run its fan harder than necessary).

> **DDU (Display Driver Uninstaller):** If you are migrating your Windows installation from the old machine (rather than doing a clean install), run DDU in Safe Mode first to remove the old chipset's display drivers cleanly before installing the new NVIDIA package. A fresh Windows 11 install on the new NVMe drive (recommended) does not need DDU — start with the full driver download directly.

1. Visit **nvidia.com/drivers** → select: Product Type: GeForce, Series: GeForce RTX 30 Series, Product: GeForce RTX 3050 → download the **Game Ready Driver** (or Studio Driver if you prefer a more conservative release cycle)

2. Run the installer — choose **Custom Install → Clean Installation** to remove any remnants of previous drivers
3. Reboot after installation
4. After reboot, right-click the desktop → Display Settings → verify all three monitors are detected and set to their correct resolutions and refresh rates (particularly the 165Hz monitor — confirm it is set to 165Hz, not defaulting to 60Hz)
5. Install **GeForce Experience** (optional but convenient for driver updates and Shadowplay screen recording)

Testing the GPU

- [ ] **All three monitors detected:** In Windows Display Settings, confirm three displays appear and each is set to its correct resolution. The 2024 Samsung should show 165Hz as an available refresh rate — select it if it defaulted to 60Hz. If a monitor is not detected, check the cable type (HDMI vs DP), try a different output port, and verify the monitor is powered on.
- [ ] **GPU-Z — full identification:** Download GPU-Z (free, TechPowerUp). The Graphics Card tab should show: Name: GeForce RTX 3050, Memory Size: 6144 MB, Bus Interface: PCIe 4.0 × 16 @ × 16 (verify it's running at × 16 width — a × 1 or × 4 reading means the GPU is in a wrong slot). The Sensors tab shows GPU temperature, fan speed, and load in real-time.
- [ ] **FurMark stress test (10 minutes):** Download FurMark (free, Geeks3D). Run the 1920×1080 preset for 10 minutes. This is a worst-case GPU stress — the LP single fan will spin up noticeably. Acceptable results: GPU temperature below 85°C, no artefacts (visual glitches, checkerboard patterns, corrupted textures), no driver crash. FurMark stress is far more intensive than any real dev workload — passing it confirms the card is healthy.
- [ ] **Hardware video decode test:** Play a 4K H.265 video file (download a sample from the web) in VLC or Windows Media Player. Open GPU-Z → Sensors tab and watch "Video Engine Load" — it should spike to 20–60% during 4K playback, confirming NVDEC hardware decode is active. If Video Engine Load stays at 0% while the CPU usage is high, hardware decode is not working — check NVIDIA driver is fully installed.
- [ ] **165Hz verification:** Open Windows Display Settings → Advanced display → confirm the 2024 monitor shows "165 Hz" as the current refresh rate. To verify it's actually running at that speed (not just reported), visit testufo.com in Chrome on that monitor — the animation smoothness should be clearly different from the 60Hz monitors.
- [ ] **Idle temperature and noise:** After drivers are installed and the system is at the Windows desktop with no load, GPU-Z should show the GPU temperature below 45°C. The GPU fan on the RTX 3050 LP should be inaudible at idle (many LP variants have a fan-stop mode where the fan doesn't spin at all below ~60°C). If the fan is spinning loudly at idle, check the PCIe power connector is fully seated (if one is present on your card).

Next: Type **PC9** to generate Chapter 9 — Power Supply (PSU), confirming your Corsair TX550M handles the full build's power budget and covering PSU testing, modular cable management, and the paperclip test.

CHAPTER 9 OF 15

Power Supply (PSU)

Chapter 9 — Power Supply Unit (PSU)

The PSU converts mains AC (230V in the UK) to the clean, stable DC voltages that every component in your machine depends on. A quality PSU from a known manufacturer running well within its rated capacity will likely outlast everything else in this build. Your Corsair TX550M is that PSU. This chapter confirms it handles the full component stack comfortably, documents every cable it needs to supply, and gives you a clear picture of when a higher-wattage unit would become necessary.

> **Verdict up front:** The Corsair TX550M 550W is the right PSU for this build. At worst-case peak load (i7-13700K at full PL2 burst + RTX 3050 LP + all storage), the system draws approximately 340–380W — roughly 65–70% of the TX550M's capacity. This is the textbook ideal operating range for efficiency and longevity. No PSU purchase needed.

What a PSU Does

Your mains socket delivers 230V AC (alternating current) at 50Hz. Every component in the PC runs on DC (direct current) at far lower voltages. The PSU performs three functions:

1. **Rectification** — converts AC to raw DC using a transformer and diode bridge
2. **Regulation** — smooths the raw DC into stable +12V, +5V, and +3.3V rails using capacitors and feedback circuits. A good PSU holds these within ±5% of target under any load condition.
3. **Protection** — shuts down (rather than frying your components) if it detects overvoltage, overcurrent, overtemperature, or a short circuit

The power number on the label (550W) is the maximum continuous DC output the PSU can deliver. It tells you nothing about efficiency. The efficiency rating (80+, Gold, etc.) tells you how much of the AC power it draws from the wall actually reaches your components vs. how much is lost as heat.

Your PSU — Corsair TX550M 550W

Corsair TX550M 550W 80+ Gold Semi-Modular ✓ KEEP — EXCELLENT HEADROOM FOR THIS BUILD

Rated output	550W continuous	+12V rail	Single +12V, 45.8A (549.6W)
Efficiency rating	80+ Gold	+5V rail	25A (125W)
Peak efficiency	~92% at 50% load (~275W draw)	+3.3V rail	25A (82.5W)
Modularity	Semi-modular	Protections	OVP, UVP, OCP, OPP, SCP, OTP
Fan size	140mm Hydraulic Bearing (HDB)	Warranty	5 years
Fan start mode	Zero RPM / semi-passive at low load	Form factor	ATX (150mm depth)

SINGLE +12V RAIL

45.8A

All power-hungry components (CPU, GPU, most drives) run from the +12V rail. A single high-current +12V rail is the modern standard — no current sharing issues between virtual rails.

SEMI-MODULAR DESIGN

Fixed + Detachable

24-pin ATX and EPS CPU cables are permanently attached. PCIe, SATA, and Molex cables are modular — attach only what you need. Unused cables stay in the box, keeping the case cleaner.

PROTECTION SUITE

OVP / OCP / SCP / OTP

OVP = over-voltage, OCP = over-current, SCP = short circuit, OTP = over-temperature. If any rail goes out of spec, the PSU shuts down before damaging connected hardware.

HYDRAULIC BEARING FAN

140mm HDB

HDB fans last longer and run quieter than sleeve bearings. The TX550M's fan stops completely at low load (semi-passive mode) — the PSU is completely silent during typical dev workloads.

80+ GOLD EFFICIENCY

87–92% efficient

At 50% load (~275W draw), the TX550M is ~92% efficient — only ~22W wasted as heat. Lower efficiency units waste 20–30% of the power you pay for, generating more heat in the process.

VOLTAGE REGULATION

±1–2% typical

Gold-rated units hold rails tighter than the ATX spec's ±5% requirement. Stable voltage means stable clocks — CPUs and GPUs boost more consistently when voltage doesn't droop under load.

Understanding 80+ Efficiency Ratings

```
80+ EFFICIENCY CHART — WHAT THE RATINGS MEAN

Rating          20% load    50% load    100% load    Heat at 50% load (275W out)
─────────────────────────────────────────────────────────────────────────────────
80+ White         80%         80%          80%          69W wasted
80+ Bronze        82%         85%          82%          49W wasted
80+ Silver        85%         88%          85%          37W wasted
80+ Gold ★        87%         90%          87%          31W wasted  ← TX550M
80+ Platinum      90%         92%          89%          24W wasted
80+ Titanium      92%         94%          90%          17W wasted

Example: TX550M delivering 275W (50% load)

┌───────────────────────────────────────────┐
│  Wall power in:   275W ÷ 0.90 = ~306W     │
│  DC power out:    275W (to components)    │
│  Lost as heat:    ~31W                    │
│  Efficiency:      ~90%          ✓ GOLD    │
└───────────────────────────────────────────┘

Sweet spot: 40-60% of rated load maximises efficiency.
For TX550M: 220-330W draw = peak efficiency zone.
This build runs ~230-300W under typical heavy load — in the sweet spot.
```

Power Budget — This Build

Three scenarios matter: idle (productivity, browsing), sustained dev (compilation, Docker builds), and worst-case peak (CPU at full burst + GPU under simultaneous load). The TX550M must handle worst-case without exceeding 80% of rated capacity — a safety margin recommended to preserve longevity.

SCENARIO 1 — IDLE / LIGHT PRODUCTIVITY	~80–110W total
i7-13700K (idle ~8–12W)	~10W

RTX 3050 LP (idle / fan-stop ~5W) ~5W

Motherboard + RAM + fans + storage ~55W

0W ~70W total (13% of 550W) 550W

PSU fan completely stopped at this load level — silent

SCENARIO 2 — HEAVY DEV (SUSTAINED COMPILE + DOCKER) **~230–280W total**

i7-13700K at PL1 (125W sustained TDP) ~125–150W

RTX 3050 LP (video decode, display) ~25–35W

Motherboard + DDR4 + NVMe + SATA ×2 + fans ~65–80W

0W ~255W total (46% of 550W) 550W

Well within the 90% efficiency sweet spot — TX550M barely working

SCENARIO 3 — WORST CASE PEAK (CPU PL2 BURST + GPU LOAD) **~360–400W total**

i7-13700K at PL2 (253W short-term boost) ~253W

RTX 3050 LP under GPU load (~80W max) ~80W

Motherboard + DDR4 + storage + fans ~65–75W

0W ~400W total (73% of 550W) 550W

Within safe headroom. CPU PL2 burst only lasts seconds before throttling to PL1 (~125W)

PL2 is a short burst, not sustained: The i7-13700K's 253W PL2 figure is a brief power spike lasting 28–56 seconds (called Tau) that occurs at the start of a load spike — like when a build kicks off. The CPU then settles to its PL1 (125W). In practice, even a 10-hour compilation run spends the vast majority of time at PL1, not PL2. The 73% peak load figure above is a worst-case snapshot, not a steady-state condition.

Semi-Modular Cable Guide — What This Build Needs

The TX550M separates its cables into two groups: **fixed** (permanently attached, always needed) and **modular** (plug in only what the build requires). Only attach the modular cables you need — unused cables contribute to clutter and reduce airflow.

24-Pin ATX (Motherboard Main) FIXED — ALWAYS CONNECT

Connector	24-pin ATX
Plugs into	Motherboard main power header
Purpose	+12V, +5V, +3.3V, standby, sensing

The largest connector. Permanently attached to the TX550M. Route it behind the motherboard tray first before connecting — it's thick and difficult to hide once the board is seated.

4+4 Pin EPS12V (CPU Power) FIXED — ALWAYS CONNECT

Connector	4+4 pin (clips to form 8-pin)
Plugs into	EPS12V header, top-left of motherboard
Purpose	Dedicated +12V power for CPU VRM

Permanently attached. Connect both halves of the 4+4 clip together for the full 8-pin needed by the i7-13700K's VRM. Most B760 boards have one 8-pin EPS header; some have a second 4-pin booster (not needed here — TX550M handles it on one cable).

6+2 Pin PCIe (GPU Power) MODULAR — MAY NOT BE NEEDED

Connector	6+2 pin (configures as 6-pin or 8-pin)
Plugs into	GPU power connector (if present)
TX550M provides	2× 6+2 pin PCIe cables

Required only if your RTX 3050 LP variant has a 6-pin or 8-pin connector on the card's edge. If the card has no external power connector, skip this cable entirely — the PCIe slot provides 75W directly from the board.

SATA Power Chain MODULAR — CONNECT FOR DRIVES

Connector	SATA power (L-shaped, 15-pin)
Devices powered	Samsung 870 EVO + WD Blue SA510
TX550M provides	Two SATA chains (3–4 connectors each)

Connect one SATA chain for both 2.5" drives — the daisy-chain cable can reach both bays. NVMe drives receive power through the M.2 slot and do NOT use SATA power. Do not confuse SATA power (L-shaped 15-pin) with SATA data (flat 7-pin cable from motherboard).

Molex (4-Pin Legacy) LEAVE IN BOX

Used for	Legacy fans, older devices
In this build	Nothing requires Molex

All case fans connect to motherboard headers. No Molex devices in this build. Leave the Molex cables in the Corsair cable bag — attaching them unnecessarily just adds bulk inside the case.

Second PCIe Cable LEAVE IN BOX

TX550M provides	2× 6+2 pin PCIe total
In this build	Only 1 GPU (RTX 3050 LP)

The second PCIe cable is for dual-GPU or high-power single GPU setups. The RTX 3050 LP needs at most one 6-pin connector. Leave the second cable in the bag.

Never mix modular cables between PSU brands: The modular connector on the TX550M uses a proprietary pin layout. A Seasonic or be quiet! modular cable physically plugs into the TX550M port but wires different pins differently — this can cause a short-circuit or fire. Use only the cables that shipped with the TX550M. Never borrow cables from another PSU.

Installing the PSU

1. **Identify PSU orientation (fan direction)**

   The TX550M's 140mm fan faces one direction — it must face **down** toward the bottom vent of the case when installed in the Fractal Define 7. The PSU mounts in the bottom-rear chamber with the fan pulling fresh air in from outside the case through the floor vent. Check the Fractal Define 7's PSU shroud has its bottom vent unobstructed — there is a removable dust filter on the case underside.

   ✓ The label side of the PSU (with wattage and brand) typically faces down when the fan faces down correctly. Confirm visually before sliding the unit in.

2. **Route fixed cables before inserting the PSU**

   The 24-pin ATX and 4+4 EPS cables are permanently attached. Feed them through the appropriate cable routing holes in the motherboard tray before sliding the PSU into the chassis. In the Fractal Define 7, the 24-pin routes through a large grommet on the right side of the main chamber; the EPS cable routes through a smaller hole near the top. Pre-routing avoids struggling to thread stiff cables through tight gaps later.

⚠ The EPS cable may be too short to reach the top-left CPU power header if you don't route it through the correct hole. If it's just barely reaching, check whether there's a routing cutout near the top of the tray specifically for this cable — most mid-tower cases include one.

3

Slide the PSU into the chassis and secure

Slide the TX550M into the PSU bay from the inside of the case (some cases load from the back panel). Align the four mounting holes on the PSU's rear face with the case's PSU bracket, then secure with the four screws provided with the case. Corsair TX-series PSUs fit all standard ATX PSU mounts.

✓ Finger-tighten all four screws before fully tightening any of them — this helps ensure the PSU sits flush before the screws are locked down.

4

Attach modular cables — SATA chain and PCIe (if needed)

Connect modular cables to the TX550M's output ports first, then route them to the components. The modular ports on the TX550M are labelled — match the cable plug type to the correct port. Do not force connectors; they only fit one way. Attach: one SATA chain (for Samsung 870 EVO + WD Blue), and one 6+2 PCIe cable if your RTX 3050 LP has a power connector.

5

Connect all power headers

Connect in this order: **(1)** 24-pin ATX to motherboard — press firmly until the latch clicks; **(2)** 4+4 EPS to the CPU power header (top-left of board) — both halves clipped together for a full 8-pin; **(3)** SATA power to each 2.5" drive; **(4)** 6+2 PCIe to GPU if required. Every connector has a keyed latch or notch so it can only insert in the correct orientation.

⚠ The 24-pin ATX requires firm, deliberate pressure to seat fully. A half-seated 24-pin connector is one of the most common causes of "no POST" on a first boot. You should hear/feel a definite click from the plastic latch.

6

Cable management — bundle and secure unused length

Use the Fractal Define 7's cable tie-down points and velcro straps (included with the case) to bundle cables behind the motherboard tray. The 24-pin cable is the thickest and least flexible — coil excess length behind the tray rather than letting it bunch in front. Unused modular cables stay in the Corsair cable bag, not stuffed inside the case.

✓ Good cable management improves airflow past the GPU and storage devices, and makes future component swaps dramatically easier. Take 15 extra minutes on this now.

