

Amulet Hotkey CoreStation HX2000 Node

User Manual

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1. Important Safety Information

Caution

To prevent damage to the CoreStation HX install and follow proper use guidelines in accordance with these instructions

- Only use accessories provided by Amulet Hotkey, including power supply mains leads. The mains leads include a protective earthing conductor which must be connected to a socket outlet with an earthing connection.
- Always turn off the compute nodes before disconnecting power
- Turn off and disconnect all power supplies before handling the enclosure
- This enclosure is designed to use one to four power supplies, to disconnect from its power source, all mains leads must be unplugged
- The network ports of this product are intended to be connected to the building internal network only and not to external ports outside of the building.
- Do not expose the enclosure to moisture
- Do not place objects filled with liquid on or near the enclosure
- Refer all servicing to qualified personnel

Laser Safety

- This enclosure may be fitted with SFP network modules that contain class 1 lasers. The SFP module emits invisible radiation which can cause harm if installed or serviced incorrectly.
- Complies with 1 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007.
- Warning: Class 1 laser product
- Warning: Invisible laser radiation can emit from the aperture of the SFP port when no fibre is connected. To avoid exposure to laser radiation, do not stare at apertures.
- Warning: Only trained and qualified personnel may install, replace, or service this equipment

2. HX2000 Overview

2.1 Overview

CoreStation HX2000 nodes are designed for use with the CoreStation HX5 enclosure. See the CoreStation HX5 System Installation Guide for details of the enclosure.

The CoreStation HX Workstation nodes are complete desktop computers which operate independently from one another and rely on support services delivered by the Enclosure and system management.

There is a system-level interaction between workstation nodes based on available system power and cooling, but otherwise the nodes can be removed and inserted without any consideration to the workload and status of others.

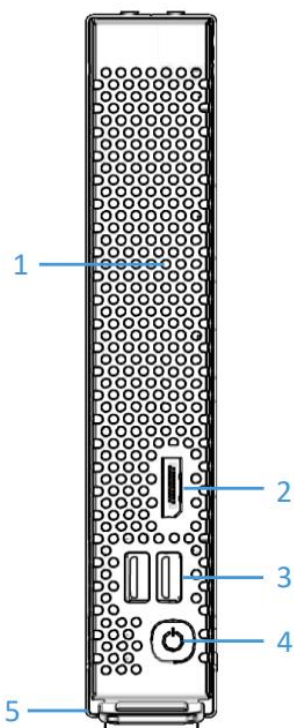


Figure 1 - HX2000 Workstation Node



Figure 2- HX2000 Workstation Node front

2.2 Workstation Node front view



1	Cooling air inlet	Cool air is drawn into the front of the workstation node over the full height of the front panel. Take care not to obstruct this inlet air when using the front panel ports.
2	Local Video Output (DisplayPort)	Used for direct connection to the local video output of the workstation for initial setup or diagnosis if out-of-band KVM is not available.
3	Local USB ports (USB-A, 3.0 5Gbps)	Used for direct connection of local USB devices to the Workstation for initial OS install when a network boot source or out-of-band KVM is not available.
4	Power button and status indicator	Power Button is used for manual shutdown when a workstation node must be removed without access to the management console. Power indicator shows a summary of the workstation node state and any serious health warnings which affect the node.
5	Latch handle	Physical handle used to latch the node into the Enclosure.

