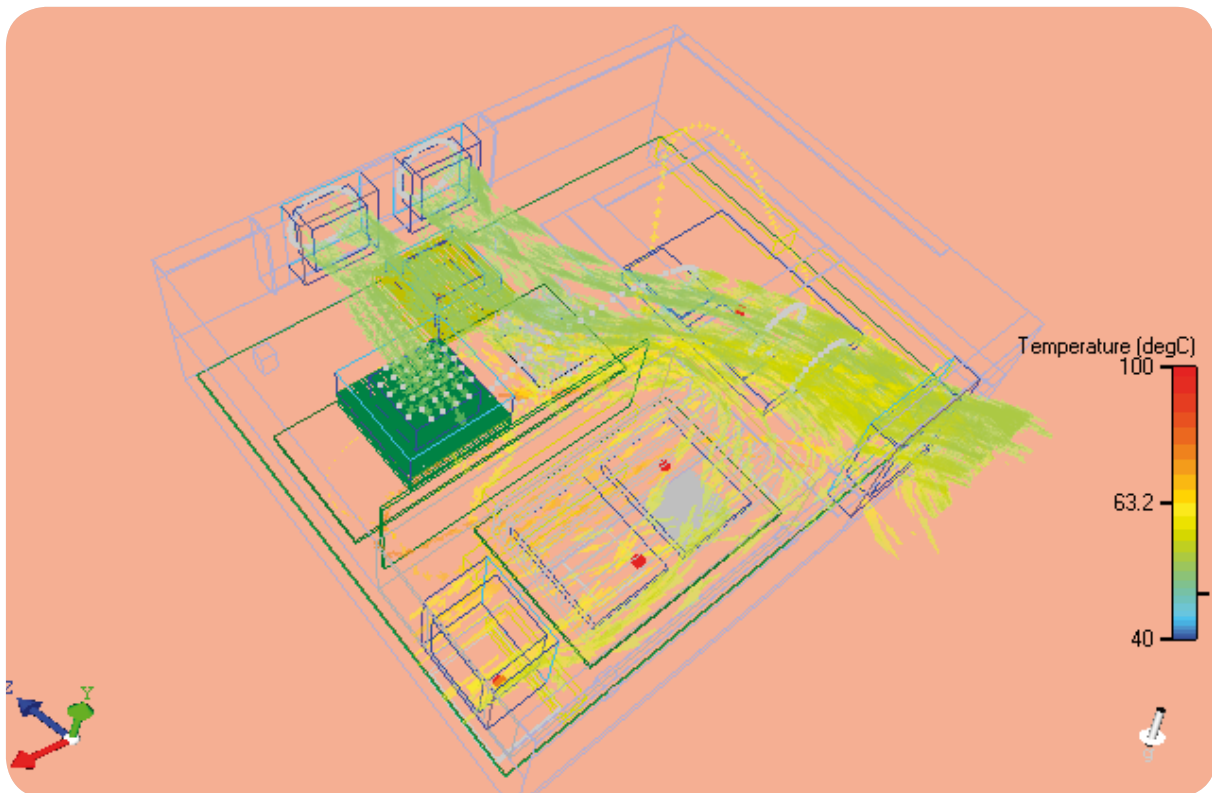


» Whitepaper «



Extended Temperature Device and Testing Advancements for COMs and SFF SBCs Enable Reliable, Long Life Systems

Extended Temperature Device and Testing Advancements for COMs and SFF SBCs Enable Reliable, Long Life Systems

Continued technology advancements have fostered high expectations that embedded systems will continue their evolutionary path to become smaller and smaller with lower and lower power consumption all while delivering ever higher performance. Furthermore, there is a steady increase in the need to design the extreme internal system applications – not only for applications in obvious harsh environments such as what outdoor POS/POI systems and those installed in military type vehicles are subjected to, but also to support rugged environments that result from space-constraints and mission critical or 24/7 design requirements.

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As smaller, rugged and reliable designs based on embedded small form factor modules and single board computers (SBCs) have proliferated, so too has the need to provide extended temperature-based systems. When individual components and the overall system design have been tested to withstand a broader range of temperature conditions, OEMs are given greater levels of assurance that the chosen base technology will function as desired for long-term, rugged deployment with maximum uptime while decreasing operational and maintenance costs. And when designers pack even more performance into smaller form factors, this too has spawned the need for components rated for more extreme temperature ranges. Today's smaller embedded applications add challenges to PCB design layout making it more critical than ever to pre-configure and test systems to ensure they operate in a given application's extended temperature range. As a result, choosing a technology partner that can ensure desired functionality and long-term system performance with pre-configured extended temperature devices can mean the difference of achieving time to market goals or missing the window.

