# MX45GM Mini ITX Motherboard Specification White Paper

## MX45GM Mini ITX Motherboard Overview

The MX45GM is an all-in-one x86-based industrial Mini ITX motherboard. The design is based on Intel's Montevina platform, now formally named Centrino 2. It is based on the Socket P with the Mobile Intel® GM45 GMCH and ICH9M-E Express Chipset architecture. This platform features high performance with low power operation, excellent graphics performance, high-speed memory and input/output (I/O) bandwidth, rich I/O and expansion interfaces, Trusted Platform Module (TPM), Intel® Active Management Technology (AMT), and seven years embedded lifecycle support.

The Intel® Socket P has 478 pins and is known as a 478-pin Micro FCPGA or µFCPGA-478. The socket P is the replacement socket for supporting the mobile Intel® Core 2™ processors including Intel® Core™ 2 Extreme, Core™ 2 Quad, and 45nm Core™ 2 Duo processors. When installed in the Socket P, the processor can run at 667, 800 or 1066 front-side bus (FSB) speed and can be throttled up or down for power saving purposes.

The Mobile Intel® GM45 Graphics Memory Controller Hub (GMCH) Express chipset provides outstanding flexibility for embedded application developers with excellent graphics, high-speed I/O bandwidth and memory transactions, as well as remote management capabilities, increased storage speed, reliability and proactive security features.

The Intel® ICH9M offers direct connection to the GMCH via Direct Media Interface and supports rich I/O interfaces including PCI Express, PCI Express x1, Mini PCI Express, Compact Flash, four SATA with RAID, five COM ports, eight USB 2.0 and 19-bit-GPIO connectors.
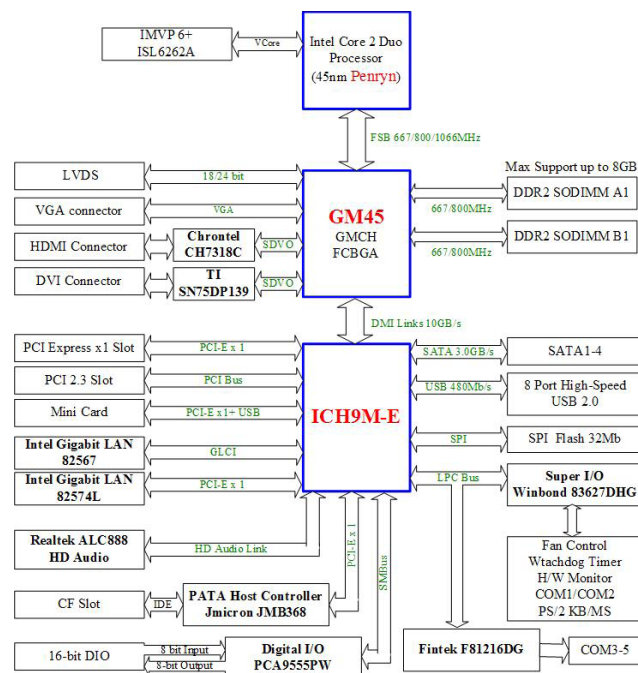


**Figure 1:** The MX45GM Mini ITX Motherboard Block Diagram

### Integrated Mobile Intel® Graphics Media Accelerator 4500MHD

The Intel® GM45 chipset integrates the Intel® Graphics Media Accelerator (GMA) 4500MHD graphics engine which delivers Blu-ray logo capable HD video playback and high resolution 3D graphics. It also supports DirectX 10 and Shader Model 4.0 features and delivers Intel® Clear Video Technology quality graphics and video to provide a sharper image, increased clarity, and customizable color controls ideal for high-end imaging-focused applications.

The Intel® GMA 4500MHD graphics engine enables MX45GM motherboard to support dual independent display through numerous display/video output

options including High Definition Multimedia Interface (HDMI), LVDS, DVI and VGA standard with integrated high-bandwidth Digital Copy Protection technology.

| Dual Display Matrix | | | | |
|---|---|---|---|---|
| | HDMI | LVDS | DVI | VGA |
| HDMI | | X | X | X |
| LVDS | X | | | |
| DVI | X | X | | X |
| VGA | X | X | X | |

The MX45GM Mini ITX motherboard supports Intel® Core™ 2 series processors, which encompasses a range of single, dual, and quad-core microprocessors based on the core microarchitecture,  It also provides many advanced innovations for smarter power-management for  reducing power consumption while increasing performance.

