Performance Grows, Enclosure Shrinks

Low voltage, fanless solution is the first SBC based on the new Intel® Embedded Compact Extended Form Factor specification

Case Summary

Business Need	Embedded single board computers (SBCs) for in-vehicle infotainment and medical equipment must gain in performance to run multimedia graphics applications. But the form factor must continue to shrink as these systems are deployed in highly mobile enclosures.
Development Issues	Controlling signal quality becomes more difficult as performance increases. This is especially challenging in small, fanless enclosures, where heat and vibration can interfere with performance. In these circumstances, a high-density, efficient board design requires components that have very low thermal output, even while delivering robust performance.
Solution	The Low Voltage Intel® Pentium® M processor and Ultra Low Voltage Intel® Celeron® M processor deliver some of the highest performance available at low power. Coupled with the Intel® 915GM chipset and Intel® ICH6-M chipset for integrated graphics solutions with dual independent display capabilities, the Intel components offer the right features for small, embedded applications like in-vehicle infotainment, transaction terminals, and medical devices. Intel turned to AXIOMTEK—an associate member of the Intel® Communications Alliance—for the expertise to develop these components into an embedded SBC that can be used as proof-of-concept for potential customers.

Demand Grows for In-Vehicle Infotainment

As people become more dependent on their computers for the conduct of daily life, there is growing interest in taking those capabilities on the road. Hence the popularity of laptops, cell phones, PDAs, portable media players and the like.

But there's another dimension to the demand for application "portability" that is just beginning to emerge. A broad category of applications known as "in-vehicle infotainment"—whereby the portable platform is a moving vehicle—are being deployed in the form of interactive terminals, multimedia systems, in-dash navigation systems, and embedded vehicle diagnostics tools.

Demand for this type of application is growing quickly, suggesting that more vehicles will come equipped with computer-powered capabilities, and an increasing variety of infotainment applications will emerge. Intel and AXIOMTEK predict some level of convergence in both mobile computing and vehicle-based infotainment, eventually enabling users to do things like email and Internet browsing from their "Car PC." Dual, independent displays will also become more important, as different passengers may use separate applications simultaneously.

More *and* Less—A Challenge

But there are challenges in developing platforms that deliver in-vehicle infotainment applications. For starters, consider the widely varying environments in which vehicle-based computers are deployed—everywhere from inside the dashboard to panels mounted on the exterior of a vehicle. This presents an unpredictable range of operating conditions that serve up an intermittent supply of power, uncontrolled temperatures, and the shock and vibration caused by travel over variable terrain.

So embedded computers for the in-vehicle infotainment industry must be wary of moving parts. For example, disk-based storage solutions would be risky because spinning parts are not designed to function in such an unstable environment.

The size of the system is also an issue. Because in-vehicle infotainment systems are used in small spaces (vehicle dashboards, for example), engineers must keep footprints small. This affects several design considerations, including everything from interfaces, to signaling and performance, to power consumption and thermal output.

For example, AXIOMTEK says it's most difficult to maintain signal quality in high-density, small-space designs, and even more so as performance increases. "Graphics applications require a high level of performance from the chip, which increases the size of the signal," explains Joseph Chou, Product Marketing Manager, AXIOMTEK.

Increasing performance also affects the way engineers must deal with thermal output and power consumption, a problem that Chou describes this way: "Higher performance components generate more heat, which is hard to dissipate in a small, embedded enclosure. Fans are not an option in a sealed enclosure, because there is no place for the air to move. So we are forced to rely on a passive thermal solution—in other words, fanless. This means we need low voltage chips that produce very little heat, as well as consume a minimum amount of power."

"The low-voltage Intel chips and the integrated graphics of the Intel® 915GM Express chipset currently offer the best combination of features for this industry. When we put them into the Intel® Embedded Compact Extended form factor SBC, you have one of the smallest, most powerful PC-based designs available today."

