Hardware alternatives for running machine learning models locally

- [Server](#)
- [Light server](#)
- [Workstation](#)
- [Desktop PC](#)
- [Embedded / mobile CPU](#)
- [GPUs](#)

Refer to the *Which GPU(s) to Get for Deep Learning: My Experience and Advice for Using GPUs in Deep Learning* blog post by Tim Dettmers.

> Tensor Cores are most important, followed by memory bandwidth of a GPU, the cache hierarchy, and only then FLOPS of a GPU

See also the Build your own machine guide on HuggingFace.

Server

Minimal 1-CPU configuration

- Supports 2x NVIDIA RTX PRO 6000 Blackwell (96GB) Desktop GPUs with open-air cooling
- Theoretical maximum RAM bandwidth of 460.8 GB/s
- Suggested processors: AMD EPYC 9354, 9534.

Component	Model	Price each [EUR]	Price subtotal [EUR]
CPU	AMD EPYC 9354	2800	2800
RAM	Micron 32GB DDR5 5600MHz MTC20F2085S1RC56BR × 12	190	2280
SSD	Samsung PM9A3 1.9TB NVMe PCIe Gen4 V6 M.2 22x110	320	320
Motherboard	Supermicro MBD-H13SSL-NT	820	820
CPU cooler	Arctic Freezer 4U-SP5	50	50
PSU	Seasonic Prime PX-2200 2200W 80 PLUS Platinum	530	530
Chassis	Fractal Design Torrent	180	180
Total			**6980**

1-CPU maximum configuration with Zen 4 architecture

- Supports 2x NVIDIA RTX PRO 6000 Blackwell (96GB) Desktop GPUs with open-air cooling,
- Theoretical maximum RAM bandwidth of 460.8 GB/s
- Suggested processors:
  - 9754 (128 cores, L3 cache 256 MB),
  - 9184X, 9384X, 9684X (16/32/96 cores, L3 cache 768/768/1152 MB)

Component	Model	Price each [EUR]	Price subtotal [EUR]
CPU	*AMD EPYC 9754*	*7220*	*7,220*
RAM	Micron 32GB DDR5 5600MHz MTC20F2085S1RC56BR × 12	190	2,280

Component	Model	Price each [EUR]	Price subtotal [EUR]
SSD	Samsung PM9A3 1.9TB NVMe PCIe Gen4 V6 M.2 22x110	320	320
Motherboard	Supermicro MBD-H13SSL-NT	820	820
CPU cooler	Arctic Freezer 4U-SP5	50	50
PSU	Seasonic Prime PX-2200 2200W 80 PLUS Platinum	530	530
Chassis	Fractal Design Torrent	180	180
Total			**11,400**

Specs

▶ CPU: AMD EPYC 9004 / 9005 (SP5 socket)

- Minimum 12 x DDR5 4800 MT/s RAM
  - RAM module side memory bandwidth:
    - 1-CPU config: 12 x 8 x 4.8 GT/s = 460.8 GB/s
      - Supports 6x PCIe 5.0 x16 GPUs
    - 2-CPU config: 24 x 8 x 4.8 GT/s = 921.6 GB/s
- Minimum 8 CCDs per processor:
  - CPU side memory bandwidth:
    - Zen 4: 8 x 32 x 1.8 GHz = 460.8 GB/s
    - Zen 5: 8 x 32 x 2.0 GHz = 512.0 GB/s
    - Supports 6x PCIe 5.0 x16 GPUs (6 x 63 = 378 GB/s)
- CPU candidates which support PCIe 5.0 x16:

- AMD EPYC 9004 series processors

MODEL	CORES	THREADS	BASE FREQ. (GHZ)	UP TO MAX BOOST FREQ. (GHZ)[a]	ALL-CORE BOOST (GHZ)[b]	DEFAULT TDP (W)	L3 CACHE (MB)	DDR5 CHANNELS	UP TO MAX DDR5 FREQ. (1DPC)	PER-SOCKET THEORETICAL MEMORY BANDWIDTH (GB/S)	PCIE® GEN 5 LANES	2P/1P
9754	128	256	2.25	3.10	3.10	360	256	12	4800	460.8	128	2P/1P
9754S		128										
9734	112	224	2.20	3.00	3.00	340	256	12	4800	460.8	128	2P/1P
9654	96	192	2.40	3.70	3.55	360	384	12	4800	460.8	128	2P/1P
9654P												1P
9634	84	168	2.25	3.70	3.10	290	384	12	4800	460.8	128	2P/1P
9554	64	128	3.10	3.75	3.75	360	256	12	4800	460.8	128	2P/1P
9554P												1P
9534	64	128	2.45	3.70	3.55	280	256	12	4800	460.8	128	2P/1P
9454	48	64	2.75	3.80	3.65	290	256	12	4800	460.8	128	2P/1P
9454P												1P
9354	32	64	3.25	3.80	3.75	280	256	12	4800	460.8	128	2P/1P
9354P												1P
9334	32	56	2.70	3.90	3.85	210	128	12	4800	460.8	128	2P/1P
9254	24	48	2.90	4.15	3.90	200	128	12	4800	460.8	128	2P/1P
9224	24	48	2.50	3.70	3.65	200	64	12	4800	460.8	128	2P/1P
9124	16	32	3.00	3.70	3.60	200	64	12	4800	460.8	128	2P/1P
AMD EPYC 9004 SERIES PROCESSORS WITH AMD 3D V-CACHE												
9684X	96	192	2.55	3.70	3.42	400	1152	12	4800	460.8	128	2P/1P
9384X	32	64	3.10	3.90	3.50	320	768	12	4800	460.8	128	2P/1P
9184X	16	32	3.55	4.20	3.85	320	768	12	4800	460.8	128	2P/1P
HIGH-FREQUENCY AMD EPYC 9004 SERIES PROCESSORS												
9474F	48	96	3.60	4.10	3.95	360	256	12	4800	460.8	128	2P/1P
9374F	32	64	3.85	4.30	4.10	320	256	12	4800	460.8	128	2P/1P
9274F	24	48	4.05	4.30	4.10	320	256	12	4800	460.8	128	2P/1P
9174F	16	32	4.10	4.40	4.15	320	256	12	4800	460.8	128	2P/1P

a. Maximum boost for AMD EPYC processors is the maximum frequency achievable by any single core on the processor under normal operating conditions for server systems. EPYC-18.
b. All-core boost for AMD EPYC processors is the average frequency of all processor cores running in performance mode while utilizing a low activity workload. Actual achievable all-core boost will vary based on hardware, software, workloads and other conditions. (EPYC-021)

Zen 4: Any AMD EPYC 9004 CPU, except 9124, 9224, 9254, 9334, because n_CCD < 8. Minimum viable: 9354 / 9354P. Performance and TDP tuned: 9754

- AMD EPYC 9005 series processors

MODEL	CORES	THREADS	'ZEN' CPU CCD	BASE FREQ. (GHZ)	UP TO MAX BOOST FREQ. (GHZ)^A	TDP (W)	L3 CACHE (MB)	DDR5 CHANNELS/ MAX MEM (2DPC)	UP TO MAX DDR5 MT/S (1DPC)	MAX PCIE® GEN 5 LANES	2P/1P
9965	192	384	5c	2.25	3.70	500	384	12/6 TB	6400	160	2P/1P
9845	160	320	5c	2.10	3.70	390	320	12/6 TB	6400	160	2P/1P
9825	144	288	5c	2.20	3.70	390	384	12/6 TB	6400	160	2P/1P
9755	128	256	5	2.70	4.10	500	512	12/6 TB	6400	160	2P/1P
9745	128	256	5c	2.40	3.70	400	256	12/6 TB	6400	160	2P/1P
9655	96	192	5	2.60	4.50	400	384	12/6 TB	6400	160	2P/1P
9655P	96	192	5	2.60	4.50	400	384	12/6 TB	6400	128	1P
9645	96	192	5c	2.30	3.70	320	256	12/6 TB	6400	160	2P/1P
9565	72	144	5	3.15	4.30	400	384	12/6 TB	6400	160	2P/1P
9575F	64	128	5	3.30	5.00	400	256	12/6 TB	6400	160	2P/1P
9555	64	128	5	3.20	4.40	360	256	12/6 TB	6400	160	2P/1P
9555P	64	128	5	3.20	4.40	360	256	12/6 TB	6400	128	1P
9535	64	128	5	2.40	4.30	300	256	12/6 TB	6400	160	2P/1P
9475F	48	96	5	3.65	4.80	400	256	12/6 TB	6400	160	2P/1P
9455	48	96	5	3.15	4.40	300	256	12/6 TB	6400	160	2P/1P
9455P	48	96	5	3.15	4.40	300	256	12/6 TB	6400	128	1P
9365	36	72	5	3.40	4.30	300	192	12/6 TB	6400	160	2P/1P
9375F	32	64	5	3.80	4.80	320	256	12/6 TB	6400	160	2P/1P
9355	32	64	5	3.55	4.40	280	256	12/6 TB	6400	160	2P/1P
9355P	32	64	5	3.55	4.40	280	256	12/6 TB	6400	128	1P
9335	32	64	5	3.00	4.40	210	128	12/6 TB	6400	160	2P/1P
9275F	24	48	5	4.10	4.80	320	256	12/6 TB	6400	160	2P/1P
9255	24	48	5	3.20	4.30	200	128	12/6 TB	6400	160	2P/1P
9175F	16	32	5	4.20	5.00	320	512	12/6 TB	6400	160	2P/1P
9135	16	32	5	3.65	4.30	200	64	12/6 TB	6400	160	2P/1P
9115	16	32	5	2.60	4.10	125	64	12/6 TB	6400	160	2P/1P
9015	8	16	5	3.60	4.10	125	64	12/6 TB	6400	160	2P/1P

A. Maximum boost for AMD EPYC processors is the maximum frequency achievable by any single core on the processor under normal operating conditions for server systems. EPYC-18.

Zen 5: Any AMD EPYC 9005 CPU, except 9015, 9115, 9135, 9255, 9335, 9365, because n_CCD < 8. Minimum viable: 9355 / 9355P. Performance and TDP tuned: 9745

- Complete list of CPU candidates:
  - Zen 4: 9174F, 9184X, 9274F, 9354, 9354P, 9374F, 9384X, 9454, 9454P, 9474F, 9534, 9554, 9554P, 9634, 9654, 9654P, 9684X, 9734, 9754, 9754S
  - Zen 5: 4245P, 4345P, 4465P, 4545P, 4565P, 4585PX, 9175F, 9275F, 9355, 9355P, 9375F, 9455, 9455P, 9475F, 9535, 9555, 9555P, 9565, 9575F, 9645, 9655, 9655P, 9745, 9755, 9825, 9845, 9965
- If CPU inference is not a priority, then lower core count and thus lower DTP/cDTP is sufficient.
- All CPUs below the 240 TDP line have less than 8 CCDs, so they cannot utilize the available RAM bandwidth.
- CPU candidates whose configurable TDP (cTDP) is in the 240-300 W range:
  - Zen 4: 9354, 9354P, 9454, 9454P, 9534, 9634
  - Zen 5: 9355P, 9355, 9365, 9455P, 9455, 9535
- CPU candidates whose configurable TDP (cTDP) is above 300 W:
  - Zen 4: 9174F, 9184X, 9274F, 9374F, 9384X, 9474F, 9554, 9554P, 9654, 9654P, 9684X, 9734, 9754, 9754S
  - Zen 5: 9175F, 9275F, 9375F, 9475F, 9555, 9555P, 9565, 9575F, 9645, 9655, 9655P, 9745, 9825, 9845

- **1-CPU minimal pick: AMD EPYC 9354** (Wikipedia) (AMD) (TechPowerUp)
  - Cores: 32
  - TDP: 280 W
  - Configurable TDP: 240-300 W

