Design Benefits of the MI/O Extension Solution

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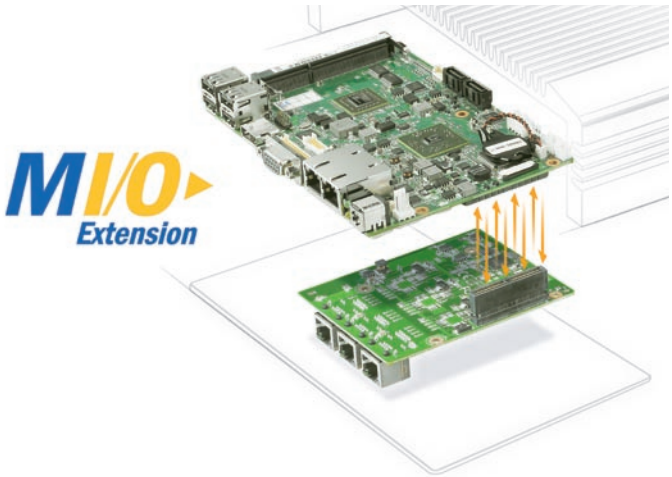
System integration is not an easy task, making system integration easier is the goal of most clients. By using the MI/O Extension solution, we can help customers retain domain knowledge and design their own extension modules, making mechanical designs more compact with fewer system parts, and centralize thermal designs to improve reliability.

The MI/O Extension provides a flexible and functional design for single-board embedded systems, and it provides new definitions for mechanical planning and cooling design. It has also made breakthroughs with regard to the limited expandability of conventional single-board designs and can extend I/O modules in a flexible manner as well as drive market demand for various vertical applications with a more efficient approach.



MIOe Pinouts and Functions

MIOe is diverse enough to meet the requirements of most applications because it is an integrated interface standard defined by Advantech. It includes a wide variety of interfaces such as DP (DisplayPort), PCIe, USB, LPC, SMBus, Audio Line Out and Power, which will meet customer requirements in terms of system integration. Compared with ordinary single-interface standards such as PCI, PCIe and PC/104, MIOe is in a position to provide better integration for more diverse applications in order to satisfy the demands from different customers.

MIOe has the ability to support up to 4 Giga LAN from 4 PCIe x1, and multiple RS232/422/485 ports with added super I/O from the LPC. On the SMBus, a SMBus-to-GPIO IC converter can be used to produce a GPIO signal, which can be used to control the switching between RS232 and RS485. If it is necessary to come up with additional specifications such as isolation, these functional designs can be used on the same MIOe module. In addition, since power to the MIOe module can be supplied directly from the MI/O Extension main CPU board, there is no need to design a separate power zone on the module, which significantly reduces the design complexity of the module. This is something a single-interface standard cannot achieve, whereas with a MIOe module it is quite simple to integrate these types of applications together.

How MIOe can lower the design barrier for customers

From the design perspective of circuit and layout

The interfaces selected in the design of MIOe are based on the knowledge and experiences provided over the years. Also, these are interfaces recognized as being future industry trends. The goal of MIOe connector is to incorporate as many interfaces as possible within a limited number of pins. The number of signals in a single interface is small, which implies relatively simple circuits and design layout, which in turn lowers the design barrier of the MIOe module. Take the design of the SMBus as an example. The SMBus contains only two wires and this simplifies circuit design and traces in layout. Furthermore, the absence of high-speed signals results in fewer things to consider in design layout, which helps substantially reduce the development duration and cost.