With its long history in developing embedded computing platforms and extensive applications and manufacturing expertise, Kontron enables its customers to quickly get to market with pre-configured, tested, standards-based assemblies of extended temperature boards and modules.

Applications in Extreme Environments

Mission-critical applications in the military, aerospace, transportation, energy and industrial automation markets offer the biggest challenges for extended temperature designs. Systems used in these applications are constantly exposed to extreme external and internal conditions such as wide temperature variances, system start-up in low/high temperature, severe, humidity, dust and other environmental circumstances that play havoc on system performance.

Temperature ranges for industrial applications are typically -40 °C to +85 °C. Some applications call out a subset of the industrial temperature range (-25 °C to +75 °C). The least strenuous temperature range is the commercial temperature range (0 °C to +60 °C). An additional and even more extreme temperature range is defined under the official Mil Spec (-55°C to +125 °C). For example, the trends for smarter and lower power systems on trains to increase safety and reduce its carbon footprint has led to growing demand in the transportation market for extended temperature devices.

The result of system field failures in these applications can mean costly repairs and downtime making it imperative that it is very reliable under a wide variety of operating conditions with the highest level of failure tolerance. Therefore, it is important to have all components and board and module assemblies tested for extended temperature tolerance to ensure the system's proven functionality for extreme operating environments.

Achieving Extended Temperature

For embedded systems, the four main categories of temperature ranges described above are still used to define devices for embedded systems today. Commercial temperature devices are designed in what would be considered a normal operating temperature range of between zero degrees Celsius and 60 degrees Celsius. Commercial temperature devices are not considered suitable for extended temperature applications. Devices that operate in the E1 Extended Temperature range and those specified for either Industrial Temperature or the Mil-Spec temperature range are the only ones chosen for very extended temperature-based systems.

Customers have two recommended ways to ensure that Computer-on-Modules (COM) and SBC solutions perform within extended temperature environments – by design (solutions built with all industrial grade components)

Achieving Extended Temperature

Temperature	Description	
Commercial Temperature	0°C to +60°C	No temperature testing needed. The majority of components and boards function in this range.
E1 Extended Temperature (a Kontron-defined subset of Industrial Temperature)	-25°C to +75°C	Products use some vendor-approved industrial temperature grade components or the assembly is tested to prove functionality in this temperature range. For best results, all components of a system should be tested together. Sub-system testing would include COM/SBC, memory and the cooling solution.
Industrial Temperature	-40°C to +85°C	Very stringent temperature range for operation. Few commercial parts function in this range. Best practice here is to use all vendor-approved industrial grade components from CPU and chipset to memory, etc. If all parts are not industrial temperature grade parts then all components of a system must be tested together. Sub-system testing would include COM/SBC, memory and the cooling solution.

Note: This is ambient temperature. Intel requires the use of a cooling solution at all times for all silicon packages. Active cooling solutions are preferred. Further details regarding temperature range definitions, warranty, terms, conditions, and MTBF impact are outlined in the Kontron America, Inc. Memorandum of Understanding Regarding Extended Temperature Products.

and by 100 percent extended temperature testing of the solution (COMs/SBC plus cooling solution and memory). However, it is essential to point out that the two methods provide different results. Products that are designed for extreme temperature range use from the outset using only components (processors, chipsets, controllers, etc) that are themselves built to operate in extended temperature ranges are the best solutions to eliminate possible field failures.

However, these solutions may be limited in terms of performance and may be cost-prohibitive for some solutions.

One hundred percent production testing of the complete assembly provides a high level of assurance that the solution will minimize a customer's risk of receiving units that may fail unexpectedly in the field. By testing each assembly, COM/SBC plus the approved cooling solution and memory for extended temperature tolerance prior to shipping to the customer, provides the assurance that only approved parts are integrated into the end application. This gives OEMs the confidence in each unit's performance and tolerance and also provides data that may be needed for system warranty life.