- Max. Memory: 12 x 128 = 1536 GB
      - PCI-Express: Gen 5, 128 Lanes (CPU only)
      - Rated Memory Speed: 4800 MT/s
      - Max memory bandwidth:
          - 12 channels x 8 x 4.8 = 460.8 GB/s,
          - 8 CCD x 32 x 1.8 GHz FCLK = 460.8 GB/s
      - Cache L3: 256 MB (shared)
- **Ideal pick for performance and low TDP: AMD EPYC 9754** (Wikipedia) (AMD) (TechPowerUp)
      - Cores: 128
      - TDP: 360 W
      - Configurable TDP: 320-400 W
      - Max. Memory: 12 x 256 = 3072 GB
      - PCI-Express: Gen 5, 128 Lanes
      - Rated Memory Speed: 4800 MT/s
      - 1-CPU configuration maximum memory bandwidth:
          - 12 channels x 8 x 4.8 = 460.8 GB/s,
          - 8 CCD x 32 x 1.8 GHz FCLK = 460.8 GB/s
          - Theoretical maximum bandwidth: 460.8 GB/s
      - 2-CPU configuration maximum memory bandwidth:
          - 24 channels x 8 x 4.8 GT/s = 921.6 GB/s
          - 2 x 8 CCD x 32 x 2.0 GHz FCLK = 1024 GB/s
          - Theoretical maximum bandwidth: 921.6 GB/s
          - A 2-CPU configuration would require a server chassis with multiple PSUs to deliver 2x 400 W (CPUs) + 2x 600 W (GPUs) + headroom = 3000 W total.
      - Cache L3: 256 MB (shared)

▶ CPU cooler

- Arctic Freezer 4U-SP5
      - Thermal compound: ARCTIC MX-6 0.8 g syringe included
      - Operating ambient temperature: 0–40 °C
      - Dimensions: 124 mm (L) × 147 mm (W) × 145 mm (H)
      - Weight: 1512 g
      - Compatibility: AMD SP5, server rack unit 4U and up
      - Heatsink:
          - Direct touch heat pipes, 10 × Ø 6 mm
          - 62 aluminum fins
      - Fans:
          - 2 × 120 mm PWM fans
          - Speed: 300–3300 rpm (PWM controlled)
          - Connector: 4-pin plug, 200 mm cable
          - Bearing: dual ball bearing
          - Noise level: 45.3 dBA
          - Air flow: 81.04 cfm (137.69 m³/h)
          - Static pressure: 4.35 mmH$_2$O
          - Current/voltage: 0.29 A / 12 V DC
          - Startup voltage: 3.1 V DC

- Silverstone XE360-SP5
    - High Performance Triple 120mm All-In-One Liquid Cooler for AMD Socket SP5
- Silverstone XED120 WS
    - 4U Form Factor Industrial-Grade CPU Cooler with TDP 450W for Intel & AMD Server-Grade Sockets
    - Model No.: SST-XED120S-WS
    - Material: Copper heat pipes with aluminum fins
    - Application:
        - Intel LGA4677/4710 (CPU carrier not included)
        - AMD Socket SP5, SP6, sTR5, SP3, TR4, sWRX8, sWRX9
    - Fan
    - Dimensions:
        - 120mm (W) x 30mm (H) x 120mm (D)
        - 4.72" (W) x 1.18" (H) x 4.72" (D)
    - Speed: 500–3000 RPM
    - Noise level: **44.9 dBA**
    - Rated voltage: 12V
    - Rated current: 0.35A
    - Maximum airflow: 102 CFM
    - Maximum air pressure: 8.24 mmH2O
    - Connector: 4-pin PWM
    - Bearing: Dual ball bearing
    - MTTF: 70,000 hours
    - CPU TDP support: up to 450W
    - Dimensions (with cooler): 120mm (W) x 145mm (H) x 120mm (D)
        - 4.72" (W) x 5.71" (H) x 4.72" (D)
- Silverstone XE04-SP5
    - 4U form factor server/workstation small form factor CPU cooler for AMD SP5 sockets
    - Model numbers:
        - SST-XE04-SP5 (Silver+Black)
        - SST-XE04-SP5B (Black+Black)
    - Material: aluminum fins and heat pipes
    - Application: AMD Socket SP5
    - Fan dimensions: 92mm (W) x 25mm (H) x 92mm (D)
    - Fan speed: 1500 to 5000 RPM
    - Noise level: **43 dBA at full speed**
    - Rated voltage: 12V
    - Rated current: 0.66A
    - Maximum airflow: 77.7 CFM
    - Maximum air pressure: 10.67 mmH2O
    - Connector: 4-pin PWM
    - Bearing type: dual ball bearing
    - MTTF: 90,000 hours
    - CPU TDP support: up to 400W
    - Cooler dimensions: 93mm (W) x 128mm (H) x 118mm (D)

▶ RAM

- The target system must support at least 2 NVIDIA RTX PRO 6000 Blackwell (96GB) GPUs

    - Required system RAM: >> total GPU VRAM
        - 2x 96 GB GPUs: 192 GB minimum, 384 GB ideally
        - 4x 96 GB GPUs: 384 GB minimum, 768 GB ideally
        - 6x 96 GB GPUs: 576 GB minimum, 1152 GB ideally
    - Memory modules:
        - Note: From the Genoa (AMD EPYC 4004, 8004, 9004) platform on, single-rank memory modules will perform well

            > The other important feature is dual rank versus single rank memory. With Milan and most Intel platforms, dual-rank memory is crucial to maximizing performance. There's a 25% performance delta on Milan, for example. With Genoa, this is brought down to 4.5%. This is another considerable cost improvement because cheaper single-rank memory can be used. (Slide)

    - Required system RAM bandwidth: min 63 GB/s per GPU (due to PCIe x16 bus bandwidth)
        - 2 GPUs: min. 126 GB/s
        - 4 GPUs: min. 252 GB/s
        - 6 GPUs: min. 378 GB/s
        - Lower RAM bandwidth will work, but not at full performance

- AMD EPYC 9004 Series Memory Population Recommendations

    - 4th Gen AMD EPYC processors support memory with the following characteristics:
        - RDIMM: 16GB 1Rx8, 24GB 1Rx8, 32GB 1Rx4, 32GB 2Rx8, 40GB 2Rx8, 48GB 1Rx4, 48GB 2Rx8, 64GB 2Rx4, 80GB 2Rx4, 96GB 2Rx4
        - 3DS RDIMM: 128GB 2S2Rx4, 192GB 2S2Rx4, 256GB 2S4Rx4, 384GB 2S4Rx4, 512GB 2S8R (pending ecosystem enablement)
        - ECC: 80b x4, 80b x8, 72b x4.
        - Optimized Bounded Fault ECC DRAM: 80b x4 AMDC, 80b x8, 72b x4
        - Use the same memory configuration for all NUMA domains in a single processor socket when using NPS=2 or NPS=4. "NPS" = NUMA node(s) per socket.

- Table 2-1 shows recommended memory speeds for a variety of memory types

DIMM Population*		DDR5 Frequency mT/s			Capacity (16 Gb x4 devices)
DIMM Type	DIMM 0	14-layer 93mil high-Dk PCB stack-up**	14-layer 74mil low-Dk PCB stack-up**	16-layer 93mil high-Dk PCB stack-up**	1 channel/ 12 channels
RDIMM***	1R (1 rank)	4800	4800	4800	32GB/384GB
	2R (2 ranks)	4800	4800	4800	64GB/768GB
3DS RDIMM	2S2R (4 ranks)	4800	4800	4800	128GB/1.5TB
	2S4R (4 ranks)	4800	4800	4800	256GB/3TB
	2S8Rx4 (16 ranks	4800	4800	4800	512GB/6TB

Notes:

* JEDEC nomenclature used to describe DDR5 DIMM types. DIMM 1 is the furthest distance from the processor for two memory slots per channel.

** Refer to the Socket SP5 Processor Motherboard Design Guide (PID 56870) for official descriptions and requirements for AMD EPYC 9004 Series Processor requirements. Platforms may require 14-layer or 16-layer stack-up, 93mil high-Dk or 74mil low-Dk PCB dielectric.

*** RDIMMs built from x4 and x8 devices are supported. The frequencies shown apply to both. The capacities listed only represent those of x4 DIMMs. RDIMMs built with x8 devices have half the capacity of the x4 RDIMMs with an equal number of ranks.

Table 2-1: Recommended memory speeds

> RDIMMs built from x4 and x8 devices are supported. The frequencies shown apply to both. The capacities listed only represent those of x4 DIMMs. RDIMMs built with x8 devices have half the capacity of the x4 RDIMMs with an equal number of ranks.
>
> The following DIMM types are not supported: LRDIMM, UDIMM, NVDIMM-N, NVDIMM-P
>
> All DIMM modules must be RDIMM or RDIMM 3DS module types with the same ECC configuration. Do not mix DIMM module types within a memory channel. Do not mix x4 and x8 DIMMs within a memory channel. Do not mix 3DS and non-3DS memory modules in a 2DPC system.

- Tested memory list for the Supermicro H13SSL-NT motherboard (see under "Resources"):

Part Number	Description	Compatible Motherboard Revision(s)
MEM-DR532MD-ER64	32GB DDR5-6400 2Rx8 (16Gb) ECC RDIMM	R2.01 and above

  - NOTE: 6400 MT/s speed requires motherboard revision 2.01 or higher and BIOS v3.4 or newer. See FAQ #43110 for more information.

- Samsung candidates: RDIMM, DDR5, 32GB

Part Number	Speed	Org	Density
M321R4GA0BB0-CQK	4800 Mbps	1R x 4	(4G x 4) x 20
M321R4GA3BB6-CQK	4800 Mbps	2R x 8	(2G x 8) x 20
M329R4GA0BB0-CQK	4800 Mbps	1R x 4	(4G x 4) x 18 (9x4)
M321R4GA0EB2-CWM	5600 Mbps	1R x 4	(4G x 4) x 20
M321R4GA3EB2-CWM	5600 Mbps	2R x 8	(2G x 8) x 20
M321R4GA0EB0-CWM	5600 Mbps	1R x 4	(4G x 4) x 20
M321R4GA3EB0-CWM	5600 Mbps	2R x 8	(2G x 8) x 20
M321R4GA0PB0-CWM	5600 Mbps	1R x 4	(4G x 4) x 20
M321R4GA3PB0-CWM	5600 Mbps	2R x 8	(2G x 8) x 20
M321R4GA0EB2-CCP	6400 Mbps	1R x 4	(4G x 4) x 20

Part Number	Speed	Org	Density
M321R4GA3EB2-CCP	6400 Mbps	2R x 8	(2G x 8) x 20
M321R4GA0PB2-CCP	6400 Mbps	1R x 4	(4G x 4) x 20
M321R4GA3PB2-CCP	6400 Mbps	2R x 8	(2G x 8) x 20

- Kingston candidates

Part Number	Capacity	Org	Ranking	DRAM MFR	Speed MT/s
KSM48R40BD8-32HA	32GB	X8	2R	Hynix	4800
KSM48R40BD8-32MD	32GB	X8	2R	Micron	4800
KSM56R46BD8-32HA	32GB	X8	2R	Hynix	5600
KSM56R46BD8-32MD	32GB	X8	2R	Micron	5600
KSM56R46BD8PMI-32HAI	32GB	X8	2R	Hynix	5600
KSM56R46BD8PMI-32MDI	32GB	X8	2R	Micron	5600
KSM56R46BS4PMI-32HAI	32GB	X4	1R	Hynix	5600
KSM56R46BS4PMI-32MDI	32GB	X4	1R	Micron	5600
KSM64R52BD8-32MD	32GB	X8	2R	16Gbit	6400

- Micron candidates

Part Number	Model	Capacity	Speed	Type	Rank	CL
MTC20F2085S1RC48BR	Micron DDR5-4800 RDIMM 2Rx8	32 GB	4800	RDIMM	2Rx8	40
MTC20F1045S1RC48BR	Micron DDR5-4800 RDIMM 1Rx4	32 GB	4800	RDIMM	1Rx4	40
MTC20F2085S1RC56BR	Micron DDR5-5600 RDIMM 2Rx8	32 GB	5600	RDIMM	2Rx8	46
MTC20F1045S1RC56BR	Micron DDR5-5600 RDIMM 1Rx4	32 GB	5600	RDIMM	1Rx4	46

▶ Motherboard

- Supermicro H13SSL-NT / Supermicro H13SSL-N:

    - Form Factor: ATX
    - LAN: N: 2x 1 Gbps LAN; NT: 2x 10 Gbps
    - 12 DDR5 slots,
    - up to 3TB RAM support, and
    - robust PCIe layout for multi-GPU.
    - CPU: AMD EPYC™ 9004 series Processors
        - Single Socket SP5 supported, CPU TDP supports Up to 400W TDP
    - System Memory
        - Memory Capacity: 12 DIMM slots
        - Up to 3TB 3DS ECC Registered RDIMM, DDR5-4800MHz
    - Memory Type: 4800 MT/s ECC DDR5 RDIMM (3DS)
        - Up to 256GB of memory with speeds of up to 4800MHz (1DPC)
    - DIMM Sizes: 16GB, 24GB, 32GB, 40GB, 48GB, 64GB, 80GB, 96GB, 128GB, 192GB, 256GB
    - Memory Voltage: 1.1V
    - Network Controllers: Dual LAN with Broadcom BCM57416 10GBase-T
    - Input / Output
        - SATA: 8 SATA3 (6Gbps) port(s)
        - LAN: 1 RJ45 Dedicated IPMI LAN port

- USB: 6 USB 3.0 port(s) (4 USB; 2 via header)
          - Video Output: 1 VGA port(s)
          - Serial Port: 1 COM Port(s) (1 header)
          - TPM: 1 TPM Header
          - Others
              - 1 MCIO (PCIe 5.0 x8/SATA3) Port(s)
              - 2 MCIO (PCIe 5.0 x8) Port(s)
      - Expansion Slots
          - PCIe
              - 3 PCIe 5.0 x16 (in x16 slot),
              - 2 PCIe 5.0 x8
          - M.2
              - M.2 Interface: 2 SATA/PCIe 4.0 x4
              - Form Factor: 2280/22110
              - Key: M-Key
      - Widely used in community for stable performance (Newegg.com).