3.3 Workstation Node internal view

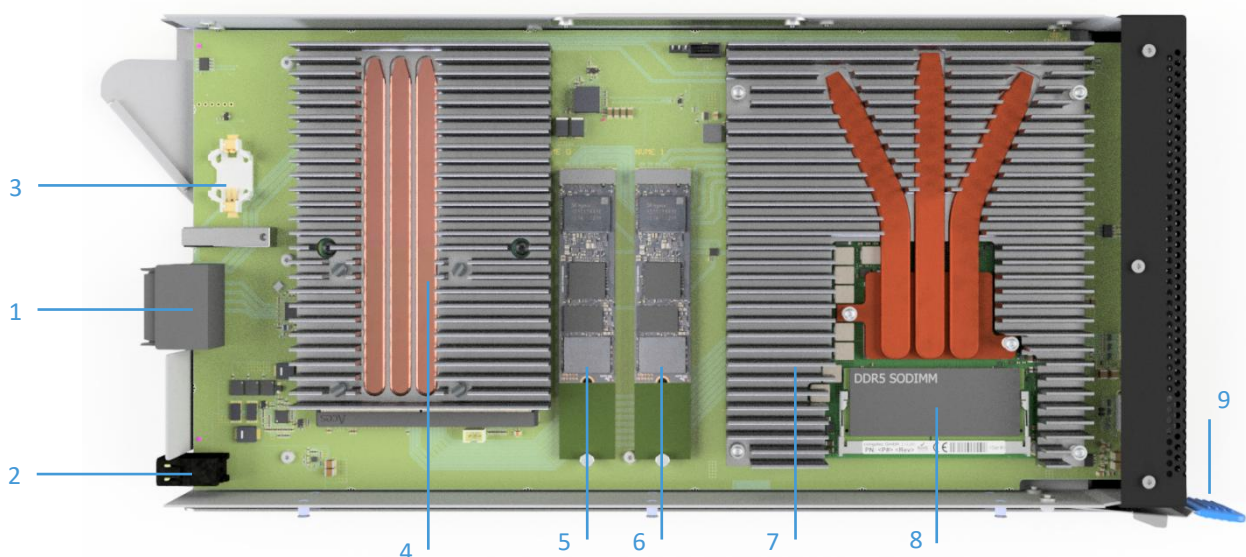


Figure 3 HX2000 Workstation Node with discrete GPU

1	Data Connector	Provides connection to Management controller module for network and system management services
2	Power Connector	Provides 12V input power to the workstation node
3	RTC Battery	Maintains Real-time clock and BIOS settings when node is removed from the Enclosure.
4	Discrete GPU	Optional discrete GPU for higher performance on graphically intensive tasks. Standard MXM 3.1 type modular GPU form factor.
5	Storage position A	Primary M.2 storage
6	Storage position B	Secondary M.2 storage
7	Processor module	Workstation Node Processor module containing fixed soldered-down CPU, support and power circuitry.
8	Memory modules	Dual-channel DDR5 SODIMM CPU Memory
9	Latch handle	Physical handle used to latch the node into the Enclosure.

3.4 Node Status Indicator

Colour and Cadance	Workstation Node State
Off	No power is provided to the node
Solid Amber	Shutdown
Solid Green	Healthy and operational
Blinking Green (Once per second)	Main Operating System is booting, or other operation is in progress such as firmware or BIOS update.
Flashing Amber	Error or health alert on this node
Flashing Blue	Node Identify - The identification request has been enabled from the management console in order to signal to a technician that this workstation node needs attention.

3.5 Node power button

Workstation node power states would typically be controlled from the management console but can also be manually changed using the power button. The power button has similar functionality to a desktop PC.

Workstation Node State	Power button function
Enclosure not powered	No effect
Shutdown/Standby	Instructs node to power on and boot
Active	Short press (< 4 seconds) - Instruct OS to perform graceful shutdown Long press (> 4 seconds) - Power off immediately

3.6 Insertion and Removal

Workstation nodes can be inserted and removed at any time.

When a node is inserted, the System Management Controller will establish communication with the Node Management Controller and check if it is possible to power up the node. The node Management Controller will be updated to the version running on the enclosure and then the node will be configured for Remote Console access.

It is recommended to power down a node before removal to avoid corruption to the operating system and also to avoid excessive wear on the power connector and power circuitry.

3. HX2000 Node Specifications

3.1 CPU

Each workstation node has its own CPU module board which contains the CPU, memory, BIOS and supporting circuitry. The module is fitted and configured at the factory and is not user-replaceable.

The CPU has an integrated AI co-processor and GPU for accelerating workloads.

