

RapiDex™ Service: Technology Innovation Drives Faster, More Competitive Board Customization

From ‘compromise fit’ to ‘perfect fit’: board customization now affordable
for all embedded Intel users

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Overview

The market for commercial off-the-shelf (COTS) embedded computer motherboards is vigorous, healthy and competitive. The range of choices available to system designers is very wide, and many different combinations of processor, memory and interface options are available as standard products.

For many designs, the choice of standard parts is adequate. Normal embedded design procedure is to define a system architecture and derive a desired motherboard specification from this. Then the design team will scan the COTS motherboard market, looking for the standard part that best fits the desired specification. In many instances, this ‘best fit’ is a good enough fit; it is, though, rarely a perfect fit.

Unfortunately, the alternative – commissioning a unique, custom board – has in the past been commercially unattractive. Custom boards made to the user’s specification provide a perfect fit for the design requirement, but customization services have been slow, inflexible, burdened with complex legal provisions and, above all, expensive. For the vast majority of embedded design projects, a custom board has been out of reach. OEMs have learned to work around the design compromises that go along with accepting a COTS motherboard with a good enough fit.

To address the need for optimized board designs when a COTS board is not suitable, Emerson Network Power has introduced the RapiDex™ service, a rapid board customization program that allows OEMs to specify processor, I/O, connector and other options within a custom board form factor. The service is available for boards using Intel® embedded processors.

The RapiDex™ service is fast and remarkably straightforward for the customer to use: no special contracts, no statements of work and no project supervision are required. And unlike conventional customization engagements, the customer need make no commitment on production volume numbers, and the minimum order quantity is merely 100 units.

The RapiDex™ service is also priced to reflect the resources of the vast majority of embedded design projects: the customer pays a small manufacturing setup fee, no Non-Recurring Engineering (NRE) fees, and unit costs per board shipped are comparable to the price of a standard part.

This new service is the result of innovative developments in design and manufacturing automation pioneered by Emerson Network Power, and it brings the advantages of board customization to a far wider range of embedded OEMs than could previously benefit from it.



Figure 1: Computer boards designed under the RapiDex™ program

Certain classes of design requirement poorly served by standard embedded boards

At the start of an embedded design project, the team's preference is to find a standard embedded computer motherboard that fits into its end product architecture. A standard part can be shipped immediately, and the only cost the customer pays is the unit price per board. This method of sourcing an embedded motherboard or computer is the fastest and cheapest available.

Indeed, embedded computing manufacturers such as Emerson Network Power succeed in meeting the common needs of the majority of users with their standard parts designs.

But certain classes of design requirement are not well served by standard boards. These designs fall into one of two categories:

- **Outliers:** design projects with uncommon requirements. The specifications are in limited demand, so it is not economical for embedded board manufacturers to make a standard part to meet them.
- **Long-lived platform products:** it is difficult to maintain uniformity of board specifications over time and over multiple product variants when sourcing from board manufacturers' standard parts, since the specifications of these changes frequently to keep pace with changes in technology and customer demand.

In both cases, the use of standard boards from a catalogue is disadvantageous. It can result in one or more of the following drawbacks: compromised design, reduced functionality, impaired performance, increased design time, increased design risk, increased materials cost and deviation from a product's marketing specification.

The following examples illustrate the issue that design teams in these situations face.

'Outlier' designs

Standard MicroATX motherboards offer a single Gigabit Ethernet port locally, since this capability satisfies the great majority of customer requirements. Nevertheless, certain kinds of end product require more generous provision of Gigabit Ethernet I/O, and MicroATX designs with a requirement for two, three or four ports are found today.

In a standard MicroATX board with a single local Gigabit Ethernet port, the three additional ports will typically be supported with plug-in PCIe Network Interface Cards.

This gives rise to four main problems:

- Extra cost: a typical bill-of-materials cost for three Gigabit NICs is \$100.
- Impaired reliability: the connectors between daughtercards and motherboards are a notoriously weak part of electronics systems, and can significantly reduce reliability and MTBF ratings.
- Extra height: the NICs are mounted on the motherboard, and thus increase its height, potentially compromising the end product's form factor.
- Extra supply chain risk: the OEM has to manage an extra supplier – the NIC manufacturer – in addition to the motherboard manufacturer.

Platform products

Embedded motherboard manufacturers such as Emerson Network Power make absolute commitments to customers about the long-term availability of products in their standard parts catalogue. So, when an OEM orders a standard part with a particular Intel processor and configured with particular memory and I/O specifications, it knows that this board will be available to buy for a guaranteed minimum period that reflects the extended nature of embedded product life cycles. For a single processor and board specification, then, OEMs are assured of long-term supply of their board.