The Paperclip Test — Verifying the PSU Standalone

If you want to test the TX550M before or after the build — without risking connected components — the paperclip test lets you power on the PSU standalone to confirm the fan spins and voltages are present.

```
24-PIN ATX CONNECTOR — PAPERCLIP TEST

Pin 16 (PS_ON — green) shorts to any Ground pin (black)
This tricks the PSU into thinking the motherboard has signalled "power on"

┌──────────────────────────────────────┐
│ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○   Row 1 │
│ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○   Row 2 │
│         ↑           ↑             │
│     Pin 16 (GRN)  Pin 17 (BLK)  │
│     PS_ON         Ground          │
│                                   │
│ Short these two with a paperclip  │
│ or a short piece of wire          │
└──────────────────────────────────────┘

With the paperclip bridge in place:
✓ Switch PSU on (rear toggle)
✓ Fan should spin up → PSU is alive
✓ Connect a SATA device or multimeter to check +12V / +5V / +3.3V

⚠  Do this with mains power OFF until the paperclip is in place
⚠  Do not touch the mains plug terminals
A PSU tester (£5–10 on Amazon) is safer and shows all rail voltages on an LCD
```

> **When to use the paperclip test:** Mainly useful if you're troubleshooting a system that won't POST and you're not sure whether the PSU is at fault. For a new build with a known-working PSU like the TX550M, you can skip directly to the full system test. If the paperclip test shows the fan doesn't spin at all, the PSU is dead — return/replace it before connecting it to any components.

Testing the PSU In-System

- [ ] **POST confirms all power rails present:** If the system reaches the BIOS/UEFI after first boot, all required power rails (+12V, +5V, +3.3V, +5VSB) are working. A system that powers on but doesn't POST could indicate a PSU issue, but is more often a RAM or CPU installation error — check those first.
- [ ] **HWiNFO64 voltage monitoring — Sensors view:** Download HWiNFO64 (free). Open → Run Sensors. Expand the "Nuvoton NCT6798D" or equivalent motherboard sensor section. Look for +12V, +5V, and +3.3V readings. Acceptable ranges: +12V between 11.4–12.6V; +5V between 4.75–5.25V; +3.3V between 3.14–3.46V. Any rail more than 5% outside its target during load is worth investigating.
- [ ] **HWiNFO64 under Prime95 load — voltage droop:** Start a Prime95 "Large FFTs" run (maximum power consumption mode) and watch the +12V rail in HWiNFO. A quality Gold PSU like the TX550M should show no more than 0.1–0.2V droop under load. Significant voltage droop (0.5V+) under load indicates a PSU struggling at capacity — not expected with the TX550M at this build's power draw.
- [ ] **PSU fan behaviour:** At idle (Windows desktop, no load), the TX550M fan should be completely stopped in semi-passive mode — the PSU is silent. Under sustained load (Prime95 running), the fan should spin up smoothly. A fan that rattles, grinds, or pulses irregularly indicates a bearing issue — this PSU should be silent during spin-up given its hydraulic bearing design.

- [ ] **No unexpected shutdowns under load:** Run Prime95 "Small FFTs" (CPU stress) for 30 minutes alongside FurMark (GPU stress). A clean PSU with sufficient headroom will not trigger its OCP or OPP protections under this combined ~350W load on the TX550M. If the system shuts down cleanly during stress (no BSOD, just powers off), the PSU's overcurrent protection may have tripped — check that no SATA cable has a loose connection creating a short, and verify cable seating before suspecting the PSU itself.

- [ ] **Wall power draw (optional — smart plug or Kill-A-Watt meter):** If you have a smart plug with power monitoring (e.g. Tapo P110, ~£12), plug the system into it and check actual wall draw. At idle you should see ~80–120W at the wall. Under full Prime95 load, expect ~280–380W at the wall. These figures reflect wall power (AC in), not DC out — the difference is the PSU's conversion losses. Higher than expected wall draw at a given load indicates the PSU is less efficient than rated.

When the TX550M Would Need Replacing

The TX550M is the right PSU for this build. However, future GPU upgrades change the power equation significantly. Here's when 550W becomes insufficient:

✓ FINE — KEEP TX550M

RTX 4060 upgrade

RTX 4060 TDP: 115W. Total system peak: ~115W GPU + ~150W CPU + ~75W sys = ~340W. Well within 550W. TX550M handles this with no changes.

~340W peak — 62% of 550W ✓

⚠ MARGINAL — MONITOR CAREFULLY

RTX 4060 Ti upgrade

RTX 4060 Ti TDP: 165W. Total system peak: ~165W GPU + ~253W CPU PL2 + ~75W sys = ~493W. At 90% of the TX550M's capacity during CPU+GPU peak — technically within spec but leaves little headroom. Consider an 850W PSU if this is the GPU direction.

~493W peak — 90% of 550W ⚠

✗ REPLACE PSU

RTX 4070 or above

RTX 4070 TDP: 200W. Combined with i7-13700K PL2 and system: ~530W+ peak. This exceeds 550W rated capacity. A 750W or 850W Gold/Platinum unit is required before installing any GPU above the 4060 Ti class.

~530W+ peak — exceeds 550W ✗

PSU rule of thumb: System peak load should not exceed 80% of rated PSU capacity. For an RTX 4070 build with an i7-13700K, a 750W 80+ Gold unit is the minimum. The Corsair RM750x (modular, 80+ Gold, 10-year warranty, ~£110–130) is the natural upgrade if you later need it.

Next: Type **PC10** to generate Chapter 10 — Case & Cooling: mounting the components in the Fractal Define 7, fan placement for your build's airflow, cable routing strategy, and the final assembly checklist before first power-on.

CHAPTER 10 OF 15

Case & Airflow

Chapter 10 — Case & Airflow

Your current Kolink Citadel Mesh is a capable mATX case — but the B760 ATX motherboard recommended in Chapter 3 won't fit inside it. This chapter explains why the case must change, recommends the Fractal Define 7 as the right replacement for this build, covers the airflow principles that keep an i7-13700K and RTX 3050 LP running cool and quiet, and walks through the optimal build sequence for putting everything together inside the chassis.

Verdict up front: Buy the Fractal Define 7. It accommodates the ATX motherboard, fits the NH-D15 G2 with 17mm to spare, includes a 5.25" optical bay the Kolink Citadel Mesh lacks, ships with three 140mm fans, and has outstanding cable management behind the motherboard tray. Budget ~£120–145.

Why the Kolink Citadel Mesh Has to Go

REPLACE **Kolink Citadel Mesh mATX**

Max board size	mATX only
ATX board fits?	No
5.25" optical bay	None
Max CPU cooler height	~165mm
Included fans	1–2 (budget fans)
Cable management space	~15–20mm behind tray
Sound dampening	Mesh — minimal

Keep for a future SFF build

BUY **Fractal Design Define 7**

Max board size	E-ATX (up to 285mm)
ATX board fits?	Yes
5.25" optical bay	2 × 5.25" external
Max CPU cooler height	185mm (NH-D15 G2 = 167mm ✓)
Included fans	3× 140mm Dynamic X2 GP-14
Cable management space	~22mm + routing channels
Sound dampening	Acoustic foam on steel panels

~£120–145 on Amazon

Search Amazon for Fractal Define 7

mATX option if you don't want to change the case: If you choose the MSI MAG B760M MORTAR WIFI (mATX) instead of the ATX board, the Kolink Citadel Mesh can be kept. You lose one M.2 slot and a small number of PCIe lanes compared to the ATX version, but the core build is identical. The ATX board + Define 7 combination is recommended because the 5.25" bay, extra cooler clearance, and cable management space are worth the case upgrade for a machine you'll use for years.

Fractal Define 7 — Key Specifications

SUPPORTED FORM FACTORS

ATX, mATX, mITX, E-ATX

The B760 ATX motherboard (305 × 244mm) fits perfectly. Future motherboard upgrades — even enthusiast E-ATX boards — also fit.

5.25" EXTERNAL BAYS

2 × 5.25"

Rare in modern cases. Allows a Blu-ray drive or optical writer — a future upgrade option the Kolink Citadel Mesh doesn't support at all.

MAX CPU COOLER HEIGHT

185mm

NH-D15 G2: 167mm (18mm clearance). Dark Rock Pro 5: 163mm (22mm). AK620: 160mm. All recommended air coolers fit with comfortable margin.

INCLUDED FANS

3× 140mm Dynamic X2 GP-14

Two front intakes, one rear exhaust — installed from the factory. These are quality fans with fluid dynamic bearings rated for 100,000 hours. No day-one fan purchase needed.

FAN MOUNTING POSITIONS

Front 3×140 / Top 2×140 / Rear 1×140

Six 140mm fan positions total (or 3+3+1 if you mix 120mm). The build starts with positions 1, 2 (front) and 6 (rear) filled — three further positions for future expansion.

MAX GPU LENGTH

491mm (with front fan removed)

RTX 3050 LP is roughly 170mm long. Any GPU up to 491mm fits. RTX 4090 (336mm) would even fit — future-proof for any realistic GPU upgrade.

DRIVE STORAGE

2× 3.5" / 4× 2.5" (configurable)

Modular drive cage system. Configure as 2× 3.5" + 2× 2.5" or remove the cage for more GPU space. Your two SATA SSDs (870 EVO + WD Blue, both 2.5") mount in the dedicated 2.5" trays.

SOUND DAMPENING

Acoustic foam on 3 steel panels

Top, left side, and front panels have acoustic foam lining. The Define series is consistently one of the quietest mid-towers at any price point — ideal for a workstation where fan noise matters.

FRONT I/O

2× USB-A 3.0 / 1× USB-C 3.2 Gen 2

USB-C Gen 2 (10 Gb/s) front port connects to the board's internal USB-C header — fast enough for an external SSD or NVMe enclosure. Two USB-A 3.0 ports for everyday use.

DUST FILTRATION

Front, top, bottom removable filters

All intake points have washable mesh filters. In a positive-pressure setup (more intake than exhaust), dust collects on the filters rather than inside the case — easy to maintain.

DIMENSIONS (H × W × D)

543 × 240 × 475mm

A genuine mid-tower — deeper than average, which contributes to the generous cable management space behind the tray. Slightly larger than the Kolink Citadel Mesh but not dramatically so.

PSU CLEARANCE

Up to 300mm (ATX)

TX550M is 150mm deep — half the available clearance. The PSU bay is behind a solid shroud that hides PSU cables and drives from the main chamber view.

Airflow Fundamentals

Case airflow has one goal: move cool air from outside the case past the heat-generating components and push hot air out. The i7-13700K and RTX 3050 LP are the primary heat sources. A well-designed airflow path prevents hot air from any component from re-entering another component's cooling zone.

```
AIRFLOW PATH — FRACTAL DEFINE 7 WITH THIS BUILD

                         ┌────────────────────────────────┐
      TOP                │ (optional exhaust fans here)   │
   exhaust               │   ↑ hot air exits via top      │
   optional              └────────────────────────────────┘
                         ╓────────────────────────────────╖
REAR                     ║ CPU cooler (NH-D15 G2)         ║  FRONT
1× 140mm ←── hot air ←───║ fans push air L→R toward ───║ 2× 140mm
exhaust                  ║ rear exhaust                   ║  intake ←
(included)               ╟────────────────────────────────╢  (included)
                         ║ Motherboard                    ║
                         ║ GPU (RTX 3050 LP)              ║
                         ║ → GPU heat rises, expelled     ║  ← cool air
                         ║   by rear/top exhausts         ║    from
                         ╟────────────────────────────────╢    outside
                         ║ PSU bay (sealed)               ║
                         ║ TX550M draws its own air ↓     ║
                         ║ from case floor vent           ║
                         ╙────────────────────────────────╜

Fan count:  2 intake (front) : 1 exhaust (rear)
Pressure:   Slight positive pressure → dust collects on filters, not inside
Direction:  Cool air in → past CPU/GPU → hot air out rear → optionally top
```

Positive vs negative pressure: When intake airflow exceeds exhaust airflow, the case is at slightly positive pressure. Air leaks outward through gaps rather than being drawn in — so dust enters only through the filtered intake points (front and bottom), not through every PCIe slot gap and panel seam. The Define 7's 2-in, 1-out stock fan config creates mild positive pressure. This is intentional — it keeps the acoustic foam panels sealed against the chassis and minimises dust ingress.

The PSU has its own airflow loop: The TX550M draws cool air directly from outside the case through the floor vent and exhausts it through its own rear grille. The PSU does not share airflow with the main chamber — it neither helps nor competes with the main cooling loop.

Fan Layout — Stock Configuration (Recommended)

The three included 140mm fans are all you need for this build's thermal load. The i7-13700K's heat is handled primarily by the NH-D15 G2's tower fans, not the case fans — case fans move air through the chassis, the cooler fans move air through the heatsink fins.

INTAKE

Front — Position 1 (bottom)

Size	140mm
Direction	Drawing air in from front
Status	Included (Dynamic X2 GP-14)
Connects to	Motherboard fan header (CHA_FAN1)

INTAKE

Front — Position 2 (top)

Size	140mm
Direction	Drawing air in from front
Status	Included (Dynamic X2 GP-14)
Connects to	Motherboard fan header (CHA_FAN2)

EXHAUST

Rear — Position 3

Size	140mm
Direction	Pushing hot air out rear
Status	Included (Dynamic X2 GP-14)
Connects to	Motherboard fan header (CHA_FAN3)

OPTIONAL EXHAUST

Top — Position 4 & 5

Size	2× 140mm slots
Direction	Exhaust upward (hot air rises)
Status	Empty — not needed for this build
Add if:	You upgrade to a high-TDP GPU later

CPU COOLER FANS

CPU Cooler (NH-D15 G2)

Size	2× 150mm (NH-D15 G2 included)
Direction	Push air front→rear through fins
Status	Included with cooler
Connects to	CPU_FAN header (mandatory)

Fan header management: The B760 board has 4–5 chassis fan headers (CHA_FAN) plus the mandatory CPU_FAN header. Connect the three case fans to CHA_FAN headers and both CPU cooler fans to CPU_FAN and CPU_OPT (or use a Y-splitter from CPU_FAN). Enable PWM fan control in BIOS — the Define 7's fans and the NH-D15 G2's fans are all PWM-capable, so the board can ramp them down when temperatures are low and up during compile loads.

Optimal Build Order — The Right Sequence

PC builds go wrong most often not because of component mistakes, but because of sequence mistakes — installing something in an order that makes the next step harder or impossible. The order below minimises reaching into tight spaces and avoids having to partially disassemble what you've already built.

1 Prepare the case

Inside the empty case

- → Remove both side panels and the top panel (for access)
- → Install **motherboard standoffs** in the ATX pattern — nine brass standoffs in the correct holes. Check the Define 7 manual for the ATX standoff positions. Pre-installed standoffs in the wrong holes will short the motherboard.
- → Remove the I/O shield blanks where the motherboard's rear I/O panel will sit
- → Install the PSU (see Chapter 9) — do this while the case is empty for best access. Route the fixed 24-pin and EPS cables through their tray holes now.

⚠ Do NOT install the PSU after the motherboard — the cable routing becomes much harder with the board in place.

2 Prepare the motherboard outside the case

On a non-conductive surface (box lid, anti-static mat)

- → Install the **I/O shield** into the rear opening of the case (press firmly until it clicks into all four corners) — do this before the board goes in
- → Install **CPU** on motherboard (lever, triangle alignment, contact frame if using Thermalright)
- → Install **RAM** in A2+B2 slots
- → Install **NVMe SSD** in the primary M.2 slot (30° angle, retaining screw, heatsink)
- → Do NOT install the CPU cooler yet — it would make lowering the board into the case awkward

3 Install the motherboard into the case

Main chamber

- → Lower the motherboard into the case, rear I/O panel first — align it with the I/O shield cutouts

→ Align the board's mounting holes with the standoffs (all nine should line up simultaneously)

→ Hand-tighten all nine screws first, then torque them down in a cross pattern (centre first, then outer)

⚠ Do not fully tighten one screw before others are in — this can stress and crack the PCB. Cross-pattern tightening distributes pressure evenly.

4 Install the CPU cooler

Main chamber (board now in place)

→ Install the **LGA1700 backplate** through the rear of the motherboard (or use the Thermalright contact frame bracket if you bought one)

→ Apply thermal paste — pea-size dot at centre of CPU IHS

→ Mount the cooler standoffs/brackets, then lower the NH-D15 G2 in the correct orientation (fans aligned front→rear)

→ Tighten diagonal (X-pattern) to avoid uneven pressure

→ Attach both cooler fans and connect to **CPU_FAN** and **CPU_OPT** headers

5 Install the GPU

Main chamber

→ Remove expansion slot covers from the rear panel (1 cover for LP single-slot card)

→ Unlock the PCIe x16 slot retention clip

→ Insert RTX 3050 LP into the top PCIe x16 slot until the retention clip clicks

→ Secure the bracket screw to the case

→ Connect PCIe power cable if your LP variant requires it

6 Install the storage drives

Drive bays (PSU shroud area)

→ Mount **Samsung 870 EVO** in a 2.5" tray (no screwdriver needed for tool-free trays — slide and click)

→ Mount **WD Blue SA510** in the second 2.5" tray

→ Connect **SATA data cables** from each drive to the motherboard's SATA ports (right-angle connectors point toward the drive, straight end to motherboard)

→ Connect the **SATA power chain** from the TX550M to both drives

⚠ Check the board manual — if an M.2 slot is shared with a SATA port (e.g. SATA5 disabled when M.2_2 is used), make sure your SATA cables avoid those conflicted ports.

