# Modular solution rises above PC/104 restrictions

*By Richard Hung*



**While PC/104 is becoming a popular module choice for system integrators, its compact size presents thermal management predicaments, especially in industrial applications that have extreme environmental requirements. Developing a total system solution with specially designed thermal fins and an embedded heat sink can prevent overheating and thus help ensure reliable system performance in harsh operating conditions.**

A recent Venture Development Corporation industry report projects that the growth of PC/104 modules will increase by more than 50 percent in 2007. The general trend appears to be that more and more system integrators are choosing PC/104 as the basis of their solutions. However, because of its intrinsic compact size and stacking capability, PC/104 can sometimes create limits for system integrators developing a solution in automation control, military, transportation, and other similar applications.

Conventionally, when building a PC/104-based system, many testing procedures for shock/vibration, thermal management, EMI, and safety are performed twice, once at the board-level stage and once more after system integration. Complications arising from mechanical adaptations such as those needed to correctly fit interfaces and routing wiring can necessitate considerable extra effort. Not only does this add cost to the overall system, it also prolongs time to market. Furthermore, the traditional method of installing the processor board uppermost on the PC/104 stack might be inadequate for new applications that pose particular environmental challenges, such as systems that start up under low temperatures or that must withstand extreme thermal shock.

### Limitations created by PC/104 modules

Many system integrators purchase PC/104 modules from different providers, which can have a negative impact on the system's overall performance and reliability because each manufacturer has different definitions for the module's thermal specifications. Lack of complete thermal information can be a dangerous oversight during system integration. Therefore, thermal issues pose the biggest roadblocks for system integrators.

Because PC/104 is small, it is relatively harder to dissipate system heat; at the same time, its limited system space makes implementing a thermal solution more complicated. A heat sink in a stackable system can help dissipate heat adequately with 7-10 W of power, but the power consumption for a Pentium M or higher processor is far more than just 10 W. The system needs a thermal design that conducts heat to the overall enclosure to achieve an effective thermal solution.

A PC/104-based system can be relatively unstable, structurally speaking, as more functions are added to the system, making it unfit for industrial applications in unpredictable environments. Concerning the system, antivibration and shock mechanisms are only applicable to hard disk drives, CompactFlash cards, and memory. Problems still exist for PC/104 modules and heat sinks because they were not designed to withstand high vibration and/or shock. For example, when used in vehicles, ticketing systems, and security cameras, vibration resistance must be kept to a minimal level of 5 *g*. Little can be done to improve the system's overall stability after it has been deployed.

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### Special industrial application requirements

Industrial solutions designed for vehicles or outdoor applications have unique demands. Extreme environmental conditions – operation in high or low temperatures, thermal shock, high humidity, electromagnetic disturbances, and start-ups in low temperature – account for most of these demands. Because system failures often result in high costs, the system must be very reliable under every possible operating condition and provide the highest level of failure tolerance.

Requirements often depend on the location and type of application. For example, when an airplane takes off, the temperature inside the cabin can drop from +50 °C to -30 °C within half an hour. The temperature change is rapid; therefore, the on-flight systems must be able to withstand this kind of thermal shock to ensure reliable system performance. Likewise, an outdoor solution may be installed in places where its internal temperature can reach up to +70 °C in the summer and -40 °C in the winter. Currently, PC/104-based solutions cannot fulfill these environmental requirements. What system integrators need is a total ruggedized system that includes thermal and shock/vibration solutions within a totally reliable mechanical build.

### A total system solution

Given these constraints in industrial and other applications, system integrators should consider developing a total system solution that preserves PC/104's stackability and compact size. This type of system is highly modularized to ensure easy integration. Each layer is a standard, secured housing unit for two PC/104 modules. The system's front and rear I/O panels are stand-alone so they can be customized to minimize any complications with the system's internal wiring.

The system's active cooling solution includes specially designed thermal fins and an embedded heat sink on top of the PC/104 module. Within each heat sink are two copper heat pipes that are quick to conduct system heat out to the heat sink, which is connected to the thermal fins at both sides. The thermal fins are designed to increase the surface area that comes in contact with the air. By speeding up the heat dissipation rate, the system will not overheat and thus can operate under extreme temperatures. With better heat dissipation, the system can house a higher-performance CPU.

Depending on the CPU board's placement, the heat generated from the topside of the board is efficiently transferred to the heat sink, the heat pipe, then finally to the thermal fins at both sides. The significant amount of heat generated by memory on the bottom side of the board, which can potentially damage nearby components, is dissipated via a heat spreader specifically designed for the bottom side of the board to prevent entrapment and overheating. Overall,

the whole enclosure acts as one big heat sink, enhancing the system's thermal performance.

### The system in transit

To demonstrate the effectiveness of this total system solution approach, consider the illustration of a rugged PC/104-based system, such as Advantech's ARK stackable system (Figure 1), deployed to fit the needs of a transportation application. Say that a bus company is looking for an in-vehicle system that includes GPS, digital surveillance, and data transmission functions. The system must be compact and able to withstand vibrations up to 7 *g* and operating temperatures as high as +70 °C. Because the system is built on PC/104 SBCs, only necessary features are included, thereby minimizing the overall system size.

Using a rugged PC/104 CPU module as the basis for the solution, by stacking three modules – DC power, GPS/GPRS, and wireless LAN – the system is only one step away from completion. A specialized aluminum enclosure can house these four modules and provide a strong antivibration mechanism on the bus. Moreover, if a system integrator offers modules that are already pretested for extended operating temperatures, high temperatures do not pose any threat to the system's reliability.

**Figure 1**

This modular design concept provides a time- and cost-effective method for solution development because any standard PC/104 module can be easily and flexibly incorporated depending on the needs of different applications. Developing this type of solution enables system integrators to overcome thermal dilemmas and ensure system stability in harsh environments.

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