But over time and over processor variants, no such assurance is available for users of standard parts. Consider the example of a manufacturer of portable health monitoring devices. The marketing specification calls for low-end, mid-range and high-end variants of the device. For reasons of manufacturing efficiency, the product's housing and connections to the outside world are to be identical across all three products. Differentiation between the variants is achieved mainly through the use of higher- and lower-performance processors.

The OEM design team, then, wants total control over its board specification, maintaining an identical board design and form factor across product variants, apart from the processor.

But this control is not available to the user of standard boards: the specification and layout of a standard board in terms of memory, I/O, peripheral features and connectors is typically different for each processor variant.

If the health monitoring device is expected to have a long product life cycle extending over several years, the problem is exacerbated. The OEM might wish to take advantage of enhanced performance or new capabilities in a next-generation processor, while maintaining unchanged the board's outline (in terms of the number and position of connectors and the board's profile). This will allow the processor and performance upgrade to be accommodated within the existing product housing, thus extending manufacturing efficiency (avoiding retooling costs for the housing) over an even more extended life cycle.

Again, standard parts will not support this design strategy: standard board manufacturers typically upgrade the entire board design with each new generation of processor.

Design control over an entire product life cycle can, then, be difficult to achieve for users of standard embedded motherboards.

Low-cost, rapid board customization: a solution for outliers and platform products

Today, the problems of OEMs that have 'outlier' designs or that require extended support for platform products are poorly addressed by conventional solutions. OEMs face two unpalatable choices:

- Compromise their design – for instance, by accepting the requirement to use plug-in daughtercards the OEM might also have to design an end product that is thicker than the marketing specification called for and that entails an expectation of higher after-sales costs resulting from field failures.
- Engage with a board manufacturer for a full-custom board – this will deliver an optimized board design, but is expensive, entails risks arising from open-ended commitments to the board supplier, and takes a long time from initial engagement to volume production. Normally, therefore, only design teams with high expectations for production volumes or making very high-margin products would be able to bear the cost of customization.

The Emerson Network Power RapiDex™ service enables low-cost, fast-turn board customization designed to meet the needs of OEMs manufacturing 'outlier' designs and platform products. It enables users to specify from a very wide range of memory, I/O, peripheral and connector options, and to customize the form factor. And this level of customization is available at a uniquely low cost and on uniquely flexible terms, thanks to the advanced design and manufacturing automation technology that Emerson Network Power has developed to support it.



Figure 2: View of an Emerson Network Power RapiDex™ service production line

Benefits to outliers

In the example above, the OEM can specify a custom board through the RapiDex™ service that includes four local Gigabit Ethernet ports provided with surface-mounted (SMT) devices. The materials cost of adding three SMT Gigabit Ethernet transceivers is approximately \$50 compared to the equivalent plug-in card cost of \$100.

The RapiDex™ solution thus offers the OEM:

- Lower materials costs
- Improved form factor – a planar design that eliminates the high-profile PCIe daughtercards
- Improved reliability – the use of SMT components eliminates the vulnerable connectors to the plug-in daughter cards
- Simplified assembling
- Improved supply chain – the complete solution is now available from a single vendor

Benefits for platform products

The RapiDex™ service is equally useful to OEMs manufacturing platform products with extended life cycles. The OEM defines the requirements for the platform, specifying common features (connectors, I/O, peripherals) and dropping in processor variants to a common board design.

Under the RapiDex™ service, future upgrades to enhanced processors can be accommodated within the board design, with the ability to maintain uniformity of outline and profile across all future variants.

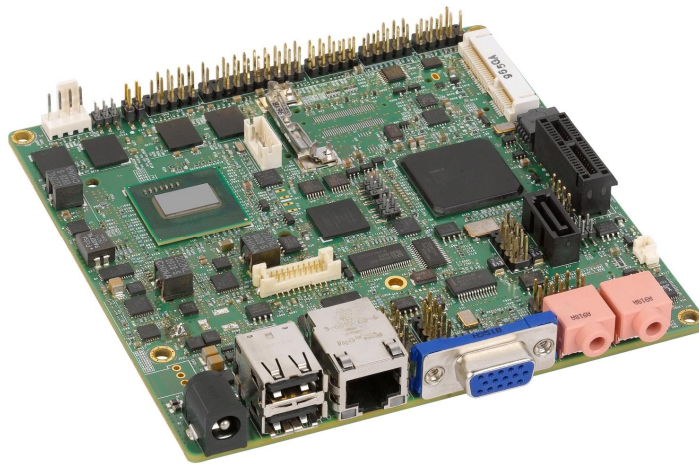


Figure 3: The NITX-300 Nano-ITX motherboard is an Emerson Network Power standard product developed using the RapiDex™ program

RapiDex™ service: technology innovation drives faster, more competitive board customization

The RapiDex™ service from Emerson Network Power, then, eliminates the drawbacks and work-arounds associated with using either inappropriate standard boards, or conventional board customization. It is fast, straightforward and competitive.