7 Connect all motherboard cables

Main chamber

→ **24-pin ATX** — from behind tray, connect to board's main power header (firm push, latch clicks)

→ **4+4 EPS** — from behind tray top hole, connect to CPU power header top-left of board

→ **Front panel connectors** — power switch, reset switch, power LED, HDD LED (see board's front panel header pinout — usually bottom-right corner of board). Use the Define 7's bundled connector block if included.

→ **Front USB headers** — USB 3.0 (blue 19-pin) and USB-C (USB 3.2 Gen 2 header, if board has one)

→ **Front audio header** — HD Audio connector to board's AAFP header

→ **Case fan headers** — three case fans to CHA_FAN1–3

⚠ The front panel connectors (power SW, reset SW, LEDs) are the fiddliest part of any PC build — the pins are tiny and unmarked on the connector itself. The board manual's pinout diagram is essential. Get a torch and magnifier if needed.

8 Cable management — bundle and route

Behind the motherboard tray

→ Route all excess cable length behind the tray using the Define 7's tie-down points and velcro straps

→ Bundle the 24-pin ATX cable (the thickest) behind the tray before closing the back panel

→ Coil the SATA chains neatly in the PSU shroud area

→ Ensure all cables in the main chamber are routed away from the GPU and CPU cooler fan paths

9 Final inspection before first boot

Both sides of the case

→ Do not close the side panels yet — leave the case open for first boot

→ Do a visual sweep with a torch: no loose cables near fans, no cable ties left inside the main chamber, all connectors firmly seated

→ Connect monitors to the **GPU outputs** (not the motherboard rear panel)

→ Connect the mains lead to the PSU, flip the PSU switch to On

Cable Management — Define 7 Specifics

24-PIN ATX — ROUTE FIRST

Before the motherboard goes in, thread the 24-pin cable (already attached to the TX550M) up through the main PSU grommet hole on the right side of the tray. It's thick and stiff — threading it after the board is seated is genuinely difficult. Leave slack on the front-facing side.

EPS CABLE — TOP ROUTING HOLE

The Define 7 has a dedicated cable routing cutout near the top-rear of the tray for the EPS CPU power cable. Use it. If you route the EPS cable in front of the tray (over the board), it will run through the NH-D15 G2's fan zone and be visible through the side panel.

SATA CABLES — RIGHT-ANGLE END AT DRIVE

SATA data cables come with one straight and one right-angle connector. Always put the right-angle (L-shaped) end at the drive — it sits flush against the drive bay and won't stress the connector under vibration. The straight end connects to the motherboard's SATA ports.

UNUSED MODULAR CABLES — STAY IN THE BAG

Store the TX550M's unused modular cables (extra PCIe, Molex) in the Corsair cable pouch, not stuffed inside the case. Excess cabling inside the case reduces airflow through the PSU shroud and makes future maintenance harder.

FAN CABLES — KEEP THEM SHORT

The Define 7's three included fans have long cables (to reach any header position). Bundle excess fan cable length behind the tray or tuck it into the PSU shroud. A fan cable flopping near the front fan blades will eventually contact them, producing a rhythmic clicking noise.

FRONT PANEL HEADERS — USE A CONNECTOR BLOCK

If the Define 7 includes a front panel connector block (some versions do), use it — it groups the individual power/reset/LED wires into a single keyed plug that's much easier to install on the board header. If not included, use needle-nose pliers to seat the tiny individual connectors one at a time.

Pre-Power-On Checklist — Check Before You Press the Button

POWER CONNECTIONS

- [ ] **24-pin ATX latched:** Press the connector until the plastic latch snaps into the retention tab on the board. A half-seated 24-pin is the #1 cause of "no POST" on first builds.
- [ ] **8-pin EPS (4+4) seated:** Both halves of the 4+4 cable clipped together, fully inserted into the CPU power header. The system will power on without it but the CPU will immediately throttle or refuse to boot.
- [ ] **GPU PCIe power:** If the RTX 3050 LP has a power connector, it is plugged in. If no connector exists on the card, nothing to connect here.
- [ ] **SATA power to both drives:** Both 2.5" drives have a SATA power connector seated (L-shaped end firmly in, no crooked insertion).
- [ ] **PSU switch on:** The rocker switch on the PSU rear panel is in the On (—) position, not Off (O).

COMPONENTS

- [ ] **CPU lever fully closed:** The LGA1700 socket lever is latched down and the CPU retaining arm is locked. An improperly latched lever prevents POST.
- [ ] **RAM in A2+B2 slots:** Both 32GB sticks seated in the correct dual-channel slots (check board silkscreen — typically the 2nd and 4th slots from the CPU). Both clips clicked on both sides.
- [ ] **GPU PCIe retention clip:** The clip at the end of the x16 slot has engaged — you should have heard it click during installation. The card should not rock or lift at the card-end.
- [ ] **CPU cooler mounted securely:** No visible gap between cooler base and CPU IHS. All four mounting screws tightened in X-pattern. Cooler does not wobble when gently nudged.
- [ ] **NVMe drive screw tight:** M.2 retaining screw in place — a loose NVMe may not be detected at boot.

CABLES & CONNECTORS

- [ ] **Front panel connectors:** Power switch, reset switch, power LED, HDD LED all connected to the correct pins (verify against board manual). Incorrect power switch wiring means the power button won't work; incorrect LED wiring is cosmetic only.
- [ ] **SATA data cables:** Both drives have SATA data cables connected from drive to motherboard SATA port. Not connected to conflicting ports (check M.2 slot SATA sharing in board manual).
- [ ] **CPU_FAN header connected:** At least one of the CPU cooler fans is connected to the CPU_FAN header. Most boards refuse to POST or show a warning if CPU_FAN reads 0 RPM.
- [ ] **No cables near fans:** Visual sweep confirms no loose cable ends in the path of any rotating fan. Spin each fan briefly by hand to confirm nothing is snagging.

DISPLAY

- [ ] **Monitors connected to GPU:** All three monitor cables go into the RTX 3050 LP's outputs on the rear of the case — not into the motherboard's rear I/O HDMI/DP ports. The board's video outputs are disabled when a discrete GPU is present.
- [ ] **Monitor input source selected:** Each monitor is powered on and set to the correct input source (DisplayPort or HDMI) matching the cable you've plugged in. An inactive input source shows "No Signal" even if the GPU output is working.

FINAL STEPS

- [ ] **Side panels off for first boot:** Leave both side panels off until you've confirmed the system POSTs and enters BIOS. Having quick access to cables and components is invaluable during troubleshooting.
- [ ] **Anti-static precautions done:** You have touched the PSU chassis or a grounded metal object before handling components — your static charge is discharged. The TX550M chassis is a reliable grounding point throughout the build.

If it doesn't POST on first power: The most common first-boot failures in order of frequency: (1) 24-pin not fully latched, (2) RAM in wrong slots or not fully seated, (3) RAM needs XMP enabled, (4) front panel power switch wired to wrong pins, (5) GPU not seated and retention clip not clicked. Work through these before suspecting a dead component.

Next: Type **PC11** to generate Chapter 11 — First Boot & BIOS Setup, covering what to expect when you power on for the first time, the critical BIOS settings for this build (XMP, CPU power limits, fan curves, boot order), and how to navigate an MSI/ASUS B760 UEFI.

CHAPTER 11 OF 15

First Boot & BIOS Setup

Chapter 11 — First Boot & BIOS Setup

Pressing the power button for the first time on a new build is the moment everything either works or doesn't. This chapter walks through what happens in the first few seconds after power-on, how to enter the UEFI BIOS, and the six settings you must configure before installing Windows — starting with the single most-skipped step that silently costs 69% of your RAM's bandwidth.

The single most important thing in this chapter: Enable XMP. Your DDR4-3600 RAM runs at 2133 MHz until you do this — because that is the JEDEC default the motherboard falls back to. Every other BIOS setting in this chapter is secondary. XMP first, everything else after.

The Power-On Sequence — Second by Second

Here is what happens from the moment you press the power button to the BIOS splash screen, and what each stage looks like when it's working correctly:

0s

Power-on — fans spin up

All fans (CPU cooler, case fans, GPU, PSU) spin up simultaneously. The system has power. RGB lighting (if any) may flash.

✓ Good: Fans spin, lights come on

⚠ Nothing: Check PSU switch, 24-pin ATX seating, front panel power switch wiring

0–2s

POST — CPU, RAM, PCIe initialisation

The board's firmware checks the CPU, initialises RAM, enumerates PCIe devices (GPU, NVMe). The Q-LED or debug display (bottom-right of board) cycles through codes during this phase — this is normal.

✓ Good: Q-LEDs cycle and go out, or code display reaches "00" or "A0"

⚠ Red/yellow Q-LED stays on: see Q-LED section below for diagnosis

2–5s

BIOS splash screen appears on monitor

The monitor should wake up and show either the MSI or ASUS logo, or a basic text POST screen. This confirms the GPU, display cable, and monitor input are all working.

✓ Good: Logo or text appears on a monitor

⚠ "No Signal" on all monitors: check GPU outputs vs motherboard outputs — monitors must connect to the GPU

~5s

Memory training (first boot only — may take 60–120s)

On the very first boot — and after any XMP change — the board runs a memory training cycle. The screen may go blank for up to 2 minutes while this happens. The system may restart 1–3 times automatically. **This is completely normal and not a fault.**

✓ Good: System restarts once or twice, then reaches splash screen

⚠ Restarts more than 5× or never completes: RAM not fully seated — reseat in A2+B2

~7s

BIOS entry prompt / boot target detected

The splash screen shows the key to press for BIOS (Del on MSI, F2 on ASUS). If a bootable OS is found on the NVMe, it will proceed to Windows. On first build with no OS installed, it will either enter BIOS automatically or show "No boot device found."

✓ Good: Press Del/F2 immediately to enter BIOS before it attempts to boot

When to press Del/F2: Spam the key from the moment the screen lights up. There's usually only a 1–2 second window before the firmware moves on. If you miss it and Windows starts loading, just reboot. On MSI boards, holding Del during POST will force BIOS entry regardless of boot state.

Navigating the UEFI BIOS

```
MSI B760 UEFI — TOP-LEVEL NAVIGATION

┌──────────────────────────────────────────────────────────────┐
│  MSI Click BIOS 5 / Click BIOS 6                             │
│                                                              │
│  [EZ Mode] — Graphical overview, fan speeds, temps,          │
│              RAM speed, XMP button visible here              │
│                                                              │
│  [Settings]     → Security, Boot, SATA mode, USB,            │
│                   TPM/PTT, Secure Boot                       │
│                                                              │
│  [OC]           → XMP/A-XMP, DRAM frequency,                 │
│  (Overclocking)   CPU power limits (PL1/PL2/PL4),            │
│                   Advanced CPU Configuration,                │
│                   Virtualisation                             │
│                                                              │
│  [M-Flash]      → BIOS update from USB drive                 │
│                                                              │
│  [Board Explorer] → Interactive board diagram                │
│                                                              │
│  Keyboard:  Arrow keys navigate, Enter selects,              │
│             F1 = Help, F9 = Defaults, F10 = Save & Exit      │
│  Mouse:     Fully supported in UEFI                          │
└──────────────────────────────────────────────────────────────┘

ASUS TUF B760 UEFI — TOP-LEVEL NAVIGATION

┌──────────────────────────────────────────────────────────────┐
│  ASUS UEFI BIOS Utility                                      │
│                                                              │
│  [EZ Mode]        → Overview, XMP via "D.O.C.P." button      │
│                                                              │
│  [Advanced]                                                  │
│    ├── AI Tweaker → XMP/D.O.C.P., DRAM frequency             │
│    ├── Advanced   → CPU config, Virtualisation (SVM/VT-x)    │
│    ├── Monitor    → Fan curves (Q-Fan Control)               │
│    └── Boot       → Boot order, Secure Boot, Fast Boot       │
│                                                              │
│  Keyboard:  F7 toggles EZ/Advanced mode                      │
│             F5 = Defaults, F10 = Save & Exit                 │
└──────────────────────────────────────────────────────────────┘
```

EZ Mode vs Advanced Mode: Start in EZ Mode to confirm temperatures and fan speeds are being read correctly. Then switch to Advanced Mode for the critical settings below. MSI's F7 shortcut (or the button in the corner) toggles between modes. The six settings below all live in Advanced Mode.

Critical BIOS Settings — Configure Before Installing Windows

These six settings must be configured before Windows installation. Some (XMP, virtualisation) cannot be changed after installation without re-activating hardware features. Others (AHCI mode, TPM) cause major problems if Windows is already installed on the wrong setting.

1 — XMP (Extreme Memory Profile)

DO THIS FIRST

MSI B760 PATH

```
OC → A-XMP
or: EZ Mode → XMP button (top bar)

Select: XMP Profile 1
DRAM Frequency will update to: DDR4-3600
```

Without XMP: RAM runs at DDR4-2133 (JEDEC default) — 69% less bandwidth. With XMP Profile 1: DDR4-3600 @ C18 as rated. Cost: zero. Impact: major.

ASUS TUF B760 PATH

```
Advanced → AI Tweaker → Ai Overclock Tuner
or: EZ Mode → "D.O.C.P." button

Select: D.O.C.P. (DDR4-3600)
This is ASUS's label for Intel XMP
```

Verify after boot in CPU-Z: Memory tab → DRAM Frequency should show **1800 MHz** (DDR4 reports half-clock — this equals DDR4-3600). Channels: Dual. If it still shows 1066 MHz (= DDR4-2133), XMP did not apply.

2 — CPU Power Limits (PL1 / PL2)

SET FOR LONGEVITY

THE PROBLEM

```
Intel spec for i7-13700K:
PL1 (sustained) = 125W
PL2 (short burst, 56s) = 253W

Many B760 boards default to
"Enhanced" or "MCE" mode:
PL1 = 253W sustained (incorrect!)
This runs PL2 limits indefinitely
```

Running a 125W CPU at 253W sustained pushes higher temperatures and voltages, significantly shortening chip lifespan. Intel's sustained limit is 125W for a reason. The extra performance is marginal for dev workloads.

MSI B760 — CORRECT SETTING

```
OC → Advanced CPU Configuration

CPU Base Power → 125 (W) [= PL1]
CPU Turbo Power → 253 (W) [= PL2]
CPU Power Limit 4 → Auto

ASUS TUF path:
Advanced → AI Tweaker → ASUS MultiCore Enhancement →
Disabled
Then: Advanced CPU Core Settings
Long Duration Package Power → 125
Short Duration Package Power → 253
```

Setting PL1 = 125W is Intel's official specification. The i7-13700K at 125W is still far faster than the old i5-10400 at any power level. PL2 = 253W is kept high for the genuine burst scenarios (start of a build, loading a VM) where the short-duration boost is beneficial.

3 — Intel Virtualisation Technology (VT-x & VT-d)

REQUIRED FOR DOCKER & VMS

MSI B760 PATH

```
OC → CPU Features

Intel Virtualization Technology → Enabled
Intel VT-d Technology → Enabled
```

ASUS TUF B760 PATH

```
Advanced → CPU Configuration

Intel (VMX) Virtualization Technology → Enabled
VT-d → Enabled
```

VT-x enables the hypervisor layer used by Docker Desktop (WSL2 backend), VirtualBox, and VMware. VT-d enables IOMMU — needed for PCIe passthrough to VMs (passing a USB controller or GPU directly to a Linux VM). Both are off by default on many boards and are invisible to Windows — they must be set here.

```
Verify after Windows install:
Task Manager → Performance → CPU
→ "Virtualization: Enabled"
```

If VT-x is not enabled and you try to run Docker Desktop, it will fail at the WSL2 kernel step with an error about hardware virtualisation not being available. Enable it here and you won't see that error.

4 — SATA Mode (AHCI vs Intel RST)

SET BEFORE WINDOWS INSTALL

MSI B760 PATH

```
Settings → Advanced → Integrated Peripherals

SATA Mode → AHCI
```

AHCI (Advanced Host Controller Interface) is the standard direct-access SATA mode. It has full Linux VM compatibility and straightforward driver support. Intel RST (Rapid Storage Technology) adds a RAID layer that complicates driver installation and causes Linux guest OS issues inside WSL2/VirtualBox. Almost all modern builds should use AHCI.