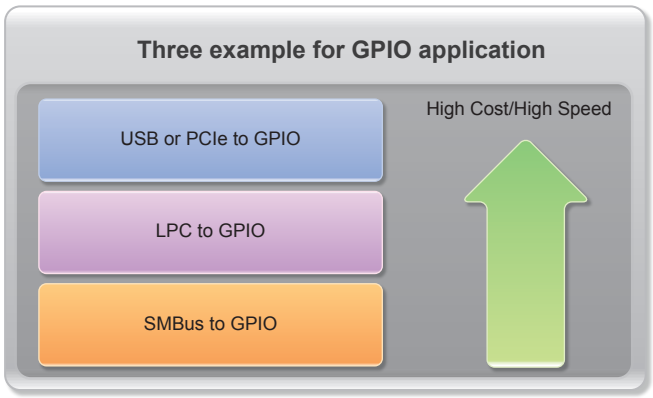
Although other interfaces, such as USB and PCIe, involve high-speed signals, the number of these signals is small and the circuit design remains simple. In terms of layout, one must still pay attention to length and impedance. However, these high-speed signals allow trace lengths of up to 10 inches or longer (depending on the chipset employed) and can resolve layout issues stemming from spatial constraints. For example, a USB connector can be placed wherever it

is actually needed and does not have to be in proximity to the MIOe connector due to length limitations. A longer permitted trace length usually implies better compatibility, and USB or PCIe signals on the MIOe module will not cause compatibility problems due to different trace lengths.

From the perspective of design cost

A MI/O Extension single board can be used individually, and the design requirements for MIOe modules emerge only when the motherboard lacks I/O functions, However, for markets with specific applications, it is difficult to fulfill certain specifications with standard board solutions. Therefore, most specific applications will require customized solutions. From the perspective of customers, a higher forecast, larger NRE, and longer development time will be required; if a customized solution is necessary, it may also be difficult to have complete control over retaining certain domain knowhow.

The design of MIOe is similar to the concept of the I/O module. The design and development capabilities of the module can be primarily achieved by the customers themselves and the barrier mentioned above can be lowered. The most complex part, normally power design, has also already been integrated into the MI/O Extension board. If the entire module consumes only 25W of power, there is no need to design a separate power unit. Resolving these problems will substantially reduce development costs.

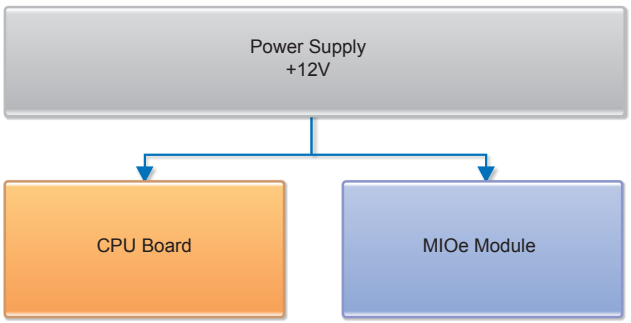


Another characteristic of MIOe is that it is possible to incorporate a wide variety of devices. For example, USB and PCIe connect with a large number of applications, such as Giga LAN or wireless LAN on the PCIe interface, and COM and storage devices to the USB interface to name a few. In order to realize the GPIO, one can utilize a PCIe-to-GPIO converter, but the cost will be relatively high, even though a faster GPIO can be achieved with PCIe's higher bandwidth. On the other hand, converting the SMBus to GPIO will result in substantially lower costs; the downside being lower speed. The response time can be measured in milliseconds, and the specific design solution will depend on the particular application and requirements of the customer.

From the perspective of power supply design

The planning of power supply for MIOe is as follows: The CPU board supplies 12V and 5V to the MIOe module. The CPU board can provide at least 25W of power to the MIOe module, which is sufficient for most applications. If the MIOe module requires more than 25W of power, the power architecture can be changed to one power supply providing electricity to the CPU board and MIOe module simultaneously, as shown in the following diagram.

Power supply planning for MIOe can meet the requirements of low- and high-power consumption applications alike. For low-power applications, the MIOe module can utilize the power supplied by the CPU board directly. Furthermore, the timing of power on the MIOe module is directly controlled by the CPU board and this prevents system boot failure due to incorrect power timing control on the MIOe module so it can reduce design effort, cost and development schedule.



