



Intel® NUC 13 Extreme Kit / Compute Element Technical Product Specification

Revision 1.1

Regulatory Models: NUC13RN / NUC13SB

August 2023

Intel® NUC 13 Extreme Kit NUC13RNGi9, NUC13RNGi7, NUC13RNGi5 Intel® NUC 13 Extreme Compute Element NUC13SBBi9, or NUC13SBBi7, NUC13SBBi5 may contain design defects or errors known as errata that may cause the product to deviate from published specifications. Current characterized errata, if any, are documented in this product specification.

Revision History

Revision	Revision History	Date
1.0	Product release	Nov 2022
1.1	Fixed typos in device/stepping/spec code table	Aug 2023

Disclaimer

This product specification applies only to the standard Intel® NUC 13 Extreme Kits and Intel® NUC 13 Extreme Compute Element with BIOS identifier SBRPL579.

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Preface

This Product Specification specifies the layout, components, connectors, power and environmental features for the Intel® NUC 13 Extreme Kit NUC13RNGi9, NUC13RNGi7, NUC13RNGi5, NUC 13 Extreme Compute Element NUC13SBBi9, NUC13SBBi7, NUC13SBBi5.



NOTE

In this document, the use of “Intel® NUC 13 Extreme Kit” will refer to the NUC13RNGi9, NUC13RNGi7, NUC13RNGi5. The usage of “NUC 13 Extreme Compute Element” refers to the Intel® NUC Element product contained inside the NUC 13 Extreme Kit.

Intended Audience

This document is intended to provide technical information about Intel® NUC 13 Extreme Kit NUC13RNGi9, NUC13RNGi7, NUC13RNGi5, and its components to the vendors, system integrators, and other engineers and technicians who need this level of information. It is specifically *not* intended for general audiences.

What This Document Contains

Chapter	Description
1	A description of the NUC13RNGi9, NUC13RNGi7, NUC13RNGi5, NUC13SBBi9, NUC13SBBi7, NUC13SBBi5
2	A technical description of the NUC13RNGi9, NUC13RNGi7, NUC13RNGi5, NUC13SBBi9, NUC13SBBi7, NUC13SBBi5
3	The features supported by the BIOS Setup program
4	Characterized errata

Typographical Conventions

This section contains information about the conventions used in this specification. Not all of these symbols and abbreviations appear in all specifications of this type.

Notes, Cautions, and Warnings



NOTE

Notes call attention to important information.



CAUTION

Cautions are included to help you avoid damaging hardware or losing data

Other Common Notation

#	Used after a signal name to identify an active-low signal (such as USBP0#)
GB	Gigabyte (1,073,741,824 bytes)
GB/s	Gigabytes per second
Gb/s	Gigabits per second
KB	Kilobyte (1024 bytes)
Kb	Kilobit (1024 bits)
kb/s	1000 bits per second
MB	Megabyte (1,048,576 bytes)
MB/s	Megabytes per second
Mb	Megabit (1,048,576 bits)
Mb/s	Megabits per second
TDP	Thermal Design Power
Xxh	An address or data value ending with a lowercase h indicates a hexadecimal value.
x.x V	Volts. Voltages are DC unless otherwise specified.
*	This symbol is used to indicate third-party brands and names that are the property of their respective owners.

Intel® NUC 13 Extreme Kit Identification Information

Intel® NUC 13 Extreme Kit / Compute Element Identification Information

AA Revision	Product Code	BIOS Revision	Notes
	RNUC13RNGi9xxxx	SBRPL579.xxxx	1,2
	RNUC13RNGi7xxxx	SBRPL579.xxxx	1,3
	RNUC13RNGi5xxxx	SBRPL579.xxxx	1,4
	BNUC13SBBi90xxx	SBRPL579.xxxx	1,2
	BNUC13SBBi70xxx	SBRPL579.xxxx	1,3
	BNUC13SBBi50xxx	SBRPL579.xxxx	1,4
	BNUC13SBBi9Fxxx	SBRPL790.xxxx	1, 5
	BNUC13SBBi7Fxxx	SBRPL790.xxxx	1, 6
	BNUC13SBBi5Fxxx	SBRPL790.xxxx	1, 7

Notes:

- The AA number is found on the rear panel of the NUC 13 Extreme and backplate of the NUC 13 Extreme Compute Element.
- The Intel® Core™ i9-13900K processor is used on this AA revision consisting of the following component:

Device	Stepping	Spec Code
Intel® Core™ i9-13900K	B0	SRMBH

- The Intel® Core™ i7-13700K processor is used on this AA revision consisting of the following component:

Device	Stepping	Spec Code
Intel® Core™ i7-13700K	B0	SRMB8

- The Intel® Core™ i5-13600K processor is used on this AA revision consisting of the following component:

Device	Stepping	Spec Code
Intel® Core™ i5-13600K	B0	SRMBD

- The Intel® Core™ i9-13900KF processor is used on this AA revision consisting of the following component:

Device	Stepping	Spec Code
Intel® Core™ i9-13900KF	B0	SRMBJ

- The Intel® Core™ i7-13700KF processor is used on this AA revision consisting of the following component:

Device	Stepping	Spec Code
Intel® Core™ i7-13700KF	B0	SRMB9

- The Intel® Core™ i5-13600KF processor is used on this AA revision consisting of the following component:

Device	Stepping	Spec Code
Intel® Core™ i5-13600KF	B0	SRMBE

Intel® NUC Products NUC13RNGi9, NUC13RNGi7, NUC13RNGi5

Kit Product Name	Intel® NUC Compute Element
NUC13RNGi9	NUC13SBBi9
NUC13RNGi7	NUC13SBBi7
NUC13RNGi5	NUC13SBBi5

Specification Changes or Clarifications

The table below indicates the Specification Changes or Specification Clarifications that apply to the Intel® NUC 13 Extreme Kit NUC13RNGi9, NUC13RNGi7, NUC13RNGi5.

Specification Changes or Clarifications

Date	Type of Change	Description of Changes or Clarifications

Errata

Current characterized errata, if any, will be documented in Section 4 of this Technical Product Specification.

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1 Product Description

1.1 Overview

The Intel® NUC 13 Extreme Kit is a small form factor PC barebones kits. The NUC 13 Extreme Kit consists of the processor, chipset, memory slots, wireless, Bluetooth*, M.2 storage slots, integrated heat sink and fan. See Table 1 for a summary.

For information on compatible devices for use with the Intel® NUC 13 Extreme Kit and the Intel® NUC 13 Extreme Compute Element see <http://www.intel.com/NUCCompatible>.

1.2 Version Summary

The different versions of the Intel® NUC 13 Extreme Kit and NUC 13 Extreme Compute Element are summarized in Table 1. Unless otherwise noted in this document, not all features are available on all versions.

Table 1. Version Summary

Version	Graphics	LAN Options	Memory	XMP	Processor
NUC13RNGi9/ NUC13SBBi9	Yes	10Gbe / 2.5Gbe	Up to 64GB	Yes	Intel® Core™ i9-13900K
NUC13RNGi7/ NUC13SBBi7	Yes	10Gbe / 2.5Gbe	Up to 64GB	Yes	Intel® Core™ i7-13700K
NUC13RNGi5/ NUC13SBBi5	Yes	10Gbe / 2.5Gbe	Up to 64GB	Yes	Intel® Core™ i5-13600K
NUC13SBBi9F	No	2.5Gbe	Up to 64GB	Yes	Intel® Core™ i9-13900KF
NUC13SBBi7F	No	2.5Gbe	Up to 64GB	Yes	Intel® Core™ i7-13700KF
NUC13SBBi5F	No	2.5Gbe	Up to 64GB	Yes	Intel® Core™ i5-13600KF



NOTE

Intel® NUC 13 Extreme Kits listed in Table 1 have been certified for use as a component in Information Technology Equipment in certain countries. The system integrator is responsible for testing and acquiring any additional country-specific regulatory approvals, including all system-wide certifications.



NOTE

For information on the Intel® NUC 13 Extreme Kit and Intel® NUC 13 Extreme Compute Element is available at www.intel.com/NUCSupport

1.3 Product Summary Tables

The following section presents a summary of the features for the Intel® NUC 13 Extreme Kit, and the two different versions of the NUC 13 Extreme Compute Element.

1.3.1 Intel® NUC 13 Extreme Kit Product Summary

Table 2 summarizes the major features of the Intel® NUC 13 Extreme Kits.

Table 2. Feature Summary

Kit Form Factor	337mm x 317mm x129mm
Processor	<ul style="list-style-type: none"> • Socketed Intel® processor <ul style="list-style-type: none"> ○ Integrated graphics ○ Integrated memory controller • The following processors are supported as intalled in the corresponding NUC 13 Extreme Compute Element <ul style="list-style-type: none"> ○ Intel® Core™ i9-13900K ○ Intel® Core™ i7-13700K ○ Intel® Core™ i5-13600K
PCH Options	<ul style="list-style-type: none"> • Intel® Z690 Platform Controller Hub
Memory	<ul style="list-style-type: none"> • Two 262-pin DDR5 SDRAM Small Outline Dual Inline Memory Module (SO-DIMM) sockets • Support for DDR5 5600 MHz SO-DIMMs • Support for 8 Gb and 16 Gb memory technology† • Support for up to 64 GB of system memory with two SO-DIMMs using 16 Gb memory technology† • Support for Intel® XMP memory profiles • Note: 2 Gb memory technology (SDRAM Density) is not compatible
Graphics	<ul style="list-style-type: none"> • Integrated graphics support for processors with Intel® Graphics Technology: • One High Definition Multimedia Interface* (HDMI*) v2.1 TMDS compatible back panel connector • Two DisplayPort signals via USB Type C back panel connectors
Audio	<ul style="list-style-type: none"> • Intel® High Definition (Intel® HD) Audio via the HDMI and Type C interfaces through the processor • Realtek ALC1220 Analog Audio with Line-in, Speaker, and Microphone 3.5mm ports <ul style="list-style-type: none"> • Jacks support connector retasking • USB Audio via a stereo 3.5mm combination headset jack on the front panel (on the NUC Kits)
Storage	<ul style="list-style-type: none"> • NUC 13 Extreme Compute Element: • One CPU-Attached PCIe Gen4 x4 NVMe M.2 2280 • One PCH-Attached SATA 6.0 Gb/s or PCIe Gen4 x4 AHCI, NVMe ports are reserved for M.2 storage modules supporting M.2 2242 / M.2 2280 Note: Supports key type M (PCI Express* x1/x2/x4 and SATA) • One PCH-Attached PCIe Gen4 x4 NVMe M.2 2242/2280 • Two SATA 6.0 Gb/s ports implemented from the baseboard inside the chassis for use with 2 x 2.5in or 1 x 3.5in hard drives
Peripheral Interfaces	<ul style="list-style-type: none"> • USB 4 Type C ports: <ul style="list-style-type: none"> • Two ports are implemented via the back panel Type C connectors • USB 3.2 (Gen 2/10 Gbps) Type A ports: <ul style="list-style-type: none"> • Six ports are implemented via the back panel connectors (blue) • USB 3.2 (Gen 2/10 Gbps) Type C port: <ul style="list-style-type: none"> • One port is implemented on the front panel of the Kit • USB 3.2 (Gen 1/5 Gbps) Type A ports: <ul style="list-style-type: none"> • Two ports are implemented on the front panel of the kit (through the baseboard expansion)
Chassis Expansion Capabilities	<ul style="list-style-type: none"> • One PCIe 5.0 x16 slot* with support for a triple slot GPU up to ~12.5" (317.5mm) maximum length

NUC Element Expansion Capabilities	<ul style="list-style-type: none"> • Three M.2 connectors supporting AHCI and NVME protocols (only Slot 1 supports AHCI/SATA) • Two Thunderbolt™ 4 via back panel Type C connectors
BIOS	<ul style="list-style-type: none"> • Intel® BIOS resident in the Serial Peripheral Interface (SPI) Flash device • Support for Advanced Configuration and Power Interface (ACPI), Plug and Play, and System Management BIOS (SMBIOS)
Wireless LAN	<ul style="list-style-type: none"> • Intel® Wi-Fi 6E Killer 1690i, 802.11ax, Dual Band, 2x2 Wi-Fi + Bluetooth 5.3 • Maximum Transfer speed up to 2.4 Gbps • M.2 2230 Form Factor NGFF PCIe only • Supports OFDMA, 1024QAM, Target Wake Time (TWT) and spatial reuse
LAN	<ul style="list-style-type: none"> • 10 Gigabit (10/100/1000/2500/5000/10000 Mb/s) LAN subsystem using the Marvell® AQtion™ AQC113C • 2.5 Gigabit (10/100/1000/2500 Mb/s) LAN subsystem using the Intel® Gigabit Ethernet Controller I226-V
Hardware Monitor Subsystem	<p>Hardware monitoring subsystem, based on an embedded controller, including:</p> <ul style="list-style-type: none"> • Voltage sense to detect out of range power supply voltages • Thermal sense to detect out of range thermal values • Two processor fan headers • Two chassis fan headers • Fan sense input used to monitor fan activity • Fan speed control
Devices Supported via PCIe Bifurcation	<ul style="list-style-type: none"> • PCI Express 5.0 x16 <ul style="list-style-type: none"> • Bifurcation supported to a maximum of two PCI Express devices (x8 + x8) when Element is used in 3rd party chassis supporting this feature
Advanced Technologies	<ul style="list-style-type: none"> • Intel® Virtualization Technology (VT-x) • Intel® Virtualization for Directed I/O (VT-d) • Intel® VT-x with Extended Page Tables (EPT) • Intel® Speed Shift Technology • Intel® Turbo Boost Technology • Intel® Hyper-Threading Technology • Enhanced Intel® SpeedStep® Technology • Intel® Identity Protection Technology (Intel® IPT) • Intel® Platform Trust Technology (Intel® PTT)
Security and Reliability	<ul style="list-style-type: none"> • Intel® Memory Protection Extensions (Intel® MPX) • Intel® AES New Instructions • Execute Disable Bit
TPM	Firmware based TPM through Intel® Platform Trust Technology (Intel® PTT)
Operating Systems Support (64-bit only)	<ul style="list-style-type: none"> • Windows 11 Home • Windows 11 Pro • Windows 11 Enterprise

1.3.2 Intel® NUC 13 Extreme Compute Element Feature Summary

Table 3 summarizes the major features of the Intel® NUC 13 Extreme Compute Elements.