When coupled with the Intel® Core™ 2 series dual-core processors, the MX45GM motherboard is able to deliver powerful break through and enhanced energy-efficient performance which can be used to handle massive computing and visualization workloads required by gaming, retail transactions, multimedia entertainment, industrial automation, and graphic intensive medical applications.

| Name | Model | Cache | CPU Clock Rate | FSB |
|---|---|---|---|---|
| Core 2 Extreme | QX9300 | 12M | 2.53 GHz | 1066 MHz |
| Core 2 Extreme | X9100 | 6M | 3.06 GHz | 1066 MHz |
| Core 2 Quad | Q9100 | 12M | 2.26 GHz | 1066 MHz |
| Core 2 Duo | T9900 | 6M | 3.06 GHz | 1066 MHz |
| Core 2 Duo | T9800 | 6M | 2.93 GHz | 1066 MHz |
| Core 2 Duo | T9600 | 6M | 2.8 GHz | 1066 MHz |
| Core 2 Duo | T9550 | 6M | 2.66 GHz | 1066 MHz |
| Core 2 Duo | T9400 | 6M | 2.53 GHz | 1066 MHz |
| Core 2 Duo | P9700 | 6M | 2.8 GHz | 1066 MHz |
| Core 2 Duo | P9600 | 6M | 2.66 GHz | 1066 MHz |
| Core 2 Duo | P9500 | 6M | 2.53 GHz | 1066 MHz |
| Core 2 Duo | P8800 | 3M | 2.66 GHz | 1066 MHz |
| Core 2 Duo | P8700 | 3M | 2.53 GHz | 1066 MHz |
| Core 2 Duo | P8600 | 3M | 2.4 GHz | 1066 MHz |
| Core 2 Duo | P8400 | 3M | 2.26 GHz | 1066 MHz |
| Core 2 Duo | P7570 | 3M | 2.26 GHz | 1066 MHz |
| Core 2 Duo | T6670 | 2M | 2.20 GHz | 800 MHz |
| Celeron | T3500 | 1M | 2.10 GHz | 800 MHz |
| Celeron | T3100 | 1M | 1.9 GHz | 800 MHz |
| Celeron | T1700 | 1M | 1.83 GHz | 667 MHz |
| Celeron | T1600 | 1M | 1.66 GHz | 667 MHz |
| Celeron | 925 | 1M | 2.30 GHz | 800 MHz |
| Celeron | 900 | 1M | 2.20 GHz | 800 MHz |
| Celeron | 585 | 1M | 2.16 GHz | 667 MHz |
| Celeron | 575 | 1M | 2.0 GHz | 667 MHz |

**Table 1:** The above processors are compatible with the Intel® GM45 Chipset. This information is collected from the Intel® website (http://ark.intel.com/chipset.aspx?familyID=35509)

**The MX45GM supports Advanced Remote Management Technology (AMT) and Intel® vPro Technology via Dual Gigabit Ethernet Controllers**

The MX45GM Mini ITX motherboard is equipped with Intel® 82567LM and 82574L Ethernet Controllers. The Intel® 82567LM controller provides high-performance Gigabit network connectivity with support for Intel® vPro technology providing always-available network connectivity, built-in manageability features, proactive security, and energy-efficient computing performance required by many corporate applications.

The Intel® Active Management Technology 4.0 (AMT) is supported through the 82567LM controller. The AMT is a hardware-based remote management technology that enables IT professionals to monitor computing systems, install software patches and upgrades necessary to keep the installed base of equipment operational under field conditions from a remote location and even when the remote computer is turned off.  It also enables the technicians to troubleshoot malfunctioning devices over a secured network in order to reduce device downtime and costly on-site repair services from lack of maintenance.

The Intel® 82574L controller use a single-port operating at 2.5 GHz with a single lane interface. It provides a pathway from legacy PCI/PCIx designs to higher performing PCI Express. The integrated

Gigabit Ethernet Media Access Control (MAC) and Physical-Layer (PHY) capabilities enable the configuration for 10/100 Mb/s or 1000 Mb/s modes depending upon specific usage requirements.

The Intel® 82567LM and 82574L Ethernet Controllers provide advanced interrupt-handling features to manage multiple interrupts simultaneously, enable load-balancing of network traffic flows, as well as drastically reduce processor overhead and power consumption for the entire system.

