Whitepaper

AAEON's Industrial-Grade Wide Temperature Assurance for Intelligent Systems

Overview

As the worldwide deployment of connected devices reaches 15 Billion in the next few years and up to 25 Billion by 2020 according to industry predictions, it is expected that an increasing percentage of these devices will be installed in locations that are subject to diverse environmental conditions. Intelligent systems and devices at the edge of the Internet of Things (IoT) must be designed to withstand temperature extremes, allowing for placement closer to the point of data collection.

Traditional applications for Industrial Temperature Systems such as Military and Aerospace, outdoor POI (Point of Information), Kiosks, Vending, Digital Signage, Security, Transportation (Bus, Rail, Marine and Automotive), Energy (Production, Delivery and Monitoring), all have an extremely low tolerance for field failure and down time. Due to the critical availability requirement, systems built to address these markets must incorporate tested devices and components to be extremely reliable under all potentially adverse conditions. As a result, AAEON has developed a rigorous Wide Temperature Assurance Service (WiTAS) to address this requirement at the board level. These products specifically meet the needs of computing applications in areas of extreme temperature variance.

By factoring thermal issues into the product development stage, AAEON embedded board designers are able to develop thermally efficient industrial computing platforms that have a high tolerance for extreme temperature environments. This white paper will highlight the procedures involved in creating computing solutions that meet the criteria for effective thermal design for optimal performance and efficiency.

AAEON's Wide Temperature Assurance Service (WiTAS)

For nearly two decades, AAEON has designed and manufactured quality embedded products to address the needs of a multitude of industrial applications. The accumulated experience in all aspects of the embedded electronics market gives AAEON a strong position in the development of wide temperature CPU boards and systems. AAEON's WiTAS program produces boards in two temperature range categories:

-20°C to 70°C (-4°F ~ 158°F) = WiTAS 1

-40°C to 85°C (-40°F ~ 185°F) = WiTAS 2

These categories of Industrial Single Board Computers are able to "pass" AAEON's strict internal WiTAS testing procedures.

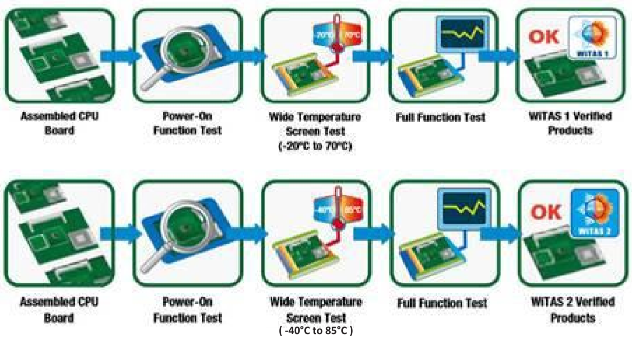

Figure 1 - WiTAS 1 and WiTAS 2 Process

Boards that pass the thermal tests of-20°C to 70°C(- 4° F ~ 158°F) are given a WiTAS 1 designation and boards that endure the thermal of-40°C to 85°C(- 40°F ~ 185°F) are assigned a WiTAS 2 designation as AAEON's special assurance of wide temperature durability and reliability. This, in conjunction with the use of durable components throughout the duration of the testing, allows AAEON to enhance the longevity of its boards and systems.

SBC Wide Temperature Design Considerations

With each new processor generation, increasingly dense chip circuitry is able to produce faster computations, at lower power requirements and at reduced manufacturing costs.

Growing industry demands push the need to create thermally efficient computing enclosures that are both compact and fast cooling. At the development stage, thermal awareness guides engineers to select verified components that can operate under wide temperature variances. Designers must also find ways to resolve the issue of power consumption and heat generation in successive processor generations and smaller board form factors. Introducing devices such as heat sinks or heat-spreaders is also a good way to deal with system heat.