Table 3. Feature Summary

Element Form Factor	295.3mm x 136.5mm x 46.1mm
Processor	<ul style="list-style-type: none"> • Socketed Intel® processor <ul style="list-style-type: none"> ○ Integrated graphics* ○ Integrated memory controller • The following processors are supported as intalled in the corresponding NUC 13 Extreme Compute Element <ul style="list-style-type: none"> ○ Intel® Core™ i9-13900K ○ Intel® Core™ i7-13700K ○ Intel® Core™ i5-13600K ○ Intel® Core™ i9-13900KF ○ Intel® Core™ i7-13700KF ○ Intel® Core™ i5-13600KF <p>*The Elements with KF CPUs do not feature graphics outputs.</p>
PCH Options	<ul style="list-style-type: none"> • Intel® Z690 Platform Controller Hub
Memory	<ul style="list-style-type: none"> • Two 262-pin DDR5 SDRAM Small Outline Dual Inline Memory Module (SO-DIMM) sockets • Support for DDR5 5600 MHz SO-DIMMs • Support for 8 Gb and 16 Gb memory technology† • Support for up to 64 GB of system memory with two SO-DIMMs using 16 Gb memory technology† • Support for Intel® XMP memory profiles • Note: 2 Gb memory technology (SDRAM Density) is not compatible
Graphics	<ul style="list-style-type: none"> • Integrated graphics support for processors with Intel® Graphics Technology: • One High Definition Multimedia Interface* (HDMI*) v2.1 TMDS compatible back panel connector • Two DisplayPort signals via USB Type C back panel connectors <p>*Graphics outputs are not present on KF SKUs.</p>
Audio	<ul style="list-style-type: none"> • Intel® High Definition (Intel® HD) Audio via the HDMI and Type C interfaces through the processor • Realtek ALC1220 Analog Audio with Line-in, Speaker, and Microphone 3.5mm ports <ul style="list-style-type: none"> • Jacks support connector retasking
Storage	<ul style="list-style-type: none"> • NUC 13 Extreme Compute Element: • One CPU-Attached PCIe Gen4 x4 NVMe M.2 2280 • One PCH-Attached SATA 6.0 Gb/s or PCIe Gen4 x4 AHCI, NVMe ports are reserved for M.2 storage modules supporting M.2 2242 / M.2 2280 Note: Supports key type M (PCI Express* x1/x2/x4 and SATA) • One PCH-Attached PCIe Gen4 x4 NVMe M.2 2242/2280
Peripheral Interfaces	<ul style="list-style-type: none"> • USB 4 Type C ports: <ul style="list-style-type: none"> • Two ports are implemented via the back panel Type C connectors • Ports not present on KF SKUs. • USB 3.2 (Gen 2/10 Gbps) Type A ports: <ul style="list-style-type: none"> • Six ports are implemented via the back panel connectors (blue)
Chassis Expansion Capabilities	<ul style="list-style-type: none"> • One PCIe 5.0 x16 Gold Finger connector for use with supported baseboard. • One NUC x4 Extension header with the following signals: <ul style="list-style-type: none"> • 2x SATA 3.0 signals • 2x USB 3.0 signals • 4x USB 2.0 signals • 2x Fan control protocols • 1x PCIe x1 signal
NUC Element Expansion Capabilities	<ul style="list-style-type: none"> • Three M.2 connectors supporting AHCI and NVME protocols (only Slot 1 supports AHCI) • Two Thunderbolt™ 4 via back panel Type C connectors <ul style="list-style-type: none"> • Thunderbolt™ 4 ports not present on KF SKUs.

BIOS	<ul style="list-style-type: none"> • Intel® BIOS resident in the Serial Peripheral Interface (SPI) Flash device • Support for Advanced Configuration and Power Interface (ACPI), Plug and Play, and System Management BIOS (SMBIOS)
Wireless LAN	<ul style="list-style-type: none"> • Intel® Killer™ Wi-Fi 6E AX1690 i, 802.11ax, Dual Band, 2x2 Wi-Fi + Bluetooth 5.3 • Maximum Transfer speed up to 2.4 Gbps • M.2 2230 Form Factor NGFF PCIe only • Supports OFDMA, 1024QAM, Target Wake Time (TWT) and spatial reuse
LAN	<ul style="list-style-type: none"> • 10 Gigabit (10/100/1000/2500/5000/10000 Mb/s) LAN subsystem using the Marvell® AQtion™ AQC113C <ul style="list-style-type: none"> • Not available on KF SKU Elements • 2.5 Gigabit (10/100/1000/2500 Mb/s) LAN subsystem using the Intel® Gigabit Ethernet Controller I226-V <ul style="list-style-type: none"> • Available on all SKUs
Hardware Monitor Subsystem	<p>Hardware monitoring subsystem, based on an embedded controller, including:</p> <ul style="list-style-type: none"> • Voltage sense to detect out of range power supply voltages • Thermal sense to detect out of range thermal values • Two onboard Element CPU fan headers • Two fan controller headers expansion through Extension x4 connector • Fan sense input used to monitor fan activity • Fan speed control
Devices Supported via PCIe Bifurcation	<ul style="list-style-type: none"> • PCI Express 5.0 x16 <ul style="list-style-type: none"> • Bifurcation supported to a maximum of two PCI Express devices (x8 + x8) <p>*Bifurcation available with supported baseboards</p>
Advanced Technologies	<ul style="list-style-type: none"> • Intel® Virtualization Technology (VT-x) • Intel® Virtualization for Directed I/O (VT-d) • Intel® VT-x with Extended Page Tables (EPT) • Intel® Speed Shift Technology • Intel® Turbo Boost Technology • Intel® Hyper-Threading Technology • Enhanced Intel® SpeedStep® Technology • Intel® Identity Protection Technology (Intel® IPT) • Intel® Platform Trust Technology (Intel® PTT)
Security and Reliability	<ul style="list-style-type: none"> • Intel® Memory Protection Extensions (Intel® MPX) • Intel® AES New Instructions • Execute Disable Bit
TPM	Firmware based TPM through Intel® Platform Trust Technology (Intel® PTT)
Operating Systems Support (64-bit only)	<ul style="list-style-type: none"> • Windows 11 Home • Windows 11 Pro • Windows 11 Enterprise

To find information about...

Intel® NUC Elements
Intel® NUC Element Support
Intel® NUC Element Warranty Information
Available configurations for Intel® NUC 13 Extreme Kit
Intel Processors
Intel Chipsets
Intel Graphics
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<http://www.intel.com/technology>
<http://www.intel.com/NUCSupport>

2 Technical Reference

2.1 Block Diagrams

2.1.1 Block Diagram – NUC 13 Extreme Compute Element

Figure 1 is a block diagram of the major functional areas of the Intel® NUC 13 Extreme Compute Element.

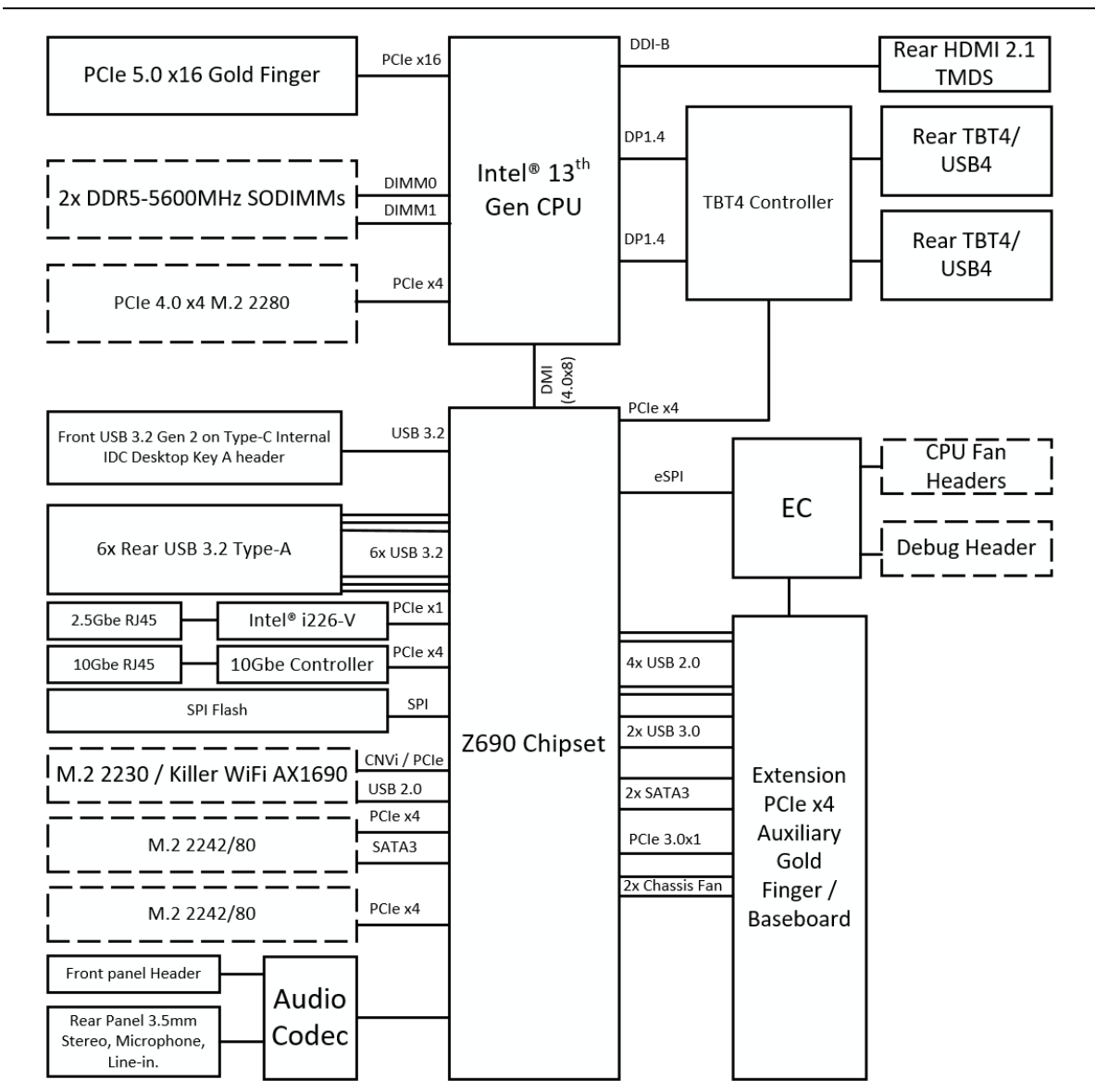


Figure 1. Block Diagram – NUC 13 Extreme Compute Element

2.2 Processor

Intel NUC 13 Extreme Kits feature the Intel NUC 13 Extreme Compute Element pre-installed. The Intel® NUC 13 Extreme Kits NUC13RNGi9, NUC13RNGi7, NUC13RNGi5 feature a 13th Gen Intel® Core™ processor with 125W TDP.

The NUC13RNGi9/NUC13SBBi9 features the 13th Gen Intel® Core™ i9-13900K 24-core processor.

The NUC13RNGi7/NUC13SBBi7 features the 13th Gen Intel® Core™ i7-13700K 16-core processor.

The NUC13RNGi5/NUC13SBBi5 features the 13th Gen Intel® Core™ i5-13600K 14-core processor.

- Intel® UHD 770 Graphics for 13th Gen Intel® Processors
- Integrated memory controller

The NUC13SBBi9F features the 13th Gen Intel® Core™ i9-13900KF 24-core processor.

The NUC13SBBi7F features the 13th Gen Intel® Core™ i7-13700KF 16-core processor.

The NUC13SBBi5F features the 13th Gen Intel® Core™ i5-13600KF 14-core processor.

- Integrated memory controller

2.3 Platform Controller Hub (PCH)

The Intel NUC 13 Extreme Kits and Compute Elements feature the Intel® Z690 Platform Controller Hub with Direct Media Interface (DMI) interconnect providing interfaces to the processor and the USB, SATA, LAN, PCI Express interfaces. The Z690 is a centralized controller for the kit's I/O paths.

2.3.1 Direct Media Interface (DMI)

Direct Media Interface (DMI) is the chip-to-chip connection between the processor and PCH. This high-speed interface integrates advanced priority-based servicing allowing for concurrent traffic and true isochronous transfer capabilities.