Both controllers are powerful Ethernet devices giving the MX45GM motherboard great networking performance in addition to its flexible, low-cost, and small footprint embedded design for space constraint applications.

**Built-in Security Features via Intel® Trusted Execution Technology (TXT) and Trusted Platform Module (TPM)**

The MX45GM supports Intel® Trusted Execution Technology (TXT) via the GM45 Express chipset. Intel® TXT is a versatile set of hardware extensions to the Intel® processors and chipsets that enhance the platform with security capabilities. It provides hardware-based mechanisms to help protect against software-based attacks by enabling each application to run within its own space in order to protect the confidentiality and integrity of data stored on the system.

The MX45GM also provides another security feature, the Trusted Platform Module (TPM) to perform platform authentication. TPM includes remote attestation and sealed storage capabilities to encrypt and decrypt the data during the transactions. It can protect important information such as passwords and digital certificates from external software attacks or physical theft. This feature is supported by Infineon SLB9535TT 1.2 microcontroller security chip and provides a Root of Trust implementation into the boot process with BIOS configurations. The data is stored within a high level of an encrypted section within the system where integrity authentication is required when accessing the data.

The above features are a special benefit to enterprise, banking, gaming, and financial related applications.

**Supported Operating Systems**

The MX45GM Mini ITX motherboard supports most operating systems in mainstream use today including

Microsoft Windows 2K/XP/XP-64/Vista-32/64/Win7-32/64, Embedded Standard, Embedded POSReady, Read Enterprise Linux 5, Novell SUSE Linux Enterprise 10, Wind Rover Linux, and VxWorks 6.6.

## Target Market Focus and Applications

Today's technology has tremendous influence on human lives and has enhanced human beings physically and intellectually in many ways. It significantly changes the way people live and continues to changes our lives exponentially as each new technological milestone becomes mainstream.

Based on the features and performances provided by MX45GM and MX45GM2 Mini ITX motherboard, its target market has been recommended to focus on HD-rich content applications including:

**Medical Applications:** Magnetic Resonant Imaging CT (MRICT), Ultrasound CT, patient's bedside mobile cart, medical imaging systems

**Retailing Applications:** Digital Signage Systems, Point-of-Sale (cashier, register), multimedia interactive clients (ticketing system, ATM terminal, self-checkout station, coin exchange machine, lottery kiosk, tourist information kiosk, vending machines)

**Gaming Applications:** Slot machines, lottery terminals, bingo machines, player tracking systems

**Industrial Control & Automation:** Factory and building automation, robotic systems.

**Digital Surveillance Systems**

Such applications require the computing ability to handle complex algorithms, data-intensive workloads, and multi-protocol wireless networking. The essentials computing components behind these everyday machines are often built around the industrial motherboards which combine powerful central processor, with built-in smart chipsets, I/O, and expandability in allow the integration of add-on and supporting technologies specific to each industry.

These cutting-edge embedded applications usually require powerful system performance with high

bandwidth to process high frequency data transactions while delivering 3D quality video via High Definition Multimedia Interfaces (HDMI), DVI, or LVDS on multiple independent displays without video performance degradation. These machines also require rich I/O interfaces to support additional devices such as RFID, receipt printers, barcode scanners, magnetic stripe card readers, etc through serial (COM) ports and USB ports.

Some of the machines, for example, an ATM banking terminal or self service check-in kiosk, may involve sensitive data entered by customers and require secure protection to prevent personal identifications and/or credit card transactions being stolen. This goal may be achieved more efficiently and robustly by Intel® TXT and TPM features provided by the MX45GM motherboard.

The MX45GM has 8 USB ports with 4 USB on the back motherboard I/O. For products such as Point-of-Sale and self-serve Kiosk, a barcode scanner, magnetic card reader, or receipt printer can be connected to these USB ports. A touch panel interface may also be connected via USB or serial connections providing graphical touch options for cashiers or customers to input data and complete transactions with the terminal.

The MX45GM has five serial (COM) ports. The serial ports are key communication inputs for Point-of-Sale, self-serve kiosk, or interactive vending machines that require connectivity to many peripheral devices such as magnetic card readers, barcode scanners, receipt printers, or touch screens.

The MX45GM has one PCI, one PCI Express x1, one Mini PCI Express slot, and one Compact Flash socket for additional expansion of add-on or storage cards wireless LAN cards.