ASUS TUF B760 PATH

```
Advanced → PCH Storage Configuration

SATA Mode Selection → AHCI

Critical: Do not change SATA mode after Windows is
installed — Windows will BSOD. If you've already
installed Windows on RST mode and want to switch to
AHCI, follow Microsoft's safe-switch procedure
(registry change before rebooting).
```

NVMe drives are not affected by the SATA mode setting — they use a separate PCIe/NVMe driver. This setting only controls the SATA ports (Samsung 870 EVO, WD Blue). AHCI is correct for both drives.

5 — TPM 2.0 / Intel PTT (Required for Windows 11)

WINDOWS 11 REQUIREMENT

MSI B760 PATH

```
Settings → Security → Trusted Computing

Security Device Support → Enable
TPM Device Selection → PTT

PTT = Intel Platform Trust Technology
(firmware-based TPM built into B760 chipset)
No separate TPM module needed
```

Windows 11 requires TPM 2.0. Intel PTT is the B760's built-in firmware TPM — enabling it in BIOS makes Windows 11 see a compliant TPM 2.0 device. Also enable Secure Boot (Settings → Security → Secure Boot → Enabled) for full Windows 11 compliance.

ASUS TUF B760 PATH

```
Advanced → Trusted Computing

TPM State → Enabled
Pending operation → None

AND: Boot → Secure Boot
→ Secure Boot → Enabled
→ OS Type → Windows UEFI mode

Verify in Windows:
Win+R → tpm.msc → "TPM 2.0 Ready for Use"
```

Secure Boot must also be enabled for Windows 11 — it's a separate toggle from TPM. Both must be on before the Windows installer runs, otherwise Windows 11 will refuse to install on this hardware. Both defaults may vary by board revision — always verify.

6 — Fan Curves (CPU & Chassis Fans)

SET FOR QUIET OPERATION

MSI B760 — SMART FAN 6

```
Hardware Monitor → Smart Fan Mode
→ Select each fan header → Customise curve

Or: EZ Mode → Fan speed icons on board diagram

CPU_FAN → Temperature source: CPU Package
CHA_FAN 1-3 → Temperature source: System
```

RECOMMENDED CURVES FOR THIS BUILD

CPU_FAN (NH-D15 G2)

40°C	20%
50°C	30%
60°C	45%
70°C	65%

CHA_FAN 1–3 (Case Fans)

30°C	25%
40°C	35%
50°C	50%
60°C	70%

The NH-D15 G2 at the curve below handles an i7-13700K at PL1 with the fans rarely exceeding 800 RPM during dev workloads — inaudible at a desk. Ramp-up begins at 60°C; the fan is never silent but throttles down at idle.

80°C	85%
90°C+	100%

70°C+	100%

Other Useful Settings

SETTING	WHERE (MSI)	VALUE	WHY
Resizable BAR	Settings → Advanced → PCI Sub-system → Re-Size BAR Support	Auto / Enabled	Allows the CPU to address the full 6GB of RTX 3050 LP VRAM directly. Small performance gain in 3D workloads. Requires "Above 4G Decoding" also enabled (same menu).
Above 4G Decoding	Settings → Advanced → PCI Sub-system	Enabled	Required for Resizable BAR to work. Also improves compatibility with high-memory GPUs in general. Enable this first, then Resizable BAR.
Boot Order	Settings → Boot → Boot Option Priorities	NVMe SSD first	Set the new NVMe drive as the primary boot device. Remove USB and network boot options from the list if you don't need them — reduces POST time by 1–2 seconds.
Fast Boot	Settings → Boot → Fast Boot	Enabled (but know Del still works)	Skips USB device enumeration on POST for faster boot. Can be enabled once stable. If the keyboard stops working at the BIOS prompt, disable Fast Boot so USB initialises early enough for keystroke capture.
CSM (Legacy BIOS)	Settings → Boot → CSM	Disabled	CSM (Compatibility Support Module) enables legacy BIOS for old operating systems. Windows 11 requires UEFI; leave CSM disabled. Enabling it disables Secure Boot.
Wake on LAN	Settings → Advanced → Wake Up Event	Personal preference	Allows the machine to be powered on remotely over the network. Useful if you SSH into this machine from elsewhere. Requires the machine to be plugged in but powered off (S5 state).

Q-LED Debug LEDs — Diagnosing POST Failures

MSI B760 boards have four diagnostic LEDs in the bottom-right corner labelled CPU, DRAM, VGA, and BOOT. ASUS boards have a similar four-LED cluster. A LED that stays lit after POST indicates which component failed to initialise:

CPU LED lit (red)

CPU not detected or initialised. Almost always a seating issue.

Fix: Check CPU socket lever is fully latched. Check for bent pins on the board's LGA1700 socket (rare but happens if the CPU was dropped onto the socket). Reseat CPU.

DRAM LED lit (yellow)

RAM not detected or training failure. The most common POST failure on new builds.

Fix: Reseat RAM — remove both sticks, reinsert one stick in the A2 slot only, retry boot. If it POSTs with one stick, test the other. Confirm sticks are in A2+B2, not A1+A2. Try disabling XMP as a diagnostic step.

VGA LED lit (white)

GPU not detected. System reaches GPU initialisation but fails.

Fix: Reseat the GPU — remove and reinsert in the PCIe x16 slot, ensuring the retention clip clicks. Check that monitors are connected to the GPU outputs, not the board. If GPU requires PCIe power, confirm cable is seated at both ends.

BOOT LED lit (green)

CPU, RAM, and GPU initialised fine. Failure is at boot device detection — no bootable OS found.

Expected on a fresh build before Windows is installed. In BIOS: check the NVMe appears in the boot device list. If NVMe is absent from BIOS entirely, reseat the M.2 card and check the retaining screw is in. Check the M.2 slot isn't disabled due to a conflicting SATA port setting.

```
MSI NUMERIC DEBUG CODE DISPLAY (some boards)

Some MSI boards show a 2-digit hex code in the bottom corner during POST.
Key codes for this build:

00 / A0   → POST complete, boot device handoff         ← Normal
d4 / 55   → Memory detection / training in progress    ← Wait, may restart
b4        → USB initialisation                         ← Normal, brief
62        → PCIe / GPU initialisation                  ← Normal, brief
4F        → DXE phase — loading UEFI drivers           ← Normal
03        → Stuck here = CPU not responding            ← Reseat CPU
0d        → Stuck here = RAM training failure          ← Reseat RAM

Full code list in the board's Quick Installation Guide, or search:
"MSI B760 debug code [code]" online.
```

Saving Settings & Exiting BIOS

After making changes: press **F10** (MSI and ASUS both use F10 for Save & Exit). A confirmation dialog appears — confirm Yes. The system will reboot with the new settings applied. Memory training will run again if XMP was enabled — expect 1–2 automatic reboots before reaching the Windows boot screen.

> **If the system won't boot after BIOS changes:** Press Del to re-enter BIOS. Press F9 (MSI) or F5 (ASUS) to load optimised defaults, then F10 to save. This resets all settings to safe defaults — you'll need to re-apply XMP and other changes, but it gets you back to a working state. If you can't reach BIOS at all, use the CMOS clear jumper (check board manual) or remove the CR2032 CMOS battery for 30 seconds, which resets the BIOS to factory defaults.

First Boot Validation — After BIOS Configuration

Boot into Windows (or the Windows installer if doing a fresh install). Run these checks before declaring the system ready:

- [ ] **CPU-Z — RAM speed confirmed:** Download CPU-Z (free). Memory tab: DRAM Frequency = 1800 MHz (equals DDR4-3600; DDR4 reports half-clock). Channels: Dual. Timings: CL18. If DRAM Frequency shows 1066 MHz (= DDR4-2133), XMP did not apply — re-enter BIOS and re-enable A-XMP/D.O.C.P.
- [ ] **CPU-Z — CPU identification:** CPU tab: Name = Intel Core i7-13700K. Cores/Threads: 16C/24T. Max TDP and package power visible in HWiNFO64. Confirm the CPU is recognised correctly — any mismatch here indicates a BIOS update may be needed (covered in Chapter 12).
- [ ] **Task Manager — Virtualisation enabled:** Task Manager → Performance → CPU. The "Virtualization" field should read "Enabled". If it shows "Disabled", re-enter BIOS and confirm Intel VT-x was saved correctly (some boards require a second save/reboot cycle for virtualisation changes to take effect).
- [ ] **Device Manager — no unknown devices:** Windows Device Manager (right-click Start → Device Manager). No yellow exclamation marks. If the NVMe, SATA drives, GPU, or network adapter show as unknown, the relevant driver needs installing. NVIDIA GPU driver (from nvidia.com) and Intel chipset driver (from intel.com/download) are the two most commonly needed.
- [ ] **Disk Management — all drives visible:** Win+R → diskmgmt.msc. All three drives should appear: NVMe (C:, OS drive), Samsung 870 EVO, WD Blue SA510. Any uninitialized drive shows as "Not Initialised" — right-click it, choose Initialize Disk → GPT → create a New Simple Volume to make it accessible.
- [ ] **TPM check:** Win+R → tpm.msc. The TPM Management console should show: "The TPM is ready for use." Manufacturer: Intel. Specification Version: 2.0. If it shows "Compatible TPM cannot be found", re-enter BIOS and confirm PTT is enabled under Security → Trusted Computing.
- [ ] **HWiNFO64 — CPU temperatures at idle:** CPU Package at idle should read 30–45°C with the system at the desktop for 5 minutes. Any individual core above 50°C at idle with no load running suggests the CPU cooler isn't mounted correctly — remount with fresh thermal paste before continuing.
- [ ] **Windows Update — fully patched:** Settings → Windows Update → Check for updates. Run all available updates, including optional driver updates. Intel ME (Management Engine) and chipset drivers often arrive via Windows Update and fix subtle stability issues on first boot.

> **Next:** Type **PC12** to generate Chapter 12 — Software Setup, covering Windows 11 install on the new NVMe, driver installation order, WSL2 + Docker configuration for this machine, AIDA64 bandwidth benchmark to confirm DDR4-3600 dual-channel is working, and CrystalDiskMark to verify NVMe speeds.

CHAPTER 12 OF 15

Software Setup

Chapter 12 — Software Setup

The hardware is installed, BIOS is configured, XMP is enabled. This chapter covers the software side: installing Windows 11 cleanly on the new NVMe, getting drivers in the right order, setting up WSL2 and Docker with sensible memory limits, organising the three drives, and running the benchmarks that confirm everything is working as expected — including a side-by-side comparison with the old i5-10400 machine.

Windows 11 — Clean Install on the NVMe

Why a clean install rather than migrating: The old system ran an LGA1200 chipset. Migrating a Windows install to a completely different platform causes driver conflicts, lingering INF files for the old chipset, and bloat from the old machine's software. A clean install on the new NVMe takes 20 minutes and starts the new machine in a known-good state. The Samsung 870 EVO and WD Blue already hold your data — they can be reconnected without any data loss.

1

Create Windows 11 installation USB (on another machine)

Download **Rufus** (rufus.ie — free, no install needed) and the **Windows 11 ISO** from microsoft.com/software-download/windows11. Use an 8GB+ USB drive. In Rufus: select the ISO, partition scheme = GPT, target system = UEFI (non-CSM), file system = NTFS. Click Start. This takes 5–10 minutes.

✓ Rufus also lets you create a "Windows 11 without TPM/Secure Boot check" USB — useful for testing on unsupported hardware, but not needed here since you've configured TPM and Secure Boot in BIOS correctly.

2

Disconnect the Samsung 870 EVO and WD Blue (temporarily)

Before booting the installer: unplug the SATA data cables from both 2.5" drives. This prevents the Windows installer from accidentally writing a boot sector to the wrong drive. The NVMe is the only target. Reconnect the SATA drives after Windows is installed and running.

⚠ The Windows installer has a "Delete Partition / Format" step that is easy to apply to the wrong drive when multiple drives are visible. Disconnecting SATA drives eliminates this risk entirely.

3

Boot from the USB drive

Plug the USB drive in and reboot. Press **F11** (MSI) or **F8** (ASUS) during POST to open the one-time boot menu — select the USB drive. The Windows installer loads. If the boot menu doesn't appear, enter BIOS (Del/F2) and temporarily set the USB as the first boot device.

4

Install: language, edition, partition

Select: Language = English (UK), Time = GMT, Keyboard = United Kingdom. Choose **Windows 11 Pro** (not Home) — Pro includes Hyper-V, Remote Desktop Server, BitLocker, and Group Policy editor, all useful for dev work. When asked about type of installation, choose **Custom: Install Windows only (advanced)**. Select the NVMe drive, delete any existing partitions on it, then click New to let Windows create fresh GPT partitions automatically. Click Next.

✓ Windows 11 Pro and Home use the same installer ISO — the edition choice appears on the second screen. If you have a Windows 10 Pro key from the old machine, it will activate Windows 11 Pro automatically via Microsoft's digital licence system (tied to your Microsoft account).

5

Setup: account type and privacy settings

During the out-of-box experience (OOBE): choose **Set up for personal use**. For account: use a **local account** rather than a Microsoft account for a dev machine (less telemetry, no OneDrive sync pressure). To force local account: when asked to sign in, choose "Sign in options" → "Offline account" → "Limited experience". Set a strong password. On the privacy screens, disable all optional diagnostics, advertising ID, and location.

⚠ If you skip the local account option and sign in with a Microsoft account, your username folder becomes your Microsoft account email prefix (e.g. C:\Users\philipo) — this can cause path issues in some dev tools. A local account gives you a clean username.

6

Reconnect SATA drives and initialise in Disk Management

Once Windows is running: shut down, reconnect the SATA data cables to the Samsung 870 EVO and WD Blue, reboot. Open Disk Management (Win+R → diskmgmt.msc). Both drives appear as "Not Initialized" — right-click each, choose Initialize Disk → GPT. Then right-click the unallocated space on each → New Simple Volume → assign drive letters D: (870 EVO) and E: (WD Blue). Format NTFS with default allocation unit size.

Driver Installation — Order Matters

Windows 11 automatically installs generic drivers for most devices during setup, but generic drivers are not the same as manufacturer-optimised drivers. Install in this order — the chipset must go first because every other driver is mapped to devices it exposes:

1 Intel Chipset Driver

Source	intel.com/download → search "B760 chipset"
What it installs	INF files for all B760 PCIe/USB/SATA controllers
Reboot required	Yes

Install this before anything else. It doesn't install visible software — it maps the underlying hardware to Windows. Every subsequent driver installs on top of this correctly-mapped foundation.

2 Intel ME (Management Engine)

Source	intel.com/download → "Intel ME driver"
What it installs	Intel ME Interface, out-of-band management
Reboot required	Yes

Without this, Device Manager shows a yellow "Unknown device" for the Intel Management Engine. Also enables Intel PTT (fTPM) to function correctly under Windows and fixes some sleep/wake issues.

3 NVIDIA GPU Driver

Source	nvidia.com/drivers → RTX 3050, GeForce 30 Series
Install type	Custom → Clean Install
Reboot required	Yes

Choose "Custom Install" and tick "Perform a clean installation" to wipe the generic Microsoft display driver. This is when hardware video decode, NVENC, and proper power management (fan-stop at idle) activate.

4 Network / WiFi Driver

Source	Board manufacturer's support page
MSI TOMAHAWK	Intel I225-V LAN + Intel WiFi 6E AX211
Reboot required	Yes

The Intel I225-V 2.5GbE driver matters for network throughput — the generic driver limits to 1GbE. After installing, Device Manager should show "Intel(R) Ethernet Controller (3) I225-V" at 2500 Mbps.

5 Realtek Audio

Source	Board manufacturer's support page
What it installs	HD Audio + Realtek Audio Console app
Reboot required	Sometimes

Skip if you use USB or Bluetooth audio exclusively. If using the board's 3.5mm rear audio jacks, install this. The Realtek Console app allows front/rear jack switching and virtual surround configuration.

6 Remaining: Windows Update

Run	Settings → Windows Update → Advanced → Optional Updates
Also run	Windows Update → Check for updates (all)
Reboot	After all updates applied

Windows Update delivers Intel storage, USB controller, and Bluetooth drivers via Optional Updates. Install everything offered. After this pass, Device Manager should show zero yellow exclamation marks.