- ASRock Rack GENOAD8QM3-2T/BCM:

      - Not suitable: **Only 8 DIMM slots (1DPC)**

- ASRock Rack GENOAD8UD-2T/X550:

      - Not suitable: **Only 8 DIMM slots (1DPC)**

- ASRock Rack GENOAD24QM3-2L2T/BCM

      - EEB (12" x 14")
      - Single Socket SP5 (LGA 6096), supports AMD EPYC™ 9005*/9004 (with AMD 3D V-Cache™ Technology) and 97x4 series processors
      - 24 DIMM slots (2DPC), supports DDR5 RDIMM, RDIMM-3DS
      - 2 PCIe5.0 x16
      - 7 MCIO (PCIe5.0 x8), 2 MCIO (PCIe5.0 x8 or 8 SATA 6Gb/s)
      - Supports 2 M.2 (PCIe5.0 x4)

- GIGABYTE MZ33-AR0

      - Form Factor: E-ATX, 305 x 330
      - CPU
          - AMD EPYC™ 9005 Series Processors
          - AMD EPYC™ 9004 Series Processors
          - Single processor, cTDP up to 400W
      - Socket: 1 x LGA 6096 Socket SP5
      - Memory
          - 24 x DIMM slots, DDR5 memory supported
          - 12-Channel memory per processor
          - AMD EPYC™ 9005:
              - RDIMM: Up to 4800 MT/s (1DPC)
              - RDIMM: Up to 4000 MT/s (1R 2DPC), 3600 MT/s (2R 2DPC)
          - AMD EPYC™ 9004:

- RDIMM: Up to 4800 MT/s (1DPC), 3600 MT/s (2DPC)
  - LAN: 2 x 10Gb/s LAN (1 x Broadcom® BCM57416)
    - Support NCSI function
    - 1 x 10/100/1000 Mbps Management LAN
  - Storage Interface
    - MCIO:
      - 2 x MCIO 8i for 4 x Gen5 NVMe or 16 x SATA
      - 4 x MCIO 8i for 8 x Gen5 NVMe
      - 1 x MCIO 8i for 2 x Gen4 NVMe
    - M.2:
      - 1 x M.2 (2280/22110), PCIe Gen4 x4
    - RAID: N/A

- GIGABYTE MZ33-CP1

  - Single AMD EPYC™ 9005/9004 Series Processors
  - 12-Channel DDR5 RDIMM, 12 x DIMMs
  - 2 x 1Gb/s LAN ports via Intel® I210-AT
  - 4 x MCIO 8i connectors with PCIe Gen5 x8 interface
  - 2 x MCIO 8i connectors with PCIe Gen4 x8 or SATA interface
  - 1 x M.2 slot with PCIe Gen3 x4 interface
  - 3 x PCIe Gen5 x16 expansion slots
  - 1 x PCIe Gen4 x16 expansion slot
  - 1 x OCP NIC 3.0 PCIe Gen5 x16 slot
  - Memory
    - 12 x DIMM slots
    - DDR5 memory supported
    - 12-Channel memory per processor
    - AMD EPYC™ 9005: RDIMM: Up to 6400 MT/s
    - AMD EPYC™ 9004: RDIMM: Up to 4800 MT/s

- GIGABYTE MZ73-LM2

  - Dual AMD EPYC™ 9005/9004 Series Processors
  - 12-Channel DDR5 RDIMM, 24 x DIMMs
  - 2 x 10Gb/s LAN ports via Broadcom® BCM57416
  - 2 x MCIO 8i connectors with PCIe Gen5 x8 or SATA interface
  - 1 x SlimSAS 4i connector with SATA interface
  - 1 x M.2 slot with PCIe Gen5 x4 interface
  - 4 x PCIe Gen5 x16 expansion slots
  - E-ATX form factor, includes
  - multiple PCIe 5 slots (x16) spaced for GPUs.
  - Reddit warns of interference issues between memory and GPU slots on some layouts - ASRock GENOA variants often preferred (Reddit).
  - ServeTheHome forum post:

    > GigaByte MZ73-LM2 Rev. 3.x E-ATX: as well as its predecessors have the famous ""WAIT FOR CHIPSET TO INITIALIZE"" issue and the Gigabyte support that let's you down.

- Asus K14PA-U12

    - Form Factor: CEB, 12" x 10.5"

    - Processor / System Bus 1 x Socket SP5 (LGA 6096)

    - AMD EPYC™ Genoa Processor (up to 400W)

    - Memory

        - Total Slots: 12 (12-channel, 1-DIMM per Channel)

        - Capacity:Maximum up to 3TB

        - Memory Type: DDR5 4800 RDIMM/3DS RDIMM

        - Memory Size: 256GB, 128GB, 96GB, 64GB, 48GB, 32GB, 24GB, 16GB (RDIMM) (RDIMM)

            - Please refer to www.asus.com for latest memory AVL update

    - Expansion Slots:

        - Total Slot : 3

        - 3 x PCIe 5.0 (x16 link, FL)

    - Storage

        - M.2: 1 x M.2 (PCIe Gen5x4, support 2280) (SATA Mode support)

        - MCIO

            - 6 x MCIO connector (PCIe Gen5x8), support 12 x NVMe drives

            - 2 x MCIO connector (PCIe Gen5x8), support 16 x SATA drives or 4 x NVMe drives

    - Networking: 2 x SFP28 25Gb/s (Broadcom BCM57414B1KFSBG) +1 x Mgmt LAN

    - On Board I/O

        - 1 x USB 3.2 Gen1 header (2 port for front panel)

        - 1 x USB 3.2 Gen1 port (1 port Type-A vertical)

        - 1 x Serial port header

        - 6 x FAN header (4-pin)

        - 1 x TPM header

        - 1 x Chassis Intruder header (2-pin)

    - Reddit thread:

        > I use Asus K14PA-U12.
        >
        > - Pros:
        >   - 12 RAM slots
        >   - 8 MCIO connectors (PCIe Gen5 x8)
        >   - 3 x PCIe Gen5 x16
        >   - 1 x M.2 (PCIe Gen5 x4)
        >   - dual 25 Gbps SFP28
        >   - price is ~700 USD
        >   - overclocking settings in BIOS
        >   - relatively compact form factor
        > - Cons:
        >   - they don't plan to release BIOS upgrade for Epyc Turin (I asked)

▶ SSD

- Supported SSDs may be limited by the motherboard's qualified vendor list (QVL)
- Samsung 990 PRO 4TB (MZ-V9P4T0BW)
- MBD-H13SSL-NT compatible SSD list

Part Number	Manufacturer	Manufacturer Part #	Capacity	Description
HDS-M2N4-400G0-E3-TXD-NON-080	Micron	MTFDKBA400TFS-1BC1ZABYY	400GB	Micron 7450 MAX 400GB NVMe PCIe 4.0 3D TLC M.2 22x80 mm, 3DWPD
HDS-M2N4-480G0-E1-T1E-OSE-080	Micron	MTFDKBA480TFR-1BC15ABYY	480GB	Micron 7450 PRO 480GB NVMe PCIe 4.0 M.2 22x80mm TCG Opal 2.0, 1DWPD
HDS-M2N4-480G0-E1-TXD-NON-080	Micron	MTFDKBA480TFR-1BC1ZABYY	480GB	Micron 7450 PRO 480GB NVMe PCIe 4.0 M.2 22x80mm 3D TLC, 1DWPD
HDS-M2N4-800G0-E3-TXD-NON-080	Micron	MTFDKBA800TFS-1BC1ZABYY	800GB	Micron 7450 MAX 800GB NVMe PCIe 4.0 M.2 22x80 mm, 3DWPD 3D TLC
HDS-M2N4-960G0-E1-TXE-OSE-080	Micron	MTFDKBA960TFR-1BC15ABYY	960GB	Micron 7450 PRO 960GB NVMe PCIe 4.0 M.2 22x80mm TCG Opal 2.0, 1DWPD
HDS-M2N4-960G0-E1-TXD-NON-080	Micron	MTFDKBA960TFR-1BC1ZABYY	960GB	Micron 7450 PRO 960GB NVMe PCIe 4.0 M.2 22x80mm 3D TLC, 1DWPD
HDS-M2N4-001T9-E1-TXE-OSE-110	Micron	MTFDKBG1T9TFR-1BC15ABYY	1920GB	Micron 7450 PRO 1.9TB NVMe PCIe 4.0 M.2 22x110mm TCG Opal 2.0, 1DWPD
HDS-M2N4-001T9-E1-TXD-NON-110	Micron	MTFDKBG1T9TFR-1BC1ZABYY	1920GB	Micron 7450 PRO 1.9TB NVMe PCIe 4.0 M.2 22x110mm 3D TLC, 1DWPD
HDS-M2N4-003T8-E1-TXD-NON-110	Micron	MTFDKBG3T8TFR-1BC1ZABYY	3840GB	Micron 7450 PRO 3.8TB NVMe PCIe 4.0 M.2 22x110mm 3D TLC, 1DWPD
HDS-M2N4-960G0-E1-TXD-NON-110	Micron	MTFDKBG960TFR-1BC1ZABYY	960GB	Micron 7450 PRO 960GB NVMe PCIe 4.0 M.2 22x110mm 3D TLC, 1DWPD
HDS-M2N4-01T92-E1-T1D-SED-110	Samsung	MZ1L21T9HCLS-00A07	1920GB	Samsung PM9A3 1.9TB NVMe PCIe Gen4 V6 M.2 22x110 (1DWPD) SED
HDS-M2N4-003T8-E1-TXD-SED-110	Samsung	MZ1L23T8HBLA-00A07	3840GB	Samsung PM9A3 3.8TB NVMe PCIe Gen4 V6 M.2 22x110 (1DWPD) SED
HDS-M2N4-960G0-E1-T1D-SED-110	Samsung	MZ1L2960HCJR-00A07	960GB	Samsung PM9A3 960GB NVMe PCIe Gen4 V6 M.2 22x110M (1DWPD) SED

▶ PSU

- CPU + RAM + SSD + motherboard: ~300-500 W
- GPU:
    - NVIDIA GeForce RTX 5090: 575 W
- Total for a 2-GPU setup:
    - 500 + 2 x 575 = 1550 W
    - Headroom: 50%
    - Required power supply: 2375 W
    - Seasonic Prime PX-2200 2200W 80 PLUS Platinum
        - Total continuous power 2200 W
- Total for a 4-GPU setup:
    - 500 + 4 x 575 = 2800 W
    - Headroom: 50%
    - Required power supply: 4200 W

▶ Chassis

- Review: (Gamers Nexus - Best PC Cases of 2022 - Best Thermals (Fractal Torrent))
- Fractal Design Torrent
    - Expansion slots: 7
    - Front interface: 1x USB 3.2 Gen 2x2 Type-C (20 Gbps), 2x USB 3.0, HD Audio
    - Total fan mounts: 7x 120/140 mm or 4x 180 mm

