

Modular Embedded Systems: for Quick Equipment Integration

Author: Maxine. Cho

E-mail: Maxine.Cho@advantech.com.tw

Table of Contents

Introduction: Market Overview and Challenges	1
Customer's Pain Points	
Modular System Solution	2
Why Modular Design	
Design Concepts of Advantech Modular ARK	
100+ Configurations	
Mechanical Challenges and Certifications	
Conclusion	6

Introduction: Market Overview and Challenges

When Industry 4.0 ushers in requirements for intelligent automation systems for various sectors and industries, system integrators face huge challenges in meeting the needs for customization and small batch production for customers from different companies or industries seeking to install or upgrade systems. Reducing product lead time and cost have become key factors that decide business competitiveness for system integrators (SIs) in the Internet of Things (IoT) era.

Customer Pain Points

Following conventional practices, when engineering a new application system to meet specific customer needs, system integrators have to choose a suitable system from off-the-shelf products, or seek a customized PCB, which must be spun to satisfy targeted applications; write or modify application programs; test software compatibility across different platforms and among components and systems; and certify their products to industrial standards. It thus usually takes half year to a year to develop a system, from commencement to completion.

As market trends are moving toward increased customization and diversified small volume production, system integrators have to deal with the following pain points:

- Lack of flexibility: Different applications require different I/O configurations. However, most industrial computers currently available use fixed I/O designs, and customization for special needs often has to go through a lengthy process of PCB re-layout, which is time consuming and expensive.
- Time consuming: In addition to PCB re-spinning, customized systems must be re-certified over and over again, which usually takes months and excludes business opportunities.
- High inventory cost: a lot of hardware must be prepared to meet customer needs; complicated inventory management causes pressure and difficulty in balancing inventory cost and product lead time.
- Complicated software integration: application programming has to be modified from platform to platform to meet varied needs, which increases the complexity and cost of software integration.

Modular System Solution

Why Modular Design?

As mentioned in the foregoing section, system integrators of intelligent automatic systems spend months to a year and huge capital investment re-spinning PCB boards, changing program coding and re-certification to build new customized systems for customers in different companies or industries. However, according to our understanding, 80% of functionalities for different target customers are identical. System integrators are actually investing time and money disproportionately fulfilling the remaining 20% of requirements for differentiated products.

Is it possible to minimize time and capital investment spent on customization and to shorten the product development cycle, alleviating inventory pressures? Advantech modular embedded systems provide an answer.

The modular design concept implies that embedded systems are becoming interchangeable, interlocking Lego blocks for constructing varied systems that meet different needs, or, intelligent Transformers, which can think and act on events to fulfill different applications.

Design Concepts of Advantech Modular ARK

Advantech, a global leader in the embedded system market, has run fastest and farthest in introducing modular systems with its modular ARK product series. ARK is one of Advantech's long-term flagship brands; the products are usually compact and fanless embedded systems delivering cost-effective performance in agile applications. The first of Advantech's modular ARK products is the ARK-2230, carrying a quad-core Celeron® processor. A complete array of modular ARKs carrying different grades of CPUs, ranging from low to high performance, are already progressing on their product roadmaps and will be rolled out soon.

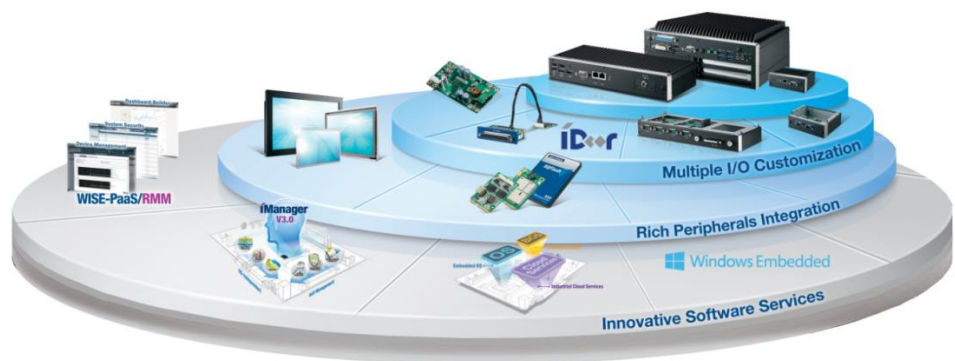


The modular design of Advantech ARK includes I/O expansion, power module selection, peripheral integration, and embedded software services.

- **iDoor extension I/O modules:** Advantech iDoor was designed in two parts. The rear part connects with the system through a miniPCleExpress interface. The front part has a unified mechanical design and fixed I/O modules, which connect with the rear part through a cable. iDoor modules are thin and compact, and can be used for entry level I/O expansion. The new series of modular design ARKs all have a slot for iDoor integration that can take any of several I/O modules, all of which are verified and certified. Within a very limited space, iDoor provides changeable and differentiated I/O port configurations on our modular ARK systems.