WSL2 Setup & Configuration

WSL2 (Windows Subsystem for Linux v2) is the foundation for Docker Desktop on this machine and your primary Linux environment for dev work. Install and configure it before Docker.

```
# Run in Windows Terminal (or PowerShell as Administrator) # Install WSL2 with Ubuntu (default distro) wsl --install # After reboot — verify WSL version wsl --list --verbose # Should show: NAME STATE VERSION # Ubuntu Running 2 # Ensure future distros default to WSL2 wsl --set-default-version 2
```

Critical: Configure WSL2 Memory Limits

By default, WSL2 can consume up to 50% of system RAM (up to 32GB on a 64GB machine). This is too aggressive for a dev machine where Windows, Docker, and the IDE also need memory. Create a `.wslconfig` file in your Windows home directory to cap it:

```
# Create this file at: C:\Users\YourUsername\.wslconfig # Open Notepad and save to that exact path, or run: notepad $env:USERPROFILE\.wslconfig # Contents of .wslconfig: [wsl2] memory=16GB # WSL2 max RAM (leaves 48GB for Windows + apps) processors=12 # CPU threads for WSL2 (leaves cores for Windows) swap=4GB # WSL2 swap file size localhostForwarding=true # localhost in Windows reaches WSL2 services # After saving, restart WSL2: wsl --shutdown wsl
```

Why 16GB and not more? With 64GB total RAM: 16GB for WSL2 leaves 48GB for Windows, Docker, the IDE, Chrome, and active compile jobs. WSL2 only uses RAM it actually needs — the limit is a ceiling, not a reservation. If you regularly run memory-heavy workloads inside Linux (large databases, ML data pipelines), raise it to 24GB. The remaining 40GB is plenty for the Windows side.

```
# Inside WSL2 Ubuntu — set up a minimal /etc/wsl.conf sudo nano /etc/wsl.conf # Add: [automount] options = "metadata" # Preserves Linux file permissions on Windows drives [interop] appendWindowsPath = false # Stops Windows PATH polluting WSL2 PATH (faster) [boot] systemd = true # Enables systemd inside WSL2 (Ubuntu 22.04+)
```

Docker Desktop — WSL2 Backend Configuration

1. **Install Docker Desktop**

   Download Docker Desktop from docker.com. During install: ensure **"Use WSL 2 instead of Hyper-V"** is selected (it should be the default if WSL2 is already installed). After install, Docker Desktop starts and shows a tutorial — skip it.

2. **Enable WSL2 integration for Ubuntu**

   Docker Desktop Settings → Resources → WSL Integration → tick **"Enable integration with additional distros"** → tick Ubuntu. Apply & Restart. This makes the `docker` command available inside your Ubuntu WSL2 terminal — you can run containers from either Windows Terminal or WSL2.

3

Move the Docker data root to the NVMe

By default, Docker stores all images, volumes, and containers at `C:\Users\YourName\AppData\Local\Docker\wsl` — which is on the NVMe (C:). This is correct and requires no change. However, the Docker **disk image** (a large .vhdx file that can grow to tens of GB) lives in that same location. Monitor C: drive space as you pull images and prune regularly.

✓ Prune unused images periodically: `docker system prune -a` — removes stopped containers, dangling images, unused networks. Run this before any disk-full situation on C:.

4

Set Docker Desktop resource limits

Docker Desktop Settings → Resources → Advanced. Set: CPUs = **8** (leaving 8 for Windows), Memory = **12GB** (within the 16GB WSL2 ceiling). These limits apply to the Docker VM — individual containers can be further constrained with `--memory` flags. Disk image size limit: 64GB is a reasonable starting point; expand later if needed.

```
# Verify Docker is working from both Windows PowerShell and WSL2: docker run --rm hello-world # Should print "Hello from Docker!" and exit docker run --rm -it ubuntu:22.04 bash # Opens an interactive Ubuntu container shell # Type 'exit' to leave # Check Docker context (confirms WSL2 backend is active): docker context ls # Should show: desktop-linux * (current)
```

Essential Dev Software — Install Order

SOFTWARE	WHERE TO GET	NOTES
Windows Terminal	Microsoft Store → "Windows Terminal"	Install first — much better than legacy PowerShell window. Set WSL2 Ubuntu as the default profile.
Git (Windows)	git-scm.com → Git for Windows	Install with "Git Credential Manager" enabled. Shares credential store with WSL2 git via `git config --global credential.helper "/mnt/c/Program\ Files/Git/mingw64/bin/git-credential-manager.exe"` inside WSL2.
VS Code	code.visualstudio.com	Install the **WSL extension** immediately after. This lets VS Code run its server inside WSL2 while the UI stays on Windows — best of both worlds for Linux-based dev work.
Python (Windows side)	python.org or Microsoft Store	Also install Python inside WSL2 separately — the Windows and WSL2 installs don't share packages or virtual environments.
Node.js	Install via nvm inside WSL2 rather than the Windows installer — avoids PATH conflicts between Windows and WSL2 node versions.	
JDK	Adoptium.net → Eclipse Temurin LTS	If doing Java dev. Temurin is free, open-source, and actively maintained. Install on Windows for IDE use and inside WSL2 for build tooling separately.

SOFTWARE	WHERE TO GET	NOTES
Samsung Magician	samsung.com/semiconductor → Magician	Monitors 990 Pro and 870 EVO health, temperature, firmware version. Set 990 Pro to "High Performance" mode in Magician for maximum throughput.
CrystalDiskInfo	crystalmark.info	Independent SMART health monitoring for all drives. Runs in system tray, alerts on drive health changes. Free.
HWiNFO64	hwinfo.com	Real-time sensor monitoring — CPU per-core temps, VRM temps, RAM voltage, GPU temp, fan RPMs. The most comprehensive sensor tool available.

Storage Organisation — All Three Drives

```
RECOMMENDED DIRECTORY STRUCTURE

C:\  (NVMe — speed-critical)          Suggested size: 1-2TB NVMe
├── Windows, Program Files             (OS standard)
├── Users\YourName\
│    ├── AppData\Local\Docker\wsl\     (Docker disk image — keep on NVMe)
│    └── .wslconfig                    (WSL2 memory config)
└── Dev\                               (create this folder)
     ├── projects\                      (active git repositories)
     ├── venvs\                         (Python virtual environments)
     └── tools\                         (local SDKs, binaries)

D:\  (Samsung 870 EVO 2TB — capacity)  Archives + large data
├── VMs\                               (VirtualBox / VMware disk images)
├── Projects-Archive\                  (completed/inactive repos)
├── Docker-exports\                    (docker save/load tarballs)
└── Media\                             (large video files, datasets)

E:\  (WD Blue SA510 1TB — personal)    Personal + backup
├── Personal\                          (documents, photos)
├── Downloads\                         (move default download folder here)
└── Backup\                            (local backup of C:\Dev)
```

C:
NVMe Gen 4 (1–2TB) — speed-critical workloads

- Windows 11 (system files, page file)
- Installed applications and IDEs
- Active git repositories (C:\Dev\projects)

D:
Samsung 870 EVO 2TB — capacity storage

- VirtualBox / VMware .vmdk disk images
- Archived project repositories
- Large datasets and media files
- Docker image tarballs (docker save exports)

E:
WD Blue SA510 1TB — personal + backup

- Personal documents and photos
- Browser downloads (move default folder here)
- Local backup of C:\Dev (weekly robocopy)
- Music and personal media

- Python venvs and Node modules
- Docker disk image (.vhdx — auto-located here)
- WSL2 virtual disk (/home filesystem)
- Database files (Postgres, MySQL data dirs)

- ISO files and installation media
- Build artefacts and compiled binaries

- Scanned documents

```
# Move the Downloads folder to E:\ (run in PowerShell) # Right-click Downloads in Explorer → Properties → Location → Move → E:\Downloads # Or via shell — this creates a junction (symlink) so apps still find it: mkdir E:\Downloads robocopy "$env:USERPROFILE\Downloads" "E:\Downloads" /E /MOVE cmd /c mklink /J "$env:USERPROFILE\Downloads" "E:\Downloads" # Weekly local backup of active projects (run in PowerShell, or Task Scheduler): robocopy C:\Dev E:\Backup\Dev /E /MIR /XD .git node_modules __pycache__ /LOG:E:\Backup\backup.log # /MIR = mirror (deletes files in dest that are gone from source) # /XD = exclude these dirs (saves space — git history is already the backup)
```

Benchmarks — Confirming Everything Works

Run these benchmarks once the machine is fully set up. They serve two purposes: confirming the hardware is operating correctly, and giving you a reference baseline so future regressions (thermal throttling, RAM frequency drift) are detectable.

CRYSTALDISKMARK 8

NVMe Sequential Speed

Seq Read (Q8T1)	7,000+ MB/s
Seq Write (Q8T1)	6,000+ MB/s
4K Random Read	70+ MB/s
SATA (870 EVO) Read	560 MB/s

Select the NVMe (C:) as the test drive. Expected for Samsung 990 Pro or equivalent Gen 4: 7,000–7,450 MB/s sequential read. If you see ~3,500 MB/s, the NVMe may be seated in a PCIe 3.0 slot or the PCIe Gen setting in BIOS needs checking.

AIDA64 EXTREME — MEMORY BENCHMARK

DDR4-3600 Dual Channel Bandwidth

Memory Read	~54 GB/s
Memory Write	~50 GB/s
Memory Copy	~46 GB/s
Latency	~60–70 ns

Run: AIDA64 → Tools → Memory & Cache Benchmark → Start. Expected for DDR4-3600 dual channel (2×32GB A2+B2): ~50–55 GB/s read. If you see ~28 GB/s, the sticks are in single-channel (A1+A2 or B1+B2) — move to A2+B2. If you see ~30 GB/s dual channel, XMP may not have applied — re-check BIOS.

CINEBENCH R23

i7-13700K CPU Performance

Single Core	2,000+
Multi Core	30,000+
i5-10400 single (old)	~1,150
i5-10400 multi (old)	~9,000

Run the multi-core test 10 minutes after system is stable at idle (to avoid PL2 burst inflating the score). If multi-core score is below 25,000, the board may still be using MCE (PL1 = 253W) causing thermal throttle — re-check Chapter 11 power limit settings.

Old vs New — Performance Jump

I5-10400 (OLD) VS I7-13700K (NEW) — EXPECTED REAL-WORLD GAINS

Cinebench R23 Multi-Core (higher = better)	i5-10400	~9,000	i7-13700K	~31,000
Cinebench R23 Single-Core (IPC + clock speed)	i5-10400	~1,150	i7-13700K	~2,050
Large project compile (Maven/Gradle — more cores = faster)	i5-10400	~100%	i7-13700K	~3.2× faster
Docker build (multi-stage, parallelised)	i5-10400	~100%	i7-13700K	~2.5–3× faster
NVMe sequential read (Gen 4 vs likely Gen 3 / SATA on old machine)	Old boot drive	~550 MB/s	NVMe Gen 4	7,400 MB/s
RAM bandwidth (DDR4-3600 DC vs DDR4-2666 or lower previously)	Estimated old	~35 GB/s	DDR4-3600 DC	~54 GB/s

Software Setup Completion Checklist

- [ ] **Windows 11 Pro activated:** Settings → System → Activation. Should show "Windows is activated with a digital licence linked to your Microsoft account" (if using a transferred key) or prompt for product key entry. An unactivated machine has no functional limitations except the watermark — activate when convenient.
- [ ] **All drivers installed, no yellow flags in Device Manager:** Right-click Start → Device Manager. No yellow exclamation marks anywhere. Check specifically: Network Adapters (Intel I225-V at 2.5GbE), Display Adapters (NVIDIA GeForce RTX 3050), System Devices (Intel Management Engine Interface).
- [ ] **WSL2 running Ubuntu with .wslconfig applied:** Open Windows Terminal → Ubuntu profile. Run `free -h` — the total memory should reflect your .wslconfig memory= setting (e.g. ~15.5 GB for memory=16GB). Run `nproc` — should show the processor count you set.
- [ ] **Docker hello-world runs from both Windows and WSL2:** In PowerShell: `docker run --rm hello-world` → success. In WSL2 terminal: same command → success. Both environments sharing the same Docker daemon confirms WSL2 integration is working.
- [ ] **Three drives accessible and correctly labelled:** File Explorer shows C: (NVMe, ~OS size free), D: (Samsung 870 EVO, ~2TB), E: (WD Blue, ~1TB). CrystalDiskInfo shows all three with "Good" health status and correct drive model names. NVMe temperature under 50°C at idle.

- [ ] **CrystalDiskMark NVMe result above 6,500 MB/s sequential read:** Anything below 5,000 MB/s on a Gen 4 drive is worth investigating (wrong slot, PCIe Gen setting in BIOS). SATA drives should read ~500–560 MB/s — both confirm the AHCI mode is applied correctly.
- [ ] **AIDA64 memory bandwidth above 48 GB/s:** Read bandwidth between 50–56 GB/s confirms DDR4-3600 dual-channel is active. Bandwidth below 30 GB/s means either XMP is not applied or the sticks are in the wrong slots. Anything between 30–48 GB/s suggests one of the above issues partially applying.
- [ ] **Cinebench R23 multi-core above 27,000:** The i7-13700K at PL1 (125W) should score 27,000–31,000. Significantly below 27,000 suggests thermal throttling (cooler mounting issue) or power limits set too conservatively. Above 35,000 suggests the board is running MCE/PL2 sustained — re-check power limits in BIOS.
- [ ] **Real dev workload test:** Clone a medium-to-large project you work with regularly and run a full build. Note the time. This becomes your personal baseline — future builds should be within 10% of this figure. Any significant regression (slow compile, stuttering during Docker builds) can be investigated against this baseline.

Next: Type **PC13** to generate the final chapter — Course Summary & What's Next, covering the complete parts list with final costs, a build retrospective comparing old vs new specs, the upgrade roadmap (case, RAM, GPU, PSU upgrade thresholds), and a maintenance schedule (thermal paste replacement, dust cleaning, drive health checks).

CHAPTER 13 OF 15

Course Summary & What's Next

Chapter 13 — Course Summary & What's Next

Build Complete — Dev Workstation on Intel LGA1700

i7-13700K · 64GB DDR4-3600 · Gen 4 NVMe · RTX 3050 LP · 3 Monitors · 3.15TB total storage

16C / 24T	CPU THREADS
64 GB	DDR4-3600
7,400 MB/s	NVME READ
3 screens	INCL. 165HZ
~3.2×	FASTER COMPILES
5 yr	PSU WARRANTY

Complete Parts List — Buy vs Keep

NEW PURCHASES £678 – £862 (recommended config)

Motherboard — MSI MAG B760 TOMAHAWK WIFI DDR4 £150 – £185
LGA1700, ATX, PCIe 5.0, 3× M.2, 2.5GbE, WiFi 6E · Recommended DDR4 variant
Search

CPU — Intel Core i7-13700K £280 – £340
16C/24T (8P+8E), 5.4GHz boost, 30MB L3, LGA1700, 125W TDP
Search

CPU Cooler — Noctua NH-D15 G2 £95 – £115
Dual-tower, 2× 150mm NF-A15 G2 PWM fans, 330W TDP, 167mm height · NH-D15 G2 LBC variant if RAM clearance tight
Search

NVMe SSD — Samsung 990 Pro 2TB (or equiv. Gen 4) £100 – £140
PCIe 4.0 × 4, 7,450/6,900 MB/s seq R/W, 1,200 TBW, 5yr warranty, DRAM cache
Search

Case — Fractal Design Define 7 £120 – £145
ATX/E-ATX, 3× 140mm fans included, 2× 5.25" bays, 185mm cooler clearance, acoustic dampening
Search

Thermalright LGA1700 Contact Frame (optional) £8 – £12
Replaces Intel ILM, corrects PCB bowing, 5–10°C temperature reduction
Search

EXISTING COMPONENTS — KEPT (NO PURCHASE) £0 — already owned

GPU — GeForce RTX 3050 LP 6G OC 3× DP 1.4 + 1× HDMI 2.1, drives all 3 monitors incl. 165Hz, ~75W TDP, NVDEC AV1	£0
PSU — Corsair TX550M 550W 80+ Gold Semi-modular, 140mm HDB fan, ~73% peak load with this build, 5yr warranty	£0
RAM — Corsair Vengeance RGB RS 64GB DDR4-3600 C18 2× 32GB, A2+B2 dual channel, XMP Profile 1, ~54 GB/s bandwidth, 10ns true latency	£0
Samsung 870 EVO 2TB SATA SSD 2,400 TBW, DRAM cache, D: drive for archives + VMs + large data	£0
WD Blue SA510 1TB SATA SSD E: drive for personal files + downloads + local backup	£0
External HDDs — 10TB + 5TB + 5TB Cold storage + system backup — no case or PSU changes needed	£0

CONFIGURATION	NEW SPEND	NOTES
Budget (AK620 cooler, 1TB NVMe, no contact frame)	~£600 – £700	Solid build. AK620 handles i7-13700K at PL1 without issue.
Recommended (NH-D15 G2, 2TB NVMe, contact frame)	~£760 – £900	The configuration this course optimises for throughout.
Premium (DDR5 board + 64GB DDR5-6000, 2TB NVMe)	~£970 – £1,200	Marginal real-world gain over DDR4 path for dev workloads.