2.4 System Memory

The Intel NUC 13 Extreme Kits and Compute Elements have two 262-pin SO-DIMM sockets and supports the following memory features:

- DDR5 SDRAM SO-DIMMs with gold plated contacts
- Two independent memory channels with interleaved mode support
- Unbuffered, single-sided or double-sided SO-DIMMs
- 64 GB maximum total system memory (with 16 Gb memory technology)
- Minimum recommended total system memory: 8192 MB
- Non-ECC SO-DIMMs
- Serial Presence Detect
- DDR5 4000/4400/4800/5200/5600 MHz SDRAM SO-DIMMs
- Intel® XMP 3.0 support

Supports 4 Gb, 8 Gb, and 16 Gb memory technology (SDRAM Density)



NOTE

To be fully compliant with all applicable DDR SDRAM memory specifications, the board should be populated with SO-DIMMs that support the Serial Presence Detect (SPD) data structure. This allows the BIOS to read the SPD data and program the chipset to accurately configure memory settings for optimum performance. If non-SPD memory is installed, the BIOS will attempt to correctly configure the memory settings, but performance and reliability may be impacted or the SO-DIMMs may not function under the determined frequency.



NOTE

Intel NUC 13 Extreme Kits support only 4 Gb, 8 Gb, and 16 Gb memory technologies (also referred to as “SDRAM density”).

For information about...

Refer to:

Tested Memory

<http://www.intel.com/NUCSupport>

The SODIMM memory slots on the NUC 13 Extreme Kits is located to the right of the CPU Blower on the NUC 13 Extreme Compute Element. See Figure 3.

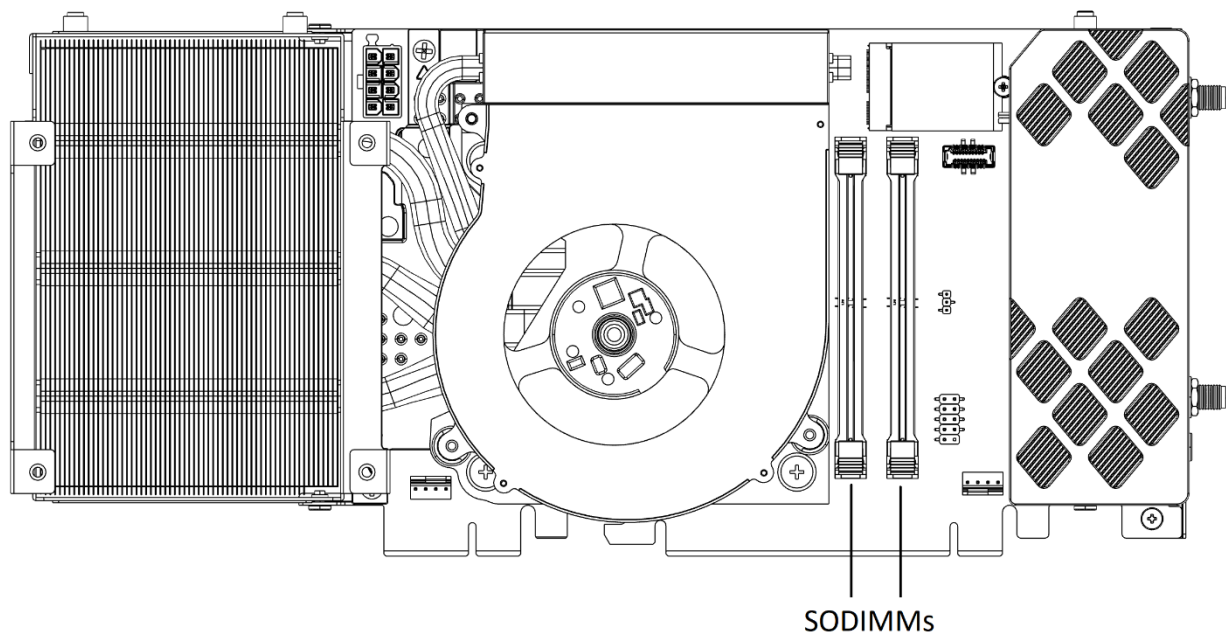


Figure 3. SODIMM Location on NUC 13 Extreme Element

2.4.1 Addressable Memory

The system has been validated with up to 64 GB of addressable system memory. Typically, the address space that is allocated for PCI Express configuration space, BIOS (SPI Flash device), and

chipset overhead resides above the top of DRAM (total system memory). On a system that has 16 GB of system memory installed, it is not possible to use all of the installed memory due to system address space being allocated for other system critical functions. These functions include the following:

- BIOS/SPI Flash device (32 MB)
- Local APIC (19 MB)
- Direct Media Interface (40 MB)
- PCI Express configuration space (256 MB)
- PCH base address registers PCI Express ports (up to 256 MB)
- Memory-mapped I/O that is dynamically allocated for M.2 add-in cards (256 MB)
- Integrated graphics shared memory (up to 1.5 GB; 64 MB by default)

2.5 Processor Graphics Subsystem

The NUC 13 Extreme Kit supports graphics through the Intel® UHD 770 Graphics for 13th Gen Intel® Processors.

For information about...

Intel Graphics Technologies

Refer to:

<http://www.intel.com/graphics>

2.5.1 Integrated Graphics

The NUC 13 Extreme Kit supports integrated graphics via the processor.

2.5.1.1 Intel® UHD Graphics for 13th Gen Intel Processors

Intel® UHD 770 Graphics for 13th Gen Intel Processors features the following:

- DirectX* 12.1 support
- OpenGL* 4.5 support
- Max HDMI resolution 4096x2304 at 60Hz
- Max Type-C DP resolution 5120x3200 at 60Hz
 - (7680x4320 at 60Hz supported with combined ports)
- OpenCL* 2.0 support

2.5.1.2 High Definition Multimedia Interface* (HDMI*)

The HDMI port is HDMI 2.1 TMDS compatible specification compliant and support standard, enhanced, or high definition video, plus multi-channel digital audio on a single cable. The port is compatible with all ATSC and DVB HDTV standards and supports thirty-two full range channels of lossless audio formats. The system can support a display at the maximum supported resolution of 4096 x 2160 @ 60 Hz, 24bpp.

For information about

HDMI technology

Refer to

<http://www.hdmi.org>

2.5.1.2.1 High-bandwidth Digital Content Protection (HDCP)

The HDMI Port supports HDCP 2.3. HDCP is the technology for protecting high definition content against unauthorized copy or interception between a source (computer, digital set top boxes, etc.) and the sink (panels, monitor, and TVs). The PCH supports HDCP 2.3 for content protection over wired displays.

2.5.1.3 DisplayPort* via Type C

DisplayPort is a digital communication interface that utilizes differential signaling to achieve a high bandwidth bus interface designed to support connections between PCs and monitors, projectors, and TV displays. DisplayPort is suitable for display connections between consumer electronics devices such as high definition optical disc players, set top boxes, and TV displays.

*The Type C DisplayPort connectors are compliant with the DisplayPort 1.4 specification and have a maximum supported resolution of 7680 x 4320 @ 30Hz 24bpp.

DisplayPort output supports Multi-Stream Transport (MST) which allows for multiple independent video streams (daisy-chain connection with multiple monitors) over a single DisplayPort. This will require the use of displays that support DisplayPort 1.4 specification and allow for this feature.



NOTE

Resolution support is subject to memory bandwidth availability. Single 8K@30hz resolution may be dependent on monitors and adapters utilized.

For information about	Refer to
DisplayPort technology	http://www.displayport.org

2.6 USB port details

2.6.1 NUC 13 Extreme Kit

The NUC 13 Extreme Kit supports eleven USB ports. All eleven ports are high-speed, full-speed, and low-speed capable. The port arrangement is as follows:

- USB 3.2 Gen 2 10Gbps Type-A ports:
 - Six ports are implemented with external back panel connectors (blue)
- USB 3.2 Gen 1 5Gbps Type-A ports:
 - Two ports are implemented on the top panel of the kit.
- USB 4 Type-C ports:
 - Two ports are implemented with as USB Type-C back panel connectors (black)
- USB 3.2 Gen 2 20Gbps Type-C port:
 - One port is implemented with external front panel USB Type-C



NOTE

Computer systems that have an unshielded cable attached to a USB port may not meet FCC Class B requirements, even if no device is attached to the cable. Use a shielded cable that meets the requirements for full-speed devices.

2.6.2 NUC 13 Extreme Compute Element

The NUC 13 Extreme Compute Element supports up to thirteen USB ports. All thirteen ports are high-speed, full-speed, and low-speed capable. The USB 3.2 Gen 2 ports are capable of up to 10gb/s per port. The port arrangement is as follows:

- USB 3.2 Gen 2 10Gbps Type-A ports:
 - Six ports are implemented with external back panel connectors (blue)
- USB 3.2 Gen 1 5Gbps Type-A ports:
 - Two ports are implemented through the Extension x4 connector
- USB 4 Type-C ports:
 - Two ports are implemented with as USB Type-C back panel connectors (black)
 - Ports are not present on the KF SKUs.
- USB 3.2 Gen 2 20Gbps Type-C port:
 - One port is implemented with external front panel USB Type-C
- USB 2.0 Gen ports:
 - Four ports are implemented through the Extension x4 connector
 - *Note that to achieve full USB certification on 3.x and higher ports USB 2.0 ports must be routed along side for backward compatibility*

2.7 Thunderbolt 4

The NUC 13 Extreme Kits and Compute Elements support Thunderbolt™ 4 with up to 40 Gbps of data throughput, two 4k (60Hz) monitor outputs, USB4 connection and charging capabilities up to 5V at 3A via the back panel USB Type C connectors. Item D in Figure 9 shows the location of the rear panel USB Type C ports.



NOTE

The two Thunderbolt™ 4 connectors share maximum available bandwidth between the two ports where a single device can utilize the full allocation until those resources are dynamically reassigned and or shared.

The KF SKUs do not feature Thunderbolt 4 ports.

For information about	Refer to
Compatible Thunderbolt™ 4 devices	https://www.intel.com/content/www/us/en/support/articles/000027966.html
Thunderbolt™ 4 information	http://www.intel.com/Thunderbolt

2.8 Storage Options

The NUC 13 Extreme Kit provides the following Storage interfaces:

- One PCH-Attached PCIe Gen 4 x4 M.2 NVMe/SATA slot, supporting M.2 2242/80 on the NUC 13 Extreme Compute Element.
- One PCH-Attached PCIe Gen 4 x4 M.2 NVMe slot, support M.2 2242/2280 on the NUC 13 Extreme Compute Element.
- One CPU-Attached internal PCIe Gen 4 x4 M.2 NVMe only slot located on the NUC 13 Extreme Element.

The PCH provides independent SATA ports with a theoretical maximum transfer rate of 6 Gb/s. A point-to-point interface is used for host to device connections.

Figure 4 shows the locations of the M.2 slots.

2.8.1 AHCI Mode

The NUC 13 Extreme Kit supports AHCI storage mode on the SATA supporting NVMe Slot 1, and the two SATA ports on the baseboard in the chassis.



NOTE

In order to use AHCI mode, AHCI must be enabled in the BIOS. Microsoft Windows* 11 includes the necessary AHCI drivers without the need to install separate AHCI drivers during the operating system installation process; however, it is always good practice to update the AHCI drivers to the latest available by Intel.*

2.8.2 NVMe

The board supports M.2 NVMe Express* (NVMe) drives. NVMe is an optimized, high-performance scalable host controller interface designed to utilize PCIe-based solid-state storage. NVMe is designed to provide efficient access to storage devices built with non-volatile memory, from current NAND flash technology to future, higher performing persistent memory technologies like Optane. NVMe is designed to meet serial bandwidth requirements and very high IOPs. It is based on PCIe Gen 4 and can deliver up to 8GB/s bandwidth. Current NVMe is based on version 1.3 of the specification.



NOTE

Actual device performance may vary based on OS version, storage type, and workload utilized.

2.8.3 Intel® Volume Management Device (Intel® VMD)

The Z690 PCH supports Intel® Volume Management Device Technology, providing both AHCI and integrated RAID functionality. The RAID capability provides high-performance RAID 0 and 1 functionality on the M.2 Slots. Other RAID features include hot spare support, SMART alerting, and RAID 0 auto replace. Software components include an Option ROM for pre-boot configuration and boot functionality, a Microsoft Windows compatible driver, and a user interface for configuration and management of the RAID capability of the PCH.



NOTE

Intel® VMD SATA or NVMe RAID is only supported if devices share the same type of connection protocol. Mixing an M.2 SATA SSD with an NVMe module is not supported. CPU attached storage can also be used with NVMe SSD RAID options, functionality of RAID from the PCH on the NUC 13 Extreme Compute Element cannot be shared with functionality of RAID from the Baseboard. See Figure 4 for the M.2 Storage location on the NUC 13 Extreme Compute Element.

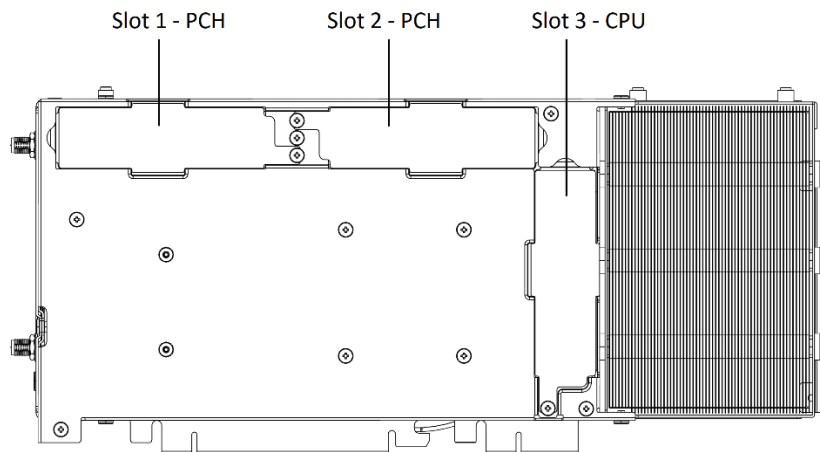


Figure 4. Location of NUC 13 Extreme Compute Element M.2 Slots

2.9 Real-Time Clock Subsystem

A coin-cell battery (CR2032) powers the real-time clock and CMOS memory. When the computer is not plugged into a wall socket, the battery has an estimated life of three years. When the computer is plugged in, the standby current from the power supply extends the life of the battery. The clock is accurate to ± 13 minutes/year at 25 °C with 3.3 VSB applied via the power supply 5 V STBY rail.



