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White Paper

Fanless IoT Edge Computing Solutions

Driving to Smarter IoT Applications

Executive Summary

IoT applications require systems that can operate efficiently in unpredictable settings and harsh environments. Most system failures are the result of dusty environments, heat damage resulting in mechanical failure of cooling devices and lack of maintenance. Traditional computers do not perform well in these extreme environments with failures resulting in production errors and in some cases loss of assets. In order to overcome these obstacles, fanless systems are designed to deliver noise-free performance, excellent thermal controls, dust immunity and energy efficiency.

IoT sizing up the business opportunities

The Embedded System market size is expected to reach USD $258.72 billion by 2023, according to a research report by Global Market Insights, Inc. This growth is being driven by industrial applications in markets such as healthcare, industrial, automotive, telecommunication and retail, where emergence of IoT is anticipated to fuel industry growth. IoT devices have reached ubiquity in daily life, and as business has evolved to rely on the automatic and real-time data accessibility provided by gateways, computers, servers and mobile devices, operation and maintenance become major concerns.

What is a Fanless System

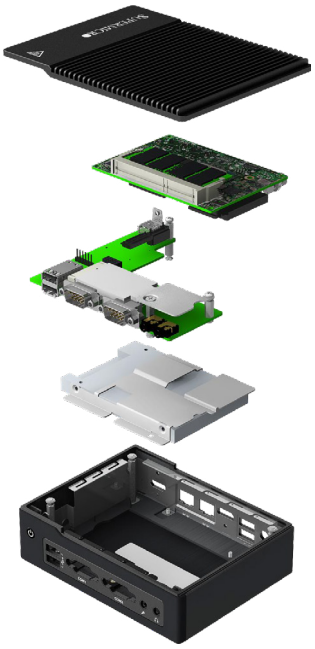
The most common cooling method for electronics of any type is the installation of multiple fans within a vented chassis creating air flow to dissipate heat radiated by the CPU and other processing components. These fans expel the heat from the system; however, they can increase the air temperature in their surrounding environment. This degraded optimal operating temperature thresholds of other electronic devices. While the fans' role is to repel heat from a system, the unintended consequence is that they attract dust and other particles that can reduce a chip package's ability to expel heat, ultimately leading to system failure. The system with a fan design will have dust on the air filter and may require the replacement service. With a fanless design, this filter replacement concern will be removed.

Fans are available in varying sizes and operating speeds, acting as intake or exhaust to moderate air flow within the chassis to dispel heat generated by moving parts and components. Unfortunately, this method generates what are, in some environments, unacceptable noise levels. Not surprisingly, the mechanical operation of the fan results in it being the component most likely to fail during normal usage or when presented with mechanical shock or random vibration. This leads to an overall reduction in the MTBF (mean time between failures) of a system.

Fanless systems shift the paradigm and solve the heat problem in a different, more effective and efficient way.

Fanless systems utilize a heatsink, which allows for the heat generated within the system to move through the heat spreading element and dissipate away from the system. Normally comprised of copper or aluminum, heatsinks are used in many electronic devices from smartphones to refrigerators because of their ability to cool components that encounter performance degradation caused by increased temperatures. Physically they appear with fins protruding from a base increasing the surface area to improve heat transfer. In a fanless system, a heatsink is normally attached directly to the CPU and in most cases is an integral part of the chassis of the system. Heat is transferred from the CPU through the fins on top of the passive heatsink which then guides the heat allowing it to radiate to the surrounding air. This effective construction and its obvious benefits have added to the appeal and subsequent adoption of fanless systems in a myriad of applications crossing over multiple industries and IoT applications, including Factory Automation, Retail Intelligence, Instrumentation, and Medical device gateway.

One of the challenges when designing a rugged computer system is to deliver a product that meets the performance requirements while operating in harsh environments over a wide range of temperatures. The challenge to meet these requirements is made greater when durability and elimination of moving parts becomes a primary consideration.