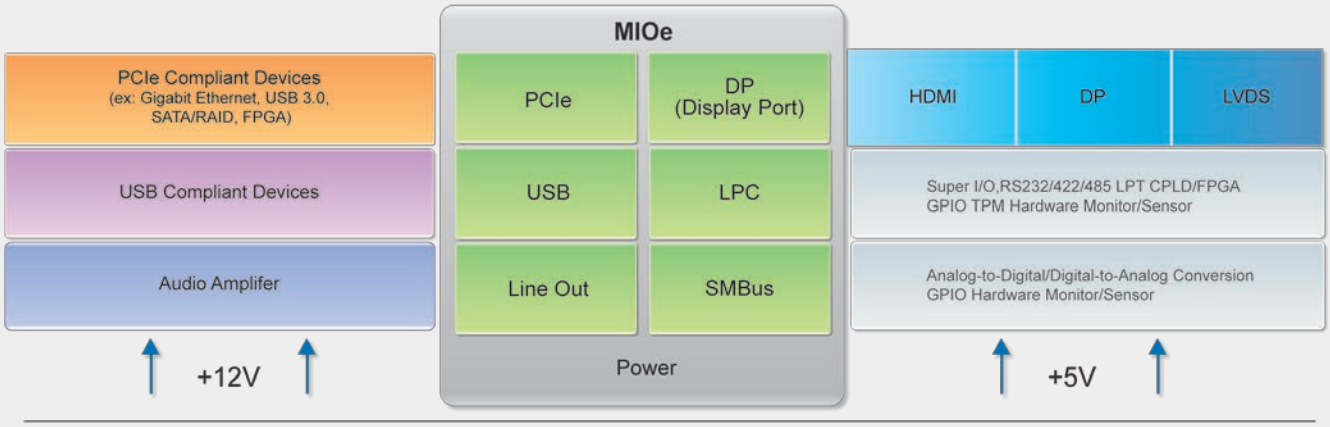
From the perspective of reference documents

For customers adopting the MIOe design architecture, Advantech has prepared the following technical documents: The MI/O Extension SPEC and MIOe Design Guide. These allow design teams to consult information in the documents directly, including pinouts, mechanical integration and cooling design. Advantech has evaluation boards and standard MIOe modules so that MIOe functions can be verified quickly. Customers can develop boards with the required capabilities rapidly, which makes system design and integration more methodical.

Devices For MIOe Functional Signals

DP (DisplayPort):

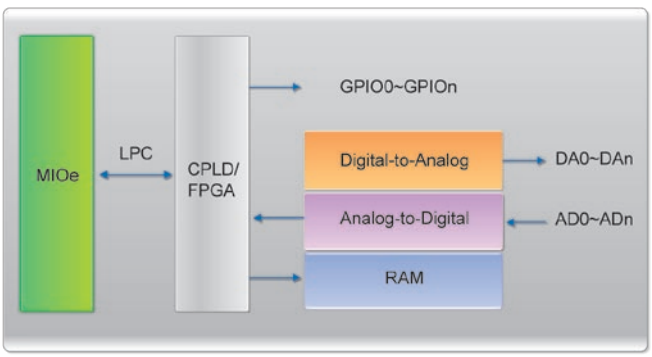
DP (DisplayPort) is an application interface related to screen display, and it has become a mainstream technology in current and future platforms. Past standards such as SDVO and LVDS may only be supported in certain platforms, and current trends indicate that these interfaces may not be supported in the future or will fall out of favor with users. Using DP in conjunction with a controller, various types of interfaces such as HDMI, LVDS and eDP can be created.



PCIe x 1:
PCIe accommodates high-speed signals and uses a relatively large amount of bandwidth. MIOe provides 4 PCIe x1 slots, which can be configured as PCIe x2 or PCIe x4 according to bandwidth or application requirements (depending on chipset specifications) and can meet the needs of applications with higher bandwidth requirements, such as high-speed transmission applications. PCIe x1 has been widely adopted in Giga LAN, PCIe-to-SATA conversions, PCIe-to- USB2.0/ USB 3.0 conversions, and it can be adapted directly into a miniPCIe interface.

