Kontron COMs Withstand Heat and Harsh Environments

Today's embedded system applications are expected to operate efficiently and reliably in a variety of environments in offices, factories, hospitals, and under harsh conditions that include industrial control, military, and transportation applications.

For reliable operation and a long lifetime, it is important to keep the operating temperatures of computer boards and their components as low as possible. Depending on the amount of thermal energy the components dissipate and the environmental conditions they operate in, customized cooling approaches are needed. And in hasher environments, computer boards must withstand severe shock and vibration and a range of outdoor conditions. In general, thermal management can range from natural air convection, heatsinks, combined with and without forced airflow, and heatpipes.

Kontron's ETX and E²Brain COMs have been engineered and battle-tested to provide greater performance no matter how rough the environment they run in. ETX heat-spreader plates and E²Brain's BrainCAPs effectively and efficiently keep processors, chipsets, and other components cool enough to function optimally in the toughest of conditions. The designs for Kontron's ETX and E²Brain products factor in usual and unusual heat and environmental conditions to better ensure their durability and resistance.

ETX modules employ heat-spreader plates to assist with conduction cooling in passive and active cooling solutions that allow the modules to operate in temperature ranges from -10°C to +75°C. In addition, Kontron offers extended temperature testing for ETX modules. Kontron engineers run the modules through cycles of extreme hot and cold temperatures to ensure that the products remain fully functional. Kontron is changing the MOSFETs in its designs to offer extended temperatures ranging from -15°C to +85°C. E²Brains are qualified for harsh environments by providing possibilities for mechanical fixing, optional conformal coating, and extended temperature ranges from -40°C to +85°C

ETX in Rugged Environments

ETX embedded modules provide a stable solution even for the toughest of conditions. EAE Electronics GmbH, a Germany-based company, designed a ruggedized panel-PC based on the ETX-P1. This heavy-duty design is hermetically sealed and allows for fanless operation with conduction cooling technology. The enclosure is IP54 safe (IP65 on request) to withstand the harshest environments. Shock and vibration are some of the greatest issues in avionics. Because of that, EAE elected to deploy Kontron's ETX-based design, which passed the test to the standards of MIL STD 810A (military) and DO 160A (avionics). The system allows operation at vibration of 4.5 G-RMS (5-500Hz, 3hours, XYZ) and 30G of shock (11ms, non rotating disk).

ETX modules also are used in the extreme environment of commercial airplanes. The ETX-P3e board is utilized as the CPU within a multi-channel video/audio system, which is the system that provides the maps, movies, radio, and other board information on commercial jetliners for passengers. This specific system is qualified according to DO 160D standard for use on commercial aircraft. Again ETX passed the demanding test for shock and vibration.

All Aboard the E²Brain Success Train

In Canada, AGC (Autorail Grande Capacité) from Bombardier is part of the new generation of regional trains for local and long-distance traffic. Up to 220 passengers glide along the rails in the AGC with a top speed of 160 km/h (100 mph). Comfort, safety, and economy were the focus of attention for the Bombardier engineers when developing the train. The fundamental building block for implementing these goals is the Canadian train manufacturer's Train Management System. The operation and monitoring of the Train Management System is based on an E²Brain module from Kontron Modular Computers in Kaufbeuren, Germany. The RISC processor board is the heart of the Bombardier GUI, which the conductor and maintenance personnel use to access the Train Management System.

The central point of service for the Train Management System is the Bombardier GUI. The visible component consists of a touch screen at every conductor's station – that is, at both ends of every motor train – with an ergonomic user interface for the conductor and the maintenance personnel. Because the Train Management System is one of the most important instruments for safe train operation, the GUI is designed so that it is intuitive to use, clearly processes information in real time for quick decision making, and processes the touch screen input as quickly as possible.

Besides the operational characteristics, the EN50155 standard for electronic railroad applications places extensive demands on the Bombardier GUI. The standard assumes that electronic rail systems must function 24 hours a day for 30 years, or approximately 250,000 hours, without failure. This means that train control systems must be designed to withstand the toughest climatic conditions, large temperature ranges (-40°C to +85°C), humidity, vibrations, and power fluctuations. Even the heat build-up and, thus, energy absorption have to stay within a narrow range: failure-prone fans are prohibited in train electronics and only passive cooling technologies are allowed.

Among the various COM solutions available from different manufacturers, Bombardier therefore decided on the E²Brain concept from Kontron. E²Brain modules are always equipped with RISC processors like XScale or PowerPC, and measure 75 mm x 115 mm. For the operation and monitoring of the Train Management System, only a RISC CPU was considered, for a variety of reasons. Because the Bombardier GUI is a 'hard' real-time application, which requires an extremely fast processor with minimal power consumption and heat emissions due to railroad construction standards, a PC processor was out of the question from the beginning. A high frequency x86 processor would be required in order to achieve the necessary computation speed, which would have consumed too much energy and generated too much heat. Added to that, a PC processor is quite a bit more expensive than a corresponding RISC CPU with the same performance. Moreover, the Bombardier GUI is designed as a thin client, which neither requires nor uses the abundance of features on an x86 chip.