- Top heatsink contact CPU & Memory for the thermal dissipation
- Header to header boards connection as cableless design
- Customization carrier board for vertical markets
- Support 7mm height cableless SATA SSD
- Built-in antennas for wireless communication

Thermal Design

For a fanless system, there are two elements that contribute to the thermal conductive efficiency of the heatsink. The first is aluminum because of its excellent thermal conductivity and its light weight in nature. The second element is copper. Although it is much heavier than aluminum, copper is more efficient at thermal conductivity compared to aluminum because it allows its electrons to maneuver freely. Passive heatsinks may include these elements separately or together. Thermal conductivity as measured in Btu/(ft*h*F) for Aluminum is 118@77°F (25°C) while copper is 232@77°F (25°C). Based on the this characteristic, designs may use either of these materials or in some cases both of the materials together.

Because the enclosure of the heatsink or CPU is never perfectly flat, there will be gaps between them when you place the CPU straight on the heatsink. As a result, this will produce detrimental effects on the process of heat transfer. This is where the technology and the role of thermal compounds come into performance. Thermal compound solutions are gooey and sticky in nature and regulate the thermal conductivity between the gaps of the CPU and heatsink. Aside from the gooey solution, there is an alternate thermal compound called the 'thermal pad'. Thermal pads are designed to replace sticky solutions and are a more convenient and popular choice for thermal conductivity and long-term productions.

Another common complication is to avoid placing something on top of a fanless system. Even a single piece of paper can trap a pocket of hot air on the lid, preventing the system from cooling. Surrounding air is another factor that should be considered. If the surrounding air is unable to circulate (as it would be in a confined space) or too thin (such as at high elevations) it will have less potential for carrying heat away from the system.

Benefits Of Fanless Systems

Fanless systems offer a number of key advantages over traditional systems with active cooling and also excel in harsh environments.

Silent Operation

This obvious benefit comes by way of reduction of audible noise from fans. Anyone that has walked through a data center housing a large population of servers mounted in rack enclosures is aware of how loud fans operate, often drowning out verbal communication amongst personnel performing work in these rooms. Silent operation is an important consideration for applications require noise-free environment such as hospitals, laboratories, schools and libraries.

Wide Operating Temperature

With a solid thermal design, fanless systems dissipate heat more efficiently and demonstrate a wider operating temperature in many industrial IoT applications. Components are chosen for their extended temperature range allowing the fanless system to operate within a much wider thermal envelope, ranging from -20°C to 60°C.

SYS-E100-9S

Key Features

- Slim size: 195(W) x 151(D) x 44(H) mm
- High Performance Processor: Intel Core i7/i5/i3
- Dual Display: HDMI + DisplayPort
- Rich I/O: 2 x LAN, 2 x USB 3.0, 4 x USB2.0, 4 x COM, 1 x DIO
- Mounting Support: Wall, VESA

Greater Reliability, Better MTBF

For most electronic systems, fans are the most likely device to fail, bringing the MTBF down considerably. Over time fan cooling systems run into the problem of their fans degrading operation or failing completely if not properly serviced through a preventive maintenance strategy. Even then, the components within the fan will eventually fail and require replacement. The maintenance and repair costs accumulate, the downtime increases production costs, especially for those applications running 24/7. By removing fans and other moving parts, fanless systems extend MTBF to minimize maintenance efforts and downtime costs.

Shock and Vibration Resistance

By eliminating moving parts and integrating mechanical design with 2.5" SSDs or M.2 devices, fanless systems are shockproof and vibration proof which will fit industrial environments. Operational vibration passed the test of IEC 60068-2-64 for 5 Grms, random, 5-500 Hz, 1hr/axis. And the operational shock passed the test of IEC 60068-2-27 for 30G, half sine, 11ms.

Dust Free

In industrial installations, environmental conditions pose a danger to fan cooling systems. Exposure to elements, dust and/or debris, along with moisture all contribute to unexpected failures of traditional computers using fans. Fanless systems account for these variables and are able to be applied in much harsher situations with some even allowing for outdoor operations as well. Medical configurations also benefit from this feature increasing the sterility level of an area where systems relying on fans are not suited for use.

Cost Saving

With cooling costs continuing to soar for sizable server infrastructures and large-scale data centers, the savings provided by fanless systems make them an ideal solution for those in search of energy efficient solutions. While an entire organization's computing architecture may not be ideal for a complete fanless configuration overhaul, replacing high power consumption systems with this option provides a significant impact in reduction of operating costs associated with cooling. Couple this with the aforementioned savings of maintenance and downtime losses, the financial benefits of a fanless design are clearly evident and serve to provide an assortment of advantages over traditional solutions.