NOTE

If the battery and AC power fail, date and time values will be reset and the user will be notified during the POST.

When the voltage drops below a certain level, the BIOS Setup program settings stored in CMOS RAM (for example, the date and time) might not be accurate. Replace the battery with an equivalent one. Figure 4 shows the location of the battery.

2.10 LAN

The onboard LAN controllers options consist of the following:

- Marvell® AQtion™ AQC113 (10/100/1000/2500/5000/10000 Mb/s)
- Intel® Gigabit Ethernet Controller i226-V (10/100/1000/2500 Mb/s)
- RJ-45 LAN connectors with integrated status LEDs

Additional features of the i226-V LAN subsystem include:

- CSMA/CD protocol engine
- LAN connect interface between the Processor and the LAN controller
- Power management capabilities
 - ACPI technology support
 - LAN wake capabilities
- LAN subsystem software

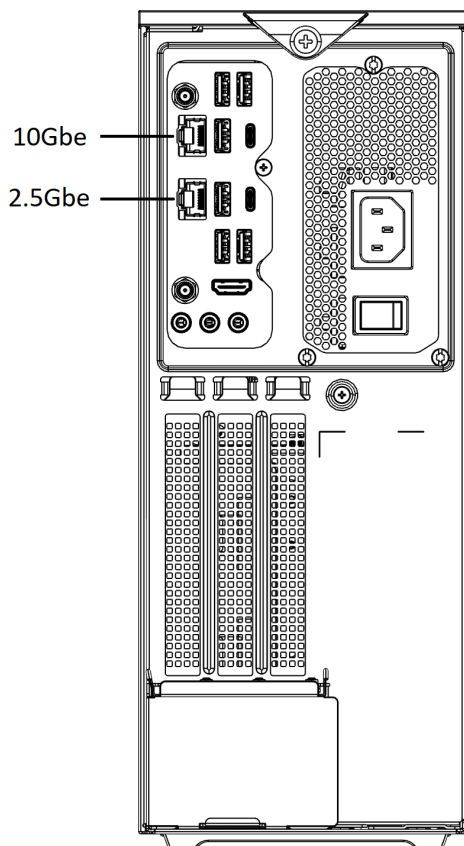


Figure 5. NUC 13 Extreme Kit LAN Controller Layout



NOTE

The 10Gbe controller is not populated on the KF SKUs.

2.10.1 LAN Software

LAN software and drivers are available from Intel's website.

For information about	Refer to
Obtaining LAN software and drivers	http://downloadcenter.intel.com

2.11 Intel® Virtualization Technology

Intel® Virtualization Technology (Intel® VT-x) is a hardware-assisted technology that, when combined with software-based virtualization solutions, provides maximum system utilization by consolidating multiple environments into a single server or client.



NOTE

A processor with Intel VT does not guarantee that virtualization will work on your system. Intel VT requires a computer system with a chipset, BIOS, enabling software and/or operating system, device drivers, and applications designed for this feature.

For information about	Refer to
Intel® Virtualization Technology	http://www.intel.com/technology/virtualization/technology.htm

2.12 Intel® Virtualization Technology for Directed I/O

Intel® Virtualization Technology for Directed I/O (Intel® VT-d) allows addresses in incoming I/O device memory transactions to be remapped to different host addresses. This provides Virtual Machine Monitor (VMM) software with:

- Improved reliability and security through device isolation using hardware assisted remapping.
- Improved I/O performance and availability by direct assignment of devices.

For information about	Refer to
Intel® Virtualization Technology for Directed I/O	https://software.intel.com/en-us/node/139035?wapkw=vt+directed+io

2.13 Power Management

Power management is implemented at several levels, including:

- Software support through Advanced Configuration and Power Interface (ACPI)
- Hardware support:
 - Power Input
 - LAN wake capabilities
 - Wake from USB

2.13.1 ACPI

ACPI gives the operating system direct control over the power management and Plug and Play functions of a computer. The use of ACPI with this board requires an operating system that provides full ACPI support. ACPI features include:

- Plug and Play (including bus and device enumeration)
- Power management control of individual devices, add-in boards (some add-in boards may require an ACPI-aware driver), video displays, and hard disk drives
- Methods for achieving less than 15-watt system operation in the power-on/standby sleeping state
- A Soft-off feature that enables the operating system to power-off the computer
- Support for a front panel power and sleep mode switch

Table 4 lists the system states based on how long the power switch is pressed, depending on how ACPI is configured with an ACPI-aware operating system.

Table 4. Effects of Pressing the Power Switch

If the system is in this state...	...and the power switch is pressed for	...the system enters this state
Off (ACPI G2/G5 – Soft off)	Less than four seconds	Power-on (ACPI G0 – working state)
On (ACPI G0 – working state)	Less than four seconds	Soft-off/Standby (ACPI G1 – sleeping state) ^{Note}
On (ACPI G0 – working state)	More than six seconds	Fail safe power-off (ACPI G2/G5 – Soft off)
Sleep (ACPI G1 – sleeping state)	Less than four seconds	Wake-up (ACPI G0 – working state)
Sleep (ACPI G1 – sleeping state)	More than six seconds	Power-off (ACPI G2/G5 – Soft off)

Note: Depending on power management settings in the operating system.

2.13.1.1 System States and Power States

Under ACPI, the operating system directs all system and device power state transitions. The operating system puts devices in and out of low-power states based on user preferences and knowledge of how devices are being used by applications. Devices that are not being used can be turned off. The operating system uses information from applications and user settings to put the system into a low-power state.

Table 5 lists the power states supported by the board along with the associated system power targets. See the ACPI specification for a complete description of the various system and power states.

Table 5. System States

State	Description
G0/S0/C0	Full On: CPU operating. Individual devices may be shut to save power. The different CPU operating levels are defined by Cx states.
G0/S0/Cx	Cx State: CPU manages C-states by itself and can be in lower power states.
G1	Suspend-To-RAM (STR): The system context is maintained in system DRAM, but power is shut to non-critical circuits. Memory is retained and refreshes continue. All external clocks are shut off; RTC clock and international oscillator clocks are still toggling.
G1/S4	Suspend-To-Disk (STD): The context of the system is maintained on the disk. All power is then shut to the system except to the logic required to resume. Externally appears the same as S5 but may have different wake events.
G2/S5	Soft Off: System context not maintained. All power is shut except for the logic required to restart. A full boot is required when waking.
G3	Mechanical Off: System context not maintained. All power shut except for the RTC. No "Wake" events are possible because the system does not have any power. This state occurs if the user removes the batteries, turns off a mechanical switch, or if the system power supply is at a level that is insufficient to power the "waking" logic.

2.13.1.2 Wake-up Devices and Events

Table 6 lists the devices or specific events that can wake the computer from specific states.

Table 6. Wake-up Devices and Events

Devices/events that wake up the system...	...from this sleep state	Comments
Power switch	S0iX, S3, S4, S5 ¹	
RTC alarm	S0iX, S3, S4, S5 ¹	Monitor to remain in sleep state
LAN	S0iX, S3, S4, S5 ^{1,3}	"S5 WOL after G3" must be supported; monitor to remain in sleep state
WIFI	S0iX, S3, S4, S5 ^{1,3}	Monitor to remain in sleep state
Bluetooth	S0iX, S3 ¹ , S4	
USB	S0iX, S3, S4, S5 ^{1,2,3}	Wake S4, S5 controlled by BIOS option (not after G3)
PCIE	S0iX, S3, S4	Via WAKE; monitor to remain in sleep state
HDMI CEC	S0iX, S3, S4, S5 ¹	Emulates power button push

Notes:

1. S0iX represents Microsoft Modern Standby.
2. S4 implies operating system support only.
3. Will not wake from Deep S4/S5. USB S4/S5 Power is controlled by BIOS. USB S5 wake is controlled by BIOS. USB S4 wake is controlled by OS driver, not just BIOS option.
4. Windows Fast startup will block wake from LAN and USB from S5.
5. S0iX and S3 are capable on the NUC 13 Extreme products but must be configured in the BIOS under Power Settings, default setting is for S0iX-Modern Standby.



NOTE

The use of these wake events from an ACPI state requires an operating system that provides full ACPI support. In addition, software, drivers, and peripherals must fully support ACPI wake events. Not all Components used will be capable of full S0iX compliance.

2.13.2 Hardware Support

The board provides several power management hardware features, including:

- Wake from Power Button signal
When resuming from an AC power failure, the computer returns to the power state defined in the BIOS. Available states are "Power On", "Stay Off", and "Last State".
- LAN wake capabilities
Enables remote wake-up of the computer through a network. The LAN subsystem monitors network traffic at the Media Independent Interface. Upon detecting a Magic Packet* frame, the LAN subsystem asserts a wake-up signal that powers up the computer.
- Wake from USB
USB bus activity wakes the computer from an ACPI S0iX/S3 state (not after G3).



NOTE

The use of Wake from USB from an ACPI state requires an operating system that provides full ACPI support. Wake from USB requires the use of a USB peripheral that supports Wake from USB.

2.14 Audio Subsystem Software

Audio is supported through the HDMI 2.1 TMDS compatible port interface through the processor and supports eight full range channels of lossless audio formats per port. When using an encoded format (such as DTS-HD MA or Dolby True HD) the board supports a single 7.1 stream. When using an un-encoded format the board supports 8 discrete, un-encoded channels per HDMI port simultaneously, for a total of 16 discrete/un-encoded channels.

2.14.1 HDMI Audio Subsystem Software

HDMI Audio drivers are built into the Graphics driver and are available from Intel's website.

For information about

Obtaining NUC software and drivers

Refer to

<https://downloadcenter.intel.com>

2.14.2 Front Panel Audio Subsystem

The Intel® NUC 13 Extreme Kit features an integrated front panel audio subsystem which supports the following features provided by the Realtek ALC4050 Codec:

- Front Panel Audio Jack Support (see Figure 6 for 3.5 mm audio jack pin out):
 - Speakers only (Stereo)
 - Headphones only (Stereo)
 - Microphone only (mono)
 - Headset (Combo Headphone Stereo/Microphone mono)
 - Maximum Bitrate of 192Khz 24bit



Pin Number	Pin Name	Description
1	Tip	Left Audio Out
2	Ring	Right Audio Out
3	Ring	Common/Ground
4	Sleeve	Audio In/MIC

Figure 6. 4-Pin 3.5 mm (1/8 inch) Audio Jack Pin Out

2.15 Connectors, Headers, and Expansion



CAUTION

Only the following connectors and headers have overcurrent protection: back panel USB, front panel USB, internal USB headers, PCI Express Slots, and M.2 slots.

All other connectors and headers are not overcurrent protected and should connect only to devices inside the computer's chassis, such as fans and internal peripherals. Do not use these connectors or headers to power devices external to the computer's chassis. A fault in the load presented by the external devices could cause damage to the computer, the power cable, and the external devices themselves.

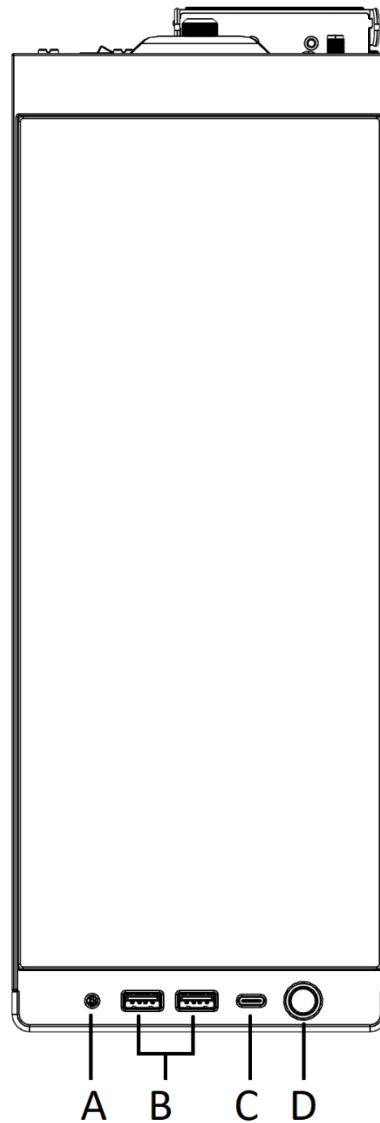
Furthermore, improper connection of USB header single wire connectors may eventually overload the overcurrent protection and cause damage to the board.

This section describes the board's connectors and headers. The connectors and headers can be divided into these groups:

- Front panel I/O connectors
- Back panel I/O connectors
- Baseboard connectors and headers
- Interior chassis connectors and headers
- NUC Element Extreme board connectors and headers

2.15.1 Front Panel Connectors on NUC 13 Extreme Kit

Figure 8 indicates the location of the front panel connectors present on the top of the chassis.