USB 2.0 / 3.0:
MIOe retains 3 x USB 2.0 interfaces, or 1 x USB 2.0 plus 1 x USB 3.0 (depending on chipset specifications). The USB is a more mature interface than others in terms of storage device, including USB Flash, USB-to- CF card and USB-to-SD card conversion, or it can be linked directly with connectors.

LPC (Low Pin Count):
The LPC interface can be used to create the RS232/422/485 serial ports, print port, floppy, TPM, hardware monitor, GPIO, and other basic functions. Designs that incorporate CPLD or FPGA will be more practical with respect to customers' actual application requirements and can be customized. As shown in the diagram below, customers can modify the firmware to accommodate their desired functionality and quantity, such as GPIO, digital to analog, analog to digital, and RAM.



SMBus (System Management Bus):
The SMBus is currently the most widely adopted and also low-cost interface. ICs that provide this interface can be found in all types of analog signal applications, e.g. digital to analog, analog to digital, and voltage/current/temperature sensing. In addition, digital signal applications such as GPIO, Clock and EEPROM have also been widely deployed on CPU boards for quite some time.

Audio Line Out:
MIOe provides an audio line-out signal for a selection of appropriate audio amplifiers based on the actual application required. Even if an audio amplifier is present, its specifications most likely won't meet the requirements of all customers. MIOe leaves the flexibility to customers, who will be able to determine the suitable amplifier to include based on their application.

Mechanical Design Advantages of the MI/O Extension

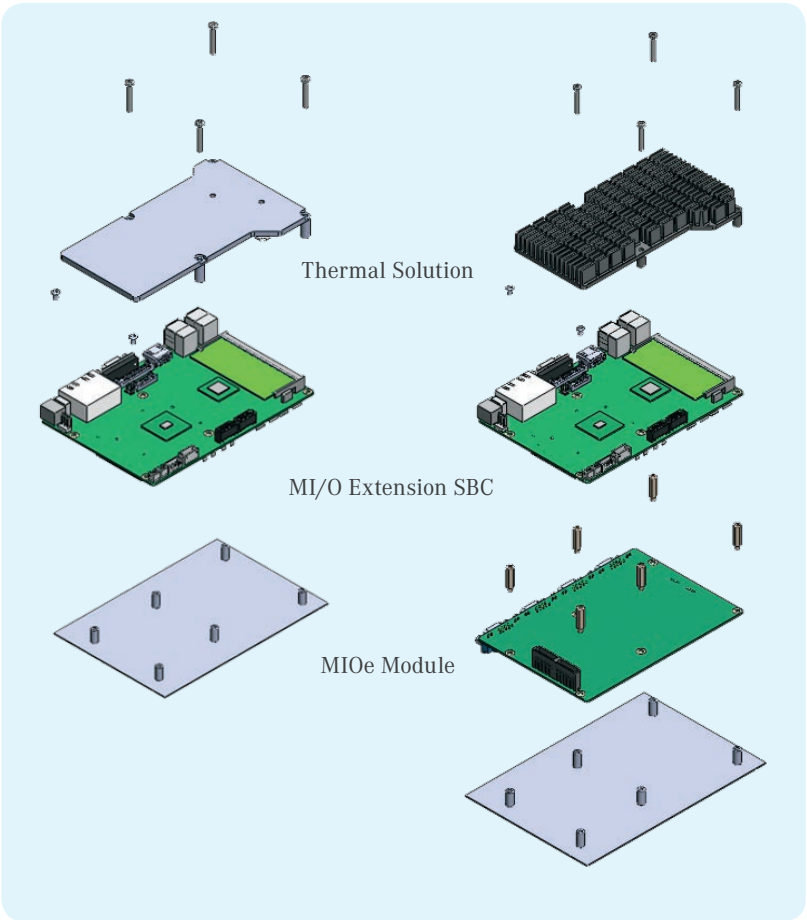
The idea for MI/O Extension's innovative form factor is primarily the result of consideration for system integration. They include concepts for simplifying mechanical parts, and approaches for easy assembly, plus how to avoid possible system integration problems that have been encountered in the past.

