FANLESS INTEL N97 REFERENCE PLATFORM

Mini-ITX Reference Configuration for Fanless Embedded Systems

This brief defines a reference architecture based on the Intel Processor N97 for fanless embedded systems, HMI, and edge-computing projects. Intel processor specifications are taken from Intel's published product specification. Board-level I/O and power options reflect the Mini ITX Board reference-platform page. Final thermal limits, interface population, enclosure performance, and validation results remain project-specific.

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Document Type	Reference Platform Brief
Reference Role	Fanless embedded / HMI / edge computing
Processor	Intel Processor N97
Status	Reference configuration - project-specific confirmation required

1. Reference Platform Summary

Processor	Intel Processor N97
CPU Architecture	Intel Processor N-series, formerly Alder Lake-N
CPU Cores	4
CPU Threads	4
Max Turbo Frequency	Up to 3.60 GHz
Cache	6 MB Intel Smart Cache
Processor TDP	12 W
Integrated Graphics	Intel UHD Graphics, 24 execution units
Graphics Max Dynamic Frequency	1.20 GHz
Reference Memory	DDR4 / DDR5 options
Reference Networking	2-4 x Ethernet
Reference Display	HDMI / DisplayPort / panel options
Reference Expansion	M.2 options
Reference Power	12-24 VDC options
Cooling	Fanless reference design

2. Intel N97 Processor Basis

Processor Attribute	Intel Published Specification	Design Relevance
Product family	Intel Processor N-series / Alder Lake-N	Low-power embedded compute platform
Cores / Threads	4 / 4	Suitable for compact multi-task embedded workloads
Max Turbo	3.60 GHz	Short-duration performance headroom

Processor Attribute	Intel Published Specification	Design Relevance
TDP	12 W	Supports fanless design when thermal path and enclosure are engineered correctly
Maximum Memory	Up to 32 GB, dependent on memory type	Final board design and memory implementation still control supported capacity
Memory Types	DDR4-3200, DDR5-4800, LPDDR5-4800	Reference page lists DDR4 / DDR5 options
Integrated GPU	Intel UHD Graphics, 24 EUs	Supports local HMI, display and media workloads
Graphics Output Capability	eDP 1.4b, DP 1.4, HDMI 2.1, MIPI-DSI 1.3	Actual board connectors depend on the chosen PCB implementation
Display Support	Up to 3 displays at processor level	Board routing and connector population determine usable outputs
PCIe	Gen 3, up to 9 lanes at processor level	Enables M.2 and other expansion subject to board routing
Tjunction / Max Operating Temp	105°C processor specification	Not a board ambient-temperature rating

3. Reference Board-Level Configuration

The following values reflect the currently published Fanless Intel N97 reference-platform configuration on MiniITXBoard.com. They describe available starting-point options, not a guaranteed single fixed SKU.

Subsystem	Reference Configuration	Project Confirmation Required
Memory	DDR4 / DDR5 options	Exact capacity, module type and board implementation
Networking	2-4 x Ethernet	Controller model, speed and port count
Display	HDMI / DP / panel options	Connector population, panel interface and resolution
Expansion	M.2 options	Socket key, PCIe/SATA/USB routing and installed module
Power	12-24 VDC options	Nominal input, allowed range, protection and connector
Cooling	Fanless	Heatsink, enclosure, mounting, orientation and ambient condition

4. Intended Application Profile

- Fanless industrial and embedded computers requiring moderate compute performance with low cooling complexity.
- Human-machine interface systems with local display output and network connectivity.
- Edge-computing gateways that combine Ethernet, local storage, and M.2 expansion.
- Compact embedded systems where acoustic noise, fan maintenance, or limited internal airflow make passive cooling preferable.

5. Fanless Thermal Design Basis

The 12 W processor TDP makes the N97 a practical candidate for passive cooling, but TDP alone does not establish a safe system ambient rating. Final thermal performance depends on heatsink thermal resistance, interface material, enclosure conduction, airflow, board orientation, memory and storage heat, workload, and surrounding ambient temperature.