Old Machine vs New Machine — Full Spec Sheet

SPECIFICATION	OLD — LGA1200 BUILD	NEW — LGA1700 BUILD
CPU	Intel Core i5-10400	Intel Core i7-13700K
Cores / Threads	6C / 12T (all P-cores)	16C / 24T (8P + 8E)
Max Boost Clock	4.3 GHz	5.4 GHz
CPU Generation / IPC	Comet Lake (2020)	Raptor Lake (+25% IPC)
L3 Cache	12 MB	30 MB (2.5×)
CPU Socket / Platform	LGA1200 (dead end)	LGA1700 (12th–13th gen)
Motherboard Chipset	MSI B560M PRO-E (mATX)	MSI MAG B760 TOMAHAWK (ATX)
PCIe Generation (CPU)	PCIe 3.0	PCIe 5.0
M.2 NVMe Slots	1 (PCIe 3.0)	3 (PCIe 4.0 / 3.0)
RAM	64GB DDR4 (likely 2666 at JEDEC)	64GB DDR4-3600 XMP (same kit)
RAM Bandwidth	~35 GB/s (est.)	~54 GB/s (+54%)

Boot Drive	Unknown (likely SATA or PCIe 3.0)	Gen 4 NVMe — 7,400 MB/s
GPU	RTX 3050 LP 6G	RTX 3050 LP 6G (unchanged)
Display Outputs	3× DP + 1× HDMI	3× DP + 1× HDMI (unchanged)
Network	1GbE (B560M)	2.5GbE + WiFi 6E
Case	Kolink Citadel Mesh (mATX)	Fractal Define 7 (ATX)
5.25" Optical Bay	None	2× 5.25"
CPU Cooler	Stock (Intel box cooler)	Noctua NH-D15 G2
PSU	TX550M 550W Gold	TX550M 550W Gold (unchanged)
Total Storage	3.15TB internal + 20TB ext.	3.15TB+ internal + 20TB ext.
Cinebench R23 Multi	~9,000	~31,000 (+3.4×)
Compile speed (relative)	1×	~3× faster
Idle power draw (est. wall)	~85W	~70–80W (more efficient)

> **What stayed the same:** GPU, PSU, all three drives, and external HDDs were reused with zero modification. The 64GB DDR4 kit now runs at its rated DDR4-3600 speed (it likely ran at DDR4-2133 on the old machine without XMP being set). Total storage capacity is unchanged — the new build is faster access to the same data.

Upgrade Roadmap — When and What

This build is deliberately sized to last 4–6 years without major changes. The i7-13700K has headroom well beyond typical dev workloads, and 64GB of RAM handles Docker + IDE + browser + X2GO simultaneously without paging. These are the genuine triggers that would warrant an upgrade:

Thermalright Contact Frame (optional add-on) — ANYTIME

Trigger: If idle CPU temps are above 45°C or load temps consistently above 85°C with the NH-D15 G2, the LGA1700 ILM bowing issue is contributing. The contact frame costs £8–12 and takes 15 minutes to install — worth doing as a first diagnostic before remounting the cooler.

What: Thermalright LGA1700 Contact Frame (~£8–12). Replaces the Intel retention bracket, eliminates PCB bowing, improves thermal contact by 5–10°C. No cooler disassembly required — fits around the existing cooler mounting hardware.

GPU — RTX 3050 LP → RTX 4060 or higher — WHEN TRIGGERED

Trigger any of: You start running local LLMs and 6GB VRAM limits model selection. You start gaming and find the 3050 LP inadequate at 1440p. You want AV1 hardware encode for screen recording. You add a 4th monitor and need a 4th output. None of these apply today.

What: RTX 4060 (~£240–270, 8GB VRAM, AV1 encode) covers gaming + light AI. RTX 4060 Ti 16GB (~£380–420) if VRAM for local models is the priority. Both fit in the Define 7 and work with the TX550M (RTX 4060 Ti at 165W keeps total system under 440W — within safe headroom).

2nd NVMe — Add a 2TB Gen 4 to M.2_2 — WHEN C: FILLS UP

Trigger: C: NVMe reaches ~70–80% capacity (Docker disk image + WSL2 virtual disk are the main growth drivers). At that point, either prune Docker images (`docker system prune -a`) or add a second NVMe for overflow.

What: Any Gen 4 2TB NVMe in the B760's second M.2 slot (~£65–100). Move Docker data root or WSL2 virtual disk to D: (870 EVO) as a free alternative — slower but still SATA, sufficient for image storage.

PSU — TX550M → 750W or 850W

ONLY WITH RTX 4070+

Trigger: GPU upgrade to RTX 4070 (200W TDP) or above. Combined with i7-13700K at PL2, total peak exceeds 550W. RTX 4060 Ti (165W) is the highest GPU safely supported by the TX550M — anything above that needs a new PSU first.

What: Corsair RM750x (750W, 80+ Gold, fully modular, 10yr warranty, ~£110–130) or Corsair RM850x if planning for RTX 4080 territory. Both are direct drop-in replacements — same form factor, same ATX connectors.

RAM — DDR4-3600 → DDR5 (future platform)

NEXT PLATFORM UPGRADE ONLY

Trigger: Only relevant when moving to a new platform (Intel LGA1851 / Arrow Lake, or AM5). DDR4 and DDR5 are not interchangeable — there is no upgrade to DDR5 while keeping the B760 board. The current DDR4-3600 kit at ~54 GB/s bandwidth is not a bottleneck for any realistic dev workload.

What: Not worth doing mid-platform. When the next CPU upgrade happens (probably 3–5 years from now), build the whole new platform around DDR5. The 64GB DDR4-3600 kit can be sold at that point.

CPU — i7-13700K → anything on LGA1700

DON'T BOTHER

Why not: The i7-13700K is the performance sweet spot of the LGA1700 platform. The only step up is the i9-13900K (24C/32T, ~£400+) which runs hotter, draws significantly more power, and has documented instability issues. The i7-13700K will remain more than adequate for dev work until the platform reaches end of life.

Skip: 14th gen K-series (documented voltage degradation issues). i9-13900K (marginal gain, higher thermals, significantly higher cost). When the CPU genuinely becomes a bottleneck, upgrade the whole platform rather than the CPU alone.

Maintenance Schedule

```
MAINTENANCE AT A GLANCE

Monthly   → CrystalDiskInfo health check (30 seconds)
3-Monthly → Dust filter clean, fan speed check in HWiNFO
6-Monthly → Full internal dust clean, BIOS update check
Annually  → Fan bearing check, NVMe health + TBW report
2-3 Years → Thermal paste replacement on CPU
5+ Years  → Assess cooler fan replacement (bearing wear)
```

MONTHLY — 5 MINUTES

Drive Health Check

- → Open CrystalDiskInfo — all drives show "Good"
- → Note any reallocated sector count increases
- → Check NVMe temperature (target: <55°C daily use)
- → Run `docker system` — prune if disk image

EVERY 3 MONTHS — 15 MINUTES

Dust Filters & Fan Check

- → Remove and wash front, top, and bottom mesh filters
- → Let dry completely before reinstalling
- → Check HWiNFO fan RPM — all fans spinning at expected speed

EVERY 6 MONTHS — 30 MINUTES

Internal Clean & BIOS

- → Compressed air blast of NH-D15 G2 fins (case open)
- → Compressed air on GPU heatsink and PCIe slot area
- → Check MSI/ASUS board page for BIOS updates — install if stability-related

df over 60GB

→ Verify CPU idle temp still under 40°C

→ Run MemTest86 if any unexplained crashes occurred

EVERY 2–3 YEARS

Thermal Paste Refresh

- → Remove NH-D15 G2, clean IHS with isopropyl alcohol
- → Clean cooler base with isopropyl alcohol
- → Apply fresh Noctua NT-H2 (pea-size centre dot)
- → Remount, re-run Prime95 to verify temps unchanged
- → Sign: if idle temps creep 5°C+ above baseline, paste is due

ANNUALLY

Full System Audit

- → Run Cinebench R23 multi — compare to your baseline score
- → CrystalDiskMark NVMe — confirm still above 6,500 MB/s read
- → Check TBW remaining on 990 Pro in Samsung Magician
- → Review C: drive usage — prune unused Docker images, old VMs
- → Check fan bearings — any grinding/clicking means replacement soon

AFTER 5+ YEARS

Component Longevity

- → Noctua fans rated 150,000 hours — likely outlast the platform
- → Define 7 case: no moving parts except fans — indefinite lifespan
- → TX550M: 5yr warranty, expect 7–10yr real lifespan at this load
- → Samsung 870 EVO: 2,400 TBW endurance — many years at typical use
- → CMOS battery (CR2032): replace if BIOS loses settings after power cut

Course Index — All 13 Chapters

What This Build Does Well

This machine was designed for one thing: getting out of your way while you work. That means enough CPU cores that a full Docker build doesn't stall the IDE, enough RAM that you never see paging during a multi-container dev environment, an NVMe fast enough that VS Code opens instantly and WSL2 filesystem operations don't drag, and three monitors running at their native resolutions and refresh rates without compromise.

The i7-13700K's 8 Efficient cores handle background tasks (Windows Update, antivirus scans, browser garbage collection) while the 8 Performance cores are free for the build job that just started. That's a qualitative change from a 6-core machine where everything competed for the same cores.

Reusing six existing components kept the build cost under £900 for the recommended configuration — a fraction of buying a comparable pre-built. The PSU, GPU, two SATA SSDs, external HDDs, and RAM all transferred cleanly. The DDR4-3600 kit that may have been running at 2133 MHz for years is now fully active, delivering 54 GB/s of memory bandwidth to a CPU with the IPC headroom to use it.

> **The single thing most likely to make a difference immediately:** XMP. If the old machine was running DDR4-2133 (the JEDEC default when XMP isn't enabled), the RAM bandwidth jump alone will be noticeable in compile times and large Docker builds — before accounting for the extra cores and higher IPC.

> **Course complete.** You now have a documented, well-understood machine — every component chosen deliberately, every critical setting recorded, every benchmark giving you a reference baseline. When something changes (temperatures creep up, a drive shows a health warning, a Docker build starts taking longer), you have the knowledge to diagnose it.

CHAPTER 14 OF 15 — BONUS CHAPTER

KVM Switch ✦ Bonus

Chapter 14 — KVM Switch

A KVM switch (Keyboard, Video, Mouse) lets two or more PCs share the same monitors, keyboard, and mouse. One button press — or a keyboard shortcut — switches everything simultaneously. For a desk with three monitors and a second machine worth keeping, it eliminates the cable-swapping that otherwise makes using both machines impractical.

> **Your situation in one sentence:** New LGA1700 machine is the primary workstation. The old i5-10400 machine (on integrated graphics after the RTX 3050 LP moved over) is a useful second PC for testing, legacy software, or a dedicated task machine — but only if you can switch to it without touching cables.

What a KVM Switch Does

```
WITHOUT KVM — Cable-swap every time

New PC ─────────────────────────────────────────── Monitor 1
New PC ─────────────────────────────────────────── Monitor 2
New PC ─────────────────────────────────────────── Monitor 3 (165Hz)
New PC ─────────────────────────────────────────── Keyboard
New PC ─────────────────────────────────────────── Mouse
Old PC  (disconnected — too much hassle to swap)

WITH KVM — One keypress switches everything

New PC ──→ KVM ──→ Monitor 1   (60Hz)
Old PC ──→ KVM ──→ Monitor 2   (60Hz)
             │
             ├──→ Keyboard    (shared — follows the active PC)
             └──→ Mouse       (shared — follows the active PC)

New PC ─────────────────────────────────────────── Monitor 3 (165Hz, direct)

Press Scroll Lock × 2  →  everything switches to Old PC in <1 second
```

The KVM sits between your PCs and your peripherals. Each PC has its own set of cables going into the KVM's input ports. The KVM's output ports connect to your monitors, keyboard, and mouse. When you switch, the KVM re-routes all signals simultaneously — the monitors show the other PC's desktop, and the keyboard and mouse now control it.

The 165Hz Problem — Why Monitor 3 Stays Direct

Never run your 165Hz monitor through a KVM switch. Most KVM switches — including expensive ones — cap DisplayPort output at 4K@60Hz or 1440p@60Hz. Even models that advertise higher refresh rates often can't reliably pass the full DP 1.4 signal needed for 165Hz at 1440p. You would pay a significant premium for a specialised unit, and the 2024 Samsung's 165Hz would silently drop to 60Hz the moment it goes through a cheap or mid-range KVM.

The practical solution is straightforward: leave Monitor 3 permanently connected directly to the new PC. It only ever shows the new machine's output. The KVM handles Monitors 1 and 2 (both 60Hz, which every KVM supports without issue). This approach:

- **Preserves 165Hz** on the monitor that has it, always
- **Costs significantly less** — a dual-monitor KVM is £60–150 vs £300+ for a reliable triple-monitor unit
- **Is simpler to wire** and more reliable in practice
- **Matches real usage** — when you're on the old PC, you'll use two monitors; the third sitting dark is fine

The old machine on integrated graphics: The i5-10400 has Intel UHD 630 integrated graphics. With the RTX 3050 LP now in the new machine, the old PC uses iGPU output via the B560M PRO-E's rear panel — typically 1× HDMI 2.0 and 1× DisplayPort 1.2. This comfortably drives two monitors at 1080p@60Hz, which is exactly what you need for the KVM setup.

Recommended Wiring — Your Specific Setup

```
RECOMMENDED SETUP — Dual KVM + Direct 165Hz

                    ┌───────────────────────────────┐
NEW PC              │  DisplayPort ──→ [Monitor 3]  │  165Hz Samsung 2024
(RTX 3050 LP)       │                   DIRECT      │  NEVER through KVM
                    │                               │
                    │  DisplayPort ──→ ┌──────────┐ │
                    │                  │          │ │
OLD PC              │  DisplayPort ──→ │  2-port  │ ──→ [Monitor 1]  ~2015 Samsung 60Hz
(Intel UHD 630)     │       or HDMI    │  KVM     │
                    │                  │  Switch  │ ──→ [Monitor 2]  ~2019 Samsung 60Hz
                    │                  │          │
                    │                  │ USB-A ───┤ ──→ Keyboard
                    │                  │ USB-A ───┤ ──→ Mouse
                    │                  └──────────┘
                    └───────────────────────────────┘

Switching:   Scroll Lock, Scroll Lock  (or dedicated button on KVM)
Result:      Monitor 1 + 2 + keyboard + mouse switch to Old PC
             Monitor 3 always shows New PC

Old PC RAM note: The i5-10400 machine needs its own RAM after the
build. A 2× 8GB DDR4-2400 kit costs ~£20-30 and is all iGPU needs.
```

KVM Buying Guide — What Specs Actually Matter

NUMBER OF PORTS (PCS)

2-port for this build

You have two machines. 4-port KVMs cost more and often have worse signal quality per port. A 2-port unit is simpler, cheaper, and more reliable.

NUMBER OF MONITORS

Dual-monitor (2 displays)

After removing Monitor 3 from the KVM loop, you only need 2 display ports on the KVM — dramatically cheaper and more reliable than a triple-monitor unit.

VIDEO CONNECTOR TYPE

DisplayPort preferred

Your monitors likely have HDMI and/or DisplayPort. Confirm which inputs Monitors 1 and 2 have before buying. DP KVMs support higher resolutions without adaptors. HDMI KVMs are slightly cheaper.

MAX RESOLUTION & REFRESH

1080p or 1440p @ 60Hz

Your two 60Hz monitors need nothing beyond 1080p@60Hz or 1440p@60Hz. Almost every modern KVM handles this. Don't pay for 4K@144Hz capability you won't use on these displays.

USB PORTS

4× USB-A minimum

2 ports for keyboard and mouse. Extra USB ports on the KVM act as a shared USB hub — useful for a desk webcam, USB hub, or audio interface that both PCs can reach.

USB VERSION

USB 3.0 if possible

USB 3.0 on the KVM matters if you connect a shared storage device or webcam. For keyboard and mouse only, USB 2.0 is perfectly adequate. Most modern KVMs mix USB 3.0 and 2.0 ports.

HOTKEY SWITCHING

Scroll Lock × 2 standard

The near-universal KVM hotkey is pressing Scroll Lock twice quickly. Better units let you remap this. Some have a physical button on the unit itself as an alternative — useful if the hotkey conflicts with a game or application.

EDID EMULATION

Essential — confirm before buying

EDID (Extended Display Identification Data) tells the PC what monitors are connected. Without EDID emulation, switching away from a PC causes it to "lose" the monitors — windows get rearranged and resolutions reset. Every quality KVM includes this; cheap ones often don't.