Designed for Extreme Environment

Another added benefit is that fanless systems can provide a smaller footprint for the installation. Industries that are taking advantage of fanless systems find the versatility of the smaller footprint an advantage by increasing the opportunity for computing solutions to be used in various configurations. This is useful for applications where the location is remote and limited space is available.

Where Are Fanless Systems Used

Fanless systems are increasingly required across many industries. While the industries served are diverse in nature, they have similar requirements when it comes to levels of performance, feature sets and reliability.

Retail Kiosk, Point-of Sale, and Banking ATM are interactive computer terminals that feature embedded low-power, small form factor hardware and software that is self-contained within the machine.

Retail intelligence applications for payment protection, security appliance and digital signage.

The Retail Industry is an area of increasing adoption of Fanless Computing Systems due to their varied installation requirements and brand impact from system failure. Blank screens and down terminals have a negative impact on customer experience and brand perception. Supermicro Fanless Systems are deployed for major retail brands providing payment authorization and security as well as managing the growth in IoT data collection. Smart Medical edge gateway for device monitoring and data analysis

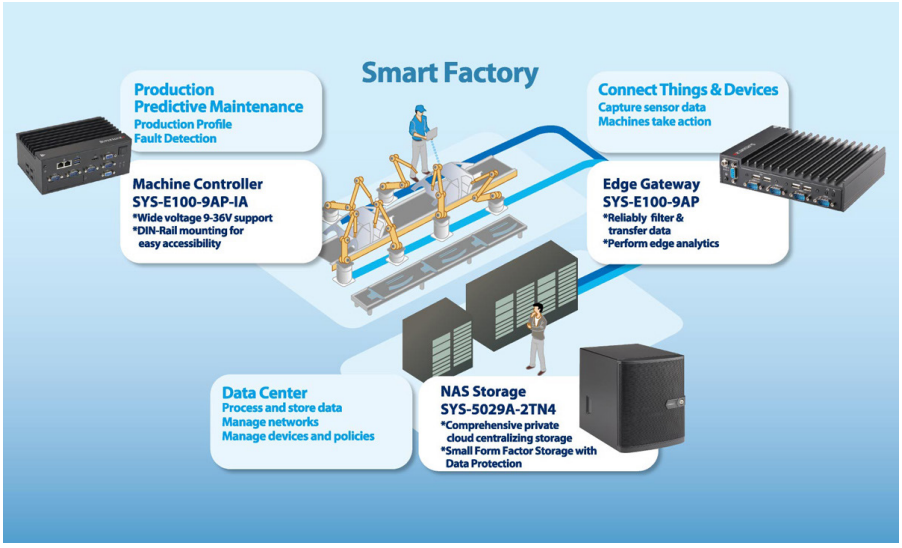
Smart Medical edge gateway for device monitoring and data analysis

Reliability of medical devices is the industries primary concern. Device failure can affect critical care or diagnostics resulting in reduced benefit to the patient. By eliminating the single highest point of failure in a system we are able to provide increased reliability over the lifespan of a device. Quiet operation is a standard requirement for many medical devices where fan noise can be disruptive during patient care. Due to the low power requirements and DC input voltage the fanless system can easily be powered by a battery, providing for mobility and backup power when needed. Supermicro's manufacturing facilities are ISO-13485 certified providing the necessary quality and traceability for medical devices. Supermicro Fanless devices are installed in medical diagnostic and laboratory equipment.

Modern factories use several forms of control systems for operating mechanical sensors, switches, relays, conveyors, hydraulics, pneumatics and electrical devices.

Industrial Applications for production line equipment control

Industry 4.0 makes high demands of manufacturing systems with a greater demand to collect data from devices and the environment in which they operate. Fanless systems are ideal for dusty manufacturing locations where a system fan would very soon succumb to the collection of dust on its moving parts as well as reducing thermal efficiency of integrated circuit packaging. The additional and rigorous testing for shock and vibration makes these devices suitable for mounting directly on or inside manufacturing equipment. Supermicro Fanless devices are used in manufacturing equipment as well as test and control devices for many of the specific industries that apply Industry 4.0 requirements.