In fact, Emerson Network Power has reinvented board customization, with the goal of creating a service in tune with customers' needs. To this end, it has developed and deployed new business processes and new technology in the provision of the RapiDex™ service.

Radical approach to design and manufacturing automation

The conventional approach to developing and manufacturing embedded computing boards involves a series of discrete steps that cross a number of distinct process 'islands'. The revolutionary impact of the RapiDex™ service is due to the bridging of these islands into one seamless process.

At the start of the chain is the customer's specification, which defines the board requirements in terms of form factor, processor, I/O and so on. The chain leads first to tools implementing the circuit design and the board layout. This then generates a materials requirement, which links to the Emerson Network Power supply chain (to supply parts) and to the enterprise resource systems (to manage payments to suppliers, to provide information to an Emerson Network Power factory, to generate invoices and so on). The system also links to a separate manufacturing process system, which is required to receive and store incoming parts, assemble and ship the custom boards, notify the enterprise resource system of shipments and so on.

Conventionally, all of these systems are discrete, and commands to initiate or approve actions as they cross from one system to another must be issued by a human being.

Technology developed by Emerson Network Power has enabled the RapiDex™ service to be automated at every point, eliminating the delay, cost, and risk of error or inconsistency associated with human involvement in processes.

Crucial to the implementation of this chain of processes is a modular implementation of board functions; the design rules developed by Emerson Network Power enable these functions to be integrated, using advanced design software, into tens of thousands of configurations of processors, I/Os, peripherals and connectors.

Together, this combination of technology and process innovations enables the delivery of a service that is faster, more responsive, extremely scalable and cheaper by far than any board customization service in the history of the embedded market.

By choosing the RapiDex™ service, you benefit from a customization service that offers:

Optimised design Using an embedded Intel processor, you can specify a choice of I/O configurations, memory specifications and peripheral capabilities (such as wireless communications) in any rectangular form factor. Emerson Network Power will design and produce a planar board to your specification with a high-performance board layout.

Fast turnaround The innovative design of the RapiDex™ process has also produced an accelerated ordering schedule: after defining the board specification from a menu of options, the unit price quotation is delivered to the customer within two working days. From the date on which the customer places its order, RapiDex™ will produce first article boards (1-12 units) within four to eight weeks. Volume orders (minimum order quantity: 100 units) follow Emerson's standard turn-around times, with forecasted orders fulfilled within eight weeks of order date.

Low costs Customers of the RapiDex™ service pay no NREs. A flat production set-up fee plus unit costs pays for the first sample boards (1-12 units). In volume production, the customer simply pays the unit price as quoted at the start of the customer engagement. Unit prices are very competitive, and are comparable with the prices of equivalent standard products.

Straightforward terms Since the customer does not pay for the provision of a design service, it is not required to negotiate the complex legal provisions that normally bedevil custom board engagements. Using the RapiDex™ service is a simple two-step process:

- 1) The customer issues a purchase order for sample boards, based on the customer's choice from a menu of processor, memory, I/O and peripheral options, at a flat cost plus the unit price of the boards.
- 2) The customer issues a purchase order for a production run (minimum order quantity: 100 units). There is no need for a complex contract, a statement of work, provision for penalties or clawback arrangements in case production volumes fall short of expectations.

The two steps are not legally coupled: a customer who takes shipment of sample boards has no obligation to order production volumes.

Conventional board customization services are slow, expensive and unwieldy.

Innovative technology developed by Emerson Network Power, and process improvement that has bridged the systems implementing board design, materials supply and manufacturing, mean that the RapiDex™ service is fast and affordable enough to be used by almost any embedded OEM; the design requirements that govern the choice between a standard board and the RapiDex™ service are outlined below.

Which projects will benefit from using the RapiDex™ service?

In order to decide whether the RapiDex™ service is a suitable option, a design team should ask the following three questions:

- Will the design be significantly compromised by the selection of a standard embedded motherboard?
- Could these design constraints be eliminated with an optimal selection of memory, I/O, peripheral and connector specifications? Or by specifying a custom rectangular form factor?
- Is the design based on a current Intel® embedded processor, such as the Intel Atom™?

If the answer to all three questions is 'Yes', a motherboard sourced through the RapiDex™ service should be considered.