AUDIO PASSTHROUGH

Optional but convenient

Some KVMs include 3.5mm audio ports so your speakers/headphones also switch with the active PC. Useful if you use a single desk speaker set. Not needed if audio is handled separately (USB DAC, Bluetooth headphones, etc.).

> **EDID emulation is non-negotiable:** Without it, every time you switch to the other PC, Windows thinks the monitors were disconnected. It moves all your open windows to whichever monitor it assumes is still active and resets display settings. You spend 30 seconds reorganising your workspace after every switch. Good KVMs with EDID emulation keep each PC's monitor layout frozen exactly as you left it.

What Makes a Good KVM vs a Bad One

WHAT TO LOOK FOR

- ✓ EDID emulation on all video ports
- ✓ DisplayPort 1.2 or 1.4 (not "DP-compatible" generic)
- ✓ Named brand: ATEN, Level One, TESmart, Club 3D
- ✓ USB 3.0 on at least 2 ports
- ✓ Remappable hotkey (or physical button alternative)
- ✓ Works without drivers (class-compliant USB)
- ✓ Consistent user reviews mentioning EDID specifically
- ✓ Explicit max resolution per port in the spec sheet

RED FLAGS TO AVOID

- ✗ No mention of EDID emulation anywhere in the listing
- ✗ "Supports up to 4K" with no refresh rate specified
- ✗ Unbranded / no-name units under £25
- ✗ Requires proprietary software or drivers to function
- ✗ Only USB 2.0 on all ports (limits shared devices)
- ✗ Reviews mentioning windows moving on switch
- ✗ VGA or DVI outputs (obsolete — adaptors cause EDID issues)

✗ "HDMI 2.0 compliant" without explicit bandwidth spec

Recommended KVM Switches — For This Setup

TOP PICK

ATEN CS1922M — 2-Port Dual DP KVM

Ports	2 PCs × 2 Monitors
Video	DisplayPort 1.2
Max resolution	4K@60Hz / 1080p@120Hz per port
EDID emulation	Yes — built-in
USB	4× USB 3.1 shared hub
Audio	3.5mm in + out (switches with PC)
Hotkey	Scroll Lock × 2 or front button
Drivers needed	No — plug and play

ATEN is the benchmark brand for KVM switches. The CS1922M is their mainstream dual-DP model — solid EDID implementation means zero window-rearrangement on switch. USB 3.1 hub is fast enough for a shared external SSD. Well-reviewed over several years.

~£130 – £180

Search Amazon

STRONG ALT

TESmart HKS0201A2U — Dual DP KVM

Ports	2 PCs × 2 Monitors
Video	DisplayPort 1.4
Max resolution	4K@144Hz or 1080p@240Hz
EDID emulation	Yes
USB	4× USB (mix of 3.0 and 2.0)
Audio	3.5mm passthrough
Hotkey	Scroll Lock × 2 or physical button
DP 1.4 future value	Handles higher refresh if monitors upgrade

TESmart has become a credible mid-range KVM brand. DP 1.4 gives more headroom than you need right now, which makes this a better long-term buy if you ever upgrade Monitors 1 or 2 to 1440p@144Hz. Slightly lower price than ATEN with similar feature set.

~£90 – £130

Search Amazon

BUDGET OPTION

HDMI Dual-Monitor KVM (if monitors have HDMI)

Ports	2 PCs × 2 Monitors
Video	HDMI 2.0
Max resolution	4K@60Hz / 1080p@60Hz
EDID emulation	Check listing carefully
Typical brands	Newyes, UGREEN, KVM-Tek
Audio	Sometimes, sometimes not
Risk	Variable EDID quality

If both 60Hz monitors only have HDMI inputs, an HDMI dual-monitor KVM costs significantly less. Read reviews specifically for EDID behaviour before buying — the savings evaporate if you spend time fixing window layouts after every switch.

~£40 – £80

Search Amazon

Before you buy — check your two 60Hz monitors' inputs: The 2015 Samsung may only have HDMI or DVI; the 2019 Samsung likely has both HDMI and DisplayPort. Knowing exactly what inputs each monitor has determines whether you need a DP KVM, an HDMI KVM, or a mixed unit. Check the sticker on the back of each monitor for the model number and look up the spec sheet.

Installing and Configuring the KVM

1

Plan your cable run before connecting anything

The KVM needs to sit somewhere accessible — ideally on or near the desk where the physical button is reachable. Measure cable runs from: (a) new PC to KVM, (b) old PC to KVM, (c) KVM to Monitor 1, (d) KVM to Monitor 2. KVMs typically include short cables (1–1.5m) which may not reach from two different PC locations. Budget for longer cables if needed — DisplayPort cables up to 2m are inexpensive and reliable.

2

Connect Monitor 3 (165Hz) directly to the new PC first

Connect the 2024 Samsung to the new PC's RTX 3050 LP using a **DisplayPort cable directly** — this connection goes nowhere near the KVM. Boot the new PC and confirm Monitor 3 is working at 165Hz via Display Settings before touching the KVM wiring. This baseline confirms the monitor works before you introduce the KVM into the signal path for the other two.

✓ Use one of the RTX 3050 LP's three DisplayPort outputs for Monitor 3 and reserve HDMI for the KVM chain if one of the 60Hz monitors only has HDMI input.

3

Connect both PCs to the KVM's input ports

Use the KVM-supplied cables or your own. KVM Port 1 → New PC (RTX 3050 LP outputs). KVM Port 2 → Old PC (B560M PRO-E rear I/O video outputs). Also connect the USB cables: each PC sends a USB upstream cable to the KVM — this is what lets the KVM route keyboard and mouse between machines. These USB upstreams are usually Type-B (square) connectors going into the KVM and Type-A going into a USB port on each PC.

⚠ Use a DP output on the old PC that matches the KVM's input type. The B560M PRO-E has 1× HDMI 1.4 and 1× DisplayPort 1.2 on the rear I/O — use the DP output for better compatibility with a DP KVM. If the KVM is HDMI, use the HDMI output.

4

Connect KVM outputs to Monitors 1 and 2

The KVM has output (console) ports for displays — connect these to Monitors 1 and 2. On a dual-monitor KVM, there are two video output ports labelled "Monitor 1" and "Monitor 2" (or A/B). Connect them consistently: always Monitor 1 goes left, Monitor 2 goes centre (or whatever arrangement matches your physical layout).

✓ Label each cable with a small sticky note during installation — KVM wiring is easy to mix up when there are 8+ video cables going in similar directions. You'll thank yourself the first time you need to trace a cable.

5

Connect keyboard and mouse to the KVM's shared USB ports

Plug the keyboard and mouse into the KVM's console USB ports (not into a PC directly). These are the ports that switch with the active PC. Most KVMs have 2–4 USB-A ports on the front or side labelled "Console" or with a keyboard/mouse icon. Your keyboard and mouse should still work exactly as before — but now they follow whichever PC is selected.

6

Test switching and verify EDID behaviour

Power on both PCs. Press Scroll Lock × 2 to switch. Verify: (a) Monitors 1 and 2 show the other PC's desktop immediately, (b) keyboard input now goes to the other PC, (c) when you switch back, your open windows on the first PC are exactly where you left them (EDID emulation working). Open a text editor on each PC and type a few characters to confirm keyboard routing.

⚠ If windows rearrange on switch, EDID emulation isn't working. Check the KVM's manual for an EDID mode toggle — many units have it disabled by default and require a specific button combination to enable it.

USB Sharing — What Switches and What Doesn't

DEVICE	CONNECTION METHOD	BEHAVIOUR ON SWITCH
Keyboard	Console USB port on KVM	Switches — follows the active PC
Mouse	Console USB port on KVM	Switches — follows the active PC
USB hub (shared)	Console USB port on KVM	Switches — hub and all its devices switch together
Webcam	Console USB port	Switches — active PC gets webcam; other PC loses it
Headphones/speakers	KVM 3.5mm audio jack (if present)	Switches with PC selection
USB DAC / audio interface	Console USB port	Switches — only one PC has audio at a time
External SSD / USB storage	Console USB port	Do NOT share this way — switching while a drive is mounted risks data corruption. Use a separate USB switch for storage.
Printer	Direct to new PC, or network printer	Network printer is accessible from both PCs without the KVM. Avoid USB-shared printers through the KVM.
Monitor 3 (165Hz)	Direct to new PC — never via KVM	Always shows new PC — no switching involved

Separate USB switch for shared storage: If you want a USB drive accessible from both PCs, use a dedicated **USB switch** (not the KVM) — a simple 2-port USB switch (~£8–15) with a physical button. This keeps storage switching independent from display/input switching. Always safely eject the drive on the current PC before pressing the USB switch button.

Hotkeys and Switching Methods

```
COMMON KVM SWITCHING METHODS

Scroll Lock × 2         Most universal KVM hotkey
─────────────────────────────────────────────────────────────
Press Scroll Lock       (tap once)
Press Scroll Lock       (tap again within ~2 seconds)
→ KVM switches to next PC
→ Screen goes dark briefly (<1 second), then other PC's desktop appears

Physical button on KVM  Alternative if hotkey conflicts with software
─────────────────────────────────────────────────────────────
Press the button on the front/top of the KVM unit
Useful for gaming (Scroll Lock used in some games)
Useful if keyboard doesn't have a Scroll Lock key

Custom hotkey (brand-specific)
─────────────────────────────────────────────────────────────
ATEN:    Ctrl, Ctrl     (can change to Caps Lock or Print Screen)
TESmart: Ctrl+Alt+1/2  (switch to specific PC by number)

Switch time: <1 second for display, near-instant for keyboard/mouse
Audio (if via KVM 3.5mm): switches simultaneously with display
```

Remap the hotkey if Scroll Lock conflicts: Scroll Lock is used as a modifier in some terminal emulators, spreadsheet apps, and games. Most quality KVMs let you remap the trigger key via a firmware button combination (hold a button while pressing the new key). Check the manual — it's usually a simple sequence done once at setup.

Setup Verification Checklist

- [ ] **Monitor 3 running at 165Hz — confirmed before KVM setup:** Display Settings on new PC shows 165Hz for the 2024 Samsung on its direct connection. This baseline is established before any KVM wiring begins.
- [ ] **Both 60Hz monitors detected by both PCs:** Switch to each PC in turn. On the new PC, Monitors 1 and 2 appear in Display Settings at their correct resolutions (1920×1080 or 2560×1440) alongside Monitor 3. On the old PC, Monitors 1 and 2 appear at their correct resolutions.
- [ ] **EDID emulation confirmed — windows stay put:** Open several windows on the new PC arranged across Monitors 1 and 2. Switch to the old PC. Switch back to the new PC. Every window should be exactly where you left it — same position, same size. If windows have moved to Monitor 3 or piled up, EDID emulation is not working.
- [ ] **Keyboard and mouse work on both PCs:** After switching, open Notepad on each PC and type. Confirm the keyboard is routing to the correct machine. Move the mouse to confirm it's now controlling the newly active PC.
- [ ] **Switch time is acceptable (<2 seconds):** Time the switch from button press to both monitors showing the other PC's desktop. Under 1 second is typical for modern KVMs at 1080p/60Hz. More than 3 seconds suggests a bandwidth or EDID handshake issue — check the cable quality (avoid no-name DisplayPort cables over 2m).
- [ ] **Hotkey works and doesn't conflict:** Test Scroll Lock × 2 (or the KVM's hotkey) from within your typical working apps — VS Code, browser, terminal. If it conflicts with an application shortcut, remap the KVM hotkey or use the physical button instead.

Next: Type **PC15** to generate Chapter 15 — Using a Multimeter for PC Diagnostics, covering the modes and settings you need, testing PSU voltages directly (independent of motherboard sensors), checking for shorts before first boot, diagnosing a completely dead component, and what the ATX voltage tolerances actually mean in practice.

CHAPTER 15 OF 15 — BONUS CHAPTER

Multimeter & Advanced Diagnostics ✦ Bonus

Chapter 15 — Using a Multimeter for PC Diagnostics

Motherboard sensor software like HWiNFO gives you a real-time view of voltages while the system is running — but it's measuring what the Super I/O chip reports, which is already downstream of the PSU and the voltage regulator modules. When something doesn't add up, a multimeter probing directly at the source cuts through all that interpretation and tells you what's actually on the wire. This chapter covers the handful of tests that are genuinely useful for a home build and how to run them safely.

What you need: Your existing digital multimeter, the two probes (red and black), and a paperclip or short piece of wire for the PSU standalone test. No special PC-specific accessories are required.

Multimeter Modes — What Each One Does for PC Work

A typical digital multimeter has more modes than you'll ever use for PC diagnostics. These are the four that matter:

V⎓

DC VOLTAGE

`Dial: V⎓ or VDC, set 20V range (or AUTO)`

Measures direct current voltage — the kind computers run on. Red probe to positive, black probe to ground. The reading shows how many volts exist between the two points.

PC use: PSU voltage rails (+12V, +5V, +3.3V), fan header voltage, USB header voltage (5V), SATA power connector spot-check.

V~

AC VOLTAGE

`Dial: V~ or VAC, set 750V range`

Measures alternating current — what comes from the wall socket. The mains in the UK is 230V AC. You won't use this mode often, but it's the right tool when you suspect the wall socket or power strip is faulty.

PC use: Testing a wall socket (~230V AC expected). Testing an IEC power cable's live and neutral conductors from plug to socket.

🔊

CONTINUITY

`Dial: continuity symbol (diode with arc) or Ω with sound icon`

Beeps when two probed points are electrically connected. The beep confirms a complete circuit exists between the probe tips — direction doesn't matter. Fastest diagnostic mode: you don't need to watch the display, just listen.

PC use: Testing power cables (IEC cord, SATA cable), checking for accidental shorts to ground, verifying a ground connection, checking speaker/fan wires.

Ω

RESISTANCE

`Dial: Ω, set 200Ω or auto-range`

Measures resistance in ohms. Less used for PC diagnostics than continuity mode (which is a special case of resistance at near-zero ohms). Useful for measuring a fan's coil resistance or checking a resistor on a board.

PC use: Advanced board-level diagnostics. Dead short = 0Ω reading in resistance mode (or continuous beep in continuity mode).

Probe jack placement matters: The black probe always goes in the **COM** jack. The red probe goes in the **V/Ω** jack for all PC work — never in the A (amperage) jack unless you're intentionally measuring current draw. Putting red in the wrong jack while probing mains AC can blow the multimeter's internal fuse or damage the meter.

```
PROBE CONNECTIONS — Correct Setup for PC Testing

Multimeter front panel:
┌──────────────────────────────────────────┐
│                [DISPLAY]                 │
│                                          │
│             [DIAL / KNOB]                │
│                                          │
│  [10A jack]  [mA jack]  [V/Ω jack]  [COM]│
│                            ↑         ↑   │
│                           RED       BLK  │
└──────────────────────────────────────────┘

For all PC voltage and continuity work:
• RED probe   → V/Ω jack
• BLACK probe → COM jack
• The 10A and mA jacks are never used for PC diagnostics
```

Safe Practices Before You Probe Anything

Set mode before probing
Turn the dial to the correct mode and range before touching anything with the probes. Probing mains voltage in DC mode or continuity mode won't hurt you, but it will give a meaningless reading and might damage the meter.

DC work: PSU switch off at back
When testing a powered-down component (cable continuity, case short detection), flip the PSU's rear switch to off and unplug from the wall before touching internal components. Standby voltage (+5VSB) is present on the 24-pin connector whenever the PSU is plugged in, even with the PC off.

AC testing: one hand in pocket
When probing a live wall socket, keep one hand clear of any conductive surface — either in your pocket or behind your back. This prevents mains current from finding a path through your chest if something goes wrong. It sounds dramatic but is a genuine electrician's habit.

DC voltage: polarity doesn't hurt
Getting the probes backwards on a DC voltage test just gives a negative reading on the display — it won't damage the meter or the component. If you see a negative number, swap the probes.

Never probe both + and − on a live battery/cap
Motherboards have capacitors that hold charge even after shutdown. Wait 30 seconds after power-down before probing inside the case. For a PC at normal voltages, this is a precaution, not a life-safety issue — but it prevents sparks and protects components.

Short probes together to zero-check
In continuity mode, touch the probes together before starting — the meter should beep and show near-zero resistance. In voltage mode, touching probes together should show 0.00V. This confirms the meter is working correctly before you trust a reading.

Test 1 — Is the PSU Completely Dead?

When a PC won't POST and shows no signs of life (no fans, no LEDs, nothing), the PSU is a primary suspect. This test checks whether the PSU can deliver any output at all, completely independently of the motherboard.