Thermal Item	Reference Requirement	Validation Action
Processor load	Sustained CPU workload	Monitor package temperature, throttling and system stability
Graphics load	HMI / media / graphics workload where applicable	Monitor combined CPU/GPU behavior

Thermal Item	Reference Requirement	Validation Action
Storage load	Installed M.2 / SATA device under representative activity	Check local heating and thermal interaction
Enclosure	Final or representative chassis	Validate with actual mounting and orientation
Ambient	Project-defined	Record measured ambient during the test
Duration	Project-defined	Use sufficient duration to reach thermal equilibrium or agreed steady-state condition

6. Power Design Considerations

The reference page lists 12-24 VDC power options. The final electrical input range must be tied to a specific board design and power architecture before publication as a production specification.

- Confirm nominal input and allowable operating range for the selected board.
- Validate cold boot, warm reboot, repeated power cycling, and automatic power recovery where required.
- Test with the final storage, Ethernet, display, USB and M.2 peripheral load.
- Record actual voltage and current data in the project-specific validation report.
- Do not infer total system power directly from the processor's 12 W TDP.

7. Display and Graphics Considerations

Intel lists HDMI 2.1, DisplayPort 1.4, eDP 1.4b, and MIPI-DSI 1.3 capabilities at the processor level, with support for up to three displays. A Mini-ITX board may expose only a subset of these interfaces. The actual connector type, panel support, simultaneous-display combination, and maximum resolution must be confirmed for the selected board design.

8. Memory and Expansion Considerations

- Intel specifies a processor-level maximum memory size of 32 GB, dependent on memory type.
- The actual Mini-ITX implementation may support less than the processor maximum depending on board routing, socket type, BIOS and validated memory list.
- Intel N97 provides Gen 3 PCIe capability at processor level; the board determines which lanes are routed to M.2 or other expansion interfaces.
- For NVMe, Wi-Fi, cellular or accelerator modules, confirm socket key, lane routing, USB connectivity, power budget and driver support.

9. Recommended Validation Scope

Area	Minimum Validation	Evidence to Retain
Configuration	Exact board, revision, N97, memory, storage, BIOS and OS	Configuration record
Power	Cold boot, reboot and representative full-system load	Voltage/current log and observation
Thermal	Sustained workload in target cooling arrangement	Ambient and temperature log
Networking	All populated Ethernet ports under data transfer	Interface checklist / traffic result
Display	Required output combinations and target panels/displays	Display test record
M.2	Installed storage or expansion module	Detection, load and thermal record
Software	OS, BIOS and driver verification	Version record
Mechanical	Heatsink and enclosure fit	Drawing / photo / fit check

10. Known Limitations

- This document defines a reference platform, not a fixed production SKU.
- Intel's 105°C processor maximum operating temperature is not a system ambient-temperature specification.
- Processor-level interface capability does not guarantee that every interface is routed or populated on a specific Mini-ITX board.
- The processor-level 32 GB maximum memory specification does not automatically establish the board-level supported memory capacity.
- The published 12-24 VDC entry is a reference-platform option; the exact electrical range must be confirmed for the final board.
- Fanless suitability must be verified against the final enclosure, ambient temperature, orientation and workload.

11. Source Basis

Intel Processor Data	Intel Processor N97 product specification - Intel
Reference Platform Data	MiniITXBoard.com - Fanless Intel N97 Platform
Validation Methodology	MIB-EV-HBK-001 - Mini-ITX Engineering Validation Handbook

12. Related Engineering Documents

MIB-EV-HBK-001	Mini-ITX Engineering Validation Handbook
MIB-EV-CHK-001	System Validation Requirements Checklist
MIB-EV-RPT Series	Project-Specific / Redacted Validation Reports

13. Revision History

Revision	Date	Description	Approved By
Rev 1.0	July 2026	Initial public reference-platform release	

Reference Configuration Statement: Intel processor specifications in this document are processor-level capabilities and limits. Mini ITX Board reference-platform entries describe starting-point options. Final board specifications and validation results apply only to the confirmed project configuration.