Going to Market with Small Form Factor Embedded Computing Modules

By Walter Chipley, Applications Engineer, Arrow Electronics

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Qseven™ offers solutions and savings for small COM module requirements.

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For many mobile, industrial, medical, and portable applications where space is limited, off-the-shelf standard footprint commercial motherboards may be too large in relation to the physical envelope available for a system installation.

To address this challenge, smaller footprint embedded CPU board products are essential. A key ingredient necessary to make this possible comes from the innovations of the semiconductor industry in the form of smaller, higher-density integrated circuits, which operate on a fraction of the power seen in earlier solutions—while delivering higher-performance processing levels than previously available.

In taking advantage of this miniaturization, system designers can find it easier to shrink their own designs by adopting a processor card in the format of an off-the-shelf, small footprint Computer-On-Module (COM) or System-On-Module (SOM) solution.

COM/SOM modules fit nicely in applications where the physical space available in the embedded computer enclosure is a fraction of the space found in a desktop PC. The miniaturization of components, lower-power devices, and fine-geometry printed circuit board design all factor into the equation of size reduction.

One of the more widely used COM/SOM form factors is “COM Express.” A key physical architectural aspect of a solution based on a COM Express module approach, is that a given embedded computer solution will consist of a “base” or “carrier” board along with a COM Express plug-on CPU module. (The *COM Express Carrier Design Guide* is available through PCI Industrial Computer Manufacturers Group [PICMG].)

The module typically houses the microprocessor, the core logic chipset, power subsection, memory, and other conventional functional blocks required in an embedded PC architecture. These modules are well suited to take advantage of recent advancements in small footprint, highly-integrated processor and core logic devices such as those available from Intel. Devices like the Intel® Atom™ Processor (Z530A) and System Controller Hub (US15W) have helped enable the development of tightly integrated small footprint COM/SOM based product offerings. These Intel® Atom™ based board products are available from key Arrow partners, including AAEON Electronics, Advantech, BCM Advanced Research, Eurotech, ITOX, Lanner Electronics, American Portwell, and RadiSys.

How It All Comes Together

In a COM Express design, the carrier board provides the electro-mechanical foundation that mounts to a system enclosure, and distributes various ports and I/O connections to locations where they make the most sense for accessibility in the target installation environment. The baseboard may also include circuitry to “harden” the interface for those signals that connect to external field devices such as communications ports, digital I/O, user input devices, etc. Carrier board design teams concentrate their efforts on developing the function blocks and features that are specific to their target application usage model, while they depend on the COM Express module to provide the processing capabilities.

Technical Challenges

Due to the small size of a COM Express module (the Type 2 basic form factor is 95 mm x 125 mm), designing a multi-layer fine-pitched printed circuit board for a high-performance plug-on module is not a trivial task when you take into account the expertise that is required to:

1) achieve matched signal flight times and minimal propagation delays;
2) avoid harmful reflections;
3) reduce ground bounce and crosstalk;
4) utilize blind and buried vias; and
5) implement other high-speed digital design techniques.

To help mitigate these risks and address time-to-market pressures, the COM module approach builds on the success of Arrow’s Intel ECA partners that have a proven track record in the successful design of high-speed**,** small-footprint, densely populated COM form factor CPU board products. This is where working with Arrow field applications engineers will help align the appropriate design resources from its ECA partners with the customer’s internal design team.

These partners often provide a development kit that consists of the targeted COM Express CPU module and a generic baseboard. This board is intended to help the customer’s system design team kick-start their project so that they can begin finalizing their architecture and developing their software application. In parallel, the electro-mechanical design team can address the requirements for the system wiring harness, power subsystem, cooling measures, enclosure, and when necessary, the design of a custom base board that is specifically tailored to address the target installation. For example, Advantech, an Arrow supplier and partner, offers a “design-to-order service” which includes a range of customization services for custom boards and system platforms.

