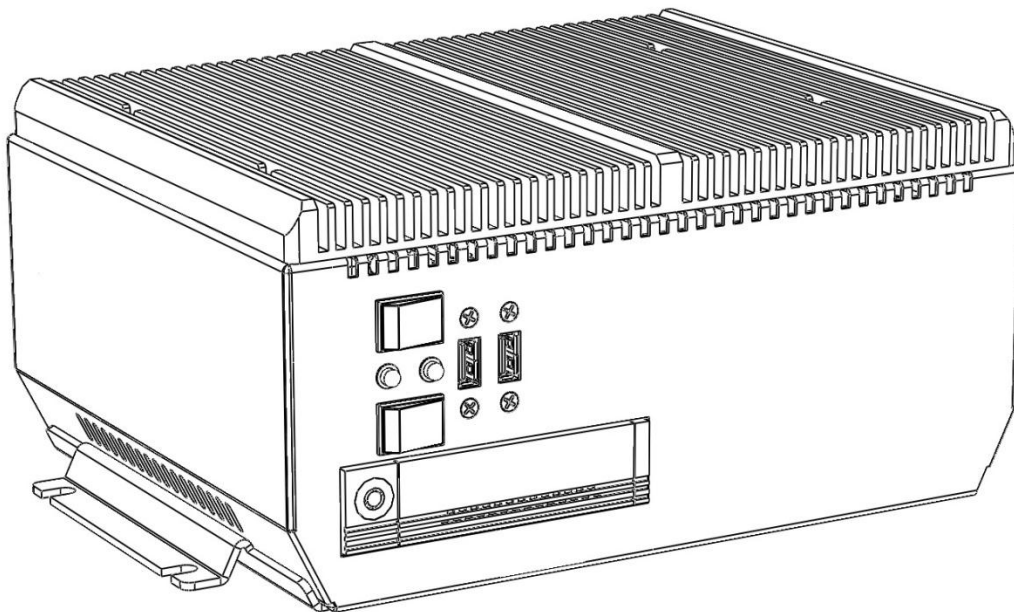




CCS-Inc.
Comprehensive Computer Solutions

The Advantages of Fanless PCs in Industrial Environments



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With new trends in technology emerging daily, computers are becoming more prevalent in all aspects of industry. However, certain areas have traditionally been difficult or harsh on conventional computer systems. Extreme temperatures, dust and particulates, airflow restrictions, and even lack of maintenance access are fairly common issues found in the typical industrial setting. These problems can greatly affect the performance of traditional computers. A variety of technologies and methods have been implemented to try and combat many of the issues found in harsh environments, but one of the best methods is to remove all moving components, including fans, from the computer system. While this approach creates a variety of challenges in design, a fanless PC can prevent many of the common stresses a traditional computer may experience and help decrease the downtime of an average system.

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Programmable Logic Controllers (PLCs) have been used in control systems for decades to accomplish simple tasks, but as tasks become more complex and control systems evolve, operating and performance desires increase. To accommodate higher processing demands, systems frequently require more energy. This energy is often lost in the form of heat, which must be removed from the computer system to prevent damage to sensitive components. Many current systems produce heat in such excess that they require dedicated systems to deal with the temperature rises. In a conventional computer system, electric fans are used to actively remove heat by means of forced convection. Electric fans can be used to draw cool air into the system, expel warm air from the system, and draw air across processors and other microchips. However, the addition of these fans creates numerous problems in industrial settings. Fans are typically one of few moving components in a computer system and are prone to mechanical failure due to dirt and debris as well as mechanical shock or random vibration. In the best case scenario if fan failure occurs, the system would experience downtime while the part was replaced. But, if the system continued to operate without airflow, the entire computer could be damaged or destroyed. By removing fans from the system, these risks can be significantly decreased. However, fan removal creates a whole new set of challenges for the system designer, including how to efficiently transfer heat away from critical heat generating components and remove this heat from the system.