- Front fan: 3x 120/140 mm or 2x 180 mm (2x Dynamic GP-18 included in standard version, 2x Prisma AL-18 included in RGB version)
- Rear fan: 1x 120/140 mm
- Bottom fan: 3x 120/140 mm or 2x 180 mm (3x Dynamic GP-14 PWM included in standard version, 3x Prisma AL-14 PWM included in RGB version)
- Dust filters: Front, Bottom
- Fixed cable straps: Yes
- Cable routing grommets: Yes
- Tool-less push-to-lock: Both side panels
- Captive thumbscrews: HDD brackets, SSD brackets, Top panel, Bottom fan bracket
- Left side panel: Steel or Tempered glass (RGB version: Tempered glass only)
- Right side panel: Steel or Tempered glass (Solid/White RGB: Steel, TG/Black RGB: Tempered Glass)
- Compatibility:
  - Motherboard: E-ATX / ATX / mATX / ITX / SSI-EEB / SSI-CEB
  - Power supply: ATX
  - PSU max length: 230 mm
  - GPU max length: 461 mm total, 423 mm with front fan mounted
  - CPU cooler max height: 188 mm
  - Front radiator: Up to 360/420 mm, including 360x180 mm
  - Rear radiator: Up to 120/140 mm
  - Bottom radiator: Up to 360/420 mm (458 mm max length)
  - Cable routing space: 32 mm
- Dimensions:
  - Case dimensions (LxWxH): 544 x 242 x 530 mm
  - Case dimensions w/o feet/protrusions/screws: 525 x 242 x 495 mm
  - Net weight: 11.1 kg (Solid: 10.4 kg, White TG: 10.8 kg)
  - Package dimensions (LxWxH): 640 x 343 x 674 mm
  - Gross weight: 13.7 kg (Solid: 13 kg, White TG: 13.4 kg)

- SilverStone SETA H2
  - Model No.: SST-SEH2-B
  - Material: Steel
  - Motherboard support: SSI-EEB, SSI-CEB, Extended ATX, ATX, Micro-ATX, Mini-ITX
  - Drive bays:
    - Internal: 3.5"/2.5" x 11, 3.5" x 1 / 2.5" x 2, 2.5" x 2
  - Cooling system:
    - Front: 120mm x 3 / 140mm x 3
    - Rear: 120mm x 1 / 140mm x 1
    - Top: 120mm x 3 / 140mm x 3 / 160mm x 2
    - Side: 120mm x 2
  - Radiator support:
    - Front: 120mm / 140mm / 240mm / 280mm / 360mm / 420mm
    - Rear: 120mm / 140mm
    - Top: 120mm / 140mm / 240mm / 280mm / 360mm / 420mm
    - Side: 120mm / 240mm
  - CPU cooler height limit: 188mm
  - Expansion slots: 8

- Expansion card length limit:
    - 428.9mm (with front 25mm thickness fans installed)
    - 330mm (with side radiator & fans installed)
- Power supply: Standard PS2 (ATX)
    - PSU length limit: 220mm
- Front I/O ports:
    - USB Type-C x 1
    - USB 3.0 x 2
    - Combo Audio x 1
- Dimensions: 244.9mm (W) x 528.3mm (H) x 543.2mm (D), 70.28 liters
    - 9.64" (W) x 20.8" (H) x 21.39" (D), 70.28 liters
- See also Level1Techs: Our DUAL RTX 5090 Silverstone MADNESS Build: Part 1!

- SuperChassis 747BTQ-R2K04B
    - 8x 3.5" SAS/SATA Backplane for Hot-Swappable Drives (Support SES2)
    - 11x Full-Height, Full-Length Expansion Slots Optimized for 4x Double Width GPU Solution
    - (2x) Rear Additional 80mm PWM Fans & (4x) Middle Lower 92mm PWM Fans
    - 4U / Full Tower Chassis Supports max. Motherboard, Sizes – E-ATX 15.2" x 13.2"/ ATX/Micro ATX
    - 2000W Redundant Titanium Level Certified High-Efficiency Power Supply
    - 3x 5.25" External HDD Drive Bays & 8x 3.5" Hot-Swappable HDD Drives
    - Form Factor: 4U tower/rachmount chassis - supports for maximum motherboard sizes: 15.2" x 13.2"
    - Processor Support: Dual and Single Intel® and AMD processors
    - Systems Cooling Fans
        - 2x 80mm Hot-swap PWM Fans
        - 4x 92mm hot-swap fan(s)
    - Power Supply: 1U 2000W Titanium Redundant Power Supply W/PMbus

- Fractal Design Define 7
    - Total fan mounts: 9 x 120/140 mm
    - Front fan: 3 x 120/140 mm (2 x Dynamic X2 GP-14 included)
    - Top fan: 3 x 120/140 mm
    - Rear fan: 1 x 120/140 mm (1 x Dynamic X2 GP-14 included)
    - Bottom fan: 2 x 120/140 mm
    - GPU max length:
        - Storage layout: 290 mm
        - Open layout: 470 mm (445 mm w/ front fan)
    - CPU cooler max height: 185 mm
        - OK with Noctua NH-D15 G2 CPU cooler
    - Front radiator: Up to 360/280 mm
    - Top radiator: Up to 360/420 mm
    - Rear radiator: 120 mm
    - Vertical GPU Support (with Flex B-20 or Flex VRC-25): 65mm total clearance, standard 2-slot GPU (<38mm thickness) recommended for optimum cooling
    - Case dimensions (LxWxH): 547 x 240 x 475 mm
- A 4U chassis cannot accommodate the NVIDIA RTX PRO 6000 Blackwell Desktop version. The card is 137 mm high, but the power connector is located at the top. The RTX 4090 is the same height, and the power connector is also located on the top. The Squeezing an RTX 4090 into the 4u Rosewell Server Chassis video demonstrates that even though the card itself fits into the chassis, the protruding power connector prevents mounting the lid.

▶ GPU

- AM5/X870E platforms split the CPU PEG lanes to x8/x8 for dual GPUs; x16/x16 isn't available.
- Physical fit: most RTX 5090 cards are 3–3.5-slot wide. Fitting two often requires:
  - A case with 8+ expansion slots and generous bottom clearance
  - Motherboard slot spacing that leaves at least 3 full slots between x16_1 and x16_2
- Power: plan for a high-end PSU (typically 1600–2000W) and adequate 12V-2×6 connectors; some boards (e.g., MSI GODLIKE) include a supplemental PCIe slot power header that helps stability with dual GPUs.
- No SLI/NVLink for 5090; dual-GPU is for compute (CUDA/ML), not gaming AFR.

Prices

▶ CPU prices

- AMD EPYC Zen 4 / Zen 5 processors with a TDP of less than 300 W

  - Zen 4:

    - Below 300 W: 9354, 9354P, 9454, 9454P, 9534, 9634
    - Above 300 W: 9174F, 9184X, 9274F, 9374F, 9384X, 9474F, 9554, 9554P, 9654, 9654P, 9684X, 9734, 9754, 9754S

Processor Model	Listed Price[EUR]
Below 300 W	
9354 ←	2800
9354P	2290
9454	2280
9454P	2070
9534 ←	1880
9634	4900
Above 300 W	
9174F	2700
9184X ←	4150
9274F	1630
9374F	2460
9384X ←	4990
9474F	3930
9554	2010
9554P	2690
9654	2290
9654P	2330
9684X ←	5290
9734	2550
9754 ←	7220

  - Zen 5:

    - Below 300 W: 9355P, 9355, 9365, 9455P, 9455, 9535
    - Above 300 W: 9175F, 9275F, 9375F, 9475F, 9555, 9555P, 9565

Processor Model	Approx. Price[EUR]

Processor Model	Approx. Price[EUR]
Below 300 W	
9355P	3560
9355 ←	2920
9365	3410
9455P	3890
9455	3980
9535	5920
Above 300 W	
9175F	2820
9275F	2850
9375F	5320
9475F ←	4230
9555	5820
9555P	5230
9565	5970
9575F	7100
9645	6920
9655	6070
9655P	7570
9745	— Not found —
9825	— Not found —
9845	— Not found —

▶ CPU cooler prices

- Arctic Freezer 4U-SP5: 70 EUR

▶ RAM prices

- Vendors:

    - [Micron RDIMM memory part catalog](#)

- Requirement:

    - DDR5 RDIMM 1Rx4 or 2Rx8

- For 1-CPU architecture: 12 x 32 GB RDIMM 1Rx4 or 2Rx8 (384 GB in total)

    - Candidates:

        - 12 x Micron RDIMM DDR5 32GB 2Rx8 6400MHz PC5-51200 ECC REGISTERED | MTC20F2085S1RC64BR: 12 x 180 = 2100 EUR
        - 12 x Micron 32GB DDR5 4800MHz MTC20F2085S1RC48BR: 12 x 200 = 2400 EUR
        - 12 x Samsung 32GB DDR5 5600MHz M321R4GA3PB0-CWM: 12 x 200 = 2400 EUR
        - 12 x M321R4GA0BB0-CQK: 12 x 316 = 3800 EUR
        - 12 x M321R4GA3BB6-CQK: 12 x 255 = 3000 EUR
        - 12 x M329R4GA0BB0-CQK
        - Kingston

- KSM48R40BD8-32HA
- KSM48R40BD8-32MD
- KSM56R46BD8-32MD
- KSM56R46BD8PMI-32MDI
- KSM64R52BD8-32MD
        - Samsung
            - M321R4GA0BB0-CQK
            - M321R4GA3BB6-CQK
            - M321R4GA3EB0-CWM
            - M321R4GA3PB0-CWM
        - Micron
            - MTC20F2085S1RC48BR (32 GB, DDR5 4800 MHz)

- For 2-CPU architecture:

    - 24 x Kingston 16GB DDR5 4800MHz KSM48E40BS8KI-16HA: 24 x 100 = 2400 EUR

▶ SSD prices

- Samsung 990 PRO 4TB (MZ-V9P4T0BW): 300 EUR

▶ Motherboard prices

- CEB:
    - Asus K14PA-U12: 800 EUR
- ATX:
    - Supermicro MBD-H13SSL-NT-O: 830 EUR
    - GIGABYTE MZ33-AR0: 1100 EUR

▶ PSU prices

- Seasonic Prime PX-2200 2200W 80 PLUS Platinum: 630 EUR

▶ Chassis prices

- Fractal Design Torrent: 240 EUR
- SilverStone H1 SST-SEH1B-G: 210 EUR

▶ Vendor sites

- https://geizhals.eu/

Links

▶ Links

- [Reddit discussion](#) on building an 8x 4090 configuration

    > I've built much the same thing here with 8x 4090, only mine lives in an open air mining frame I designed and I used ROME2D32GM-2T motherboard as I didn't see any point in Genoa when none of the cards can use PCIe Gen5. My configuration is:
    >
    > - Mobo: ASRockRack ROME2D32GM-2T
    > - CPU: 2x AMD Epyc 7443

- CPU Cooler: 2x Noctua NH-U14S TR4-SP3

- Memory: 8x Samsung M393A4K40EB3-CWE

- GPU: 8x MSI GeForce RTX 4090 Gaming X Slim

- GPU adapters: 8x C-Payne SlimSAS PCIe gen4 Device Adapter x8/x16

- GPU cable set 1: 8x C-Payne SlimSAS SFF-8654 8i cable - PCIe gen4

- GPU cable set 2: 8x C-Payne SlimSAS SFF-8654 to SFF-8654LP (Low Profile) 8i cable - PCIe gen4

- PSU: 4x Thermaltake Toughpower GF3 1650W

- Boot drive: Samsung SSD 990 PRO 2TB, M.2 2280

- Data drives: 4x Samsung SSD 990 PRO 4TB, M.2 2280

- Data drive adapter: C-Payne SlimSAS PCIe gen4 Device Adapter x8/x16

- Data drive breakout: EZDIY-FAB Quad M.2 PCIe 4.0/3.0 X16 Expansion Card with Heatsink

- Data drive cable set: 2x C-Payne SlimSAS SFF-8654 to SFF-8654LP (Low Profile) 8i cable - PCIe gen4

- Case: Custom open air miner frame built from 2020 alu extrusions

- Smallest RTX Pro 6000 rig | OVERKILL

  - Low profile (quiet) Noctua fans: https://amzn.to/4nlXWM4

  - Water CPU cooler: https://amzn.to/4nDQUbj

  - New tiny case NR200P V3: https://amzn.to/4lnMROM

  - Extremely fast NVMe SSD: https://amzn.to/4kzaCCn

  - AMD CPU: https://amzn.to/3IkD7pV

  - Fast RAM: https://amzn.to/40Dyr4z

  - Mini-ITX Motherboard with EVERYTHING!: https://amzn.to/4eIVgd6

  - Tiny 1000W power supply: https://amzn.to/4lF471z

  - RTX Pro 6000 GPU: https://amzn.to/4eIUnRZ

- Building an Efficient GPU Server with NVIDIA GeForce RTX 4090s/5090s

  - Server model: ASUS ESC8000A-E12P

  - GPUs: 8x NVIDIA RTX 4090

  - CPU: 2x AMD EPYC 9254 Processor (24-core, 2.90GHz, 128MB Cache)

  - RAM: 24x 16GB PC5-38400 4800MHz DDR5 ECC RDIMM (384GB total)

  - Storage: 1.92TB Micron 7450 PRO Series M.2 PCIe 4.0 x4 NVMe SSD (110mm)

  - Operating system: Ubuntu Linux 22.04 LTS Server Edition (64-bit)

  - Networking: 2 x 10GbE LAN ports (RJ45, X710-AT2), one utilized at 10Gb

  - Additional PCIe 5.0 card: ASUS 90SC0M60-M0XBN0

Light server

Light server configuration

- Supports 2x NVIDIA RTX PRO 6000 Blackwell (96GB) Desktop GPUs with open-air cooling
- Theoretical maximum RAM bandwidth of 115.2 GB/s
- Suggested processors: AMD EPYC 8224P, 8124P (8024P if 67.6 GB/s memory bandwidth is tolerable)
- Suggested motherboards: ASRock Rack SIENAD8-2L2T.
    - Maybe GIGABYTE ME03-PE0 if using one x16 slot at PCIe 4.0.
    - Maybe ASUS S14NA-U12 if using MCIO extension.