Workstation Node Series	Processor family	CPU Options	Core Count	Integrated GPU	AI Co-processor
CoreStation HX2000	Intel Core Ultra 100 series “Meteor Lake H”	Core Ultra 7 165H	16 Cores 22 threads 6P+8E+2ELP	Intel Arc Graphics (Alchemist architecture)	Intel AI Boost NPU3 11.5 TOPS
	Intel Core Ultra 200 series “Arrow Lake H”	Core Ultra 9 285H	16 Cores 16 threads 6P+8E+2ELP	Intel Arc 140T GPU (Battlemage architecture)	Intel AI Boost NPU3 13 TOPS

3.2 Memory

The CPU module supports dual-channel memory, where each channel has one SODIMM connector. Both channels must be populated for maximum performance.

The SODIMM memory can be replaced and upgraded by the customer using compatible modules supplied by Amulet Hotkey. Only memory modules supplied by Amulet Hotkey are supported for use with HX2000.

SODIMM modules with hardware error correction (ECC) are not compatible, but the workstation node can be configured to use in-band ECC. This slightly reduces the memory capacity and bandwidth available to the operating system and applications to provide additional resilience.

The following configurations are supported using unbuffered, non-ECC DDR5 SODIMMs operating at 1.1V. Use of modules rated for a lower speed will reduce the available memory bandwidth and system performance.

Workstation Node Series	Total Memory	Memory Modules	Memory interface speed
HX2000 165H “Meteor Lake”	16GB	Two 8GB DDR5-5600	5,600 MT/s
	32GB	Two 16GB DDR5-5600	5,600 MT/s
	64GB	Two 32GB DDR5-5600	5,600 MT/s
	96GB	Two 48GB DDR5-5600	5,600 MT/s
HX2000 285H “Arrow Lake”	16GB	Two 8GB DDR5-6400	6,400 MT/s
	32GB	Two 16GB DDR5-6400	6,400 MT/s
	64GB	Two 32GB DDR5-6400	6,400 MT/s
	96GB	Two 48GB DDR5-6400	6,400 MT/s

3.3 GPU

HX2000 makes use of the integrated GPU as part of the Intel system-on-chip and HX2000 series can also be fitted with a discrete GPU module. When an external GPU is fitted, both the integrated GPU and external GPU are available to the Operating System and applications for graphical workloads.

Discrete GPUs on HX2000 series are connected directly to the CPU via PCIe using the PEG (PCI Express Graphics) port with a x8 lane count and transfer speed up to Gen 4.0 (16 GT/s)

GPU	GPU Memory	Core count	PCIe	FP32 Peak Performance	Graphics Power
Intel 'Arrow Lake' Arc Graphics	Shared DDR memory with CPU	8 Iris Xe cores 128 EUs	Integrated with CPU package	4.61 TFLOPS	Part of CPU power, max 25W for GPU-only workloads
Intel Arc 140T	Shared DDR memory with CPU	8 Iris Xe cores 128 EUs	Integrated with CPU package	4.8 TFLOPS	Part of CPU power, max 25W for GPU-only workloads
NVIDIA RTX 2000 Ada Lovelace architecture	8GB dedicated GDDR6	3072 CUDA cores 96 Tensor cores 24 RT cores	PCIe x8 Gen4.0	14.5 TFLOPS	60W TGP

3.4 Storage

There are two positions for M.2 22110 PCIe expansion cards which are available for high speed NVMe storage devices supporting PCIe/NVMe Gen 4 with x4 link width.

RAID Configuration

If both devices are fitted, these can be used as either two separate storage drives or combined into a single RAID volume using Intel VMD RAID in the CPU system-on-chip. When configured as RAID 1, the storage array is tolerant to the failure of either M.2 drive and this failed drive can be replaced at the next suitable maintenance window. The M.2 storage devices are not possible to hot-swap whilst the workstation node is operating, it must be removed from the Enclosure and powered-down.

The configuration of the RAID array must be performed before the OS installation and cannot be changed without re-imaging. When configured for VMD RAID, the windows installation requires the Intel VMD RAID driver as part of the installation.