Methodologies that Support Extended Temperature

Supporting extended temperature devices goes beyond just the hardware itself. It also includes a group of value-added features and design methodologies. Fanless system design, shock and vibration tolerance testing, advanced thermal management techniques, thermal analysis (including CAD modeling) and conformal coating services are all elements of solution design that protect a system against performance degradation or even system failure caused by harsh environments. Together with a customer, Kontron Engineers work to define the complete solution that best matches the conditions of the end application.

Airflow is a key element of solution design and temperature control, which becomes especially crucial when processor performance and other intense capabilities are integrated into the overall application design. To ensure proper cooling in fanless systems, power management techniques such as BIOS modifications are employed to reduce power usage and have an impact on the overall thermal profile. Fanless systems are also a good solution because over time, fans can slowly degrade or fail completely, severely affecting the thermal health of a system. Additionally, applications that are subjected to high levels of shock and vibration will elect to minimize moving parts such as fans that represent points of failure. In addition to mechanical failures, fan use increases total system power consumption and contributes to noise in the system.

As a means of counteracting the potentially harmful effects of humidity, moisture, dust and other corrosive materials, Kontron offers conformal coating services and uses specially

designed sealants to protect board level solutions and best match the environmental conditions under which the end application will run. Conformal coating services are also available for the memory modules used in the solution. These conformal coatings meet IPC CC-830B regulations. In addition, a Certificate of Conformance is provided with each delivery of coated product to show compliance to the invoked specification. What it all comes down to is that Kontron partners with customers to evaluate the application environment and deliver a solution that works best for the customer.

Value of Proven Assembly Testing

Building extended temperature solutions for demanding applications that call for reliable operation under harsh environmental conditions requires a strong combination of design expertise, proven components and thorough testing. Kontron's approach to rugged designs for extreme environments includes wide temperature range testing with a temperature profile of -25 °C ~ +75 °C for extended temperature, and -40 °C ~ +85 °C for industrial temperature. To ease and speed design development, customers can select a pre-assembled Computer-on-Module or single board computer that is best suited for their application. Assuring compliance with extended temperature requirements, Kontron tests each assembly so it is ready to install when delivered to the customer.

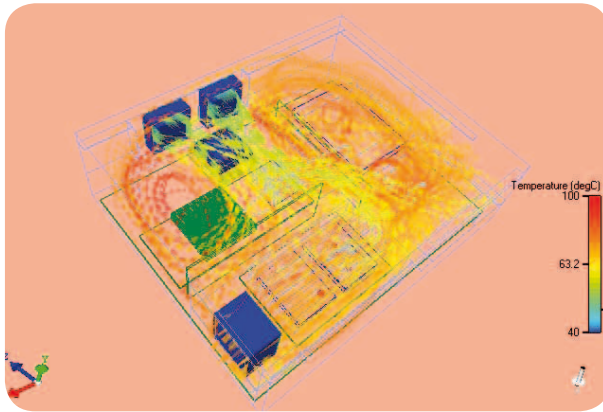
Kontron testing evaluates performance of components or systems under the specified environmental conditions. This includes a variety of dynamic temperature burn-in cycles over extended periods of time depending upon an application's temperature requirements. Testing ensures that pre-configured assemblies operate as expected upon receipt. Using strict testing methods, Kontron gives customers confidence that the solution will function as desired in their end application even though the environmental conditions are too harsh for other solutions.



In addition, Kontron assigns a team to each project for planning and execution. This team also assists in coordinating product customization as needed by aiding in the selection of core technologies and standards, providing product concept images and CAD modeling to facilitate concept testing and rapid prototyping.

Extended Temperature Testing Procedure

- » Test evaluates product performance at extended temperature ranges
- » E1 or custom temperature range as defined by customer/application.
- » Tests are run 5 °C colder and 5 °C warmer than specified temperature range.
- » Test Duration: 130 min, 110 min (run time), 20 min (set up)



Equipment used beyond board/COM, memory and cooler:
Oven, Carrier Board, Power Supply, Display, Keyboard/Mouse, and Hard Drive w/ MS Windows/Linux & Passmark Burn-In Test.

Success for Mobile Embedded Extended Temperature Application

A leading military and aerospace system provider was in a pinch. The company had a short development window for a mobile embedded application that required leading-edge computing performance, large memory capacity and the ability to operate in extreme temperatures (-25 °C to +85 °C) with thermal management limited to passive cooling. The company knew its options were limited to designing with certified parts or tested parts.

With certified parts, this mil-aero supplier would realize a lower price, but would not have the per unit testing needed for a fully verified solution to eliminate the high risk of field failures.