The MX45GM has three SATAII and one eSATA connectors with RAID function to maximize the use of storage devices including hard drives and CD/DVD-ROM. The RAID function is used to divide and replicate data among multiple hard disk drives. This allows users to backup data in multiple hard drives and is recoverable if one of the hard drives is damaged. The goal is to increase data reliability and input/out performance.

## MX45GM for Medical Applications

The MX45GM Mini ITX motherboard's high performance and low-power design enables medical systems built around it to run multiple software and clinical applications at the same time expanding functionality while reducing energy consumption.

Today, many medical professionals enjoy the instant access to data and the efficiency provided mobile medical workstations for instant record keeping and access to medical histories or periodicals for faster diagnosis and analysis. The MX45GM's small form factor and mobile technology is ideal for medical mobile carts or other battery operated computing terminals increasing usage on a single battery charge. Additionally, the MX45GM's security features such as TXT or TPM are significant features in protecting sensitive and confidential patient data. The MX45GM is used in a mobile medical cart application today.

High-end advanced medical Computer Tomography (CT) systems, such as the Magnetic Resonant Imaging CT (MRICT) and Ultrasound CT, are medical imaging techniques commonly used in radiology to visualize the internal structure and function of the human body. In order to achieve this goal, the computer must have strong graphic performance for image rendering to capture high quality atomic information of the human organs including the structures of the organ and the organ's tissue properties. The captured data is very helpful for physicians to develop more accurate diagnosis. The MX45GM offers the built-in Intel® Graphics Media Accelerator 4500MHD and the Intel® Clear Video Technology by the GM45 Express chipset. Together it delivers enhanced 3D image capabilities, high-definition video playback, sharp images and precise color control as required by the advanced medical imaging applications.

In addition to the MX45GM's advanced graphic performance, its dual display capabilities are another useful feature for medical devices that have primary and secondary display requirements, patient and physician independent displays, or diagnostic and primary display purposes. A medical mobile cart with dual display monitors enables the physician to easily roll to the patient's bedside. The physician is able to pull up two X-Rays or the CT scans displayed in each monitor for side-by-side comparison purposes enabling the physician to provide more informative consultations and to help patients better understand their medical conditions.

The MX45GM has rich I/O and expansion interfaces. There are total of eight USB devices. The USB device for a bedside mobile cart could include a mouse or keyboard, a drawing pad which enables the physician to access patient's data, a touch screen, or barcode scanner for medication and patient authentication. More advanced connectivity could include an Intra-Oral dental camera device allowing the physician to capture detail images of a patient's oral cavity; the iridology camera device for

eye exam enables the physician to capture the clear and sharp image of patient's pupil of the eye. The captured images are received and displayed on the monitor in real time via the wireless USB adapter plugged into the mobile cart.

## Safety and Environmental Regulations

BCM is committed to protect and enhance the global environment. To meet the expectations of our customers, employees, and the community in which our products are manufactured, marketed and used, all BCM motherboards are made with lead-free materials since July 1$^{st}$, 2006. The MX45GM (with DC power) and MX45GM2 (with ATX power) are no exceptions to this commitment and are regulated as RoHS Compliant motherboards.

In addition to the RoHS Compliant, both MX45GM and MX45GM2 motherboards have passed FCC and CE emission testing to ensure their safe use in the equipment and applications mentioned in this paper.

### Embedded Lifecycle Support through Intel® Embedded Alliance

BCM is an Associate member of the Intel® Embedded Alliance, a community of embedded developers and solution providers. Through this membership, Intel® provides its members with long life product support for its processors, chipsets and technologies to ensure at least 7 or more years life cycles.

Intel's long life product support enables the industrial motherboard manufactures like BCM to design and manufacturing long life embedded boards by using these high–quality, modular, standards-based building components. Thus the benefits are extended to our ODM/OEM customers by helping them to design more efficiently knowing they can count on the industrial motherboard they have selected, lime the MX45GM, to be available for many years reducing frequent and costly redesigns and qualifications.

In conclusion, the MX45GM and MX45GM2 provide the major features and functionality required by most industrial applications in gaming, medical, retailing and industrial segments.