Storage Config	OS Storage Driver mode
Two separate devices	AHCI
Single RAID 0 volume	VMD RAID
Single RAID 1 volume	VMD RAID

Storage Devices

HX2000 nodes are tested and validated with specific M.2 NVMe SSDs which can be supplied at purchase and also later as upgrades or replacement. Only storage devices supplied by Amulet Hotkey are supported.

The following drives are supplied with the workstation nodes and are supported for upgrade and replacement

Capacity	Drive Model	Interface	Seq. read	Seq. write	Endurance (5yrs)	Minimum Firmware
512GB	Micron 3500	NVMe Gen 4	7000MB/s	5100MB/s	300 TB / 0.32 DWPD	P8MA002
1TB	Micron 3500	NVMe Gen 4	7000MB/s	6900MB/s	600 TB / 0.32 DWPD	P8MA002
2TB	Micron 3500	NVMe Gen 4	7000MB/s	7000MB/s	1,200 TB / 0.32 DWPD	P8MA002

3.5 Network

The HX2000 workstation node uses a pair of Intel i226 Network Controllers to provide network and management services. Management services use fabric A, whilst data connections to the OS can use either fabric A or B. The network controllers appear as separate logical devices to the Operating System.

Refer to the HX5 System Installation Guide for further detail of the network setup.

Connectivity	Network Controller	Capabilities	Uses
Fabric 1A	Intel i226	2.5GBase-T Ethernet 100/1000/2500 Mbit/s	Out-of-band management Data network connection to the operating system when using N120 uplinks.
Fabric 1B	Intel i226	2.5GBase-T Ethernet 100/1000/2500 Mbit/s	Data network connection to the operating system when using N120 passthrough network.
Fabric 2A	No Connection	-	
Fabric 2B	No Connection	-	

Controller	Hardware ID	Typical Name
Intel i226	VID: 0x8086 PID: 0x125B	Intel(R) Ethernet Controller I226-LM

4. OS, Firmware and Drivers

4.1 Operating Systems

CoreStation nodes are shipped with an operating system installed for ease of deployment and setup.

Operating System	Version	Driver Pack	Status
Microsoft Windows 11 Pro	25H2	Available on Amulet Hotkey Resources website	Available pre-installed and licensed and supported for customer install
Ubuntu Desktop Linux	Ubuntu 24.04.2 LTS (HWE Kernel 6.11+)	Integrated in mainline kernel	Available pre-installed and supported based on customer requirements
Red Hat Enterprise Linux Workstation	RHEL 9.6+ RHEL 10.0+	Integrated in RHEL packages	Available pre-installed and supported based on customer requirements

4.2 OS Deployment

There are several supported routes for OS deployment:

Route	OS Installation	Description
Proof-of-concept image	AHK factory	Windows 11 Pro Pre-installed with default user accounts and Remote Desktop enabled to simplify initial testing. Intended for initial testing, not production deployments.
Windows Autopilot	AHK factory	Windows 11 Pro Pre-installed with hardware hash ready to upload to Microsoft Intune for cloud management
Manual Setup	AHK factory	Windows 11 Pro pre-installed with standard Out-of-box experience for manual setup or on-prem domain join
PXE/HTTPS	Using WinPE via Microsoft MDT or TFTP/HTTPS server	Customer image installs using PXE boot. Requires <i>HX2000 pre-installation OS driver</i> pack for network and RAID drivers.
USB	Using .wim or WinPE from local USB media	Customer image installs using local USB ports on the node. Requires <i>HX2000 pre-installation OS driver</i> pack for network and RAID drivers.

4.3 Required Windows OS Settings and Customisation

HX2000 requires specific OS customisation to operate correctly with the Management Controller and out-of-band management functions.

