

The Evolution of Backplane Technology to Meet Enhanced Network Performance Requirements

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Reliable communication is key to today's businesses' success, longevity and overall operation. To ensure continuous access to information and communications platforms, it is crucial to implement high-performing network equipment. Backplanes are one of the most significant components of an electronics packaging system. Designed to meet operators' data transfer needs, backplanes are responsible for data traffic and supplying power to individual function boards managing large volumes of data. To properly maintain a high-functioning network, it is essential to understand the design and functionality of a backplane.

With current trends moving towards multi-core processors and the dramatically increased processing power of bus systems, backplanes are expected to consistently reach new performance heights. To accommodate these changes, backplane technology has evolved, delivering high-speed options capable of meeting next-generation data transfer needs, without significantly increasing costs.

Backplane Architecture and Technology

The architecture of the backplane is determined by the type of data transmission required (parallel or serial) and the bus system specification, such as VMEbus, CompactPCI, MicroTCA or AdvancedTCA. In an electronics packaging system, the mechanical framework is provided by the enclosure, including the mounting of the boards—which used to be electronically connected to one another via cables. Today, these cables are typically contained on PCB boards situated near the rear of the system (or the center when a rear I/O board cage is added), and have since replaced the original wiring between boards. Now, these boards, or wiring backplanes, provide the necessary electrical connections to direct data transmitted between boards via a data bus and deliver power to the individual function boards.

In the past, backplane supply voltage was typically 5 VDC, while today's boards are often supplied at 12 V, and the lower voltages for the logic components are derived from this on-board. A reason for this change is to accommodate the supply voltages for processors and controllers, which vary considerably and are generally very low. Containing entire copper layers integrated into the backplane for the main supply voltages, these solutions are constructed to minimize interference and ensure high current capacity.

In addition to its electrical functions, the backplane adds an important element of mechanical stability to the system. Now, backplanes may contain from four to over 30 layers and thus have a thickness of 2.4 mm to 8 mm or more. By bolting the backplane to at least every other slot, it delivers a system construction with superior strength.



Early backplane versions only needed one data line between communication partners, but due to the ever-expanding data volumes exchanged between boards, this design is no longer sufficient. Connecting multiple lines in parallel, referred to as a parallel bus, is a solution that allows several bits to be transmitted simultaneously. With this configuration, the number of parallel lines can be endlessly increased to eliminate limits on data transfers. However, this means the number of pins on the connector must be continually increased or the transmission rate must be increased, resulting in physical space constraints and synchronization issues for data being sent or received.

Alternatively, a serial data transmission — a process in which each bit is sent in succession through a single transmission line — is compatible with multiple topographies, such as dual star, full-mesh, replicated mesh and daisy chain, providing greater performance flexibility. For instance, dual star provides a failure safety, with a second redundant switch taking over for the first in the event of any malfunction. The second switch can alternatively be used to double the transfer rate. Also, by using a full-mesh topography with AdvancedTCA, each board is connected through four data ports. While this method eliminates the need for a star point between sender and receiver, it does require a considerable number of lines. Additionally, new configurations such as replication mesh and daisy chain are all designed to provide faster data transmission and reliable performance.

Advancements in Backplane Design

Just a few years ago, high-speed backplanes were still a rare exception to the rule, but the arrival of PCI Express, Gigabit Ethernet and Serial Rapid I/O has elevated the need for these higher-speed solutions. As a result, new requirements mandate backplane manufacturing and design validation requirements.

As technology advances, users desire backplanes that not only provide the transfer rates needed, but also remain a cost-effective solution. Advanced high-speed backplanes can operate at 40G, meeting current demands for transmission rates. Further, some 40G backplanes are even manufactured with improved FR4 material to support networking needs without increasing costs. By combining cost-efficiency with superior signal integrity, these backplanes offer faster point-to-point connection between boards for enhanced internal and external communications.

Additionally, due to the broad spectrum of available configurations with serial data transfer, such as CompactPCI Plus, MicroTCA and AdvancedTCA, modern backplane manufacturing includes enhanced customization capabilities. Custom configurations showcase the advantages of a complete system provider. All components, including the backplane, are intelligently matched to the system. With these demands on design and variability, backplanes need to be manufactured with a high level of flexibility, while maintaining precision and quality.

Looking Ahead

Technology will continue to become more advanced, and to accommodate rising processing power and networking demands, backplanes will continue to evolve. This will not only ensure that crucial data is transferred faster, but also maintain consistently reliable data traffic patterns and deliver the necessary power distribution to networking boards.