- **ARK Plus expansion modules:** ARK Plus is an expansion module interlocked to the base of an ARK system like a Lego block to accommodate more I/O ports, a MIOe add-on board, a removable hard disk or an additional iDoor slot. Compared to iDoor, the MIOe interface carries several more types of high speed communication buses and provides more signals such as PCIe, USB, SMBUS, and SATA, which can support more I/Os than a single iDoor module.
- **Changeable power modules:** In addition to the standard offering of a 12v DC power supply module, a changeable power module providing for wide range input voltage (9-36v DC) is available at the customer's option to cope with industrial environments prone to instable power supply.
- **Rich peripheral integration and Software Services:** Customers can choose which devices and accessories they want to add, including industrial memory, industrial storage, wireless modules, and display modules. Advantech also provides embedded software services to customers. Services include a selection of Microsoft® Embedded OSs, WISE-PaaS/RMM – Remote Monitoring and Management with self-sensing to make their products more reliable and competitive.



100+ Configurations are Possible

Currently Advantech has completed four standard ARK Plus modules: AMO-2201E provides 4 serial ports and a removable 2.5" hard drive, suitable for industrial automation, kiosks or applications needing more data storage capacity; AMO-2202E is rich in PoE ports, allowing for connecting more cameras without the need of deploying power lines and thus suitable for surveillance purposes or machine vision applications; AMO-2203E has a 2-port isolated CAN-Bus supporting real-time data transmission, also suitable for industrial automation or in-vehicle applications; AMO-2204E has three GbE ports and an iDoor slot, suitable for heavy use of Local Area Network (LAN) data transmission—mostly used for the internet.

As for the iDoor system, there are several selected modules with different communication emphases, such as multi-port RS-232/422/485 serial COM, and digital I/O; these also offer options with isolation protection. For high speed communication, there are USB 2.0 and gigabit Ethernet modules. Other commonly used I/Os for industrial automation include parallel port and CANBus, which are also available in the iDoor selection.

Also, if you include the two optional power modules, there are over 100 possible configurations for a computing unit created by combining different modules with ARK, with more coming as Advantech's modular ARK product portfolio continues to grow. SIs and OEMs can conveniently select a configuration that best fits their application purpose, or they can take advantage of Advantech DTOS service and technical support and design their own iDoor/ARK Plus expansion.

Advantech worldwide Configure-to-Order Service (CTOS) with the new modular-design ARK will enable fast sampling for customization and a delivery service model with professional assembly and testing. This can also help SIs and OEMs to leave the hardware effort behind and focus on their software and integration domain expertise, while minimizing their inventory pressure, costs, and lead time.



Mechanical Challenges and Certifications

Bringing the modular computer to reality needs sophisticated expertise in mechanical and electronic design and in dealing with challenges in shock-and-vibration resistance, heat dissipation, and power input variations, as automatic systems are usually located in harsh environments and require high standards of stability and reliability. Compared to the traditional, fixed I/O design, modular design tends toward weaker mechanical structures, which decreases the vibration resistance of the system. To solve this problem, modular ARK systems feature a stronger overall structure, which is true for both the single-layer ARK with iDoor, and for the dual-layer ARK system (with ARK-Plus); both resist vibration at military spec levels. Moreover, the modular ARK system employs a lockable I/O design to secure cable connections for power input, VGA, HDMI, GbE, COM and/or DIO; all can sustain constant vibration during operation and connectors remain secure.

For such a compact and fanless system, thermal design is also essential for reliable and stable operation. For an ARK Plus extension that generates high heat, such as the PoE, independent thermal design keeps the expanded system successfully fanless.

In addition to reliability and stability, compatibility between computers, extended modules, add-on components, and operating system platforms is also critical. All possible configurations are fully tested and verified by Advantech before they reach the customer.

Recertification is a severe problem for system customization that demands significant amounts of time and resources. Each type of I/O configuration needs to pass certification tests. All the listed iDoors, and ARK Plus for modular ARK systems, are fully tested and verified by Advantech and have been certified by extensive international standards, including EMC standards of CE/FCC (Class B), CCC and BSMI, as well as the safety standards of UL, CCC, and BSMI; these products offer the most complete list of certifications in their field.



Conclusions

Stackable, option-ready, and interchangeable, the Advantech Modular ARK is a versatile, compact, fanless, and certification-ready system that can quickly be transformed into many variations by adding or changing modules to fulfill different application missions. It is a new breed of box PC that provides for quick customization, easy and inexpensive upgrades, and efficient system development with fully modular designs.

The modular design addresses the pain points currently suffered by SIs and OEMs, and is expected to deliver the following benefits:

- **Faster time to customization:** The modular design helps to eliminate the need for lengthy PCB re-layout and the re-fabrication processes traditionally required for custom ASIC board development, and also reduces product lead time from nearly a year to less than a month.
- **Minimize software integration effort:** By providing rich, selectable I/O modules for the same system, an SI can focus just on the changeable I/O software integration, which helps to minimize development time and cost.
- **Simplified inventory management:** The modular design helps customers reduce inventory, allowing for more flexible inventory management and lowering total cost of inventory.
- **Fast time-to-market:** The modular design provides easy assembly methods and pre-verified and pre-certified components, so that SIs and OEMs can quickly build up systems without having to conduct their own compatibility testing, bringing fast time-to-market efficiency and resulting business competitiveness.