Customisation	Description
HX2000 Baseline driver pack	• Latest validated drivers for all system components
HX2000 GPU Drivers	• Latest drivers for Intel integrated GPU and NVIDIA discrete GPU (if fitted)
HX2000 BIOS (CGOS) Capsule driver	• Enables BIOS firmware updates from Windows with Secure Boot enabled
CoreStation Agent	• CoreStation Agent is required for full functionality and integration with the Management Console
HX2000 Power and sleep settings	• Disable Fast Boot, Hibernation • Disable sleep and screen lock • Set Pressing the power button will make my PC -> Shutdown

4.4 Windows OS Baseline drivers and Firmware updates

CoreStation HX2000 Windows OS drivers are provided in a single bundle called a Baseline driver pack.

These are provided on the Amulet Hotkey resources page at <https://www.amulethotkey.com>

The latest Baseline driver pack and node firmware updates can be found in the CoreStation HX firmware release notes and it is recommended to update these at a similar time.

Installing drivers

The Baseline Driver pack can be installed as a single bundle using the supplied installer application or else the drivers can be extracted and installed individually for greater control. See the HX Windows driver installer Knowledge Base Article KBA221 for further details.

4.5 HX Node Firmware Updates

Firmware Item	Update Route	Restrictions
Node Management Controller	Updated automatically as part of system firmware at next restart	Management controller and nodes must run the same firmware version
Node BIOS	Updated from the OS using BIOS Capsule updater from Amulet Hotkey website	Node BIOS version must be the same as or earlier than the Management controller firmware.
CPU Microcode	Included in BIOS image	No Restrictions
Intel ME Firmware	Included in BIOS Image	No Restrictions

4.6 CoreStation Agent for Windows

The CoreStation Agent provides integration between the CoreStation Management Controller and the node OS to provide key system information on the Management Console. The Agent runs as a background service on the node OS and communicates with the Management Controller directly using a serial port. It does not communicate over the network or internet in any way.

Installation of the Agent is optional and if not installed then the information it provides is not available in the Management Console, but no errors or warnings are generated.

The Agent is provided as a signed installer package for Windows 11 Pro on the resources page.

Item	Details	Where it is displayed
Hostname	Workstation Hostname set on the OS - to make it easy to find in other management tools	Shown on Node Info page
IP Address	Current IP address assigned to the workstation	Shown on Node Info page
OS Name	Current OS Product Name as reported by the OS	Shown on Node Info page
OS Version	Current OS Version and release running on this Node	Not currently shown
User	The username for the current desktop session	Shown on Node Info page
Session Status	Current state of the workstation and session as reported by Windows, for example: - Remote Desktop session connected - User logged on - Session locked	Shown on Node Info page
Agent Version	Current version of the installed agent	Not currently shown

5. Servicing and Maintenance

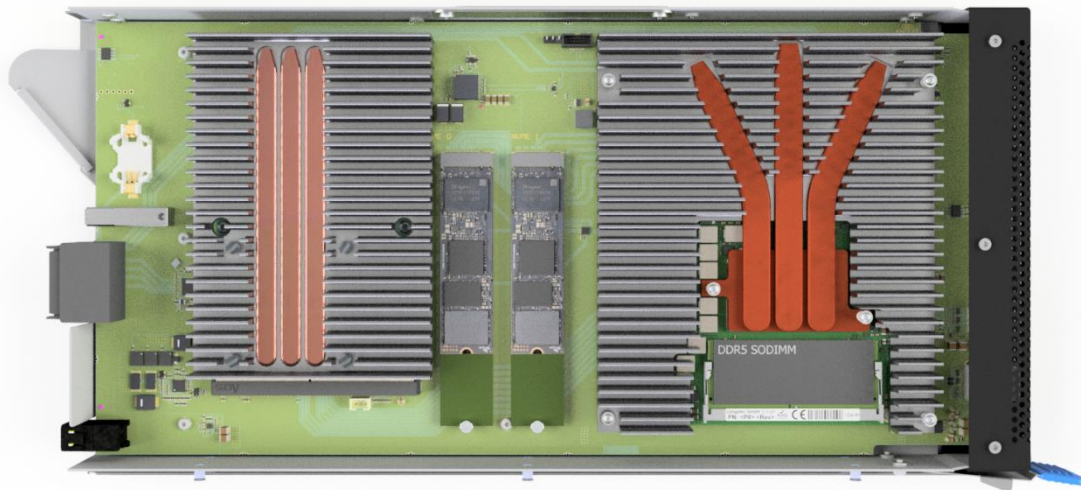


Figure 4 - HX2000 Workstation Node with discrete GPU

HX2000 nodes have several user-serviceable parts which can be upgraded or replaced.