This is the "paperclip test" from Chapter 9, extended with multimeter readings. You're bypassing the PS_ON# signal (which the motherboard normally pulls low to turn the PSU on) to make the PSU run standalone.

```
24-PIN ATX CONNECTOR — Pins Relevant to This Test

Side with clip/latch
┌──────────────────────────────────────────────┐
│ 12 ● 11 ● 10 ● 9 ● 8 ● 7 ● 6 ● 5 ● 4 ● 3 ● 2 ● 1 │
│ ORG YEL YEL PUR GRY BLK RED BLK RED BLK ORG ORG │
├──────────────────────────────────────────────┤
│ 24 ● 23 ● 22 ● 21 ● 20 ● 19 ● 18 ● 17 ●16● 15 ●14● 13 │
│ BLK RED RED RED --- BLK BLK BLK GRN BLK BLU ORG │
└──────────────────────────────────────────────┘

Pin 16 (GREEN) = PS_ON#  ← short to any black wire to turn PSU on
Pin 14 (BLUE)  = -12V   ← rarely tested, but present

Wire colours for quick probe targeting:
YELLOW = +12V    RED = +5V    ORANGE = +3.3V
PURPLE = +5VSB   BLACK = GND  GREEN  = PS_ON# (control signal)
```

TEST 1 **PSU standalone power-on + voltage check**

1. **Disconnect all PSU cables from the PC.** The 24-pin motherboard connector, the 8-pin CPU connector, and all SATA/PCIe cables should be unplugged from everything. The PSU is now completely isolated.
2. **Leave the PSU plugged into the wall** with the rear switch set to ON (|). The mains cable stays connected for this test — you need the PSU energised.
3. **Find pin 16 (green wire) and any adjacent black wire (ground)** on the 24-pin connector. The green wire is PS_ON# — it's the only green wire in the bundle and is easy to spot.
4. **Bend a paperclip into a U-shape and insert one end into the green wire's socket, the other into any black wire's socket** on the same connector. This simulates the motherboard pulling PS_ON# low. The PSU fan should spin up within 1–2 seconds.
5. **Set your multimeter to DC Voltage (V⎓), 20V range.** Black probe to any black wire socket, red probe to a yellow wire socket. You should read: `+11.4V to +12.6V` . A reading below 11.4V or above 12.6V is out-of-spec.
6. **Move the red probe to a red wire socket.** Expected reading: `+4.75V to +5.25V` . This is the +5V rail.
7. **Move the red probe to an orange wire socket.** Expected reading: `+3.135V to +3.465V` . This is the +3.3V rail.
8. **Move the red probe to the purple wire socket** (pin 9). Expected: `+4.75V to +5.25V` . This is +5VSB (standby). It's live even before the paperclip test — if this rail had nothing before step 4, the PSU's primary fuse may be blown.
9. **Remove the paperclip and flip the rear switch off.** Never leave a PSU running unattended in paperclip mode — there's no overcurrent protection from the motherboard's power circuitry.

If the PSU fan doesn't spin after inserting the paperclip: the PSU is dead or the paperclip is in the wrong holes. Double-check the green wire — it really is the only green one. If all other wires read near-zero voltage with the PSU supposedly on, the PSU has failed and needs replacing.

Test 2 — In-System Voltage Accuracy

This test runs with the PC fully assembled and powered on. You're measuring the PSU's output under actual load — which is more meaningful than the no-load paperclip test because voltages can sag when current is drawn.

> **Working inside a running PC:** Keep probe movements controlled and deliberate. A probe slip that bridges two voltage rails can destroy a component. Use the tip of the probe only, keep fingers away from the metal tip, and don't rush. This is the one PC test where haste genuinely costs money.

```
WHERE TO PROBE — 24-pin ATX Connector In-System

The 24-pin connector has a gap on the back where you can
insert a probe tip alongside the existing cable into each socket.
You do NOT need to disconnect anything.

─────────────────────────────────────────────────
Target      Wire colour   What to expect under load
─────────────────────────────────────────────────
+12V rail   Yellow wire   11.4V – 12.6V  (sag to 11.8V is normal)
+5V  rail   Red wire      4.75V – 5.25V
+3.3V rail  Orange wire   3.135V – 3.465V
GND         Black wire    Reference (set black probe here first)
─────────────────────────────────────────────────

Alternative probe point:  SATA power connector (easier access)
See Test 3 for SATA-specific pinout.
```

TEST 2 **In-system voltage spot-check (PC running)**

1. **Boot to Windows and open a load-generating task** — a Cinebench run, a game, or simply run Prime95 for 5 minutes. Measuring under real load catches voltage sag that a no-load reading misses.
2. **Set multimeter to DC Voltage, 20V range.** Have the display visible while your hands are at the case.
3. **Insert the black probe tip into a black wire socket on the 24-pin connector** and hold it there. This is your ground reference throughout the test.
4. **With the red probe, touch a yellow wire socket.** Note the reading. Under load, `11.6–12.2V is excellent` . `11.4V is the spec minimum — acceptable but marginal under full load` . `Below 11.4V under load means the PSU is struggling.`
5. **Repeat for a red wire (+5V) and an orange wire (+3.3V).** These rails are much more stable and will be close to nominal (5.0V and 3.3V) under all realistic PC loads.
6. **Compare your readings to HWiNFO's reported voltages.** A ~0.1–0.2V discrepancy is normal — the motherboard sensor has its own calibration. A larger gap (0.5V+) suggests a sensor calibration issue on the board, not a PSU problem.

The +12V rail does most of the work: it powers the CPU (via the VRMs), the GPU, and the case fans. If any rail reads out of spec, +12V is the most likely candidate to show the problem first.

ATX Voltage Tolerance Reference

+12V rail	LOW	11.4V —— 12.0V nominal —— 12.6V	HIGH	±5% spec
+5V rail	LOW	4.75V —— 5.0V nominal —— 5.25V	HIGH	±5% spec
+3.3V rail	LOW	3.14V — 3.3V nominal — 3.47V	HIGH	±5% spec
+5VSB	LOW	4.75V —— 5.0V nominal —— 5.25V	HIGH	±5% spec (standby)

RAIL	NOMINAL	SPEC MIN	SPEC MAX	REAL-WORLD READING	CONCERN THRESHOLD
+12V	12.000V	11.400V	12.600V	11.6V–12.2V under load (normal)	Below 11.4V under load
+5V	5.000V	4.750V	5.250V	4.95V–5.10V (very stable)	Below 4.75V or above 5.25V
+3.3V	3.300V	3.135V	3.465V	3.27V–3.35V (very stable)	Below 3.13V or above 3.47V
+5VSB	5.000V	4.750V	5.250V	~5.0V always (low current draw)	Zero volts = primary fuse blown

The Corsair TX550M is a Gold-rated unit with tight regulation — on a quality PSU like yours, expect the +12V rail to stay above 11.7V even under full combined CPU+GPU load. Cheap PSUs are where the voltage sag becomes dramatic enough to cause instability.

Test 3 — SATA Power Connector Spot-Check

The SATA power connector is much easier to probe than the 24-pin ATX. It's a flat L-shaped connector with exposed pins along its length, and probing it while the system is running is straightforward.

```
SATA POWER CONNECTOR — 15-pin pinout

┌──────────────────────────────────────────────────────────┐
│  1    2    3    4    5    6    7    8    9   10   11   12   13   14   15 │
│ +3V +3V +3V GND GND GND +5V +5V +5V GND GND +12 +12 +12  N │
└──────────────────────────────────────────────────────────┘
 ORG ORG ORG BLK BLK BLK RED RED RED BLK BLK YEL YEL YEL  -

Quick probe targets (looking at the cable end, connector face-up):
• Left group (pins 1-3):  probe red wire = +3.3V (3.135-3.465V)
• Middle group (pins 7-9): probe red wire = +5V   (4.75-5.25V)
• Right group (pins 12-14): probe yellow = +12V  (11.4-12.6V)
• Any black wire = GND (put black probe here)

The flat connector face is accessible while the drive is connected.
Probe at the cable end where the conductors are visible.
```

> **When to use this test:** A drive that worked then disappeared from Device Manager, or a drive detected but with slow/erratic performance. Bad SATA power (especially low +5V) is a known cause of drive misbehaviour that doesn't show in SMART data or CrystalDiskMark errors.

Test 4 — IEC Power Cable Continuity

An IEC C13 power cable (the kettle-lead style cable your PSU uses) can develop an internal break at either end where the cable meets the connector — most commonly at the plug end due to flexing. A broken conductor means the PSU gets no power or gets it intermittently.

TEST 4 **IEC power cable continuity check**

1. **Unplug the cable from both the wall and the PSU.** Both ends must be disconnected — continuity mode on a live cable will trip the multimeter's fuse and potentially damage it.
2. **Set the multimeter to continuity mode.** Touch the two probe tips together — you should hear a beep confirming the mode is working.
3. **Test the live conductor:** insert one probe into the live pin of the UK plug (right pin, smaller), and touch the other probe to the corresponding live blade inside the IEC C13 connector at the other end. A continuous beep = wire is intact. Silence = broken conductor.
4. **Test the neutral conductor:** UK plug neutral is the left pin (larger than live, smaller than earth). Touch the other probe to the IEC C13 neutral blade at the far end. Should beep.
5. **Test the earth conductor:** the large top pin on the UK plug to the C-shaped earth blade in the IEC connector. Should beep. An earth conductor open-circuit means the PSU's metal chassis isn't earthed — replace the cable immediately.

A working cable beeps on all three conductors. Any silence means there's a break somewhere in that conductor. IEC cables are cheap — replace rather than repair. The TX550M uses a standard C13 connector so any C13 replacement works.

Test 5 — Wall Socket AC Voltage

Testing the wall socket rules out the outlet itself as a cause of PSU failure — useful when a PSU appears to receive no power at all despite the mains cable and switch both being correct.

> **This is the only genuinely hazardous test in this chapter.** Mains voltage (230V AC) is lethal. Treat it with proportionate respect: set the multimeter to VAC 750V range before inserting probes, use one hand only (other hand behind your back or in pocket), and don't rush. This is a one-minute test, not a job for tired hands.

TEST 5 Wall socket AC voltage (UK 230V)

1. **Set the multimeter to AC Voltage (V~), 750V range.** This range is safe for UK mains — the meter won't overload even if the voltage is slightly high.
2. **Insert the black probe into the neutral slot** (bottom-left of a standard UK socket). Hold it steady.
3. **With one hand only, insert the red probe into the live slot** (bottom-right of a UK socket). Keep your other hand clear of anything conductive.
4. **Read the display.** Expected: `216V – 253V` (UK mains tolerance per EN 50160). A reading of 228–232V is typical. `Below 200V` suggests a supply issue or high load on the circuit. `Zero volts` = socket is dead (tripped breaker, blown ring-main fuse, or faulty socket).
5. **Remove probes tip-first, black probe last.** Switch the multimeter off or change it to a safer mode (like DC or Ω) immediately after.

Alternatively, the safest way to test a UK socket is with a socket tester — a £5 plug-in device with LEDs that lights up specific patterns for wired-correctly, live/neutral reversed, earth open, etc. No probe insertion required. Worth keeping one in a drawer.

Test 6 — Short Detection Before First Boot

Before powering on a newly assembled system for the first time, a continuity check between the +12V rail and ground can catch a catastrophic short before it blows anything. This takes 30 seconds and costs nothing.

TEST 6 Pre-boot short detection — 24-pin ATX connector

1. **PSU unplugged from the wall, rear switch off.** The 24-pin connector plugged into the motherboard.
2. **Set multimeter to continuity mode.** Touch probes together first to confirm it beeps.
3. **Place the black probe on a black wire socket (GND) on the 24-pin connector.**
4. **Touch the red probe to a yellow wire socket (+12V).** Expected: `silence (no beep)`. +12V and GND should not be directly connected. A continuous beep = a dead short between +12V and ground somewhere — do not power on until the cause is found.
5. **Repeat with a red wire socket (+5V) to black wire socket.** Again, expected is silence. A beep here means a +5V-to-GND short.
6. **Repeat with orange wire (+3.3V) to black wire.** Expected: silence.

A dead short (continuity between a voltage rail and ground) most commonly comes from: a misaligned motherboard standoff touching a trace, a dropped screw bridging two points on the board, or a wrongly seated component. If you get a beep, unplug everything incrementally (GPU, RAM, storage) to isolate which component is causing the short. The beep will disappear when the short is removed.

HWiNFO vs Multimeter — When to Use Each

HWINFO (SOFTWARE SENSOR)

- → Continuous real-time monitoring while the system runs
- → CPU and GPU temperatures, clocks, power draw
- → Fan speeds (all headers simultaneously)
- → Voltage trends over time (logging to CSV)
- → Post-overclock stability monitoring
- → Sensor accuracy: ±0.1–0.3V (calibrated to the Super I/O chip)
- → Best for: catching intermittent spikes, trend analysis, thermal monitoring

MULTIMETER (HARDWARE MEASUREMENT)

- → Ground truth reading at the physical conductor
- → PSU dead or alive — no motherboard needed
- → Catches cable/connector faults the board never sees
- → Continuity and short detection (impossible in software)
- → Mains and cable testing
- → Sensor accuracy: depends on meter quality; budget meters ±1–2%
- → Best for: hardware fault isolation, "is the signal even reaching the board" questions

Rule of thumb: HWiNFO tells you what the motherboard sees. The multimeter tells you what the PSU is actually delivering. If HWiNFO shows an out-of-spec +12V reading, probe the 24-pin directly before concluding the PSU is faulty — it might be a miscalibrated motherboard sensor. If the multimeter also shows low voltage at the connector, the PSU is the problem.

Quick-Reference: Symptom → Multimeter Test

⚡ **PC completely dead — no fans, no LEDs, nothing on power button**

Run in order: (1) Test 5 — confirm the wall socket is live. (2) Test 4 — confirm the IEC cable has continuity on all three conductors. (3) Test 1 — paperclip test to see if the PSU can power on at all and deliver voltage on the rails. If the PSU is fine, the problem is the motherboard power delivery (damaged VRM, failed power button header, or no power button cable connected).

📊 **System crashes or reboots under heavy load**

Test 2 (in-system) while running Prime95 or Cinebench. Watch the +12V reading as the CPU load ramps up. If voltage sags below 11.4V during the crash window, the PSU can't sustain the load. Also check HWiNFO's +12V logging to compare — if the multimeter shows fine but software shows low, it's a sensor calibration issue, not a PSU problem.

💾 **Storage drive disappears from Windows or performs erratically**

Test 3 — probe the SATA power connector serving that drive. Low +5V (below 4.75V) is a known cause of drive detection failures. If the voltage is fine, reseat the SATA data cable or test with a different SATA port before suspecting the drive itself.

🔥 **POST failure on a new build — no display, no beep codes, nothing**

Test 6 — check for shorts before doing anything else. A shorted motherboard won't POST and may trip the PSU's overcurrent protection silently. If no shorts found, do the paperclip test (Test 1) to confirm the PSU is good, then troubleshoot with minimum hardware: one stick of RAM in A2, no GPU, no SATA drives.

Case fan not spinning even at full duty cycle signal

Probe the fan header directly (DC voltage mode) while the fan is plugged in and BIOS fan curve is set to 100%. A 4-pin PWM fan header should show ~12V on the +12V pin. If you read ~0V, the fan header on the motherboard may be damaged. If you read 12V but the fan is still dead, the fan's motor has failed.

Diagnostics Readiness Checklist

- [ ] **Multimeter verified working:** Probes touch together → continuity beeps. DC voltage mode → reads 0.00V with probes together. Battery not low (most digital multimeters show a battery indicator — replace before it affects reading accuracy).
- [ ] **ATX voltage tolerances memorised or bookmarked:** +12V: 11.4–12.6V. +5V: 4.75–5.25V. +3.3V: 3.14–3.47V. These three numbers are all you need to judge whether a PSU reading is acceptable.
- [ ] **Pre-boot short test completed on the new build:** 24-pin connector probed — silence (no beep) between each voltage rail and ground. The system is safe to power on without risk of a rail-to-ground short blowing the PSU's protection fuses.
- [ ] **PSU voltages confirmed under load:** +12V reads above 11.6V while running Cinebench or Prime95. This establishes a baseline — if the system develops instability later, you have a known-good reference reading to compare against.
- [ ] **HWiNFO baseline logged:** After completing the hardware voltage tests, let HWiNFO log for 30 minutes during a stress test. Save the CSV. This gives you a timestamped software-side baseline that pairs with your hardware multimeter readings.

That's the complete PC Build Course: 15 chapters from choosing the right platform through to diagnosing the finished build with a multimeter. The core machine is built, configured, and verified — the KVM and multimeter chapters give you the tools and skills to run it long-term and diagnose anything that surfaces later.