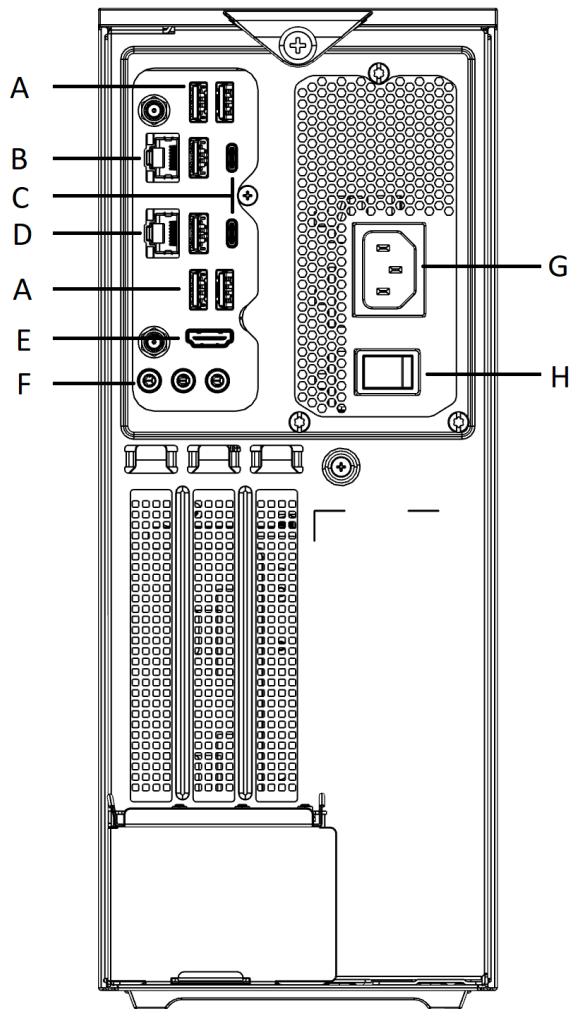


Item	Description
A	3.5mm Speaker/Headset
B	USB 3.2 Gen 1 5Gbps
C	USB 3.2 Gen 2 20Gbps
D	Power button (backlit)

Figure 8. Front Panel Connectors

2.15.2 Back Panel Connectors

Figure 9 indicates the location of the back panel connectors present.



Item	Description
A	USB 3.2 Gen 2 10Gbps Type-A
B	LAN Connector (AQC113-10Gbe)
C	Thunderbolt 4 ports
D	LAN Connector (i226-V)
E	HDMI 2.1 TMDS
F	Audio Jacks (Analog 3.5mm)
G	C13 AC Power Connector
H	AC Power Switch

Figure 9. Back Panel Connectors

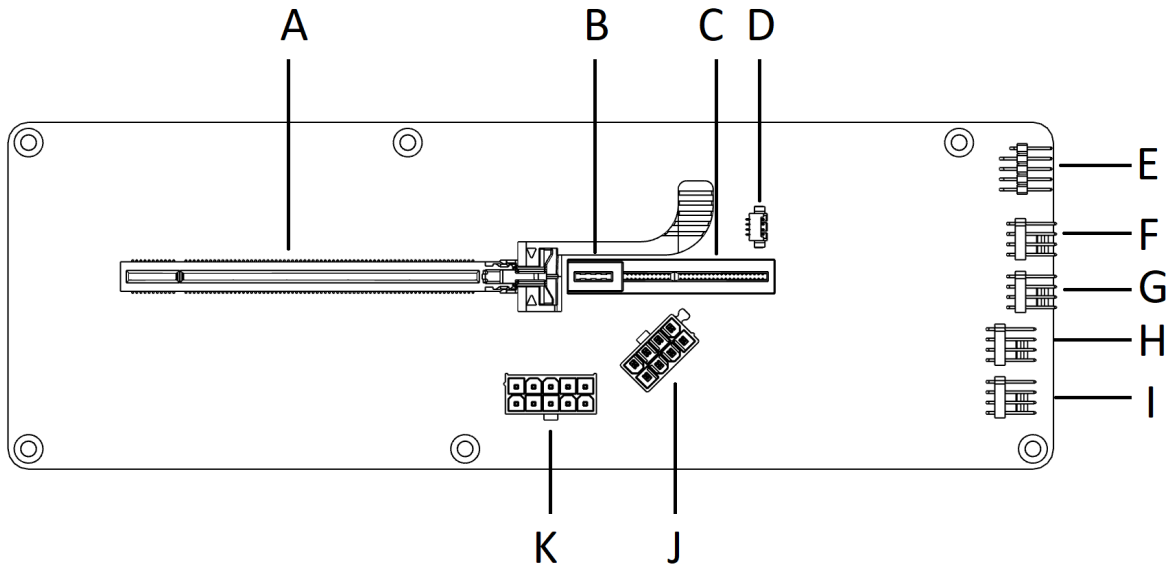
2.15.3 Baseboard Connectors

The NUC 13 Extreme Kit has a baseboard that expands the connectivity of the NUC 13 Extreme Compute Element through the usage of PCI Express lanes. Connectors that are used for expansion through the NUC Element gold fingers to the Baseboard are shown in Table 7.

Item Descriptor	Description
A	Intel NUC 13 Extreme PCIe and IO slot (PCIe Gen5 x 16)
B	NUC Power Tab (Lotes connector Section 2.1.1)
C	Intel NUC Extreme Compute Element Auxiliary x4 slot
D	USB 2.0 micro connector
E	Front Panel IO Header (Standard Desktop Size and layout)
F	System Fan 1
G	System Fan 2
H	System Fan 3 (shares Tach/PWM with Fan 2)
I	12V Pump Fan (does not contain Tach/PWM)
J	EPS 8pin Power Connector
K	ATX12VO 10pin Power Connector

Figure 10 shows a top down view of all connectors and headers on the BBRN1B1 Baseboard.

Table 7. Intel BBRN1B1 Baseboard Topside configuration

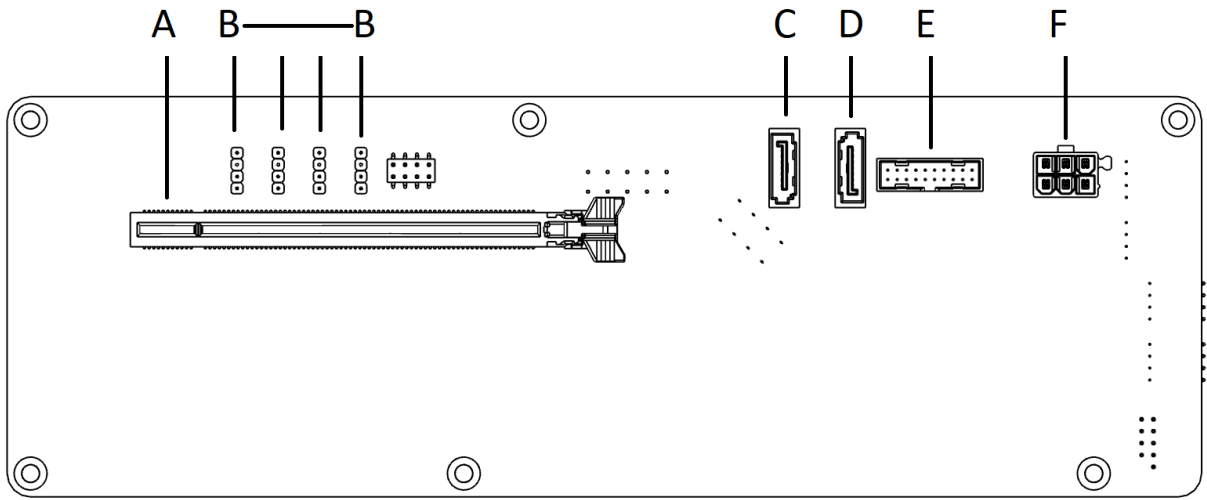


Item Descriptor	Description
A	Intel NUC 13 Extreme PCIe and IO slot (PCIe Gen5 x 16)
B	NUC Power Tab (Lotes connector Section 2.1.1)
C	Intel NUC Extreme Compute Element Auxiliary x4 slot
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F	System Fan 1
G	System Fan 2
H	System Fan 3 (shares Tach/PWM with Fan 2)
I	12V Pump Fan (does not contain Tach/PWM)
J	EPS 8pin Power Connector
K	ATX12VO 10pin Power Connector

Figure 10. BBRN1B1 Topside Baseboard Connectors

2.15.3.1 BBRN1B1 baseboard Bottom Side.

The Intel® NUC 13 Extreme Kit features a bottom mounted LED toggle switch on the baseboard that is has a dedicated button for enabling or disabling the LEDs on the chassis.



Item Descriptor	Description
A	PCIe Gen5 Slot
B	Addressable RGB headers
C	SATA 0
D	SATA 1
E	USB 3.0 IDC Header (2xUSB 3.0, Standard Desktop)
F	SATA Power Header (included in Kit to power two SATA Devices)

Figure 11. BBRN1B1 Baseboard Bottom Side Connectors

2.16 NUC 13 Extreme Element Headers and Connectors

The NUC 13 Extreme Compute Element contains headers and connectors necessary for function inside the NUC 13 Extreme Kit. Figure 12 shows the headers and connectors that are utilized by default and for expansion.

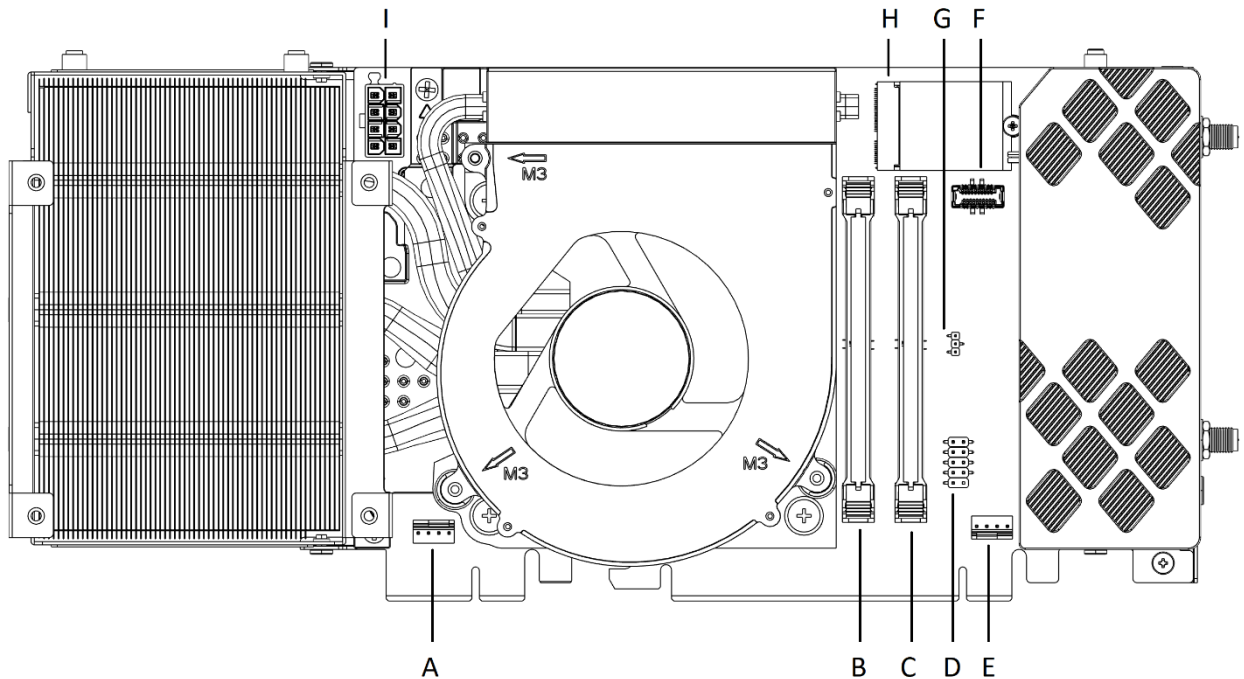


Figure 12. NUC 13 Extreme Compute Element Headers and Connectors

Table 8. Headers and Connectors of the NUC 13 Extreme Compute Element in Figure 12.

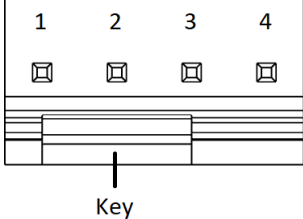
Item from Figure 12	Description
A	4pin Desktop PWM CPU Fan Header 1
B	DDR5 SODIMM 0
C	DDR5 SODIMM 1
D	Desktop Front Panel header
E	4pin Desktop PWM CPU Fan Header 0
F	Internal USB 3.1 Gen 2 Type-C 20pin Header (Key A)
G	BIOS Recovery Jumper
H	M.2 2230 PCIe / CNVI
I	Auxiliary EPS 8-pin Power Connector
J (Not pictured) under shroud.	HD Audio Front Panel Header

2.16.1 Signal Tables for Headers and Connectors

This section more clearly defines the pinouts and connector types used in Table 8.

A, E – 4pin Desktop PWM CPU Fan Headers

Connector is a 1 x 4, 2.54mm pitch; Standard Desktop PWM 4pin fan.