See Knowledge Base Article KBA219 for details of disassembly, component replacement and re-assembly process.

Replacement items are available from Amulet Hotkey as individual spares for customer use or as part of an on-site service contract.

Component	Details	Requirements
Storage	One or Two M.2 Flash-based storage devices for Operating System, Applications and User Data. For RAID 1 setup using two drives, it is recommended to use two drives of the same model and size. Located on carrier top-side	• Standard NVMe M.2 SSD in 2280 or 22110 form factors • PCIe Gen 3 or Gen 4 • PCIe interface width x4 • Max active power consumption 12W
Memory	Two modules providing primary CPU system memory. Both memory sockets must be populated with modules of the same type and capacity. Memory modules are fitted to the CPU module, one top-side, one bottom-side	• DDR5-5600 SODIMM (165H) • DDR5-6400 CSODIMM (285H) • non-ECC • Single Rank or Dual Rank • 8GB, 16GB, 32GB, 48GB or 64GB (285H only) capacity
RTC Battery	Coin cell battery to maintain system time when the node is not powered. The battery is expected to last for approximately ten years of normal operation or three years of un-powered storage.	• CR2032 Coin-cell battery • 20 mm diameter, 3.2 mm height • Nominally 3V, approx. 220 mAh capacity • Primary cell, not rechargeable

6. HX2000 BIOS Features

HX2000 Nodes use AMI Aptio V UEFI firmware for the initial bootloader BIOS and system configuration. This works like the standard boot firmware on a desktop PC to initialise the system, load firmware for the CPU and provide boot devices.

6.1 Accessing the BIOS Setup Menu

The BIOS Setup menu is accessible using the Remote Console feature or the front-panel USB and Displayport connections on each node. To enter the BIOS Setup menu use the with the *Boot to BIOS* power action from the node page; this will power up the node and enter the BIOS password automatically. See CoreStation HX management guide for further details.

The BIOS setup menu is like any desktop PC and is driven interactively by the keyboard to change settings and save to non-volatile storage.

6.2 BIOS Configuration Options

There are a larger number of possible settings and customisations available in the BIOS, some of which are exposed and some of which are pre-configured by Amulet Hotkey based on the design of the node.

The following settings are supported for customer configuration and persist through BIOS updates. These can be pre-configured in production to reduce the required configuration on-site.

Setting	Description	Options
Integrated Components	Advanced → Processor (Integrated Components)→	
Enable VMD Controller (VMD Setup)	The VMD RAID controller is a high-performance RAID controller integrated into the chipset to provide RAID 0 and RAID 1 with NVMe drives. Enable both settings to create RAID volumes on the two M.2 storage drives or disable if the drives should be used individually	• Enabled (Default) • Disabled
Enable VMD Global Mapping (VMD Setup)		• Enabled (Default) • Disabled
ECC Support (Memory Config)	When enabled, configures the memory to use in-band ECC. This reserves around 5% of the memory capacity and bandwidth for error checking and correction.	• Enabled • Disabled (Default)
Primary Display (Graphics Config)	Set the Primary display used for boot-time output. Hybrid Graphics is the preferred option for CoreStation HX to enable BIOS output on the front panel ports. Windows OS has independent settings to select the appropriate GPU for each application.	• Auto [Discrete GPU if available] • IGD [Integrated Graphics] • HG [Hybrid Graphics] (Default)
Internal Graphics Device (Graphics Config)	Enable or Disable the Integrated Intel Arc GPU in the CPU Package.	• Auto [Enabled] • Disabled • Enabled (Default)
Port 12 (x8 PEG)	Advanced → PCI Express Configuration→	
PCI Express Root Port 12 (x8 PEG)	Enable or disable the PCIe port connected to the MXM GPU.	• Enabled (Default) • Disabled
Config TDP Configurations	Advanced → Power & Performance → CPU - Power Management Control → Config TDP Configurations	•