Joseph Chou
Product Marketing Manager
AXIOMTEK

Contrast these needs with the demand to increase the calculating power of the CPU. Operating systems are growing in complexity, the I/O interfaces involve high-speed, serial communications, and new multimedia applications use a high degree of bandwidth-intensive graphics—all increasing the performance demands on embedded computing systems.

Multi-Faceted Solution

Intel turned to AXIOMTEK—an associate member of the Intel® Communications Alliance—to develop an embedded SBC that meets the performance demands for in-vehicle infotainment applications, taking care to optimize the design to withstand a wide range of adverse operating conditions.

Starting with a new SBC form factor specification, and using components that deliver the highest level of performance at the lowest possible voltage, the solution from Intel and AXIOMTEK can meet the needs of the most demanding vehicle-based applications. Elements of the solution include:

Intel® Embedded Compact Extended (ECX) Form Factor—SBC. Intel and AXIOMTEK started with the non-standard 3.5 inch form factor (with a measured X:Y dimension of 105 x 146 mm), which makes it one of the industry's smallest, widely adopted single board computer (SBC) form factors.

Intel used this footprint as the basis to publish the Intel ECX form factor SBC. By publishing it as an open design for use by the entire industry, Intel is enabling embedded board developers to deliver the tiny platforms that will enable a plethora of in-vehicle infotainment applications.

The Intel ECX form factor calls for x86 architecture, compact flash storage devices, minimal thermal output, and low power consumption for a fanless solution. With a combination of low-voltage Intel processors and high-performance chipsets in a highly integrated, high-density design, boards built on the Intel ECX form factor can sustain performance in a high-vibration environment, like a car.

Low Voltage Intel® Pentium® M Processor or Ultra Low Voltage Intel® Celeron® M Processor. There are currently two Intel processors available that offer the highest performance at low voltage—ideal for the Intel ECX form factor. The Low Voltage Intel® Pentium® M processor offers Intel's highest level of performance at low voltage. Using a new microarchitecture for high-performance, low-power embedded computing and Intel's advanced 90nm process technology, the Low Voltage Intel® Pentium® M 738 processor has a very low thermal output of just 10W, with an L2 cache of 2 MB, and a front-side bus speed of 400 MHz. While incorporating advanced processor technology, it remains software-compatible with previous members of the Intel® microprocessor family.

The Ultra Low Voltage Intel® Celeron® M 373 processor also offers exceptional performance and value combined with low power for thermally sensitive embedded and communications applications. At a maximum 1.0 GHz, the Ultra Low Voltage Intel® Celeron® M processor 373 delivers an L2 cache of 512 KB, with a front-side bus speed of 400 MHz, and an extremely low thermal output of 5.5W—optimizing the value and performance for POS, terminal, kiosk and other in-vehicle infotainment applications.

Intel® 915GM Express Chipset. Both the Low Voltage Intel Pentium M processor and Ultra Low Voltage Intel Celeron M processor are validated for use with the Mobile Intel® 915GM Express Chipset for Embedded Computing, consisting of the Intel 915GM Graphic Memory Controller Hub (GMCH) and Intel® I/O Controller Hub 6-M (ICH6-M). This chipset is an optimized integrated graphics solution with a 400 MHz and 533 MHz front-side bus. The integrated 32-bit 3D graphics engine, based on Intel® Graphics Media Accelerator 900 (Intel® GMA 900) architecture, operates at core speeds of up to 320 MHz. It features a low-power design and supports up to 2 GB of DDR2 533 MHz system memory.

"Graphics are essential for in-vehicle infotainment applications," says Chou. "The low-voltage Intel chips and the integrated graphics of the Intel® 915GM Express chipset currently offer the best combination of features for this industry. When we put them into the Intel® Embedded Compact Extended form factor SBC, you have one of the smallest, most powerful PC-based designs available today."

SBC "Proof-of-Concept" Board. AXIOMTEK has implemented the Intel ECX form factor SBC in a proof-of-concept in-vehicle infotainment application. The system operates in a fanless configuration. Different GPS modules on the market today can easily fit onto the board's I/O interface, whether based on the COMM or USB interface. And the form factor's 105 x 146 mm dimensions fit a standard DIN slot. Wireless network access can be enabled through expansion on the form factor's defined region.