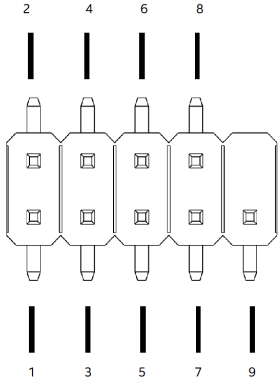
	Pin Number	Pin Definition - Signal
	1	Ground
	2	+12V DC POWER
	3	Tachometer / Sense
	4	Pulse-Width Modulation (PWM)

B, C – DDR5-SODIMM Slots

Connectors are standard vertical mount 262pin DDR5 SODIMM connectors.

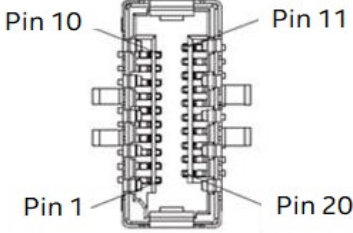
D – 10-pin Front Panel IO Header

Connector is a 2 x 5, 2.54mm pitch connector.

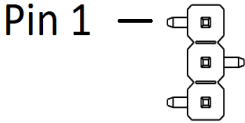
I, Front Panel Header	Pin Number	Signal Name	Description
	1	HDD_POWER_LED	Pull-up 750Ω to +5V
	2	POWER_LED_MAIN	[Out] Front panel LED (main color)
	3	HDD_LED#	[Out] HDD activity LED
	4	POWER_LED_ALT	[Out] Front panel LED (alt color)
	5	GROUND	Ground
	6	POWER_SWITCH#	[In] Power switch
	7	RESET_SWITCH#	[In] Reset switch
	8	GROUND	Ground
	9	+5V_DC (1A) (Vcc)	Power
	10	Key (EMPTY)	No Pin

F - Internal USB 3.1 Gen 2 Type-C 20pin Header (Key A)

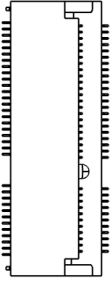
C, Internal USB 3.1 Gen 2 Type-C 20pin Header (Key A)	Pin Number	Signal	Pin Number	Signal
	1	Ground	11	VBUS
	2	TX1+	12	TX2+
	3	TX1-	13	TX2-
	4	Ground	14	Ground
	5	RX1+	15	RX2+
	6	RX1-	16	RX2-

	7	VBUS	17	Ground
	8	CC1	18	D-
	9	SBU1	19	D+
	10	SBU2	20	CC2

G – BIOS Security Jumper

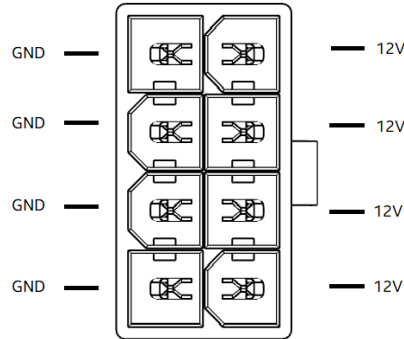
G, M.2 2230 Key E	Spec	Definition
	Normal	Pin 1 and 2 Jumped
	Recovery	Header removed - BIOS in Recovery Mode
	Locked	Pin 2 and 3 Jumped

H – M.2 2230 slot Key -E

G, M.2 2230 Key E	Spec	Definition
	CNVi	CNVi Compliant
	PCIe	PCIe x1 Compliant
	Maximum Power rating	3.3Vdc @ 2.75A

I - EPS 8 Pin Power Connector

The EPS 8 Pin Power Connector follows the ATX standard layout and requirements. With one side being Ground and the opposite side with the connector lock being 12V. When using the NUC Power Tab this connector is not used.



J - 10-pin Front Panel IO Header – Not shown in image under shroud

Connector is a 2 x 5, 2.54mm pitch connector.

I, Front Panel Header	Pin Number	Signal Name
	1	[Port 1] Left Channel
	2	Ground
	3	[Port 1] Right Channel
	4	Presence# (Dongle present)
	5	[Port 2] Right Channel
	6	[Port 1] Sense Return
	7	[Port 1] Sense_Send (Jack Detection)
	8	Key (No Pin)
	9	[Port 2] Left Channel
	10	[Port 2] Sense_Return

2.17 Wireless Network Module

The Intel® NUC 13 Extreme Kit / Compute Element comes with an Intel® Killer™ WI-FI 6E 1690 i module preinstalled into the M.2 2230 slot.

For information about

Intel Wireless Technologies

Refer to

<http://www.intel.com/wireless>

2.18 Antenna Connectors

The NUC 13 Extreme Kit wireless module has front and rear panel internal antennas that connect to the NUC 13 Extreme Compute Element RPSMA style connectors. For wireless and Bluetooth operation appropriate antennas will be required. Figure 13 shows the location of the two antenna connectors on the NUC 13 Extreme Compute Element

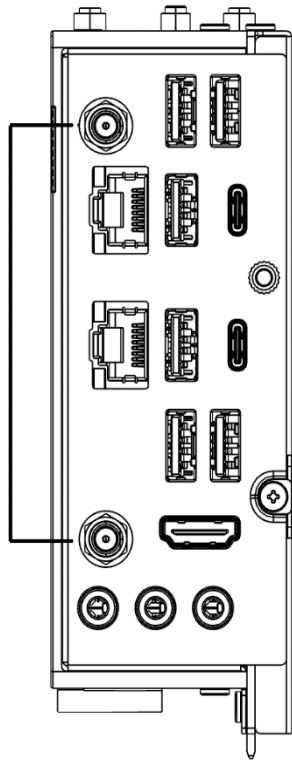


Figure 13. Location of the Antenna Connectors

The wireless module on the NUC 13 Extreme Compute element is the Intel® Killer™ WIFI 6E AX1690 i and uses a standard 2x2 mm size RF micro coaxial receptacle (connector) with an outer diameter of 1.5 mm as defined in the PCI-E M.2 Specification, the coaxial receptacle is then changed to the RPSMA standard antenna connectors.

2.19 Internal Power Supply

The Intel® NUC 13 Extreme Kit has an internal power supply that takes in AC 100-240V and outputs DC 12V, and 12Vsb.

The default power supply installed in the NUC 13 Extreme Kit is a FSP750-27SCB 750W 80+Gold ATX12VO rated supply.

Table 9. Power supply rating table.

Model No. FSP750-27SCB		
AC Input	100-240V~, 10-5A, 60-50Hz	
DC Output	+12V	+12Vsb
	54.0A	1.5A
	750W Max	18W
Total output continuous shall not exceed	750W	

The internal power supply FSP650-57SAB-A 650W features the following cables:

- 12VO 10pin power connector for System baseboard
- EPS12V 8pin power connector for System baseboard
- PCI Express 6+2pin straight power connector
- PCI Express 6+2pin straight power connector + 6+2 Daisy Chain*
- PCI Express Gen5 connector 300W for GPU



CAUTION

The maximum combined rated power distribution from the PCI Express connectors is 450W, exceeding this rating may result in damage.

Disconnect the attached AC power cable before you open or service the device. Installing or removing devices from the Intel® NUC 13 Extreme Kit while a power source is connected to the Kit may cause damage to the Intel® NUC 13 Extreme Kit, operating system corruption, create a no boot condition or result in data loss.

*The Intel® NUC 13 Extreme Kit and Intel® NUC 13 Extreme Compute Element are compatible and compliant with the **ATX12VO** design specification. Using a standard ATX 12V or other power supply design solutions is not a supported or warranted use case and may result in damage to the system.*

2.20 Add-in Card Limitations

The Intel® NUC 13 Extreme Kit supports the installation of add-in PCIe cards. The PCI Express 5.0 x16 on the baseboard mentioned in Section 2.15.3 is designed to accept PCI Express compliant devices. The table below demonstrates the maximum accepted dimensions and specifications for add-in cards.

Table 10. PCI Express Add-in Cards Limitations

Dimensions			
Add-in Card Type	Maximum Length	Maximum Width	Maximum Height
PCI Express 5.0 x16 Add-in Card Triple Slot	313mm from rear of internal PCIe bracket to end of card	Triple Slot Spec limit Total ~63mm (55.12mm Front components +2.7mm rear backplate +1.7mm PCB thickness)	155mm From Card edge to absolute top most component or connector of card, this includes power cables necessary.

The maximum power consumption supported for add-in card design is ~450W (150W from each PCI Express 6+2/8pin). Other design restrictions may occur, using the PCIe Gen5 connector while also using the 6+2 connectors may result in damage. The PCIe Gen5 power connector, also known as the 12VHPWR connector is designed for use with 300W GPUs.

For a list of validated and compatible add-in cards go to the Intel® Product Compatibility Tool <https://compatibleproducts.intel.com/ProductDetails?activeModule=Intel%C2%AE%20NUC>

2.21 NUC 13 Extreme Kit Dimensions

The following figures illustrate the mechanical form factor for the NUC 13 Extreme Kit. All dimensions are shown in millimeters (mm).