Integrated design for wiring
Cables are used when assembling chassis. Too much wiring will require wrapping and may result in airflow and cooling problems. Therefore in the design of the MI/O Extension form factor, the amount of internal wiring is minimized and wires with a uniform style have been adopted to improve usability and avoid the complexities associated with wrapping.

Unified Connector Location:
The connectors such as COM, SATA and Audio are designed to be close to the edge of the board. This is conducive to system integration applications, allowing for easy wiring and bundling as well as convenient centralized management.

Centralized thermal design

The cooling design of the MI/O Extension enables system, thermal and mechanical engineers to arrange the desired layout during project development and design without giving special considerations to the locations of heat spots on the CPU board or requiring separate cooling designs. For single board applications, it is also unnecessary to reserve heat dissipation space under the CPU board for heat-generating components, which makes slimmer system designs possible. Components that generate large amounts of heat are concentrated in one top side on the board, and with the Heatspreader cooling solution or customized cooling modules can easily achieve a fanless system design.



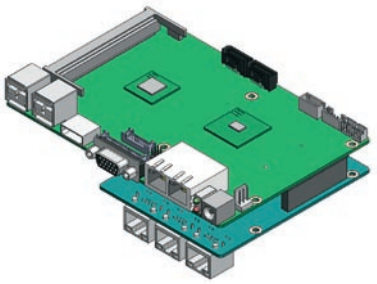


Diagram showing MI/O-Compact in conjunction with the MIOe module.

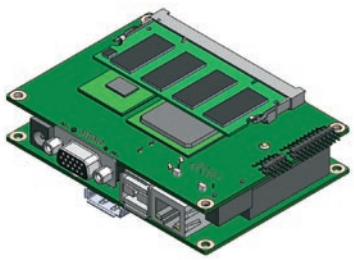
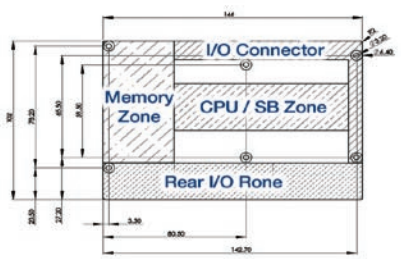
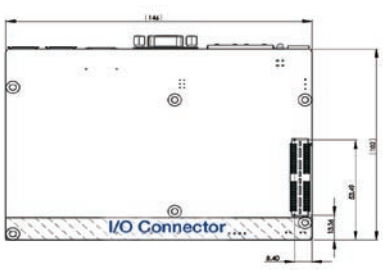


Diagram showing MI/O-Ultra in conjunction with the MIOe module.

Unified expansion

The module expansion area can be found underneath the MI/O Extension board. Module expansions include the outward-facing CFast, PCIe Mini Card and the MIOe module, which enables customers to design their own expansion features, and mechanical engineers only need to create holes or design the base board modules for system integration purposes. In addition, under the board there are no components that generate large amounts of heat, and therefore there are fewer restrictions on the selection of expansion modules.



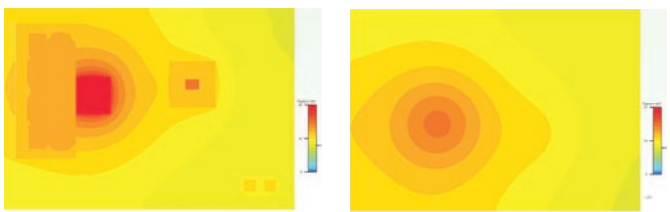


The MI/O Extension form factor functional divisions provide simpler system assembly and cooling integration.