In establishing the criteria for a board to have a wide temperature designation, there are several steps that must be taken. First, the list of desired features must be decided, based on the board's potential applications. This "Plan of features" will help to initially determine the types of components that will be placed on the PCB. Next, a careful selection of components that fit the criteria for wide temperature applications will help to ensure that the most suitable and durable elements are included in the board design. Each component must be evaluated to determine its thermal characteristics and what type of non-moving heat dissipation solution can be utilized. By choosing components such as "Solid State" capacitors, CPUs, chipsets, DRAM, power and passive components, AAEON ensures that the highest level of durability can be achieved for each board.

It is important when designing a SBC or CPU Module, to determine how much power in Watts will be dissipated by the board during typical operation. This is described as Thermal Design Power (TDP). As an example, a board with an Intel® Atom™ processor along with its chipset and other heat generating components may have a total TDP of 15W. Using this TDP as the basis for designing the computer will allow a thermal solution to work for all boards in that line and to function safely within the same temperature range.

It is also vital to know the maximum junction temperature (Tj max) of the processor. During operation, the maximum junction temperature of the processor is higher than the case temperature and the temperature of the component's exterior. The difference is equal to the amount of heat transferred from the junction to the case multiplied by the junction-to-case thermal resistance. In addition, the ambient temperature of the air that will surround the device must be known for accurate thermal solution development. Fanless systems are sought after for rugged environments. Fans often add unwanted noise and fragility to industrial computers and reduce reliability with the addition of each moving part while at the same time, accumulating undesirable dust in the system. To counteract these issues, each component must be evaluated to determine its thermal characteristics and what type of non-moving heat dissipation solution can be utilized. At the board level, components must be arranged in a way that allows for optimal heat dissipation by ensuring the most effective placement of heat producing components on the board.

Critical components are spaced according to extensive experience and component thermal design guide that takes into account the temperature tolerances of the various components and the thermal flow

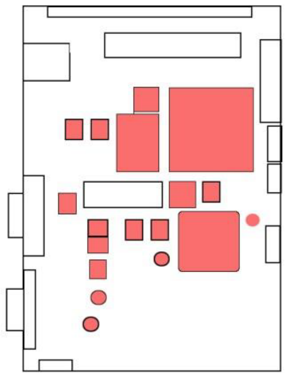

Figure 2 - Poor Thermal Component Design

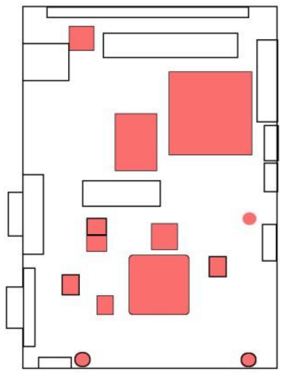

Figure 3 - Ideal Thermal Component Design

among these components to optimize heat dissipation. The primary heat flow path is comprised of thermal interface material, heat spreader and heat sink. The secondary heat flow path contains interconnect layers, I/O pads and the printed circuit board. Initial in-house selection of key components is followed by careful sorting of assembled boards.

Finally, a test plan is carried out in order to ensure the board can meet the harsh variations in temperature that it may be subjected to while used in real-world applications. The test plan includes stress testing the board under controlled conditions to evaluate any potential design or performance faults during normal operation. These procedures further assure optimum levels of performance for boards designated to have Wide Temperature functionality.

After the electrical design and board assembly are completed, the board is subject to eight to ten days of temperature stress testing, where careful attention is placed on any instance of failure. Depending on the test lot size, failure data from the function test can trigger a board re-design or layout change. The stringent requirements for performance instill a high level of confidence in the completed designs. Isolating errors at this stage of the Engineering Verification Test (EVT) further refines the final product as issues are addressed.

Thermal Testing System

By using a **Natural Convection Chamber** or a **Rapid Rate Thermal Cycling Chamber** to create atmospheric conditions similar to those actually found in an industrial application setting, very reliable in-house results can be obtained as to the real-world thermal tolerances in industrial situations.

Figure 4 - Thermal Testing Chamber

The Stress Test illustrated in Figure 5 moves the board through many hours of Wide Temperature testing in stages. A randomly selected board is chosen during the EVT to undergo the power On/Off stress test. Beginning from 70°C, the board temperature is incrementally raised 10°C every hour as the board is switched on and off, until it fails. If it fails within the -20°C to +70°C temperature range (WiTAS1) or -40°C to +85°C (WiTAS2), it is sent for a “design re-check”. If it passes 90°C, it is cooled down and undergoes the low temperature testing beginning at -20°C, until it fails.