Power Limit 1 (Custom Settings Level2)	CPU Package TDP Limit - Maximum power use for steady-state operation	Range: - Ultra 5/7 CPUs: 20W - 65W - Ultra 9 CPUs: 28W - 65W
Power Limit 2 (Custom Settings Level2)	CPU Package Turbo Power Limit - Maximum power use for short-duration peaks	Range: - Min: Power Limit 1 - Max: 115W
Power Limit 1 Time Window (Custom Settings Level2)	Duration for which the CPU Package power can exceed PL1 in a single burst. Also known as Turbo Duration.	Range: - Min: 0 (Turbo disabled) - Max: 128s (Default)
	Advanced→	
Wake on LAN Enable (PCH)	Allow the node to be powered up from sleep using Wake-on-LAN Magic Packets. Check if WoL packets are compatible with the intended network setup.	- Enabled (Default) - Disabled
USB Mass Storage Driver Support (USB)	When enabled, allows USB devices to populate the list of bootable devices. Only USB Mass storage devices which are formatted and written as UEFI-compatible can be selected as boot targets.	- Enabled (Default) - Disabled
UEFI Network Stack (UEFI Network Stack)	When enabled, allows PXE and HTTPS network boot modes to be selected as boot targets in the boot menu	- Enabled (Default) - Disabled
Security	Security→	
Secure Boot (Secure Boot)	If enabled, the BIOS will only boot to images which are signed with a valid key which matches those in the allowed list (db list). When disabled, BIOS will boot any UEFI compatible image.	- Enabled (Default) - Disabled
Secure Boot Mode (Secure Boot)	Standard – Use the default AHK Secure Boot keys, allow list (db) and exclude lists (dbx). Custom – Use customer-specific Secure boot keys, lists and settings	- Standard (Default) - Custom
Secure Boot Keys (Secure Boot)	Option to upload customer-specific Secure Boot keys (PK, KEK, DB and DBX). Factory defaults are AHK keys.	- Factory Keys (Default) - Custom keys
Boot	Boot→	
Power Loss Control	Action to take when power is restored. Typically, the result of sudden loss of power to the enclosure	- Remain Off - Turn On - Last State (Default)
Boot Priority Selection	Selects the order to try boot devices.	- Local Disk - Local RAID Volume - USB Mass storage - HTTPS (If enabled) - PXE (If enabled)
USB Support	When enabled, allows USB devices to populate the list of bootable devices. Only USB Mass storage devices which are formatted and written as UEFI-compatible can be selected as boot targets.	- Enabled (Default) - Disabled
Network Stack Driver Support	When enabled, allows PXE and HTTPS network boot modes to be selected as boot targets in the boot menu	- Enabled - Disabled (Default)

6.3 BIOS firmware updates

The BIOS update package is a collection of firmware for different elements of the CPU, GPU and chipset as well as the BIOS Setup menu and UEFI boot firmware. These are all updated together as part of the BIOS firmware update tool running from Windows.

Following a BIOS update, only some settings are preserved, others are reset to defaults.

Refer to the BIOS update Knowledge Base Article (KBA) for further information about BIOS updates.