The requirement for long-term availability also added favor to a RISC processor: with PC processors, one cannot develop applications that are designed to function for 30 years, because their product life and availability come to less than a decade. RISC processors, on the other hand, 'live' significantly longer – and if they are canceled early after all, the COM concept, which permits a 'soft' CPU migration, applies.

The Bombardier GUI works with the E²Brain EB8245. The implemented Freescale PowerPC processor, with its 330 MHz, offers a performance of 465 MIPS Dhrystone (2.1). That means maximum computing power without a fan and with minimal power consumption. For data handling, the board offers up to 512 MB SDRAM, up to 32 MB soldered Flash (133 MHz, 64 Bit), 1 MB buffered SRAM and E²Prom for application and configuration data. This system performance manages all of the comfort, core system and maintenance functions at any time without critical system situations arising. As a result, there is no need to implement software controlled prioritization routines for executing time-critical commands.

Beyond pure processor performance, the E²Brain EB8245 offers the user the features and interfaces that are necessary for real-time applications in the industry as well as in the train: the COM communicates with its environment via four serial ports, a Fast Ethernet connection and a CAN interface. Customer-specific expansions are realized via 32 bit, 33/66 MHz PCI, and/or LPC buses. Both buses are linked to the baseboard via the four standardized SMD connectors – as are all other interfaces.

The power supply is designed as 'single source' with 3.3 volts. In the standard version, the E²Brain modules are specified for a temperature range from 0°C to 70°C. The expanded temperature range from -40°C to +85°C, as Bombardier requires as well, is also offered. The thermally and mechanically robust design of the modules qualifies them for use under the toughest environmental conditions, such as those that prevail in trains.

ETX Keeps Its Cool

Kontron's ETX (Embedded Technology eXtended) Computer on Module (COM) follows an open standard designed to fit the needs of embedded applications. Complete PC functionality is provided within very compact ETX module dimensions of 114 x 100 mm. The use of a wide range of CPU classes also allows for performance scalability. Kontron's ETX modules can fit into a variety of form factors, some of which include: ATX, PICMG, CPCI, and VME. The compact module offers complete PC functionality within a 95 mm x 100 mm (4.5" x 3 3/4") footprint.

To minimize shock and vibration issues, ETX modules use four rugged and fixed high-density connectors to connect to a custom built baseboard that contain all customer-specific functions. By combining a standard "off-the-shelf" product with a custom baseboard, ETX allows rapid time to market because the products core has already been implemented, reducing development costs.

ETX-powered embedded applications work well in industrial automation, control, image processing, medical, engineering, and telecommunications.

ETX modules employ heat-spreader plates to assist with conduction cooling in passive and active cooling solutions that allow the modules to operate in temperature ranges from -10°C to +75°C. Other ETX boards use Mobile Celeron processors, which rely on passive cooling solutions. Some of Kontron's ETX modules allow reduced CPU voltage, which ensures high performance while using reasonable power consumption and feature trigger points that automatically shut down the processor if exceeds the operating temperature recommended by its manufacturer.

To retain their cool, some ETX modules rely on a heat-spreader, which is a 2mm thick aluminum plate, and it provides a thermal interface surface for heat removal from the

ETX module. Because of the thickness of the plate, components that must fit under the plate are limited to a height of 6mm unless clearance holes are provided.

The ETX heat-spreader is thermally coupled to the CPU die or package surface. The heat-spreader also may be coupled to other heat-generating devices on the module. The heat-spreader is the thermal interface surface for most of the heat generated within the module. The heat spreader is not intended to function as a heat sink, although it may be suitable for such purposes if low-power modules are used under benign conditions. Higher-power ETX modules require heat-removal devices such as heat sinks and fans, and heat pipes attached to the heat-spreader or be thermally coupled to the chassis.

Thermal dissipation varies considerably among ETX modules and proper heat removal from the heat-spreader is an essential consideration for any ETX design. For maximum flexibility, ETX cooling methods should be secured to as much of the heat-spreader plate area as possible because the location of the CPU varies among the many different ETX module designs.

Customers also can attach finned-heat sinks to the tops of the heat-spreader to further dissipate excess heat. Some ETX modules that use CPUs that generate extra heat also employ fans to keep systems operating efficiently and coolly.

Most Kontron heat-spreaders use a minimum of four threaded posts to secure them to the ETX module. The heat-spreader must be first affixed to the ETX module before the ETX module assembly is fastened to the baseboard. The screws used for the heat-spreader posts are shorter (6mm) than the ones used for the four main ETX posts (at least 10mm). The posts also securely hold the ETX modules to the baseboard, enabling it to further withstand shock and vibration experienced in tough environments. The heat-spreader also mechanically solidifies the ETX modules, thus reducing the already remote chance of the module bending or flexing, which could affect the operation of the module if solder joints break. The module and the heat-spreader post combine to eliminate board flexing,

warping, or bending. The heat-spreader creates greater heat conduction because it is tightly secured to the tops of heat-generating components such as the CPU and the chipset. The pads attached to the heat-spreader draw the heat from the module and transfer it up to the heat-spreader itself, which then dissipates the heat.