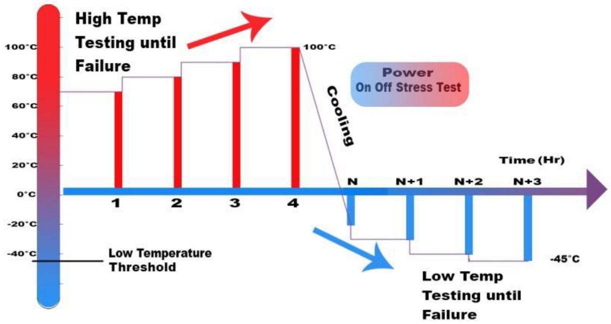

Figure 5 - AAEON Board Stress Test

The precision heating and cooling chambers used, allow for uniform stress testing through linear temperature change rates of the SBCs and Modules at all operating temperatures to ensure certifiable functionality for end users.

Certifying Extended Temperature Systems

Devices in the commercial temperature range of 0°C to 40°C are not suitable for extended temperature applications. For system integrators who are looking to build products that can withstand high temperature extremes, can choose AAEON WiTAS certified wide temperature boards, which are tailored for harsh environments. By doing so, customers can be assured these products will be able to perform as expected within the tested functional temperature range.

Using AAEON WiTAS certified boards, system builders can reduce design risks and avoid having to use large and expensive thermal solutions. The product can operate under both frigid and hot environments. AAEON customers can be confident that all of the components used in the completed system are equipped to perform at required levels of tolerance, suiting the application for which the customer intends to use it.

AAEON's WiTAS 1 and WiTAS 2 Product Applications

AAEON's WiTAS 1 and WiTAS2 verified Modules and Single Board Computers can be found in the Industries including:

- **Transportation**: Train, Ship, Airplane and Traffic Surveillance Systems
- **Factory Automation**: Metal Refineries, Factories
- **Military:** Field Electronic Devices, Aerospace System Controllers
- **Energy:** Wind Turbine Controller, Solar Energy Controller, Power Stations
- **Environmental**: Climate, Water, Pollution and Weather Monitoring Applications
- **Medica**l: Chemical and Pharmaceutical processing

Figure 6 - Renewable Energy Monitoring

A number of AAEON products effectively meet the **WiTAS 1** specification, such as the Intel® based **EPIC-9457W1** EPIC board, **ETX-945GSEW1** ETX module, **COM-945GSEW1** COM module, AMD based **GENE-5315W1 Rev.B** embedded board, and the Intel® Atom™ based **PICO-CV01W1** Pico-ITX SBC.

A range of products also meet the **WiTAS 2** specifications such as the **GENE-TC05W2**, **GENE-LN05W2 Rev.B** and **GENE-CV05W2** subcompact SBCs; **COM-TCW2**, **COM-CVW2 Rev. B** and **nanoCOM-TCW2** COM modules, all of which offers Intel solutions, and the AMD powered **PFM-541IW2** stackable PC/104 module.

Figure 7 - AAEON GENE-CV05W2 3.5" SubCompact Board

These powerful boards and modules represent some of the best in Wide Temperature Computing Devices available today, and along with a range of associated products, are able to meet the expanding needs of intelligent systems and devices as the applications of this technology presses onward into challenging new frontiers.

About AAEON

AAEON is a leading manufacturer of advanced industrial and embedded computing platforms. Committed to innovative engineering, AAEON provides integrated solutions, hardware and services for premier OEM/ODMs and system integrators worldwide. Reliable and high quality computing platforms include industrial motherboards and systems, industrial displays, rugged tablets, PC/104 modules, PICMG half-size and full-size boards and COM modules, embedded SBCs, embedded controllers and related accessories. AAEON also offers customized end-to-end services from initial product conceptualization and product development on through to volume manufacturing and after-sales service programs. AAEON is an Associate member of the Intel Intelligent Systems Alliance.