Fanless PCs may use liquid cooling, thermoelectric devices, or active and passive conduction methods to dissipate heat from critical components. In industrial applications, passive conduction methods are often the simplest and most robust means to remove heat from a system. In systems that use this approach, heat is removed from the critical components via conduction through specifically designed heat transfer blocks. These transfer blocks can be made in a variety of ways. Copper is typically used to transfer heat due to its high thermal conductivity. Aluminum may also be used to transfer lower amounts of heat across short distances. However, the desired path of heat transfer is often complex enough that using aluminum or copper heat transfer blocks would result in a large thermal resistance and therefore, significant heat rises in the system. In these situations, mechanisms referred to as "heat pipes" are often used. Heat pipes are hollow, sealed tubes made of a thermally conductive material which encapsulates a small amount of fluid. When one end of the heat pipe is warmed, the fluid vaporizes. Due to a pressure differential in the heat pipe, the vapor will travel to the opposite and cooler end of the heat pipe where it condenses back into a liquid state. This liquid then travels via capillary action through a wicking structure to the opposite and warmer end of the heat pipe. This process becomes a cycle in which heat can be transferred with significantly less resistance than by copper or aluminum blocks alone.

Typically, heat pipes or copper and aluminum blocks will be in contact with a heat sink mounted externally on a system. The purpose of an extended surface, such as a finned heat sink, is to increase the surface area by which heat can leave the system, either by free or forced

convection, while decreasing the thermal resistance of the system. Since heat will ultimately be leaving the system through the heat sink, it is important that this feature be well-designed and optimized for all situations. The level of airflow in the environment can significantly affect the performance of the system. With sufficient airflow, the system may perform well with small or relatively few fins. But in environments with low airflow, the system would overheat and become damaged. Unless otherwise informed, it is paramount to design a system with the assumption that very little airflow will be available across the fins, and that natural convection will be the primary mode of heat transfer. Because the designer is often unaware of the location in which the fanless computer will be installed, the unit must be designed to withstand the worst case scenario. This ensures that the engineer and customer can be confident that the system will perform successfully in all environments.

When properly designed, a fanless PC functions much like a conventional computer, while alleviating the problems that would have occurred in systems utilizing fans. Several aspects of choosing a fanless computer system for a job are similar to those of choosing a conventional system. For instance, when considering a fanless PC for a project, it is important to consider the level of computing which must be done. Many fanless PCs are low power, and consequently, low performance. This however, can be advantageous if the system is to perform a simple task in an extended temperature environment. Fanless PCs can also be quite powerful. Engineers are beginning to configure fanless computer systems that utilize high-end processors with great success. These systems are invaluable when a fully functional workstation is needed in a harsh environment. These workstations may offer expandability via riser cards as well as multiple media storage options. In addition to computer processing specifications, fanless and industrial PCs typically specify the environment in which they are designed to perform. All systems should indicate optimal temperature and humidity ranges for operation and storage. Many will also specify the level of shock and vibration which they can withstand as well as the level of EMC/EMI testing that has been performed. If high levels of heat or shock and vibration are to be expected, solid state media may be preferred to standard rotational media.

When specifying computers for an industrial environment, fanless PCs can offer a viable alternative to traditional fan-cooled systems. The lack of moving parts increases the MTTF/MTBF, which decreases the amount of time and money the consumer spends repairing the system and dealing with downtime. It also reduces internal airflow, preventing dust and particulates from being drawn through the system and damaging components. The space that would have been used for airflow is thus condensed to create a significantly smaller unit, allowing deployment in spaces not available to conventional PCs. As performance continues to improve, fanless computers will become more prevalent due to their size, durability, and reliability.

Related Links:

- [A Discussion on The Power Consumption of Various Generations of Microprocessors](#)
- [Understanding the Principals of Heat Pipes](#)

Utilize our expertise! [Contact CCS-Inc.](#) if you would like to know more about Fanless PCs.