Working with the experts at Kontron lead the company to choose the tested assembly solution. Utilizing Kontron’s expertise and proven testing procedures, the customer could take the temperature tested assembly directly to production in the application. While the cost of this solution is initially higher for the customer, in the end, the total cost of ownership is much lower by minimizing the risk of costly field failures.

The fully tested assembly gave the customer a qualified memory and cooling solution with memory approved by the supplier for use at the customer’s temperature range. Helping to meet its time to market goals, the customer was provided a fully tested solution on the module, memory and cooler prior to shipping and only received the assemblies that passed the screening. The complete Kontron tested solution for this application included:

- » ETXexpress-PC Computer-on-Module
- » Two units of 4GB extended temperature memory
- » ETXexpress-PC passive heatsink

Kontron Extended Temperature Solutions

ETX®		COM Express™		PC/104
	Basic FF	Compact FF	Ultra FF	
ETX®-PM	ETXexpress®-PC	microETXexpress®-XL *	nanoETXexpress-SP	MOPS/520
ETX®-PM3	ETXexpress®-CD		nanoETXexpress-TT *	MOPSLcdLX
ETX®-LX	ETXexpress®-MC			MOPS-PM
ETX®-CD	ETXexpress-PC-XT * (US-only)			MSM200S/X/XP/XU
ETX®-DC				MSM945/P
ETX®-CD				

Additional assemblies will be made available as the roadmaps for each technology family grow. Each pre-configured assembly includes module/SBC, approved memory and cooling solution.

(*) By-Design extended temperature products.

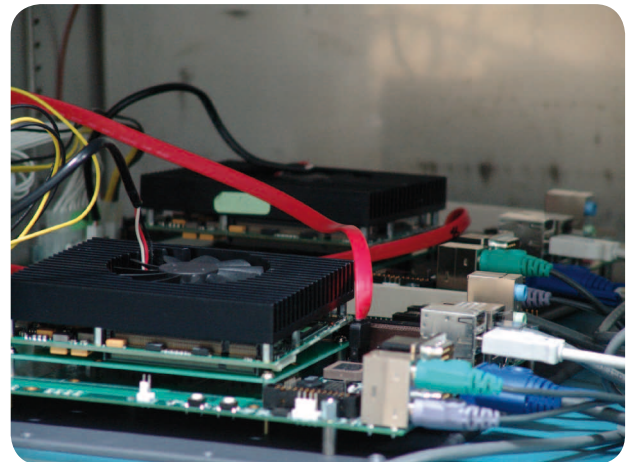
The customer also benefited from additional data learned from the testing process. A review of the testing process and engineer-to-engineer discussions of results and impact on the application have led to enhanced development methodologies for the future from the availability of system-specific data points. Utilizing FloTHERM® modeling allows Kontron to show the thermal make-up of the application and allow the customer to implement appropriate cooling measures.



Extended Temperature "By Design"

Designing a system using extended temperature components is the most effective method to ensure reliable functionality in an extreme temperature range is met. Kontron has put in the needed advance work to determine the best selection extended temperature and industrial temperature components and other hardware that meet extreme application requirements. Enabling OEMs to reach their product life goals, Kontron makes selecting extended temperature solutions easier and provides the confidence that using these solutions will ensure the end-application will operate reliably for its expected life span.

Kontron now offers three Computer-on-Modules in all available COM Express™ form factors that have been designed from the ground up for industrial temperature-based systems—the nanoETXexpress-TT, the microETXexpress-XL and the ETXexpress-PC-XT (US-only). Industrial temperature solutions by design can alleviate the need and cost of per unit testing by using only components that meet industrial temperature specifications.



About Kontron

Kontron designs and manufactures embedded and communications standards-based, rugged COTS and custom solutions for OEMs, systems integrators, and application providers in a variety of markets. Kontron engineering and manufacturing facilities, located throughout Europe, North America, and Asia-Pacific, work together with streamlined global sales and support services to help customers reduce their time-to-market and gain a competitive advantage. Kontron's diverse product portfolio includes: boards & mezzanines, Computer-on-Modules, HMIs & displays, systems & platforms, and rugged & custom capabilities.

Kontron is a Premier member of the Intel® Embedded Alliance and has been a VDC Platinum Vendor for Embedded Computer Boards 5 years running.

Kontron is listed on the German TecDAX stock exchange under the symbol "KBC".

For more information, please visit: www.kontron.com

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