7. Specifications and Compliance

7.1 HX2000 Dimensions

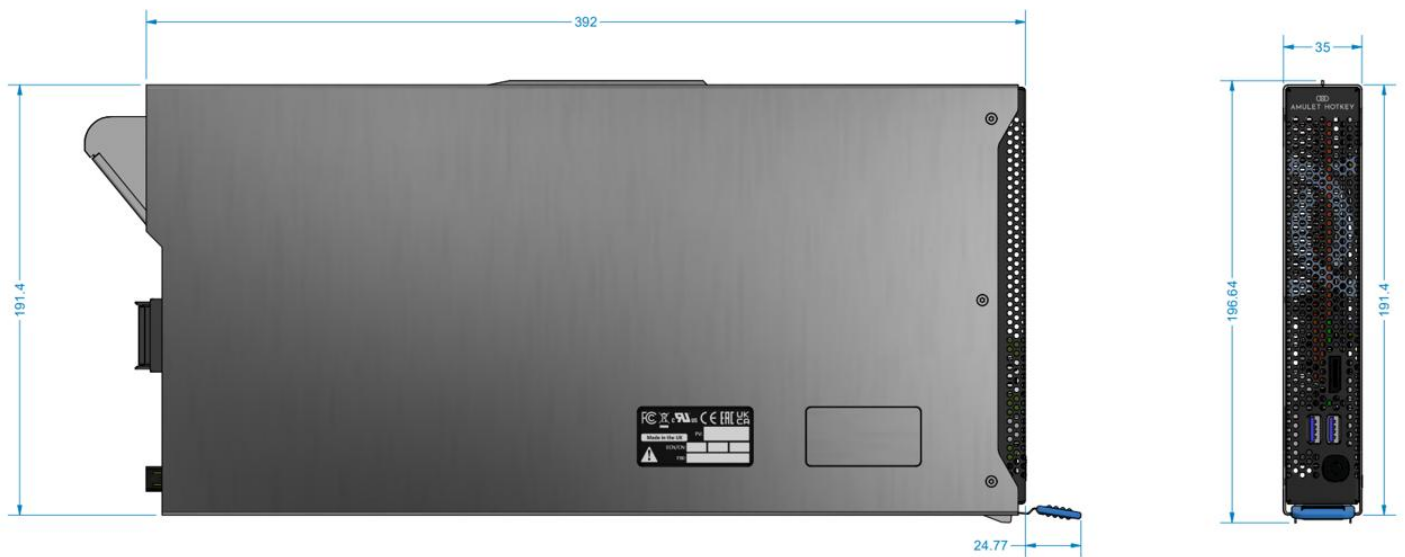


Figure 5 - HX2000 node dimensions

7.2 Ambient Thermal Tables

The maximum ambient temperature for continuous operation depends on the configuration of the system, workload and use case.

The table below is based on a cooling channel using two identical workstation nodes, a continuous 100% workload on each node and fans set to automatic or 100% fixed. See the CoreStation HX System Installation guide, section 2 for further details of the enclosure cooling provision.

Short-term operation above these limits will cause temporary performance throttling and higher fan speeds, but the system will continue to operate. Long-term use above these limits may result in premature failures in nodes and fan and may invalidate the system warranty.

For a typical Workstation use-case, the average CPU load and power consumption is typically lower than the maximum CPU power configured, which may give additional thermal headroom to operate in a higher ambient temperature. For further details and advice on ambient temperature limits and typical system load, discuss any specific applications and use cases with Amulet Hotkey.

Node CPU Power	Up to 28W	Up to 45W	Up to 65W
Up to 27°C Ambient	Standard Heatsink	Standard Heatsink	Standard Heatsink
Up to 30°C Ambient	Standard Heatsink	Standard Heatsink	Not Supported
Up to 35°C Ambient	Standard Heatsink	Standard Heatsink	Not Supported

7.3 Electrical Specifications

System batteries

Used to maintain real-time clock when module or enclosure is not powered

Battery	Location and Purpose	Chemistry	Specification
Node RTC Battery	Battery holder on node carrier board. Maintains Node real-time clock when removed from Enclosure.	Lithium Manganese dioxide. Primary cell, not rechargeable.	CR2032 coin-cell battery. 20 mm diameter, 3.2 mm height approx. 220 mAh capacity User-replaceable.

7.4 Weights

HX2000 Workstation Node with integrated GPU: 3.0 kg (6.6 lbs)



Resources

<https://www.amulethotkey.com>

EMEA Support

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