## About the Intel® Embedded and Communications Alliance

The Intel® Embedded and Communications Alliance is one of the world's most recognized embedded and communications provider. This community offers customers a trusted supply line of Intel® based products and technologies. The alliance members are committed to provide ideal solutions and total lifecycle support to help customers develop quick time-to-market and faster time-to-profit applications.

## About BCM

BCM is a leading supplier of the long life industrial motherboards & systems serving our customers with turn-key stable computing platforms since 1990. We specialize in designing and manufacturing custom motherboards for industrial markets including gaming, retail, security and surveillance, industrial controls and automation, and medical equipment. In addition to customized ODM products, we also carry a broad line of off-the-shelf standard products in popular industrial motherboard form factors including Nano ITX, Mini ITX, mATX and ATX.

BCM is an Associate member of the Intel® Embedded Alliance member. We specializes in supporting our custom motherboard design services through our strong engineering and project management teams located in Southern California complimenting our core development teams located in Taipei, Taiwan. Additionally, we are well staffed in North America to provide local warranty service, logistics, and technical support for prompt problem solving assistance. Our products are have guaranteed extended lifecycles and are designed for 24/7/365 operation. For more information please visit BCM's website at www.bcmcom.com. Additional information about Intel® embedded products, please visit www.intel.com/embedded/index.htm.

**Product Pictures with highlights**
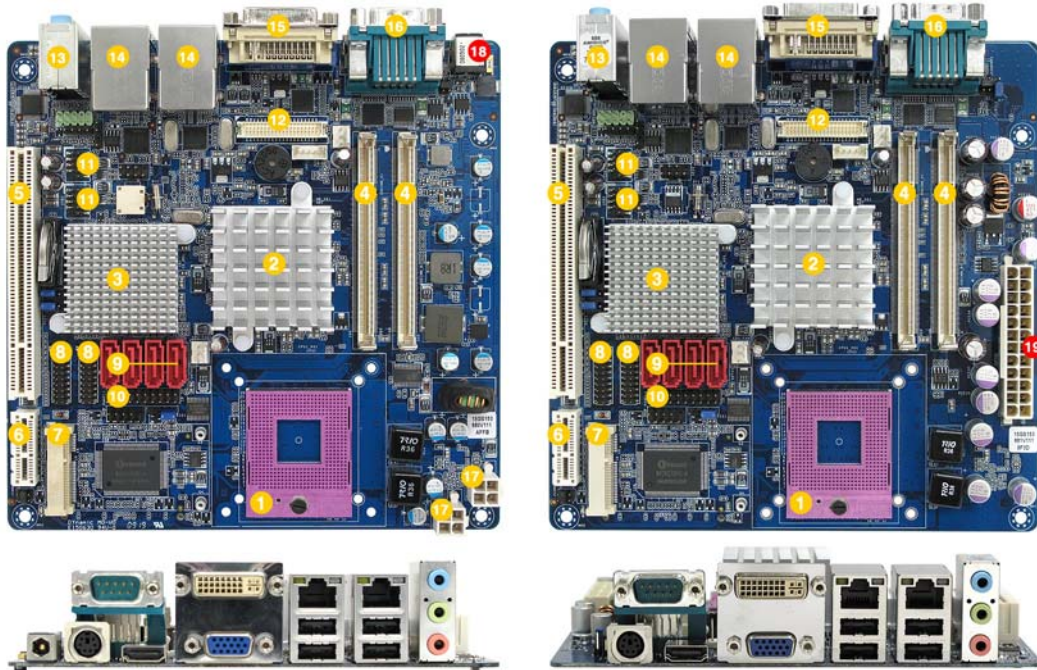


**Figure 2:** MX45GM with DC Power (left) and MX45GM2 with ATX Power (right)

**1** Socket P supports Intel® Core™ 2 Duo / Intel® Core™ 2 Extreme Mobile Processor with 45nm process technology

**2** Intel® GM45 Mobile Express Chipset

**3** Intel® ICH9M-E Express Chipset

**4** Dual-channel DDR2 for 667/800 MHz memory support up to 4 GB

**5** PCI Slot

**6** PCI Express x1 Slot

**7** Mini PCI Express Socket

**8** COM Ports: Two COM port connectors for four ports (COM2 – COM5)

**9** Four SATA Connectors

**10** 16-bit GPIO Connector

**11** Four Hi-Speed USB 2.0 ports: Two USB Connectors for four USB Ports

**12** 18/24-bit Dual-channel LVDS Connector

**13** High Definition Audio: Three stack analog audio ports

**14** Stackable USB and LAN ports: Two USB 2.0 ports and one 10/100/1000 Network Connection for high speed and low power consumption