Companies developing new system-level products put a great amount of emphasis on what differentiates their products from competitive products in the marketplace. A customer's design team generally invests its efforts on the portions of a system design that represent their unique solution or value proposition, while taking advantage of existing function blocks from third parties when feasible.

Depending on the specifications for a given customer application, there may be a need for a custom baseboard design. In the event a customer needs a derivative of an existing baseboard, a seasoned board design team would require roughly 30 to 45 days to produce working hardware. When a more significant re-design of a baseboard involves adding new features and functionality, the development time may require 60 to 90 days.

Another source of design services is available through Arrow Consulting Engineering Services (ACES). Depending on the scope of the project, ACES offers its customers system-level and board-level design solutions through alliances with third-party engineering design firms. As outsourcing of non-core competencies has become more attractive to customers, the ACES group has frequently managed the program process and quickly connected customers with the right design resources for their engineering requirements. ACES can manage the overall program to drive a successful product launch as the end product transitions into production.

Cost Considerations

There are a number of different COM/SOM formats that exist for the system designer to choose from. As designers begin to evaluate the system requirements, and to consider the various cost factors related to both components and printed circuit boards, their peers and product management teams may challenge their decision with regard to the cost associated with one approach versus another. In making these trade-offs, one area that is likely to be a source of concern in a COM Express based design is the cost of the connectors that are required in the COM Express interface.

The COM Express module and corresponding carrier board connector design are based on a pair of fine-pitch surface mounted stacking receptacle connectors which are positioned on the carrier board to align with a pair of mating plug connectors mounted on the bottom side of the COM Express module. Each pair of connectors accounts for 440 points of contact and collectively account for roughly $60 in raw material cost. This combination of connectors represents a significant portion of the overall cost of the COM Express module and carrier board assembly.

Qseven™ Arrives!

To address the cost burden of the COM Express connector type, a group of companies have forged the Qseven Consortium. This group has defined a new approach that builds on the highly successful and robust connector used for notebook computer MXM graphics cards. According to Qseven, "The Qseven concept is an off-the-shelf, multi-vendor, single-board computer that integrates all the core components of a common PC,

and is mounted onto an application-specific carrier board."[1] With the Qseven module, the requirements of an embedded application are met. A single MXM connector provides the carrier board interface to carry all the I/O signals to and from the Qseven module. The MXM connector is well known and is used as the high-speed signal interface connector commonly found on high-speed PCI Express graphic cards in notebook computers. Qseven presents the newest I/O technologies in the embedded module marketplace on a very compact form factor of 70 mm x 70 mm.

Qseven offers a wide range of features and functions that can be supported on this minimum size form factor. Examples include:

- PCI Express
- USB 2.0
- ExpressCard
- High-Definition Digital Audio
- Serial ATA
- LPC Interface
- Secure Digital I/O Interface
- Gigabit Ethernet
- Display Port, TDMS, or SDVO Interface
- LVDS Display Interface

For the system designer faced with the requirement of using a COM module/carrier board solution—yet with a budget for a product that can't support the cost of a COM Express solution—the Qseven specification offers an alternative that can result in a cost-reduced, yet robust, solution. At a quantity of 100 pieces, the comparison between the Qseven implementation versus the COM Express scheme results in a potential material cost savings of approximately $60 in the connectors alone.

Conclusion

Off-the-shelf COM modules offer significant time-to-market advantages over designs developed in house. When a designer is looking at the various form factor options, the new Qseven is a viable alternative to COM Express and other existing COM/SOM standards. Arrow Electronics offers solutions based on both COM Express and Qseven. You can rely on Arrow to provide guidance tailored to your company's experience level and to help streamline your journey to market.

Where To Get Qseven

Arrow Electronics has partnered with American Portwell and Advantech to offer Qseven small form factor boards. To learn more, call your local Arrow representative at 1-800-777-2776.

[1] Note: According to Qseven Specification at www.qseven-standard.org.