Component	Model	Price each [EUR]	Price subtotal [EUR]
CPU	AMD EPYC 8224P (Zen 4)	1000	1000
RAM	Micron 64GB DDR5 4800MHz MTC40F2046S1RC48BA1R × 6	400	2450
SSD	Samsung PM9A3 1.9TB NVMe PCIe Gen4 V6 M.2 22x110	320	640
Motherboard	ASRock Rack SIENAD8-2L2T	790	790
CPU cooler	BE QUIET! Silent Loop 3 360mm Liquid cooler	150	150
PSU	Seasonic Prime PX-2200 2200W 80 PLUS Platinum	530	530
Chassis	Corsair iCUE 9000D RGB Airflow Big-Tower	660	660
Fans	Noctua NF-F12 iPPC-3000 Industrial PWM 120mm × 13	30	420
Total			**6640**

Specs

▶ CPU: AMD EPYC 8004 (SP6 socket)

- Minimum 6 x DDR5 4800 MT/s RAM
    - RAM module side memory bandwidth:
        - 1-CPU config: 6 x 8 x 4.8 GT/s = 230.4 GB/s
    - CPU side memory bandwidth:
        - Zen 4:
            - 4 CCD x 32 x 1.8 GHz = 230.4 GB/s
            - 2 CCD x 32 x 1.8 GHz = 115.2 GB/s
            - 1 CCD x 32 x 1.8 GHz = 67.6 GB/s
- Zen 4:
    - 96 PCIe 5.0 lanes (5 x PCIe 5.0 x16 + 2x PCIe 5.0 x8)
- CPU candidates which support PCIe 5.0 x16:

- AMD EPYC 8004 series processors

MODEL	CORES	THREADS	BASE FREQ. (GHZ)	UP TO MAX BOOST FREQ. (GHZ)^A	ALL-CORE BOOST (GHZ)^B	DEFAULT TDP (W)	CONFIGURABLE TDP (W)	L3 CACHE (MB)	DDR5 CHANNELS	UP TO MAX DDR5 MT/S (1DPC)	PER-SOCKET THEORETICAL MEMORY BANDWIDTH (GB/S)	PCIE® GEN 5 LANES	2P/1P
8534P	64	128	2.30	3.10	3.10	200	155–255	128	6	4800	230.4	96	1P
8434P	48	96	2.50	3.10	3.10	200	155–225	128	6	4800	230.4	96	1P
8324P	32	64	2.65	3.00	3.00	180	155–225	128	6	4800	230.4	96	1P
8224P	24	48	2.55	3.00	3.00	160	155–225	64	6	4800	230.4	96	1P
8124P	16	32	2.45	3.00	2.95	125	120–150	64	6	4800	230.4	96	1P
8024P	8	16	2.40	3.00	2.95	90	70–100	32	6	4800	230.4	96	1P
NEBS-FRIENDLY PROCESSORS													
8534PN	64	128	2.00	3.10	3.05	175	–	128	6	4800	230.4	96	1P
8434PN	48	96	2.00	3.00	3.00	155	–	128	6	4800	230.4	96	1P
8324PN	32	64	2.05	3.00	3.00	130	–	128	6	4800	230.4	96	1P
8224PN	24	48	2.00	3.00	2.90	120	–	64	6	4800	230.4	96	1P
8124PN	16	32	2.00	3.00	2.90	100	–	64	6	4800	230.4	96	1P
8024PN	8	16	2.05	3.00	2.95	80	–	32	6	4800	230.4	96	1P

  - 1 CCD, 67.6 GB/s: 8024P
  - 2 CCDs, 115.2 GB/s: 8124P, 8224P
  - 4 CCDs, 230.4 GB/s: 8324P, 8434P, 8534P
- Suggested picks: AMD EPYC 8224P, 8324P

▶ Motherboard

- ASRock Rack SIENAD8-2L2T (Review)
  - 8 DIMM slots (2DPC/1DPC), supports DDR5 RDIMM
  - 3 PCIe5.0 / CXL1.1 x16, 1 PCIe5.0 x16, 1 PCIe5.0 x8
  - 2 MCIO (PCIe5.0 x8)
  - 2 M.2 (PCIe5.0 x4)
  - Memory QVL

Type	Speed	DIMM	Size	Vendor	Module	Part No	Cell
DDR5	5600	RDIMM	128GB	Micron	MTC40F2047S1RC56BB1QLFF	4FB7DD8GDF	Micron
DDR5	4800	RDIMM	96GB	Micron	MTC40F204WS1RC48BB1IGFF	3LB75D8DHL	Micron
DDR5	4800	RDIMM	96GB	Samsung	M321RYGA0BB0-CQKZJ	K4RHE046VBBCQK	Sec
DDR5	4800	RDIMM	64GB	Micron	MTC40F2046S1RC48BA1GCCH	IQA45D8BNH	Micron
DDR5	4800	RDIMM	64GB	Micron	MTC40F2046S1RC48BA1FICC	3HA45D8BNH	Micron
DDR5	4800	RDIMM	64GB	SMART	SR8G8RD5445-SB	K4RAH046VBBCQK	Sec
DDR5	4800	RDIMM	32GB	Micron	MTC20F2085S1RC48BA1NGCC	3FA45D8BNJ	Micron
DDR5	4800	RDIMM	32GB	Micron	MTC20F1045S1RC48BA2HCCH	IQA45D8BNH	Micron
DDR5	4800	RDIMM	32GB	Samsung	M321R4GA0BB0-CQKET	K4RAH046VBBCQK	Sec
DDR5	4800	RDIMM	16GB	SMART	SR2G8RD5285-SB	K4RAH086VBFCQK	Sec

  - **This motherboard is a viable choice**

- [GIGABYTE ME03-PE0](#)
    - 3 x PCIe Gen5 x16 expansion slots
    - 4 x PCIe Gen4 x16 and x8 expansion slots
    - **Not optimal: Need to use one PCIe 5.0 x16 and one PCIe 4.0 x16 slot**
    - [Qualified Vendor List](#)
- [ASRock Rack SIENAD8UD3](#)
    - 2 PCIe5.0 / CXL1.1 x16
    - **Not suitable: PCIe slots are too close to each other**
- [ASRock Rack SIENAD8UD2-2Q](#)
    - 2 PCIe5.0 / CXL1.1 x16, 1 PCIe5.0 / CXL1.1 x8
    - **Not suitable: PCIe slots are too close to each other**
- [ASRock Rack SIENAD8UD-2L2Q](#)
    - 2 PCIe5.0 / CXL1.1 x16, 1 PCIe5.0 / CXL1.1 x8,
    - **Not suitable: PCIe slots are too close to each other**
- [ASUS S14NA-U12](#)
    - 2 x PCIe 5.0 x 16 slot (x16 link, FL)
    - 1 x PCIe 5.0 x 8 slot (x8 link, FL)
    - **Not suitable: PCIe slots are too close to each other**
- [Advantech ASMB-561](#)
    - Four PCIe Gen5 x16 slots with CXL support on slot 4/6
    - **Possible candidate**

▶ CPU cooler

- [Noctua NH-D9 TR5-SP6 4U](#)
    - [Specification](#)
    - [CPU compatibility](#): OK
    - The NH-D9's direction of airflow is parallel to the long axis of the socket, so it is ideal for builds where the hot air is exhausted this way.
    - Height (with fan): 134 mm
    - Max. airflow: 96,3 m³/h
    - Max. acoustical noise: 30,6 dB(A)

▶ Chassis

- Review: ([Gamers Nexus - Best PC Cases of 2022 - Best Thermals (Fractal Torrent)](#))
- [Fractal Design Torrent](#)
    - Expansion slots: 7
    - Front interface: 1x USB 3.2 Gen 2x2 Type-C (20 Gbps), 2x USB 3.0, HD Audio
    - Total fan mounts: 7x 120/140 mm or 4x 180 mm
    - Front fan: 3x 120/140 mm or 2x 180 mm (2x Dynamic GP-18 included in standard version, 2x Prisma AL-18 included in RGB version)
    - Rear fan: 1x 120/140 mm
    - Bottom fan: 3x 120/140 mm or 2x 180 mm (3x Dynamic GP-14 PWM included in standard version, 3x Prisma AL-14 PWM included in RGB version)
    - Dust filters: Front, Bottom
    - Fixed cable straps: Yes
    - Cable routing grommets: Yes

- - Tool-less push-to-lock: Both side panels
  - Captive thumbscrews: HDD brackets, SSD brackets, Top panel, Bottom fan bracket
  - Left side panel: Steel or Tempered glass (RGB version: Tempered glass only)
  - Right side panel: Steel or Tempered glass (Solid/White RGB: Steel, TG/Black RGB: Tempered Glass)
  - Compatibility:
    - Motherboard: E-ATX / ATX / mATX / ITX / SSI-EEB / SSI-CEB
    - Power supply: ATX
    - PSU max length: 230 mm
    - GPU max length: 461 mm total, 423 mm with front fan mounted
    - CPU cooler max height: 188 mm
    - Front radiator: Up to 360/420 mm, including 360x180 mm
    - Rear radiator: Up to 120/140 mm
    - Bottom radiator: Up to 360/420 mm (458 mm max length)
    - Cable routing space: 32 mm
  - Dimensions:
    - Case dimensions (LxWxH): 544 x 242 x 530 mm
    - Case dimensions w/o feet/protrusions/screws: 525 x 242 x 495 mm
    - Net weight: 11.1 kg (Solid: 10.4 kg, White TG: 10.8 kg)
    - Package dimensions (LxWxH): 640 x 343 x 674 mm
    - Gross weight: 13.7 kg (Solid: 13 kg, White TG: 13.4 kg)

Workstation

Workstation configuration

- Supports 2x NVIDIA RTX PRO 6000 Blackwell (96GB) Desktop GPUs with open-air cooling
- Theoretical maximum RAM bandwidth of 204.8 GB/s
- Suggested processors: AMD Ryzen Threadripper 9960X, 7960X

Component	Model	Price each [EUR]	Price subtotal [EUR]
CPU	AMD Ryzen Threadripper [9960X][cpu_tr_9960x] (Zen 5)	1790	1790
RAM	KSM64R52BD8-32HA, 32GB 6400MT/s DDR5 ECC Reg CL52 DIMM 2Rx8 Hynix A × 8	230	1900
SSD	Samsung 9100 PRO, PCIe 5.0, NVMe 2.0, 2TB M.2 SSD × 2	270	540
Motherboard	Gigabyte MB Sc Sc sTR5 TRX50 AI TOP, AMD TRX50, 8xDDR5, WI-FI, E-ATX	1020	1020
CPU cooler	BE QUIET! Silent Loop 3 360mm Liquid cooler	150	150
PSU	Seasonic Prime PX-2200 2200W 80 PLUS Platinum	530	530
Chassis	Corsair iCUE 9000D RGB Airflow Big-Tower	660	660
Fans	Noctua NF-F12 iPPC-3000 Industrial PWM 120mm × 13	30	420
Total			**7010**

Specs

▶ CPU: AMD Ryzen Threadripper / Threadripper Pro (sTR5 socket)

- PCIe 5.0 lanes:

  - Required: 2x PCIe 5.0 x16 = 32

- Zen 4 provides 48 PCIe 5.0 lanes, Zen 5 128 PCIe 5.0 lanes
    - Either is fine

- Zen 4 Threadripper:

    - RAM module side memory bandwidth: 4 x 8 x 5.2 GT/s = 166.4 GB/s
    - CPU side memory bandwidth: 4 CCD x 32 x 1.8 GHz = 230.4 GB/s
        - Minimum 4 CCD is required to saturate the RAM
    - CPU candidates: AMD Ryzen Threadripper 7960X, 7970X, 7980X

- Zen 4 Threadripper Pro:

    - RAM module side memory bandwidth: 8 x 8 x 5.2 GT/s = 332.8 GB/s
    - CPU side memory bandwidth: 8 CCD x 32 x 1.8 GHz = 460.8 GB/s
        - Minimum 8 CCD is required to saturate the RAM
    - CPU candidates: AMD Ryzen Threadripper Pro 7985WX, 7995WX

- Zen 5 Threadripper:

    - RAM module side memory bandwidth: 4 x 8 x 6.4 GT/s = 204.8 GB/s
    - CPU side memory bandwidth: 4 CCD x 32 x 2.0 GHz = 256 GB/s
        - Minimum 4 CCD is required to saturate the RAM
    - CPU candidates: AMD Ryzen Threadripper Pro 9960X, 9970X, 9980X

- Zen 5 Threadripper Pro:

    - RAM module side memory bandwidth: 8 x 8 x 6.4 GT/s = 409.6 GB/s
    - CPU side memory bandwidth: 8 CCD x 32 x 2.0 GHz = 512 GB/s
        - Minimum 8 CCD is required to saturate the RAM
    - CPU candidates: AMD Ryzen Threadripper Pro 9985WX, 9995WX

- AMD Ryzen Threadripper CPU lineup

Arch	Branding	Model	Cores	L3 cache
Zen 5	Threadripper Pro	9995WX	96	384 MB
Zen 5	Threadripper Pro	9985WX	64	256 MB
Zen 5	Threadripper Pro	9975WX	32	128 MB
Zen 5	Threadripper Pro	9965WX	24	128 MB
Zen 5	Threadripper Pro	9955WX	16	64 MB
Zen 5	Threadripper Pro	9945WX	12	64 MB
Zen 5	Threadripper	9980X	64	256 MB
Zen 5	Threadripper	9970X	32	128 MB
Zen 5	Threadripper	9960X	24	128 MB
Zen 4	Threadripper Pro	7995WX	96	384 MB
Zen 4	Threadripper Pro	7985WX	64	256 MB
Zen 4	Threadripper Pro	7975WX	32	128 MB
Zen 4	Threadripper Pro	7965WX	24	128 MB
Zen 4	Threadripper Pro	7955WX	16	64 MB
Zen 4	Threadripper Pro	7945WX	12	64 MB
Zen 4	Threadripper	7980X	64	256 MB

Arch	Branding	Model	Cores	L3 cache
Zen 4	Threadripper	7970X	32	128 MB
Zen 4	Threadripper	7960X	24	128 MB

- Theoretical maximum memory bandwidth

    - The TRX50 motherboards supports both Threadripper and Threadripper Pro CPUs, but only 4 memory channels. (Even if 8 RDIMM modules are installed, they operate in a 4-channel configuration.)
    - The WRX90 motherboards support 8-channel memory configuration, but they support only Threadripper Pro processors. The Threadripper line is not supported.
    - This table assumes that a TRX50 motherboard is used, and calculates with 4 memory channels even for the Threadripper Pro line.

Model	CCDs	CPU BW [GB/s]	Mem ch	Mem speed	Mem BW [GB/s]	OC Mem speed	OC Mem BW	Approx. price[EUR]
9995WX	12	768.0	4(8)	6400 MT/s	204.8	8000 MT/s	256.0	
9985WX	8	512.0	4(8)	6400 MT/s	204.8	8000 MT/s	256.0	8540
9975WX	4	256.0	4(8)	6400 MT/s	204.8	7200 MT/s	230.4	4380
9965WX	4	256.0	4(8)	6400 MT/s	204.8	7200 MT/s	230.4	3070
9955WX	2	128.0	4(8)	6400 MT/s	204.8	7200 MT/s	230.4	
9945WX	2	128.0	4(8)	6400 MT/s	204.8	7200 MT/s	230.4	
9980X	8	512.0	4	6400 MT/s	204.8	8000 MT/s	256.0	5350
9970X	4	256.0 √	4	6400 MT/s	204.8	8000 MT/s √	256.0 √	2890
9960X	4	256.0 √	4	6400 MT/s	204.8	8000 MT/s √	256.0 √	1790

Model	CCDs	CPU BW [GB/s]	Mem ch	Mem speed	Mem BW [GB/s]	OC Mem speed	OC Mem BW	Approx. price[EUR]
7995WX	12	499.2	4(8)	5200 MT/s	332.8	8000 MT/s	256.0	7770
7985WX	8	460.8	4(8)	5200 MT/s	332.8	7200 MT/s	230.4	4150
7975WX	4	230.4	4(8)	5200 MT/s	332.8	7200 MT/s	230.4	2680
7965WX	4	230.4	4(8)	5200 MT/s	332.8	7200 MT/s	230.4	
7955WX	2	115.2	4(8)	5200 MT/s	332.8	7200 MT/s	230.4	
7945WX	2	115.2	4(8)	5200 MT/s	332.8	7200 MT/s	230.4	
7980X	8	460.8	4	5200 MT/s	166.4	8000 MT/s	256.0	2670
7970X	4	230.4 √	4	5200 MT/s	166.4	7200 MT/s √	230.4 √	1550
7960X	4	230.4 √	4	5200 MT/s	166.4	7200 MT/s √	230.4 √	1570

▶ RAM

- RAM module candidates for the Threadripper 9000 series CPUs, 4 x 64 = 256 GB configuration:

Speed	Supplier	Capacity	Rank	Module P/N	Chip Brand	Timing	Voltage	Native
7200	V-COLOR	64GB	2Rx8	TRA564G72D836	Hynix M	36-51-51-112	1.4V	6400
7200	V-COLOR	64GB	2Rx8	TRA564G72D836Q √	Hynix M	36-51-51-112	1.4V	6400
7200	V-COLOR	64GB	2Rx8	TRA564G72D836O	Hynix M	36-51-51-112	1.4V	6400
7200	V-COLOR	64GB	2Rx8	TRAL564G72D836	Hynix M	36-51-51-112	1.4V	6400
7200	V-COLOR	64GB	2Rx8	TRAL564G72D836Q √	Hynix M	36-51-51-112	1.4V	6400
7200	V-COLOR	64GB	2Rx8	TRAL564G72D836O	Hynix M	36-51-51-112	1.4V	6400
6400	Micron	64GB	2Rx4	MTC40F2046S1RC64BD2R	Micron	CL52	1.1V	6400
6400	V-COLOR	64GB	2Rx4	TR564G64D452	Hynix A	52-52-52-103	1.1V	6400
6400	V-COLOR	64GB	2Rx4	TR564G64D452Q √	Hynix A	52-52-52-103	1.1V	6400
6400	V-COLOR	64GB	2Rx4	TR564G64D452O	Hynix A	52-52-52-103	1.1V	6400
6400	V-COLOR	64GB	2Rx8	TRL564G64D852	Hynix M	52-52-52-103	1.1V	6400
6400	V-COLOR	64GB	2Rx8	TRL564G64D852Q	Hynix M	52-52-52-103	1.1V	6400
6400	V-COLOR	64GB	2Rx8	TRL564G64D852O	Hynix M	52-52-52-103	1.1V	6400

  - Geizhals.eu *All modules: DDR5 RDIMM 288-Pin, JEDEC PC5-51200R, Registered ECC.*

Brand	Model / P/N	Capacity	Speed	CL	Rank	ECC	Price (EUR)
Samsung	M321R8GA0EB2-CCP	64 GB	6400 MT/s	CL52	2Rx4	Sideband + On-Die	339.00
Micron	MTC40F2046S1RC64BR	64 GB	6400 MT/s	CL52-52-52	2Rx4	Sideband + On-Die	360.87
Kingston	KSM64R52BD4-64MD	64 GB	6400 MT/s	CL52-52-52	2Rx4	Sideband + On-Die	417.98
Micron	MTC40F2046S1RC64BD2R	64 GB	6400 MT/s	CL52-52-52	2Rx4	Sideband + On-Die	440.07
Kingston	KSM64R52BD4-64HA	64 GB	6400 MT/s	CL52-52-52	2Rx4	Sideband + On-Die	441.00
G.Skill	F5-6400R3644E64GQ4-T5N (Kit)	256 GB	6400 MT/s	CL36-44-44-102	4x64GB	Sideband + On-Die	1240.00

- RAM module candidates for the Threadripper 9000 series CPUs, 8 x 32 = 256 GB configuration:

Speed	Supplier	Capacity	Rank	Module P/N	Chip Brand	Timing	Voltage	Native
8000 √	V-COLOR	32GB	1Rx8	TRA532G80S842O	Hynix M	42-60-60-126	1.4V	6400
8000 √	V-COLOR	32GB	1Rx8	TRAL532G80S842O	Hynix M	42-60-60-126	1.4V	6400
7200 √	V-COLOR	32GB	2Rx8	TRA532G72D834O	Hynix A	34-45-45-96	1.35V	6400
6800	G.SKILL	32GB	—	F5-6800R3445G32GE8-ZR5NK	Hynix	34-45-45-108	1.4V	4800

Speed	Supplier	Capacity	Rank	Module P/N	Chip Brand	Timing	Voltage	Native
6800	Kingston FURY	32GB	2Rx8	KF568R34RBK8-256	Hynix A	34-44-44-105	1.4V	4800
6800	Kingston FURY	32GB	2Rx8	KF568R34RBK4-128	Hynix A	34-44-44-105	1.4V	4800
6800	Kingston FURY	32GB	2Rx8	KF568R34RB-32	Hynix A	34-44-44-105	1.4V	4800
6400	Kingston FURY	32GB	1Rx4	KF564R32RBK8-256	Hynix A	32-39-39-80	1.4V	4800
6400	Kingston FURY	32GB	1Rx4	KF564R32RBK4-128	Hynix A	32-39-39-80	1.4V	4800
6400	Kingston FURY	32GB	1Rx4	KF564R32RB-32	Hynix A	32-39-39-80	1.4V	4800

- RAM module candidates for the Threadripper 9000 series CPUs, 4 x 48 = 192 GB configuration:

Speed	Supplier	Capacity	Rank	Module P/N	Chip Brand	Timing	Voltage	Native
7200	V-COLOR	48GB	2Rx8	TRA548G72D834	Hynix M	34-45-45-96	1.35V	6400
7200	V-COLOR	48GB	2Rx8	TRA548G72D834Q	Hynix M	34-45-45-96	1.35V	6400
7200	V-COLOR	48GB	2Rx8	TRA548G72D834O	Hynix M	34-45-45-96	1.35V	6400
7200	V-COLOR	48GB	2Rx8	TRAL548G72D834	Hynix M	34-45-45-96	1.35V	6400
7200	V-COLOR	48GB	2Rx8	TRAL548G72D834Q	Hynix M	34-45-45-96	1.35V	6400
7200	V-COLOR	48GB	2Rx8	TRAL548G72D834O	Hynix M	34-45-45-96	1.35V	6400
6800	V-COLOR	48GB	2Rx8	TRA548G68D834Q	Hynix M	34-46-46-92	1.4V	4800
6800	V-COLOR	48GB	2Rx8	TRA548G68D834	Hynix M	34-46-46-92	1.4V	4800
6400	G.SKILL	48GB	—	F5-6400R3239G48GE8-ZR5NK	Hynix	32-39-39-102	1.4V	4800
6400	V-COLOR	48GB	2Rx8	TRA548G64D832Q	Hynix M	32-39-39-102	1.4V	4800
6400	V-COLOR	48GB	2Rx8	TRA548G64D832	Hynix M	32-39-39-102	1.4V	4800
6400	V-COLOR	48GB	2Rx8	TR548G64D852	Hynix M	52-52-52-103	1.1V	6400
6400	V-COLOR	48GB	2Rx8	TR548G64D852Q	Hynix M	52-52-52-103	1.1V	6400
6400	V-COLOR	48GB	2Rx8	TR548G64D852O	Hynix M	52-52-52-103	1.1V	6400
6400	V-COLOR	48GB	2Rx8	TRL548G64D852	Hynix M	52-52-52-103	1.1V	6400
6400	V-COLOR	48GB	2Rx8	TRL548G64D852Q	Hynix M	52-52-52-103	1.1V	6400
6400	V-COLOR	48GB	2Rx8	TRL548G64D852O	Hynix M	52-52-52-103	1.1V	6400

- RAM module candidates for the Threadripper 7000 series CPUs, 8 x 32 = 256 GB configuration:

Speed	Supplier	Capacity	Rank	Module P/N	Chip Brand	Timing	Voltage	Native

Speed	Supplier	Capacity	Rank	Module P/N	Chip Brand	Timing	Voltage	Native
6800	G.SKILL	32GB	2Rx8	F5-6800R3445G32GE8-ZR5NK	Hynix	34-45-45-108	1.4V	4800
6400	G.SKILL	32GB	2Rx8	F5-6400R3239G32GE8-ZR5NK	Hynix	32-39-39-102	1.4V	4800
6400	Kingston FURY	32GB	2Rx8	KF564R32RBK8-256	Hynix A	—	1.4V	4800
6400	Kingston FURY	32GB	2Rx8	KF564R32RBK4-128	Hynix A	—	1.4V	4800
6400	Kingston FURY	32GB	2Rx8	KF564R32RB-32	Hynix A	—	1.4V	4800
6400	ADATA	32GB	2Rx8	AX5R6400C3232G-B	Hynix A	32-39-39-89	1.4V	5600
6400	ADATA	32GB	2Rx8	AX5R6400C3232G-BLAR	Hynix A	32-39-39-89	1.4V	5600
6400	ADATA	32GB	2Rx8	AX5R6400C3232G-SLAR	Hynix A	32-39-39-89	1.4V	5600
6400	ADATA	32GB	2Rx8	AX5R6400C3232G-DTLAR	Hynix A	32-39-39-89	1.4V	5600
6400	V-COLOR	32GB	2Rx8	TRA532G64D832Q	Hynix A	32-39-39-102	1.4V	4800
6400	V-COLOR	32GB	2Rx8	TRA532G64D832	Hynix A	32-39-39-102	1.4V	4800

- RAM module candidates for the Threadripper 7000 series CPUs, 4 x 48 = 192 GB configuration:

Speed	Supplier	Capacity	Rank	Module P/N	Chip Brand	Timing	Voltage	Native
6800	V-COLOR	48GB	2Rx8	TRA548G68D834Q	Hynix M	34-46-46-92	1.4V	4800
6800	V-COLOR	48GB	2Rx8	TRA548G68D834	Hynix M	34-46-46-92	1.4V	4800
6400	G.SKILL	48GB	2Rx8	F5-6400R3239G48GE8-ZR5NK	Hynix	32-39-39-102	1.4V	4800
6400	V-COLOR	48GB	2Rx8	TRA548G64D832Q	Hynix M	32-39-39-102	1.4V	4800
6400	V-COLOR	48GB	2Rx8	TRA548G64D832	Hynix M	32-39-39-102	1.4V	4800

▶ Motherboard

- [Why is the Gigabyte TRX50 AI Top the Most Returned Threadripper Motherboard?](#)
- [BIGGEST AI Motherboard EVER Created & why it's THE BEST!! feat. Gigabyte TRX50 AI TOP](#)

Desktop PC

▶ Details

- 10 GB LLM model expected CPU-only performance: Prompt processing: 125 token/s, Token generation: 8 token/s
- Supports 1 PCIe x16 GPU, or 2 PCIe x8 GPUs.

Component	Model
CPU	AMD Ryzen 9 9950X3D
RAM	[G.Skill 4x64GB F5-6000J3644D64GX4-TZ5NR 256GB](#)
SSD	Samsung PM9A3 1.9TB NVMe PCIe Gen4 V6 M.2 22x110

Component	Model
Motherboard	MSI B850 Tomahawk Max Wifi
CPU cooler	Noctua NH-D15 G2
PSU	Seasonic Prime PX-2200 2200W 80 PLUS Platinum
Chassis	Fractal Design Torrent
Total	

AMD Ryzen 9 9950X3D

Specs

- CPU: AMD Ryzen 9 9950X3D (Wikipedia) (AMD) (TechPowerUp)
    - Max. Memory: 192 GB
    - Zen 5: BW_CPU = 2 CCD x 32 x 2.0 GHz = 128.0 GB/s
    - Max Memory Speed
        - 2x1R DDR5-5600
        - 2x2R DDR5-5600
        - 4x1R DDR5-3600
        - 4x2R DDR5-3600
    - Max memory bandwidth:
        - 2 modules -> 5600 MT/s -> 2 x 8 x 5.6 = 89.6 GB/s
        - 4 modules -> 3600 MT/s -> 2 x 8 x 3.6 = 57.6 GB/s
            - **Note:** This is not sufficient to saturate the PCIe 5.0 x16 lanes, which require 63 GB/s.
    - 128MB L3 cache
        - 192MB L3 cache variant is available (soon)
        - Default TDP: 170W
- RAM:
    - CPU max RAM: 192 GB
    - Motherboard: 2x/4x DDR5 DIMM slots
    - 128 GB: 360 EUR
        - RAM BW upper limit: 2 x 8 x 5.6 = 89.6 GB/s
    - 192 GB: 760 EUR
        - RAM BW upper limit: 2 channels x 8 x 3.6 MT/s = 57.6 GB/s
            - **Note:** 192 GB (vs 128 GB) system RAM will **reduce** 10 GB LLM model CPU-only token generation speed from 8 token/s down to 5 token/s maximum. Overclocking may improve a few token/s, but no substantial improvement.
            - **Note:** This practically limits the system RAM to 128 GB.
    - 256 GB may be viable, 4 modeles, at 6000 MT/s: Level1Techs: 256 GB on AM5: E-Z Mode!
        - BW_RAM = 2 ch x 8 x 8.0 MT/s = 128.0 GB/s
        - BW_RAM = 2 ch x 8 x 6.0 MT/s = 96.0 GB/s
- CPU cooler
    - Noctua NH-D15 G2
        - CPU compatibility: OK
        - Height (with fan): 168 mm
            - OK with Fractal Design Define 7 case
        - RAM clearance in dual fan mode:
            - 32mm with 140mm fan [168mm total height]

- 52mm with 120mm fan [168mm total height]
- Chipsets ([AMD doc](#)) ([TechPowerUp](#)): ([Wikipedia](#))
  - Has 24 PCIe 5.0 lanes: X870E, X870, X670E, B650E
  - Has USB 4.0: X870E, X870
  - X870E:
    - USB 4.0
    - 2 SUPERSPEED USB 20Gbps
    - PCIe 5.0 1x16 or 2x8
    - 1x4 PCIe 5.0 plus 4x PCIe GPP
- Motherboard:
  - [ASRock X870E Taichi](#)
    - [Tom's Hardware review](#)
    - E-ATX
    - 2 x PCIe 5.0 x16 Slots (PCIE1 and PCIE2), support x16 or x8/x8 modes
    - Supports DDR5 ECC/non-ECC, un-buffered memory up to 8200+(OC)*
    - Max. capacity of system memory: 256GB
    - Supports RAID 0, RAID 1 and RAID 10 for M.2 NVMe storage devices
    - 2 x 8 pin 12V Power Connectors (Hi-Density Power Connector)
    - Dual RTX 5090 readiness:
      - Supported electrically (PCIe 5.0 x8/x8 for two GPUs).
      - No supplemental PCIe slot power header is advertised; ensure robust PSU and airflow.
    - **Note:** May burn the CPU with unfortunate PBO settings
  - [ASUS ROG Crosshair X870E Hero](#)
    - Dual RTX 5090 readiness:
      - Supported electrically (x8/x8).
      - Auxiliary PCIe slot power header may vary by revision—verify in the manual; spacing/airflow are critical.
  - [ASUS ROG Crosshair X870E Extreme](#)
    - Dual RTX 5090 readiness:
      - High confidence. Flagship boards typically include an auxiliary PCIe slot power header—verify in the manual; strong pick for dual GPUs.
  - [Gigabyte X870E Aorus Xtreme AI TOP](#)
    - Dual RTX 5090 readiness:
      - High confidence. AORUS XTREME-class boards usually include an auxiliary PCIe slot power header—verify in the manual; strong pick for dual GPUs.
  - [MSI MAG X870 TOMAHAWK WIFI](#)
    - Chipset: AMD X870
    - CPU: Supports AMD Ryzen™ 9000/ 8000/ 7000 Series Desktop Processors
    - Memory:
      - 4x DDR5 UDIMM, Maximum Memory Capacity 256GB
      - Memory Support DDR5 8400 - 5600 (OC) MT/s / 5600 - 4800 (JEDEC) MT/s
      - Ryzen™ 9000 Series Processors max. overclocking frequency:
        - 1DPC 1R Max speed up to 8400+ MT/s
        - 1DPC 2R Max speed up to 6400+ MT/s
        - 2DPC 1R Max speed up to 6400+ MT/s
        - 2DPC 2R Max speed up to 6400+ MT/s

- MSI MEG X870E GODLIKE
  - Datasheet
  - E-ATX
  - 4x DDR5 UDIMM, Maximum Memory Capacity 256GB
  - Memory Support DDR5 9000 - 5600 (OC) MT/s / 5600 - 4800 (JEDEC) MT/s
  - Ryzen™ 9000 Series Processors max. overclocking frequency:
    - 1DPC 1R Max speed up to 8400+ MT/s
    - 1DPC 2R Max speed up to 6400+ MT/s
    - 2DPC 1R Max speed up to 6400+ MT/s
    - 2DPC 2R Max speed up to 6400+ MT/s
  - Supports AMD POR Speed and JEDEC Speed
  - Supports Memory Overclocking and AMD EXPO
  - Supports Dual-Channel mode
  - Supports Non-ECC, Un-buffered memory
  - Supports CUDIMM, Clock Driver bypass mode only*
  - Dual RTX 5090 readiness:
    - Yes. Includes a supplemental PCIe slot power header ("PCIe Supplemental Power"); best-in-class choice for dual high-power GPUs.
  - RAM modules supported by the MSI MEG X870E GODLIKE motherboard: https://www.msi.com/Motherboard/MEG-X870E-GODLIKE/support#mem

Vendor	Model	SPD Speed (MHz)	Supported Speed (MHz)	Voltage (V)	Sided	Size (GB)	1/2 DIM
G.SKILL	F5-6000J3644D64GX4-TR5NS	5600	6000	1.25	DUAL	64	√ √
G.SKILL	F5-6000J3644D64GX4-TZ5NR	5600	6000	1.25	DUAL	64	√ √
G.SKILL	F5-6000J3644D64GX4-FX5	5600	6000	1.25	DUAL	64	√ √
G.SKILL	F5-6000J3444F64GX4-FX5	5600	6000	1.35	DUAL	64	√ √
Kingston	KF556C40BBK2-128	4800	5600	1.25	DUAL	64	√ √
Kingston	KF556C36BBEAK2-128	4800	5600	1.25	DUAL	64	√ √
Kingston	KF556C36BBE-64	4800	5600	1.25	DUAL	64	√ √
Kingston	KF556C36BBEA-64	4800	5600	1.25	DUAL	64	√ √
Kingston	KF556C36BBEK2-128	4800	5600	1.25	DUAL	64	√ √
Kingston	KF556C40BBA-64	4800	5600	1.25	DUAL	64	√ √
Crucial	CT64G56C46U5.M16B1	5600	3600	1.1	DUAL	64	√ √
Crucial	CP64G56C46U5.M16B1	5600	3600	1.1	DUAL	64	√ √
BIWIN	OCBXL59264DW1-Q30FB	5600	**6400**	1.4	DUAL	48	√ √
ADATA(XPG)	AX5U6000C2848G-BB300X4	4800	6000	1.4	DUAL	48	√ √
ADATA(XPG)	AX5U6000C2848G-BW300X4	4800	6000	1.4	DUAL	48	√ √
KingBank	KPR548G60C28-P	4800	6000	1.4	DUAL	48	√ √
ADATA(XPG)	AX5U6000C2848G-BLABBKX4	4800	6000	1.4	DUAL	48	√ √
BIWIN	OCBXL59260DW1-Q28FB	5600	6000	1.4	DUAL	48	√ √
CORSAIR	CMH192GX5M4B5200C38 ver5.53.13	4800	5200	1.25	DUAL	48	√ √

Vendor	Model	SPD Speed (MHz)	Supported Speed (MHz)	Voltage (V)	Sided	Size (GB)	1/2 DIM
CORSAIR	CMK192GX5M4B5200C38 ver3.53.02	4800	5200	1.25	DUAL	48	√ √
KLEVV	KD5LGUD80-56G4600	5600	3600	1.1	DUAL	48	√ √
Crucial	CP48G56C46U5.C16B	5600	3600	1.1	DUAL	48	√ √
Kingston	KVR56U46BD8-48	5600	3600	1.1	DUAL	48	√ √