IoT Gateways with software for remote management, security control and application onboarding

With the continued growth of IoT applications across all industries, fanless systems have an important role as gateway devices to collect and manage the enormous amounts of data being collected today. Gateway devices are often located in remote areas where servicing is difficult and costly so system failure is not an option. Increased connectivity is a typical requirement with Supermicro Fanless products providing both wired and wireless connectivity. Supermicro partners with Independent Software Vendors (ISV's), such as Zededa, to provide a complete solution for remote management of devices.

Supermicro Embedded Fanless Solutions

As a global leader in high-performance, high-efficiency server, storage technology and green computing, Supermicro is dedicated to developing embedded fanless systems. Supermicro Embedded Fanless systems feature a ruggedized chassis with up to IP51 dust and water proof, 30G shock proof, 5G vibration resistance, and these systems meet strict safety standard certifications by CE, FCC Class B, UL, CB and VCCI.

Supermicro's Embedded Fanless systems provide a wide range of performance options, connectivity and I/O, and form factors, as well as management software tools, enabling customers to rapidly implement IoT applications to maximize benefits and control of installations at scale.

Product Selection

Unique Selling Proposition		Built-in Antenna	5 LANs	Easy I/O	Rich I/O	4K Display	Wide Range DC
Server Model		SYS-E50-9AP/-WiFi	SYS-E50-9AP-N5	SYS-E50-9AP-L	SYS-E100-9AP/9APP	SYS-E100-9S/-E/-L	SYS-E100-9AP-IA
							
Processor		Atom™ x5-E3940, 4C/9.5W	Atom™ x5-E3940, 4C/9.5W	Atom™ x5-E3940, 4C/9.5W	Atom™ x5-E3940, 4C/9.5W Pentium® N4200, 4C/6W	7th Gen Core™ i7-7600U/ i5-7300U/ i3-7100U, 2C-4C/15W	Atom™ x5-E3940, 4C/9.5W
Memory (SO-DIMM)		1 x DDR3L up to 8GB	1 x DDR3L up to 8GB	1 x DDR3L up to 8GB	1 x DDR3L up to 8GB	2 x DDR4 up to 32GB	1 x DDR3L up to 8GB
Wi-Fi Connectivity		Supported / Wi-Fi included	Supported	N/A	Supported	Supported	Supported
I/O	HDMI	2	2	1	1	1	1
	VGA	N/A	N/A	N/A	1	N/A	1
	Display Port	N/A	N/A	N/A	N/A	1	N/A
	USB 2.0	2	2	N/A	4	4	4
	USB 3.0	2	2	2	2	2	2
	LAN	2	5	2	2	2	2
	COM	2	1	N/A	4	4	4
Storage Module	2.5" drive bay	1	1	N/A	N/A	N/A	1
	M.2 (B-key)	1	1	1	1	1	1
Power Adapter (Lockable 12V DC)		40W	40W	40W	40W	60W	60W
Dimension (W x H x D)		5.82" x 1.72" x 5.5"	5.82" x 1.72" x 5.5"	5.82" x 1.72" x 5.5"	7.68" x 1.73" x 5.94"	7.68" x 1.73" x 5.94"	7.64" x 3.15" x 4.96"
Mounting Options		Wall/VESA	Wall/VESA	Wall/VESA	Wall/VESA	Wall/VESA	DIN/Wall/VESA
Long Life Cycle		7 YEARS	7 YEARS	7 YEARS	7 YEARS	7 YEARS	7 YEARS
Operating Temperature		-20°C - 50°C / 0°C - 50°C (WiFi)	-20°C -50°C	-20°C - 50°C	-20°C - 60°C / 0°C - 50°C (9APP)	0°C - 50°C	-20°C - 60°C

About Super Micro Computer, Inc.

Supermicro® (NASDAQ: SMCI), the leading innovator in high-performance, high-efficiency server technology is a premier provider of advanced server Building Block Solutions® for Data Center, Cloud Computing, Enterprise IT, Hadoop/Big Data, HPC and Embedded Systems worldwide. Supermicro is committed to protecting the environment through its "We Keep IT Green®" initiative and provides customers with the most energy-efficient, environmentally-friendly solutions available on the market.

Learn more on www.supermicro.com

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