About the Intel® Embedded Compact Extended (ECX) Form Factor Specification

The Intel® Embedded Compact Extended (ECX) form factor SBC specification is written and published as an open specification for the industry. The specification describes the mechanical and electrical interfaces, design dimensions, and regions for placement of major components so that hardware vendors and system integrators can build and integrate compliant components, systems, and devices.

The Intel ECX form factor is a highly integrated single board computer concept with rich generic I/O connections and interfaces. This ultra-compact system uses legacy technology to enable integrators to meet the needs of several different market segments. Its compact size and general-purpose I/O interfaces enable the form factor to fit into a standard DIN slot for use in vehicle infotainment systems, medical imaging systems, portable point-of-sales (POS) systems, panel PCs for industrial use, compact information stations, entertainment, gaming, and other computation-intensive embedded systems.

The nature of embedded systems also requires a great deal of I/O flexibility to meet the expansion needs of a particular application. While maintaining its basic single board computer function, a dedicated I/O region is defined in the form factor to provide the greatest flexibility to accommodate expansion needs. Powered by Low Voltage Intel® Pentium® M or Ultra Low Voltage Intel® Celeron® M processors, the Intel ECX form factor delivers some of the highest computation power in its class to address various application needs.

Intel has enabled multiple thermal solutions for the system to achieve both system cooling and a fanless (natural convection) operating environment. Therefore, the form factor can be implemented both with and without a system fan, depending on the system's intended environment.

Supporting Technology

Intel and AXIOMTEK believe the new compact SBC will be a strong catalyst for growth in the in-vehicle infotainment industry. Offering a much-needed industry standard for a tiny embedded form factor, along with the high-performance/low-voltage components needed to execute applications in these systems, the Intel and AXIOMTEK solution brings numerous technology advantages to the industry. Among them:

PC-Based Solution. Using PC technology in an embedded form factor enables software developers to reach the marketplace more quickly with new designs. It's an advantage that can't be matched by RISC-based designs. "The PC developer ecosystem is very mature. Peripherals, software, and a lot of other third-party solutions are ready to go—just the platform is needed," explains Chou. "This is the ready-to-go point for PC architecture."

Existing Prototype. With the proof-of-concept board developed by AXIOMTEK, vendors can begin working on applications without the time and expense involved in prototype development. "That saves at least three months off the usual development process," says Chou. "If they're using PC-based software, it's just like using boxed software—install it and it works. There's no porting or modification work required."

90nm Process. The advanced process (90nm) technology used to build the Low Voltage Intel Pentium M and Ultra Low Voltage Intel Celeron M processors opens new solutions opportunities for the embedded market segment, where space and power consumption are challenging factors. This enables members of the Intel Communications Alliance—an extensive network of third-party developers—to provide the high-performance, low-power platforms needed by the in-vehicle infotainment industry.

Conclusion

Growing performance on a shrinking form factor is a perpetual problem for technology engineers. But Intel continues to lead the industry with innovations to make it possible—including the 90nm process technology used for chips destined for tiny embedded applications. Enabling easy development of an industry-leading combination of high performance at low power, Intel is winning new admirers, including former RISC-based developers like AXIOMTEK.

Consider too how whole industries can benefit. The next time you view a dashboard display, a vehicle-mounted interactive terminal, or a mobile multimedia system, consider the computer that powers it.

For more information

About AXIOMTEK

www.axiomtek.com

About Low Voltage, Embedded Intel® Architecture

www.intel.com/go/embedded

About Intel® Embedded Compact Extended (ECX) Form Factor Specification

www.intel.com/technology/ecsff/app.htm

About Embedded Intel® Architecture

www.intel.com/design/intarch/papers

About the Intel® Communications Alliance

www.intel.com/go/ica

Intel® Communications Alliance

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