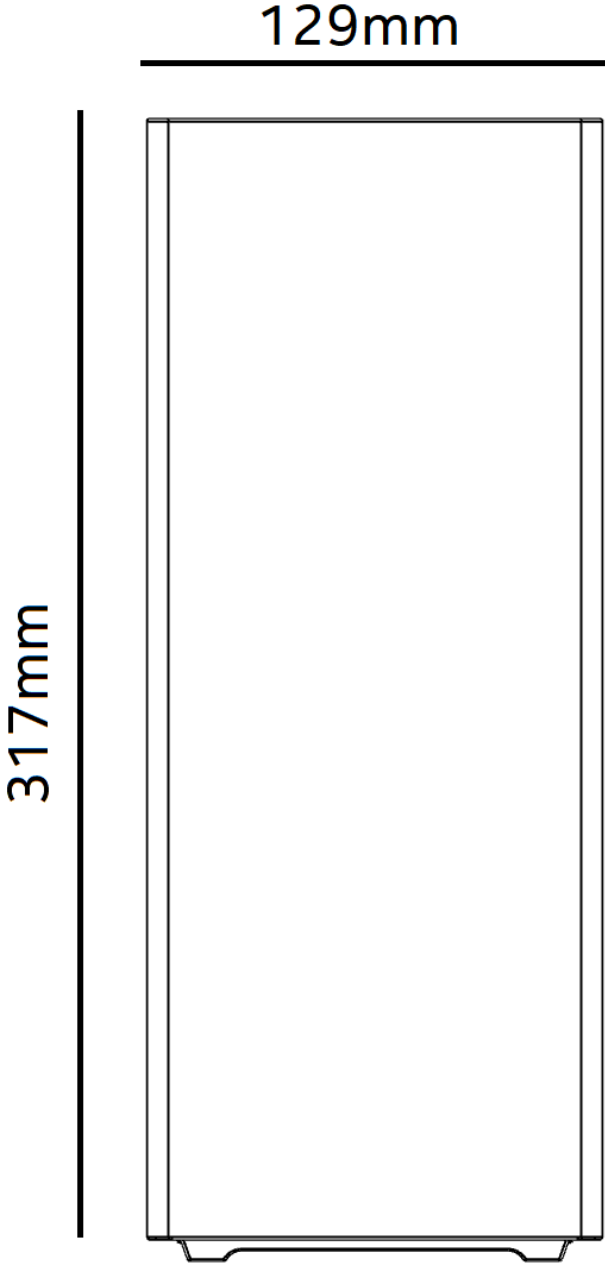


Figure 14. Front Side

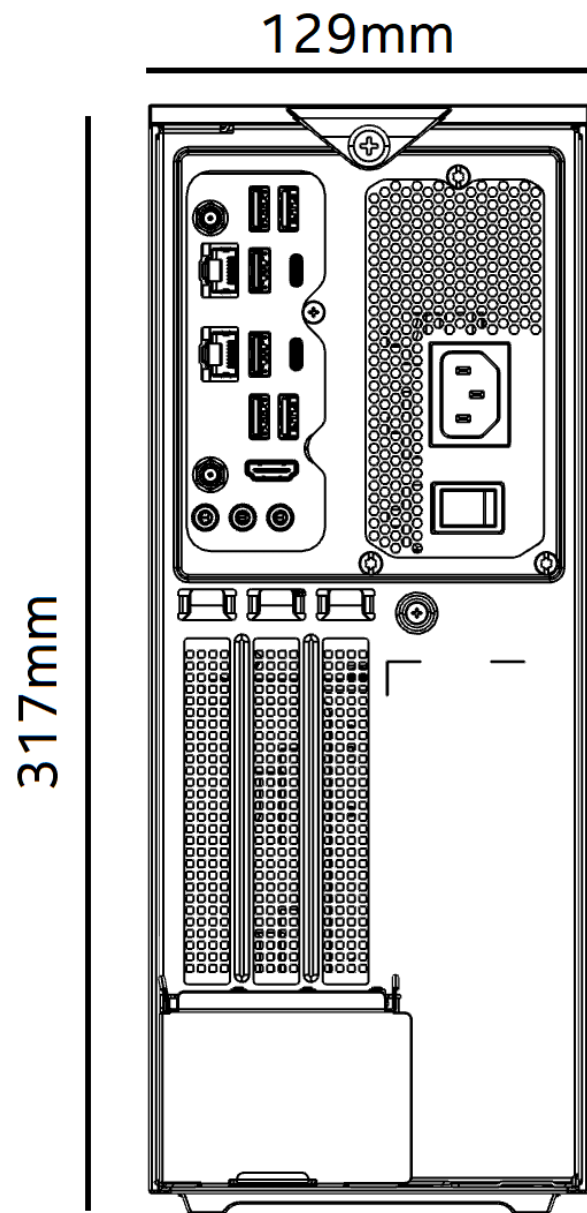


Figure 15. Back Side

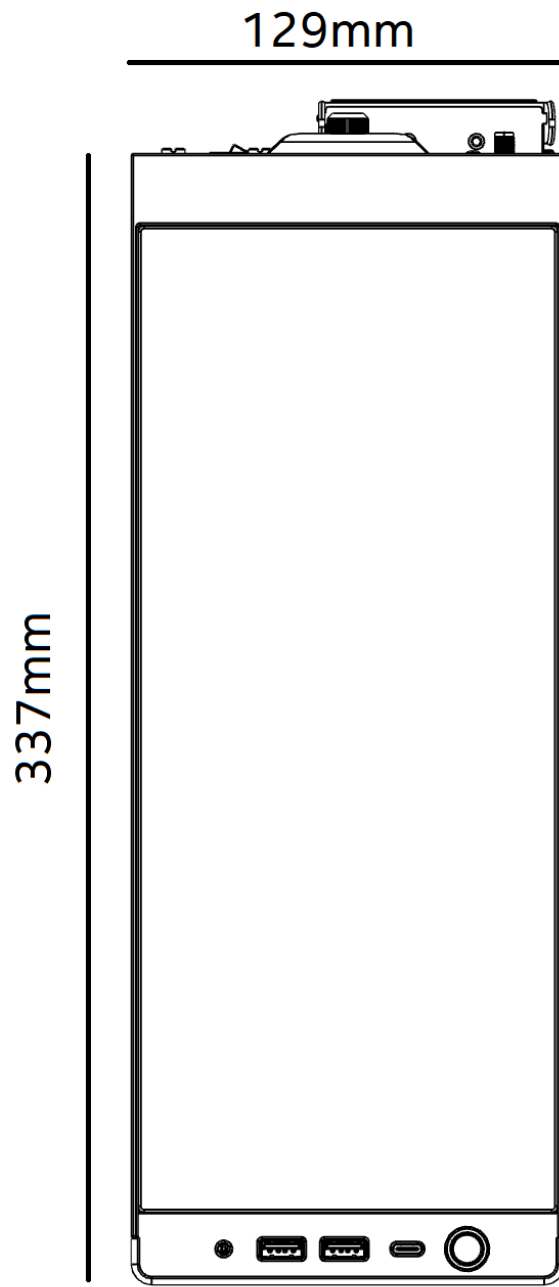


Figure 16. Top Side

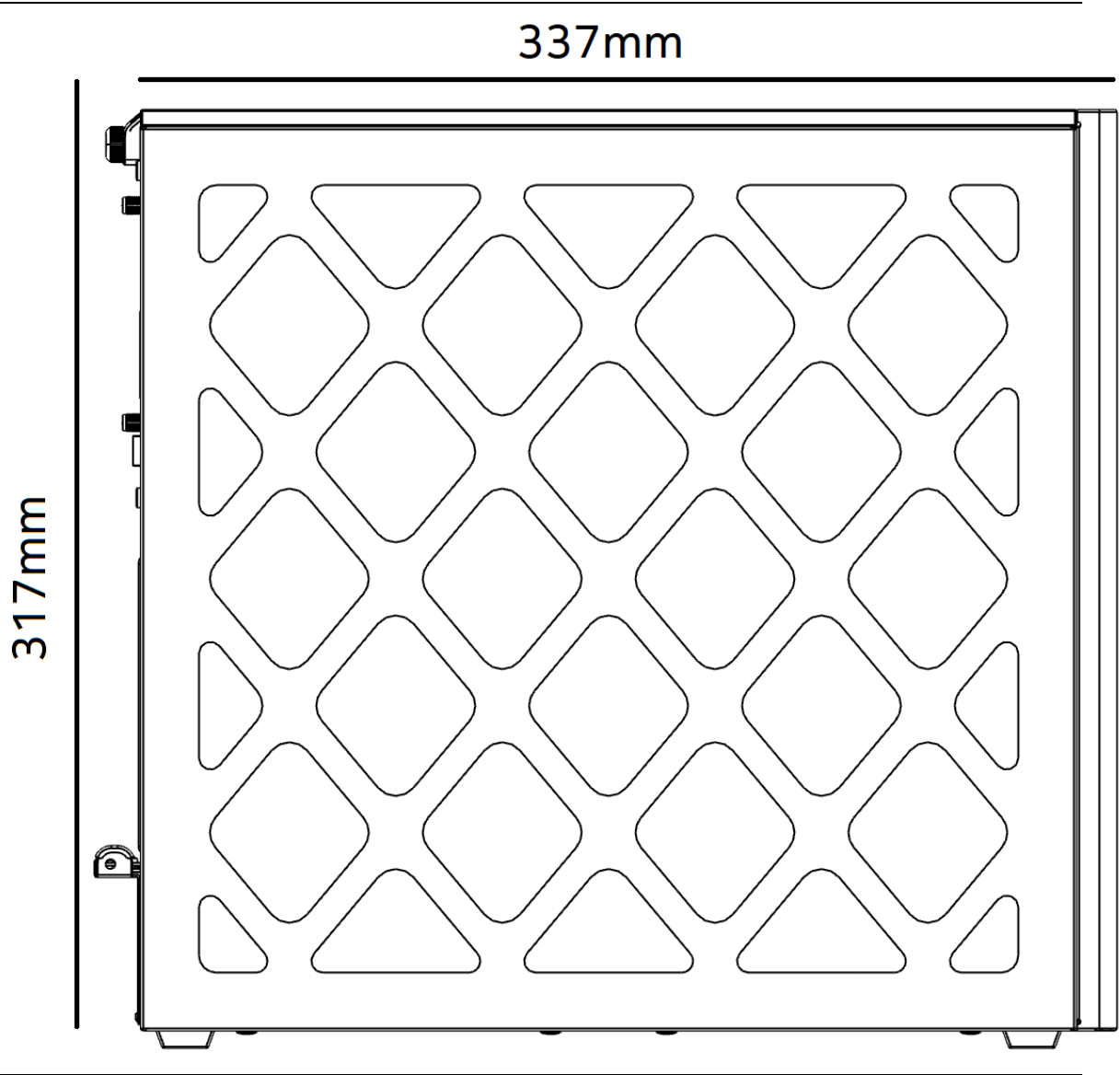


Figure 17. Side Panel

2.22 Thermal Considerations



CAUTION

The thermal design of the NUC 13 Extreme Kit is designed as a flow through to take in airflow from the right side and pass it to the left side. Failure to ensure appropriate airflow may result in reduced performance of both the processor and/or voltage regulator or, in some instances, damage to the board.

The NUC 13 Extreme Kit features split chamber design which is designed to prevent pre-heated air from entering the CPU blower fan, failure to provide adequate air gap of the left and right panels may result in reduction of performance of both the processor and/or the voltage regulator.

All responsibility for determining the adequacy of any thermal or system design remains solely with the system integrator. Intel makes no warranties or representations that merely following the instructions presented in this document will result in a system with adequate thermal performance.



CAUTION

Ensure that the ambient temperature does not exceed the board's maximum operating temperature. Failure to do so could cause components to exceed their maximum case temperature and malfunction. For information about the maximum operating temperature, see the environmental specifications in Section 2.24.

2.23 Reliability

The demonstrated Mean Time Between Failures (MTBF) is done through 24/7 testing. Full Intel® NUC systems in chassis with memory, SSD or HDD, and fans are run at 100% of target PWM for 90 days while running system wide stress inducing software in a 35 °C ambient air temperature chamber. The demonstrated MTBF for Intel NUC 13 Extreme Kit is 50,000 hours.

2.24 Environmental

Table 11 lists the environmental specifications for the Intel® NUC 13 Extreme Kit.

Table 11. Environmental Specifications

Parameter	Specification		
Temperature			
Sustained Storage Limits (i.e. warehouse)	-20 °C to +40 °C		
Short Duration Limits (i.e. shipping)	-40 °C to +60 °C		
Ambient Operating – NUC Kit*	0 °C to +35 °C		
* Processor performance may automatically decrease when the system exceeds ambient operating temperature ranges above.			
Shock (Board)			
Unpackaged	25 g trapezoidal waveform		
	Velocity change of 170 inches/s ²		
Packaged	Free fall package drop machine set to the height determined by the weight of the package.		
	Product Weight (pounds)	Non-palletized Product drop height (inches)	Palletized drop heights (single product) (inches)
	<20	36	N/A
	21-40	30	N/A
	41-80	24	N/A
	81-100	18	12
	100-120	12	9
Vibration (System)			
Unpackaged	Random profile 5 Hz @ 0.001 g ² /Hz to 20 Hz @ 0.01 g ² /Hz(slope up)		
	20 Hz to 500 Hz @ 0.01 g ² /Hz (flat)		
	Input acceleration is 2.20g RMS		
Packaged	Random profile 5 Hz @ 0.01 g ² /Hz to 20 Hz @ 0.02 g ² /Hz(slope up)		
	20 Hz to 500 Hz @ 0.02 g ² /Hz (flat)		
	Input acceleration is 3.13g RMS		

Note: Before attempting to operate the Intel® NUC 13 Extreme Kit, the overall temperature of the system must be above the minimum operating temperature specified. It is recommended that the system temperature be at least room temperature before attempting to power on the NUC 13 Extreme Kit. The operating and non-operating environment must avoid condensing humidity.

2.25 Shipping Considerations for System Integrators

The Intel® NUC 13 Extreme Kit is designed to properly integrate full length triple slot add-in-cards. Due to drop forces exerted on packages being shipped, it is recommended where possible to ship the add-in-card separately to avoid damage to the interior of the NUC 13 Extreme Kit chassis or the add-in-card itself.

When shipping the add-in-card separately is not possible it is highly recommended to use the included GPU Support Bracket and potentially add ESD-Safe packing material in-between the add-in-card and the bottom panel, as well as around the add-in-card to prevent vibration and the chance to dislodge the card mid shipment. Figure 18. GPU support Bracket Installation Guidance provides simple instruction for installing the GPU support bracket, for more detailed instructions from the integration guide visit. www.intel.com/NUCSupport

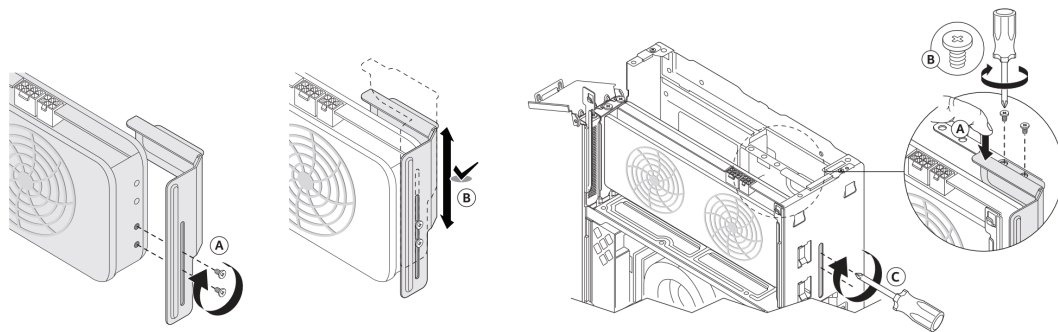


Figure 18. GPU support Bracket Installation Guidance



NOTE

Packaging material must be removed from system prior to operation to maintain proper thermal performance of the NUC 13 Extreme Kit.

2.26 Optional Fan Mounting Locations

The NUC 13 Extreme Kit and Compute Element feature additional fan mounting locations to provide cooling options for customers.

2.26.1 Optional Fan Mounting Locations Kit

The NUC 13 Extreme Kit features three additional chassis fan mounting locations. These locations are designed to mount a standard desktop 120mm x 120mm fan with self-tapping fan mount screws. Two of the fan mounts are on the bottom of the chassis, while one is on the back side if the hard drive bracket is removed. While there are three total extra mounting locations, there is only one additional header for these fan locations. See figure 19 below for the locations.

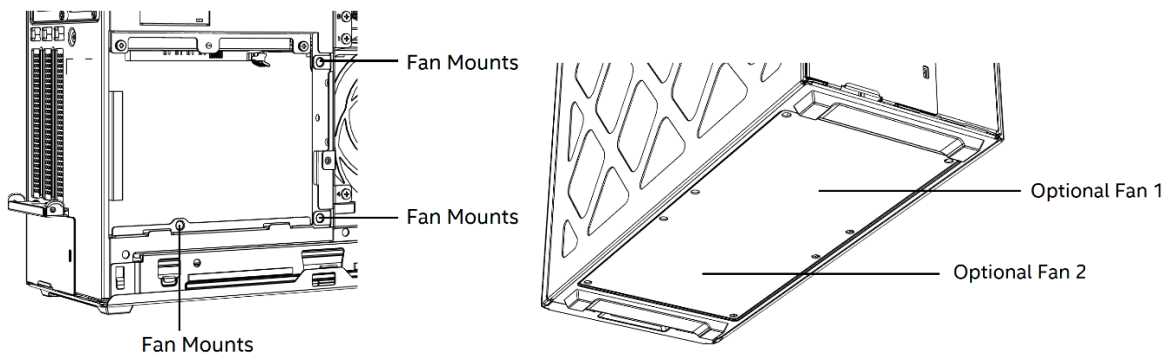


Figure 19. Optional Chassis Fan Mounting Locations

2.26.2 Optional Fan Mounting Location Compute Element

The NUC 13 Extreme Compute Element features one additional chassis fan mounting location. This additional location is designed to mount a standard desktop 92mm x 92mm fan to the Element thermal solution using M3 threaded screws. It is possible to mount a 92mm x 92mm x 15mm thick fan in this location while using the NUC 13 Extreme chassis. See figure 20 below for the location.