When specifying a board through the RapiDex™ service, the OEM system designer will be given the opportunity to select from a menu of options. These specifications relate to:

Intel processor	The RapiDex™ service follows the Intel embedded processor roadmap, and currently supports the Atom embedded processors.
Form factor	Choose a standard outline, such as COM Express, Mini-ITX or MicroATX. Custom form factors can also be chosen by the customer.
Expansion slots	MicroSD, PCI Express, COM Express options available.
I/O functions	Specify the exact combination of I/O you require, from a range including Ethernet, SATA/eSATA, HDMI, LVDS, USB 2.0 and CAN.
Internal connectors	Wide range of options available, including USB, RS-232, LVDS and TPM 1.2.
I/O connectors	Options include USB, HDMI, VGA, eSATA and Mini DB-9. External connectors can be routed to any point on the board's edge.

How to specify an optimized embedded motherboard through the RapiDex™ service?

The process of engaging with Emerson Network Power for the supply of an optimized embedded motherboard has been designed for speed and simplicity.

The engagement starts with a meeting between an Emerson Network Power representative (either a technical sales executive of Emerson Network Power, or a franchise representative from our authorized distributor powerBridge Computer). At this meeting, the customer will specify the board requirements, choosing from a wide range of options supported by the RapiDex™ service.

Within two business days, the customer will receive a comprehensive quotation package. As well as stating the guaranteed unit price for the customer's required production volume (minimum 100 units), the package includes a datasheet, a user manual and a 3D rendering of the proposed board configuration. This quotation package confirms the specifications of the board that Emerson Network Power will manufacture.

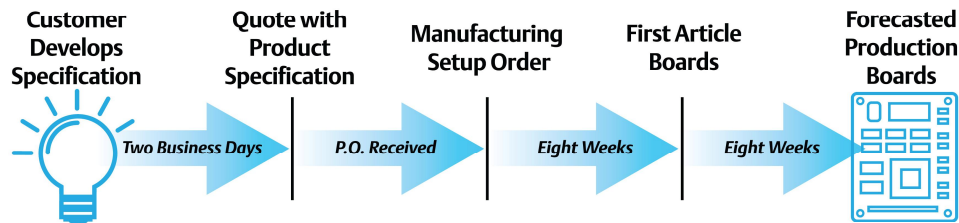


Figure 4: Timeline of a board design using the RapiDex™ Service

Within eight weeks (and potentially within as little as four weeks) of receiving the customer's purchase order, Emerson Network Power will ship sample, or first article, boards (1-12 units) for acceptance testing by the customer. These boards are produced according to the specification laid down in the quotation package.

Within another eight weeks of receiving a forecasted volume order, Emerson Network Power will begin production shipments. (Volume orders follow Emerson's standard turn-around time.)

The process is simple and fast, and is similar to the process of ordering a standard embedded motherboard from a supplier's catalogue.

Emerson Network Power: a world-class manufacturing capability for embedded OEM customers

The RapiDex™ service is the embedded motherboard customization capability from the Embedded Computing division of Emerson Network Power. Emerson Network Power is itself an operating unit of Emerson, a global manufacturing company that produced \$21bn in revenues in the financial year 2009/10 from products and services in fields such as process management, industrial automation, distributed power and appliances and motors.

Emerson is one of the world's leading manufacturing companies, operating from 250 manufacturing locations (165 outside the US). Emerson gained 730 patents in 2009, and invested \$686m in engineering and development.

The Embedded Computing division is a powerful force in important embedded markets such as telecoms and network equipment, military and aerospace and process control. Standard products available from Emerson Network Power include ATCA blades and platforms, embedded motherboards compliant with a variety of standards, and power modules and bricks for use in medium- and high-voltage applications.

Emerson Network Power is a Premier member of the Intel Embedded Alliance.

powerBridge Computer supplies the boards and computers

powerBridge Computer markets computer boards and systems for applications in telecommunication, industrial automation, medical, transportation, defence, and aerospace. We design and integrate computer systems based on standard components and manufacture systems according to customer specification. Experienced engineers advise and support our customers. Continuity and reliability are our strength.

powerBridge Computer is authorized distributor of Emerson Network Power. Since 18 years now we are distributing the embedded products of Emerson Network Power and formerly the Motorola Computer Group.

Our product line does cover boards, chassis and systems based on industry standards such as AdvancedTCA, CompactPCI, VMEbus, VPX and μ TCA, motherboards and Computer-on-Modules in all standard form factors, and AdvancedMC, PMC/XMC and IndustryPack mezzanine modules.

In addition to system integration and OEM solutions, we offer consulting, development systems, drivers, protocols and protocol integration. We complete our product offering with Windows, Linux, and real-time operating systems.