- SSD:
    - [Samsung 990 PRO 4TB (MZ-V9P4T0BW)](#)
- PSU:
    - CPU + RAM + SSD + motherboard: ~300 W
    - GPU:
        - NVIDIA GeForce RTX 5090: 575 W
    - Total for a 2-GPU setup:
        - 300 + 2 x 575 = 1450 W
        - Headroom: 50%
        - Required power supply: 2175 W
    - [Seasonic Prime PX-2200 2200W 80 PLUS Platinum](#)
        - Total continuous power 2200 W
- Case: E-ATX
    - [Fractal Design Define 7](#)
        - Total fan mounts: 9 x 120/140 mm
        - Front fan: 3 x 120/140 mm (2 x Dynamic X2 GP-14 included)
        - Top fan: 3 x 120/140 mm
        - Rear fan: 1 x 120/140 mm (1 x Dynamic X2 GP-14 included)
        - Bottom fan: 2 x 120/140 mm
        - GPU max length:
            - Storage layout: 290 mm
            - Open layout: 470 mm (445 mm w/ front fan)
        - CPU cooler max height: 185 mm
            - OK with [Noctua NH-D15 G2](#) CPU cooler
        - Front radiator: Up to 360/280 mm
        - Top radiator: Up to 360/420 mm
        - Rear radiator: 120 mm
        - Vertical GPU Support (with Flex B-20 or Flex VRC-25): 65mm total clearance, standard 2-slot GPU (<38mm thickness) recommended for optimum cooling
        - Case dimensions (LxWxH): 547 x 240 x 475 mm
- GPU:
    - AM5/X870E platforms split the CPU PEG lanes to x8/x8 for dual GPUs; x16/x16 isn't available.
    - Physical fit: most RTX 5090 cards are 3–3.5-slot wide. Fitting two often requires:
        - A case with 8+ expansion slots and generous bottom clearance
        - Motherboard slot spacing that leaves at least 3 full slots between x16_1 and x16_2
    - Power: plan for a high-end PSU (typically 1600–2000W) and adequate 12V-2×6 connectors; some boards (e.g., MSI GODLIKE) include a supplemental PCIe slot power header that helps stability with dual GPUs.
    - No SLI/NVLink for 5090; dual-GPU is for compute (CUDA/ML), not gaming AFR.

Price

- CPU:
    - AMD Ryzen 9 9950X3D: 700 EUR
- CPU cooler:
    - Noctua NH-D15 G2: 180 EUR
- RAM:
    - 128 GB: 360 EUR
- SSD:
    - Samsung 990 PRO 4TB (MZ-V9P4T0BW): 300 EUR
- Motherboard:
    - ASRock X870E Taichi: 490 EUR
    - Ausus ROG Crosshair X870E Hero: 650 EUR
    - Ausus ROG Crosshair X870E Extreme: 1300 EUR
    - Gigabyte X870E Aorus Xtreme AI TOP: 800 EUR
    - MSI Meg X870E Godlike: 1300 EUR
- PSU
    - Seasonic Prime PX-2200 2200W 80 PLUS Platinum: 550 EUR
- Case
    - Fractal Design Define 7: 240 EUR
- Total price without GPU:
    - 700 + 180 + 360 + 300 + 490 + 550 + 240 = 2820 EUR minimum.
    - 2520 + 300 ~= 3100 EUR with Gigabyte X870E Aorus Xtreme AI TOP motherboard.

Desktop CPU Links:

- https://www.anandtech.com/show/21524/the-amd-ryzen-9-9950x-and-ryzen-9-9900x-review/10
- https://www.amd.com/en/products/processors/desktops/ryzen/9000-series/amd-ryzen-9-9950x.html
- https://www.amd.com/en/products/processors/desktops/ryzen/9000-series/amd-ryzen-9-9950x3d.html
- https://www.amd.com/en/products/processors/chipsets/am5.html
- https://skatterbencher.com/2025/03/11/skatterbencher-85-ryzen-9-9950x3d-overclocked-to-5900-mhz/

Embedded / mobile CPU

▶ Details

Technical information:

- https://www.techpowerup.com/cpu-specs/ryzen-ai-max-pro-395.c3998
- https://www.amd.com/en/products/processors/laptop/ryzen-pro/ai-max-pro-300-series/amd-ryzen-ai-max-plus-pro-395.html
- https://www.amd.com/en/blogs/2025/amd-ryzen-ai-max-395-processor-breakthrough-ai-.html

  > 128GB of unified memory – out of which up to 96GB can be converted to VRAM through AMD Variable Graphics Memory

- https://www.tomshardware.com/pc-components/cpus/more-affordable-strix-halo-model-emerges-early-ryzen-ai-max-385-geekbench-result-reveals-an-eight-core-option

Discussion about adding an eGPU to the main board:

- https://www.reddit.com/r/LocalLLaMA/comments/1kedbv7/ryzen_ai_max_395_a_gpu/
- Note that the Framework mainboard has only 1 x PCIe x4 slot

Expected performance for a 10 GB LLM model:

- Prompt processing: 84 token/s
- Token generation: 11 token/s (100-200 GB/s RAM throughput)

GMKtec EVO-X2 AMD Ryzen™ AI Max+ 395 Mini PC - 2000 EUR

- Spec:
    - AMD Ryzen™ AI Max+ 395
    - Radeon 8060S graphics
    - 128 GB RAM
- Price: 2000 EUR

Framework Desktop mini PC - 3200 EUR

- Spec:
    - AMD Ryzen™ AI Max+ 395 (soldered)
    - Noctua CPU Fan - NF-A12x25 HS-PWM
    - Form Factor: FlexATX
    - Wattage: 400W
    - 128GB LPDDR5x-8000 memory (soldered)
    - Memory Bus width: 256-bit
    - Memory Speed: 8000 MT/s
- Price:
    - 3200 EUR
    - Ships 2025 Q4

Framework Desktop mainboard only - 2100 EUR

- Spec:

- AMD Ryzen™ AI Max+ 395 (soldered)
- 128GB LPDDR5x-8000 memory (soldered)
- Memory Bus width: 256-bit
- Memory Speed: 8000 MT/s
- Mini-ITX case,
- Power supply: 500W or higher ATX, SFX, or FlexATX
- Fan: 120mm, with a minimum of 85.1 CFM air flow and 3.82 mmH2O air pressure
- Can be used in a cluster:

  > Run legit, state-of-the-art AI models like Llama 70B right on your desk with up to 96GB of graphics addressable memory and a 256-bit memory bus.
  >
  > Framework Desktop has 5Gbit Ethernet along with two USB4 ports, allowing networking multiple together to run even larger models with llama.cpp RPC. Grab a few Mainboards and build it into your own mini-racks or standard rackmount server cases for high density.

- PCIe:

  > 1 x PCIe x4 slot (not exposed on default case)

- Price:
  - 2100 EUR

HP ZBook Ultra G1a Mobile Workstation PC - 3600 EUR

- Spec:
  - AMD Ryzen™ AI Max+ PRO 395 (up to 5.1 GHz max boost clock, 64 MB L3 cache, 16 cores, 32 threads)[6,7]
  - 128 GB LPDDR5x-8533 MT/s (onboard)
  - Graphics: Integrated: AMD Radeon™ 8060S Graphics
  - SSD: 2 TB PCIe Gen4 NVMe™ TLC SSD
  - Display: 14" diagonal, 2.8K (2880 x 1800), OLED, touch, IPS, BrightView, Low Blue Light, 400 nits, 100% DCI-P3
- Price:
  - 4200 USD ~= 3600 EUR

Other embedded/mobile options

Some other links:

- https://store.minisforum.com/products/elitemini-ai370
- https://minisforumpc.eu/en/products/ai-x1-pro-mini-pc?variant=51875206496622
- https://www.hp.com/us-en/workstations/z2-mini-a.html
- https://www.techpowerup.com/333983/sapphire-develops-edge-ai-mini-pc-series-with-amd-ryzen-ai-300-targeting-gamers-and-creatives
- https://www.reddit.com/r/LocalLLaMA/comments/1judxsq/gmktec_evox2_powered_by_ryzen_ai_max_395_to/

GPUs

▶ Details

NVIDIA RTX PRO 6000 Blackwell (96GB)

Specs (TechPowerUp):

- Memory Size: 96 GB
- Memory Bus: 512 bit
- Bandwidth: 1.79 TB/s
- Shading Units: 24064
- Tensor Cores: 752
- L1 Cache: 128 KB (per SM)
- L2 Cache: 128 MB
- FP16 (half): 126.0 TFLOPS (1:1)
- FP32 (float): 126.0 TFLOPS
- Bus Interface: PCIe 5.0 x16
    - 63 GB/s required PCIe bandwidth
- Variants:
    - NVIDIA RTX PRO 6000 Blackwell
        - TDP: 600 W
        - Suggested PSU: 1000 W
        - Open-air fan
    - NVIDIA RTX PRO 6000 Blackwell Server
        - TDP: 600 W
        - Suggested PSU: 1000 W
        - Fan: Bowler type
    - NVIDIA RTX PRO 6000 Blackwell Max-Q
        - TDP: 300 W
        - Suggested PSU: 700 W
        - Fan: Bowler type

NVIDIA GeForce RTX 5090 (32GB)

- Power

> Being a dual-slot card, the NVIDIA GeForce RTX 5090 draws power from 1x 16-pin power connector, with power draw rated at 575 W maximum.

NVIDIA GeForce RTX 5070 Ti SUPER (24GB)

TechPowerUp

NVIDIA GeForce RTX 5080 SUPER (24GB)

TechPowerUp

AMD Radeon RX 7900 XTX - 1000 EUR

Specs ([TechPowerUp](#)):

- Memory Size: 24 GB
- Memory Bus: 384 bit
- Bandwidth: 960.0 GB/s
- Shading Units: 6144
- Compute Units: 96
- FP16 (half): 122.8 TFLOPS (2:1)
- FP32 (float): 61.39 TFLOPS
- FP64 (double): 1.918 TFLOPS (1:32)
- TDP: 355 W
- Suggested PSU: 750 W

Price:

- 860 to 1100 EUR

AMD Radeon™AI PRO R9700

Specs ([TechPowerUp](#)) ([AMD](#))

- GPU Architecture: AMD RDNA™ 4
- Memory Size: 32 GB
- Memory Type: GDDR6
- Memory Bus: 256 bit
- Bandwidth: 644.6 GB/s
- Shading Units: 4096
- Compute Units: 64
- Matrix Cores: 128
- TDP: 300 W
- Suggested PSU: 700 W
- Peak Single Precision (FP32 Vector) Performance: 47.8 TFLOPs
- Peak Half Precision (FP16 Vector) Performance: 95.7 TFLOPs
- Peak Half Precision (FP16 Matrix) Performance: 191 TFLOPs
- Peak Half Precision (FP16 Matrix) Performance with Structured Sparsity: 383 TFLOPs
- Peak 8-bit Precision (FP8 Matrix) Performance (E5M2, E4M3): 383 TFLOPs
- Peak 8-bit Precision (FP8 Matrix) Performance with Structured Sparsity (E5M2, E4M3): 766 TFLOPs
- Peak 8-bit Precision (INT8 Matrix) Performance: 383 TOPs
- Peak 8-bit Precision (INT8 Matrix) Performance with Structured Sparsity: 766 TOPs
- Peak 4-bit Precision (INT4 Matrix) Performance: 766 TOPs
- Peak 4-bit Precision (INT4 Matrix) Performance with Structured Sparsity: 1531 TOPs

Variants:

- [ASUS Turbo Radeon AI PRO R9700](#)
    - [TURBO-AI-PRO-R9700-32G](#)
- [GIGABYTE Radeon AI PRO R9700 AI TOP](#)
    - [GV-R9700AI TOP-32GD](#)
- [PowerColor Radeon AI PRO R9700](#)
    - [AI PRO R9700 32G](#)

- [Sapphire AMD RADEON AI PRO R9700 32GB](#)

eGPU Dock

Peladn Link S-3

[Specs](#)

- I/O: Thunderbolt3*2[(1),75W (2),25W]
- Power: ATX/SFX
- Size: 300*220*180mm
- Support: Basically meet most existing models of graphics cards(It is recommended that AMD graphics card use RX570 or above, and NVIDIA graphics card use GTX 1060 or above)
- System Requirement: Windows 10 64 Bit(Support AMD&NVIDIA graphics cards) MacOS > 10.13.4(Only AMD graphics cards are supported)
- Computer Requirement: Thunderbolt 3 port and support external GPU
- Transfer Speed: 40 Gbps