**15** DVI + VGA Port: Supports dual independent display and allows for the most flexible display output for Intel® processors with Intel HD Graphics

**16** COM1 + HDMI + PS/2 Port

**17** SATA Power Connector

**18** DC-in Power Connector

**19** ATX Power Connector

**Product Specifications**

Table 2 is a summary of the MX45GM Mini ITX Motherboard product specifications.

| System | |
|---|---|
| CPU | Supports Intel® socket P Core™ 2 Duo / Intel® Core™ 2 Extreme / Celeron 575/585 mobile CPU with 45nm process technology |
| FSB | 667/800/1066 MHz |
| BIOS | AMI 32Mb SPI BIOS |
| System Chipset | Intel GM45/ICH9M-E |
| I/O Chipset | Winbond W83627DHG-A |
| Memory | 2 x 200-pin SODIMM socket supports up to 4 GB Dual channel DDR2 667/800 SDRAM |
| Watchdog Timer | Reset: 1 sec.~255 min. and 1 sec. or 1 min./step |
| H/W Status Monitor | Monitoring CPU temperature, voltage, and cooling fan status. Auto throttling control when CPU overheats |
| Expansion Slots | 1 x PCI slot (PCI Rev.2.2 compliant) |
| | 1 x PCI Express x1 Slot |
| | 1 x Compact Flash Type I/II socket |
| S3 | S3 Support |
| SmartFan Control | Yes |
| **Display** | |
| Chipset | Intel Graphics Media Accelerator 4500MHD |
| Display Memory | Intel DVMT 5.0 supports 1GB video memory |
| Resolution | 2048 x 1536 @ 32 bpp(@ 60Hz) |
| Dual Display | CRT + LVDS or CRT + DVI-D or CRT + HDMI |
| LVDS | Dual-channel 24-bit LVDS |
| DVI | Chrontel CH7318C DVI transmitter up to 165M pixels/second |
| HDMI | TI SN75DP139 Display Port to TMDS transmitter |
| **Audio** | |
| Audio Codec | Realtek ALC888 Audio Codec 5.1+2 CH. with two independent audio stream |
| Audio Interface | Mic-in, Line-in, Line-out |
| Audio Amplifier | TPA3005D2 Stereo 6Watt per channel |
| **Ethernet** | |
| LAN 1 | Intel 82567LM Gigabit Ethernet Controller |
| LAN2 | Intel 82574L PCI-E Gigabit Ethernet Controller |
| **Onboard I/O Headers** | |

| | |
|---|---|
| SATA & SATA Power | 4 x Standard SATA Connectors / 2 x SATA Power Connectors |
| COM | 2 x RS-232 Headers (4 ports, 1 with Voltage Selection) |
| USB | 2 x USB 2.0 Headers (4 ports) |
| SPDIF | 1 x SPDIF Header |
| Front Audio | 1 x Front Audio Header |
| Amplifier | 1 x Amplifier Header |
| GPIO | 16-bit General Purpose I/O for DI and DO |
| LVDS | 1 x LVDS Connector |
| Inverter | 1 x Inverter Connector |
| Front Panel | 1 x Front Panel Header |
| **Back I/O Panel** | |
| Display | 1 x DB15 Connector / 1 x DVI-D Connector / 1 x HDMI Connector |
| LAN / USB / Audio | 2 x Stack up RJ45 and USB Connectors / 1 x 3 Jacks Audio connector |
| RS | 1 x COM Port (with voltage selection) / 1 x DIN 6 |
| DC-in | 1 x Barrel Type DC In |
| **Mechanical Environment** | |
| Power Requirement | Available in ATX or DC Version<br>* MX45GM: DC power<br>** MX45GM2: ATX power. |
| Power Type | 19VDC/ 5A and up. Barrel Type (Int. dia 2.5mm – 3mm; Ext. dia 5.5mm) |
| Operation Temp. | 0C – 60C |
| Operating Humidity | 0C – 90C Relative Humidity , Non-Condensing |
| Form Factor | Mini ITX |
| Size (L x W) | 6.7" x 6.7" |
| Weight | 0.88" lbs |

Note: Specifications are subject to change without notice.