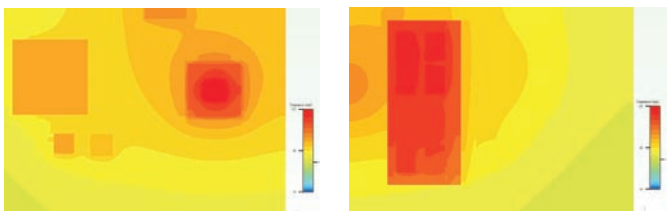
Advantages of cooling design in the MI/O Extension

With system integration, a serious problem that customers often encounter is heat generated by the system. There are a large number of components besides the CPU board within a system, for example power supply, hard drive, and panel inverter. Plus, other peripherals may be sources of heat themselves, or may be affected by heat-generating components. If the system's mechanical components are poorly designed, excessive heat may cause problems, or perhaps it may be necessary to employ peripherals of higher quality which cost more, to ensure the stability of the product.

In addition, chipsets generate part of their energy into heat during operation, which will in turn affects reliability and lifespans. For example, if the environment temperature rises by 10 degrees, its lifespan will be reduced by half. Therefore, adoption of a single-unit, integrated heat sink can improve the heat exchange and conduction efficiency within and outside of the system.



Thermal simulation diagram of centralized heat source design (e.g. MI/O Extension)



Thermal simulation diagram of non-centralized (dispersed) heat source design

Advantages of implementing centralized cooling:

With Advantech's MI/O Extension cooling design, all heat-generating components, including the CPU, southbridge, memory, Power PMIC, Clock GEN and selected Active IC, are centrally located on the same side of the PCB, so that customers only need to consider the cooling design for a single surface, which simplifies mechanical design.

Single-surface heat generation reduces problems with heat beneath the board

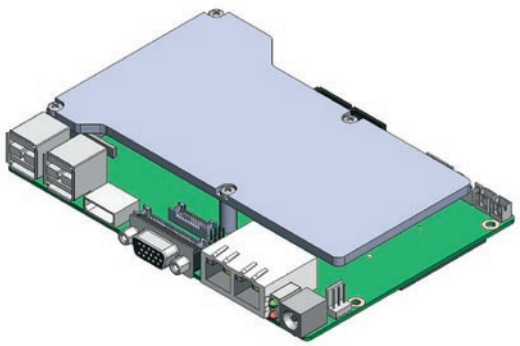
The centralized heat design of the CPU board can also prevent issues that may arise from high heat-generating components on the other side affecting other peripherals. If the heat-generating components are scattered on different PCB surfaces, then components on the opposite side of the heat sink will not be able to take advantage of the heat sink and dissipate heat appropriately. There is also less space underneath the board and air flow can become a problem, as the heat that accumulates under the board cannot dissipate quickly.

Maximized heat dissipation area

The form factor of MI/O Extension is designed to include a fixed cooling area, and therefore the overall area of heat dissipation is maximized, which increases cooling effects significantly.

Reduction of overall system height

With an optional heat spreader, the surface can be applied directly to the top cover of the chassis for full-surface heat conduction. This reduces the height of the system that may otherwise have required cooling fins, and achieves optimal cooling effects.



Advantech has gained considerable experience during its many years of involvement in the industrial computer sector. Taking future application trends and feedback from the market into consideration, and looking at the issues from the perspective of providing solutions to customers' problems, the company has introduced the industry's pioneering MI/O Extension technology. In addition to providing an optimized cooling and mechanical design to solve system integration problems, the technology has retained the maximum level of I/O expandability, enabling customers to realize their desired modular product designs with the fewest resources available. It also allows customers to utilize Advantech's single-board computers with MI/O Extension to create more solutions and gain new business opportunities with more flexible designs.