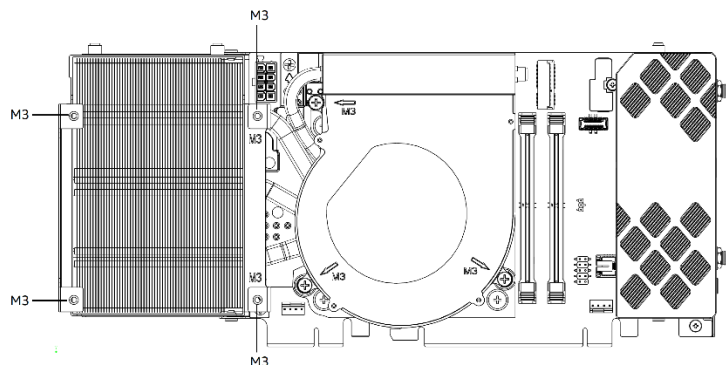


Figure 20. Optional NUC Element Fan Mounting Location

3 Overview of BIOS Features

3.1 Introduction

The board uses Intel AMI BIOS core that is stored in the Serial Peripheral Interface Flash Memory (SPI Flash) and can be updated using a disk-based program. The SPI Flash contains the Visual BIOS Setup program, POST, the PCI auto-configuration utility, LAN EEPROM information, and Plug and Play support.

The BIOS displays a message during POST identifying the type of BIOS and a revision code. The initial production BIOSs are identified as TBD.

The Visual BIOS Setup program can be used to view and change the BIOS settings for the computer. The BIOS Setup program is accessed by pressing the <F2> key after the Power-On Self-Test (POST) memory test begins and before the operating system boot begins.



BIOS FLASH MEMORY ORGANIZATION

The Serial Peripheral Interface Flash Memory (SPI Flash) includes a 16 MB flash memory device.

3.2 System Management BIOS (SMBIOS)

SMBIOS is a Desktop Management Interface (DMI) compliant method for managing computers in a managed network.

The main component of SMBIOS is the Management Information Format (MIF) database, which contains information about the computing system and its components. Using SMBIOS, a system administrator can obtain the system types, capabilities, operational status, and installation dates for system components. The MIF database defines the data and provides the method for accessing this information. The BIOS enables applications such as third-party management software to use SMBIOS. The BIOS stores and reports the following SMBIOS information:

- BIOS data, such as the BIOS revision level
- Fixed-system data, such as peripherals, serial numbers, and asset tags
- Resource data, such as memory size, cache size, and processor speed
- Dynamic data, such as event detection and error logging

Non-Plug and Play operating systems require an additional interface for obtaining the SMBIOS information. The BIOS supports an SMBIOS table interface for such operating systems. Using this support, an SMBIOS service-level application running on a non-Plug and Play operating system can obtain the SMBIOS information. Additional board information can be found in the BIOS under the Additional Information header under the Main BIOS page.

3.3 Legacy USB Support

Legacy USB support is not offered with the Intel® NUC 13 Extreme Kit or Intel® NUC 13 Extreme Compute Element.

3.4 BIOS Updates

The BIOS can be updated using one of the following methods:

- Intel® Express BIOS Update utility, which enables automated updating while in the Windows environment. Using this utility, the BIOS can be updated from a file on a hard disk, a USB drive, a CD-ROM, or from the file location on the Web.
- Intel® F7 switch during POST allows a user to select where the BIOS Capsule file .CAP file is located and perform the update from that location/device. This is similar to performing a BIOS Recovery without removing the BIOS configuration jumper. The F7 switch supports FAT, FAT32, and NTFS format storage.

Both utilities verify that the updated BIOS matches the target system to prevent accidentally installing an incompatible BIOS.



NOTE

Review the instructions distributed with the upgrade utility before attempting a BIOS update.

For information about	Refer to
BIOS update utilities	https://www.intel.com/content/www/us/en/support/articles/000033291.html

3.4.1 Language Support

The BIOS Setup program and help messages are supported in US English. Check the Intel web site for support.

3.4.2 BIOS Recovery

It is unlikely that anything will interrupt a BIOS update; however, if an interruption occurs, the BIOS could be damaged. Table 12 lists the drives and media types that can and cannot be used for BIOS recovery and Table 13 lists the behaviors demonstrated by use of the Security Jumper. The BIOS recovery media does not need to be made bootable. Location of Security jumper is detailed in Figure 12.

Table 12. Acceptable Drives/Media Types for BIOS Recovery

Media Type ^(Note)	Can be used for BIOS recovery?
Hard disk drive (connected to SATA or USB)	Yes
CD/DVD drive (connected to USB)	Yes
USB flash drive	Yes

Table 13. BIOS Security Jumper Settings

Function/Mode	Jumper Setting	Configuration
Normal	1-2	The BIOS uses current configuration information and passwords for booting.
Lockdown	2-3	The BIOS uses current configuration information and passwords for booting, except: <ul style="list-style-type: none"> All POST Hotkeys are suppressed (prompts are not displayed and keys are not accepted. For example, F2 for Setup, F10 for the Boot Menu). Power Button Menu is not available (see Section 5.4.2 Power Button Menu). BIOS updates are not available except for automatic Recovery due to flash corruption.
Configuration	None	BIOS Recovery Update process if a matching *.bio file is found. Recovery Update can be cancelled by pressing the Esc key. If the Recovery Update was cancelled or a matching *.bio file was not found, a Config Menu will be displayed. The Config Menu consists of the following (followed by the Power Button Menu selections): <ul style="list-style-type: none"> [1] Suppress this menu until the BIOS Security Jumper is replaced. [2] Clear BIOS User and Supervisor Passwords. [3] Reset Intel® AMT to default factory settings. [4] Clear Trusted Platform Module. Warning: Data encrypted with the TPM will no longer be accessible if the TPM is cleared. <ul style="list-style-type: none"> [F2] Intel® Visual BIOS. [F4] BIOS Recovery. See Section 5.4.2 Power Button Menu

NOTE

Supported file systems for BIOS recovery:

- NTFS (sparse, compressed, or encrypted files are not supported)
- FAT32
- FAT16
- FAT12
- ISO 9660

For information about**Refer to**

BIOS recovery

<https://www.intel.com/content/www/us/en/support/articles/000033291/>

3.5 Boot Options

In the BIOS Setup program, the user can choose to boot from a hard drive, optical drive, removable drive, or the network. The default setting is for the optical drive to be the first boot device, the hard drive second, removable drive third, and the network fourth.



NOTE

Optical drives are not supported by the onboard SATA connectors. Optical drives are supported only via the USB interfaces.

3.5.1 Network Boot

The network can be selected as a boot device. This selection allows booting from the onboard LAN or a network add-in card with a remote boot ROM installed.

Pressing the <F12> key during POST automatically forces booting from the LAN. To use this key during POST, the User Access Level in the BIOS Setup program's Security menu must be set to Full.

3.5.2 Booting Without Attached Devices

For use in embedded applications, the BIOS has been designed so that after passing the POST, the operating system loader is invoked even if the following devices are not present:

- Video cable
- Keyboard
- Mouse

3.5.3 Boot Device Selection During POST

Pressing the <F10> key during POST causes a boot device menu to be displayed. This menu displays the list of available boot devices. Table 14 lists the boot device menu options.

Table 14. Boot Device Menu Options

Boot Device Menu Function Keys	Description
<↑> or <↓>	Selects a default boot device
<Enter>	Exits the menu, and boots from the selected device
<Esc>	Exits the menu and boots according to the boot priority defined through BIOS setup

3.5.4 Power Button Menu

As an alternative to Back-to-BIOS Mode or normal POST Hotkeys, the user can use the power button to access a menu. The Power Button Menu is accessible via the following sequence:

1. System is in S4/S5 (not G3)
2. User pushes the power button and holds it down for 3 seconds
3. The system will emit three short beeps from the front panel (FP) audio port, then stop to signal the user to release the power button. The FP power button LED will also change from Solid White to Flashing White when the user can release the power button.
4. User releases the power button before the 4-second shutdown override

If this boot path is taken, the BIOS will use default settings, ignoring settings in VPD where possible.

At the point where Setup Entry/Boot would be in the normal boot path, the BIOS will display the following prompt and wait for a keystroke:

[ESC] Normal Boot
[F2] Intel Visual BIOS
[F3] Disable Fast Boot
[F4] BIOS Recovery
[F7] Update BIOS
[F10] Enter Boot Menu
[F12] Network Boot

[F2] Enter Setup is displayed instead if Visual BIOS is not supported.

[F3] Disable Fast Boot is only displayed if at least one Fast Boot optimization is enabled.

If an unrecognized key is hit, then the BIOS will beep and wait for another keystroke. If one of the listed hotkeys is hit, the BIOS will follow the indicated boot path. Password requirements must still be honored.

If Disable Fast Boot is selected, the BIOS will disable all Fast Boot optimizations and reset the system.

3.6 Hard Disk Drive Password Security Feature

The Hard Disk Drive Password Security feature blocks read and write accesses to the hard disk drive until the correct password is given. Hard Disk Drive Passwords are set in BIOS SETUP and are prompted for during BIOS POST. For convenient support of S3 resume, the system BIOS will automatically unlock drives on resume from S3. Valid password characters are A-Z, a-z, and 0-9. Passwords may be up to 19 characters in length.

The User hard disk drive password, when installed, will be required upon each power-cycle until the Master Key or User hard disk drive password is submitted.

The Master Key hard disk drive password, when installed, will not lock the drive. The Master Key hard disk drive password exists as an unlock override in the event that the User hard disk drive password is forgotten. Only the installation of the User hard disk drive password will cause a hard disk to be locked upon a system power-cycle.

Table 15 shows the effects of setting the Hard Disk Drive Passwords.

Table 15. Master Key and User Hard Drive Password Functions

Password Set	Password During Boot
Neither	None
Master only	None
User only	User only
Master and User Set	Master or User

During every POST, if a User hard disk drive password is set, POST execution will pause with the following prompt to force the user to enter the Master Key or User hard disk drive password:

“Enter Hard Disk Drive Password:”

Upon successful entry of the Master Key or User hard disk drive password, the system will continue with normal POST.

If the hard disk drive password is not correctly entered, the system will go back to the above prompt. The user will have three attempts to correctly enter the hard disk drive password. After the third unsuccessful hard disk drive password attempt, the system will halt with the message:

“Hard Disk Drive Password Entry Error”

A manual power cycle will be required to resume system operation.



NOTE

The passwords are stored on the hard disk drive so if the drive is relocated to another computer that does not support Hard Disk Drive Password Security feature, the drive will not be accessible.

3.7 BIOS Security Features

The BIOS includes security features that restrict access to the BIOS Setup program and who can boot the computer. A supervisor password and a user password can be set for the BIOS Setup program and for booting the computer, with the following restrictions:

- The supervisor password gives unrestricted access to view and change all the Setup options in the BIOS Setup program. This is the supervisor mode.
- The user password gives restricted access to view and change Setup options in the BIOS Setup program. This is the user mode.
- If only the supervisor password is set, pressing the <Enter> key at the password prompt of the BIOS Setup program allows the user restricted access to Setup.
- If both the supervisor and user passwords are set, users can enter either the supervisor password or the user password to access Setup. Users have access to Setup respective to which password is entered.
- Setting the user password restricts who can boot the computer. The password prompt will be displayed before the computer is booted. If only the supervisor password is set, the computer boots without asking for a password. If both passwords are set, the user can enter either password to boot the computer.
- For enhanced security, use different passwords for the supervisor and user passwords.
- Valid password characters are A-Z, a-z, and 0-9. Passwords may be up to 16 characters in length.
- To clear a set password, enter a blank password after entering the existing password.

Table 16 shows the effects of setting the supervisor password and user password. This table is for reference only and is not displayed on the screen.

Table 16. Supervisor and User Password Functions

Password Set	Supervisor Mode	User Mode	Setup Options	Password to Enter Setup	Password During Boot
Neither	Can change all options (Note)	Can change all options (Note)	None	None	None
Supervisor only	Can change all options	Can change a limited number of options	Supervisor Password	Supervisor	None
User only	N/A	Can change all options	Enter Password Clear User Password	User	User
Supervisor and user set	Can change all options	Can change a limited number of options	Supervisor Password Enter Password	Supervisor or user	Supervisor or user

Note: If no password is set, any user can change all Setup options.

3.8 Error Messages

3.8.1 BIOS Error Messages

Table 17 lists the error messages and provides a brief description of each.

Table 17. BIOS Error Messages

Error Message	Explanation
CMOS Battery Low	The battery may be losing power. Replace the battery soon.
CMOS Checksum Error	The CMOS checksum is incorrect. CMOS memory may have been corrupted. Run Setup to reset values.
Memory Size Decreased	Memory size has decreased since the last boot. If no memory was removed, then memory may be bad.
No Boot Device Available	System did not find a device to boot.
CMOS Timer Not Set	The battery may be losing power. Replace the battery soon.
Processor Thermal Trip	Processor overheated.
Auto RTC Reset	The system triggers RTC clear to recover the system back to the normal condition from consecutive boot failure.

4 Characterized Errata

This section of the document communicates product Errata for the Intel® NUC 13 Extreme Kit and the Intel® NUC 13 Extreme Compute Element.

Errata are design defects or deviations from current published specifications for a given product. Published errata may or may not be corrected. Hardware and software designed to be used with any given processor stepping must assume that all errata documented for that process stepping are present on all devices.

There are no characterized errata at this time.