Exclusively for Kontron, Hirose designed rugged and durable FX8 and the FX8C ETX mating connectors to accommodate different contact length to achieve different stacking heights. The posts provide superior mechanical stability and contact reliability in every kind of application and in virtually any kind of operating environment.

Clearance holes in the heat-spreader plate are permitted for access purposes such as SODIMM removal or to allow the use of high-profile components up to 8mm high. All hole locations and sizes should be carefully considered so that the mechanical integrity of the heat-spreader is maintained.

E²Brain's BrainCAP Keeps It Cool

Kontron's E²Brain (Embedded Electronic Brain) is an application-oriented architecture for advanced computer modules. It meets the needs for industrial, medical, communications, transportation, and military by providing a comprehensive, perfectly tailored set of features and interfaces. The E²Brain specification defines a mechanical form factor and a set of functional interfaces providing a maximum of flexibility and scalability. E²Brain is open for all CPU architectures, including PowerPC, ARM, SH, and others. Thus a CPU technology, which fits best to the application requirements, can be chosen without making compromises. E²Brain is qualified for harsh environments by providing possibilities for mechanical fixing, optional conformal coating, and extended temperature ranges from -40°C to +85°C.

The E²Brain approach to a computer-on-module standard for RISC provides a means of addressing application areas including: networking, telecom, datacom, industrial control, transportation, military, and medical. The form-factor provides scalable performance and

upgradeability as well as the flexibility to use a variety of RISC processors. Consideration for ruggedness and extended temperature range in the most critical applications ensures a successful design for the entire range of targeted applications.

E²Brain (Embedded Electronic Brain) modules are optimized to run at high performance while using low power. Passive cooling and a comprehensive thermal design is a prerequisite for deeply embedded applications. This has been achieved with BrainCAP. (The acronym stands for Cooling Assembly Protector.) In addition to serving as a heat sink, the BrainCAP's milled aluminum element provides mechanical stability, which prevents board bending, as well as EMI protection.

The E²Brain's heat sink absorbs the heat from the CPU and other heat-generating components, transferring it to the BrainCAP, which then dissipates the heat. Another advantage to using E²Brains is that they can use RISC processors, which use less power and generate less heat than x86 processors.

The E²Brain specification defines a PCB module with a form factor of 115 x 75 x nn (L x W x H) millimeters where H is (within a specific range) a function of the application. For interfacing with applications, the specification calls for up to four connectors, which provide not only interfacing capability for current industry standards but also for future standards or application-specific requirements. The type, location, and usage of these connectors are also defined in the E²Brain specification to guarantee standardized compatibility and resistance to board bending.

In addition, the E²Brain specification envisions considerations for thermal energy dissipation, which can range from heat-spreaders to highly sophisticated designs that rely on heat-sink cooling.

Even if low-power E²Brain modules do not require additional cooling measures, the thermal aspect is taken into consideration by the specification. E²Brain concentrates on

passive cooling, which means no fans on the module. Moreover, E²Brain relies on module cooling instead of component cooling. Therefore, the thermal concept provides BrainCAPs with standardized mechanical profiles and mounting.

E²Brain heat sinks allow modules to operate at up to 85°C without forced airflow created by fans. For applications in which the chassis itself serves as the heatsink or the cooling device is mounted on the carrier, a heat-spreader may be preferred.

The E²Brain's BrainCAP is mated to the surface of a metal chassis, further dissipating heat buildup and providing greater mechanical stability. The coupling of the aluminum BrainCAP to the E²Brain also reinforces the E²Brain module itself, greatly reducing the probability of the board bowing or bending. E²Brain uses rugged connectors on the bottom of the modules themselves, which are securely fixed to the baseboard. The secured module connectors also reduce the chances of shock and vibration problems. In addition, components can be soldered to the PCB to further withstand shock and vibration in more dynamic environments.

Conclusion

As demonstrated by the successful deployment of ETX modules in extreme operating conditions of airplanes and helicopters, and the E²Brain's deployment to manage a region's train system, Kontron products are up to the task. In addition, Kontron engineers can run the modules through cycles of extreme hot and cold temperatures to ensure that the products remain fully functional. Kontron offers ETX modules that can operate from -10°C to +75°C and is changing the MOSFETs in designs to offer extended temperatures ranging from -15°C to +85°C. E²Brain heat sinks and other cooling solutions allow modules to operate at temperatures from -40°C to +85°C.

Kontron pioneered the COM concept as a revolution in simplifying the development of embedded computer systems. Kontron offers a range of x86 or RISC modules. Customers can create their own baseboards by following Kontron's industry-leading design guides

and schematics, all of which are available online at Kontron's Web site. Kontron's ETX and E²Brain COMs provide successful embedded computer system designs that feature a range of power options, low cost, great features, and superior reliability. Because of their engineering design and the use of heat sinks and heat-spreader plates, ETX modules can withstand high and low temperatures in rugged of environments without overheating the applications or the modules themselves.

Because of its thermally and mechanically robust design, E²Brains, available in RISC architectures, are suitable for use in extremely harsh environments. E²Brain modules deliver an excellent performance/power consumption ration qualifying them for use in the extended temperature ranges.