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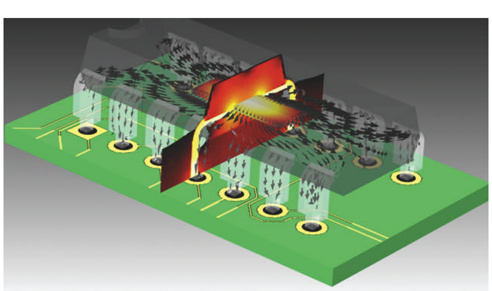

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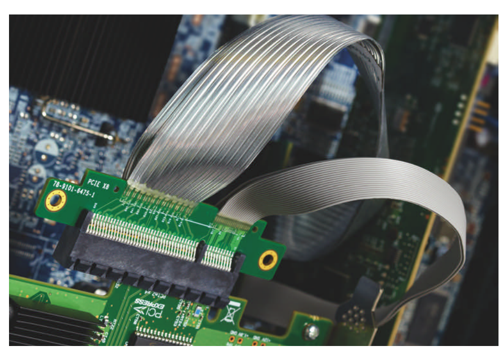

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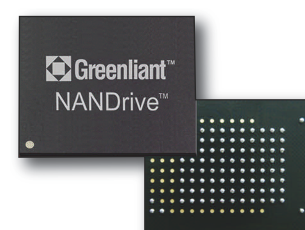
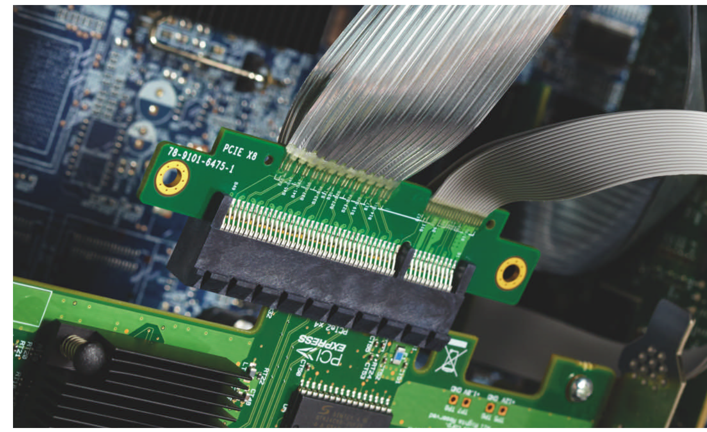


Thin, foldable cable a better choice for some PCIe applications

A high-performing flexible, routable option enables higher density designs

By Charles Staley, 3M Electronic Solutions Division, www.3M.com



Interconnect extender choices for internal PCI Express applications have generally been limited to short cable assemblies, rigid PCB assemblies and flexible circuit assemblies. As data rates climb and system density increases, the limitations of these solutions have become more apparent. PCIe implementations often require 8, 16, or even 32 bi-directional channels, plus supporting signals and power.

Rigid riser cards are limited to simple offsets, which constrains the design. Flexible circuits can free up the mechanical constraints, but potentially at the cost of reduced signal integrity. Standard copper twin axial cable is another option, but assembly costs can be high due to the large number of individual wires, the large bend radius of a high-channel count cable can present an additional mechanical obstacle, and the bulk can impede airflow.

A newer option is now available. The emergence of thin, foldable, ribbon-style cable assemblies for PCIe applications presents system designers with a high-performing, highly routable alternative. The cable assemblies can be configured to virtually any orientation within the cable length. They can be bent and folded to maximize space and reduce obstruction to airflow, enabling higher density designs for certain PCIe applications.

In response to acute space constraints, cable manufacturers have worked to develop thinner, more routable, high-speed twin axial cables. The cables appeared on the market in 2010, and cable assemblies based on it are currently being used for internal and external applications from SAS to QSFP+ to speeds up to 14 Gbps and potentially much higher, depending on cable length and configuration. The cable has been recently incorporated into an extender cable assembly for PCIe that is being made generally available this year.

The newest twin axial cables have a fundamentally different construction than conventional wrapped twin axial cable. Thickness is now as low as 0.88 mm for a single ribbon of 30 AWG (American Wire Gauge) cable (two ribbons stacked or side-by-side are needed for an eight-pair cable), making these newer cables significantly slimmer than their predecessors. For the new high performance flat, foldable cable, all of the conductors in a multi-channel cable are placed together and simultaneously laminated into the desired pair structure. This method reduces variability of pair geometries, resulting in more consistent pair behavior.

Flexible circuits offer a similar level of flexibility as cables, but both flex and riser cards contain much less copper overall than cables.

Shielding construction is also different. In conventional twin axial constructions, shielding is typically applied by wrapping it spirally around the insulated wire pairs. The shielding layer is then overwrapped with another film layer to provide support and retain the primary shield wrap. While wrapped-shield cables offer some limited ability to bend around corners, manufacturers must be careful not to bend the cables too much because the shielding and overwrap materials can distort the precise cable geometry needed to maintain impedance control, which can degrade signal performance. Repeated breaks in the shield along the cable length can produce an unwanted resonance effect, evident at certain frequencies.

The new ribbon-style twin axial cables use a longitudinal shield structure with a signal response that is highly tolerant of decreased bend radii. Tests by 3M show each fold (180° fold at 1 mm bend radius) impacts impedance at the fold location by approximately 0.5 Ohms (70 ps 20/80 percent rise time), which is well within the tightest impedance specification.

The tight bend radius and low profile of ribbon-style twin axial cables opens up entirely new options for routing cable in PCIe-based systems. The cable can be run along cabinet walls and bent flush into corners, out of the way of airflow. It can snake between processors, heat sinks and fans, freeing up valuable space in the mechanical design of the unit for components. Therefore, it can potentially reduce the cost, complexity and power consumption of cooling the system.

These routing options represent a major break from the design constraints posed by rigid riser cards and flexible circuits in PCIe applications. Riser cards are the tried-and-true option with proven performance. However, a riser card can be positioned in only two dimensions. Often, a variety of cards must be used in a single system to achieve a desired design. One the other hand, the same twin axial cable product can be positioned in a multitude of ways, offering much more freedom in the orientation of the peripheral cards.

Flexible circuits offer a similar level of flexibility as cables, but both flex and riser cards contain much less copper overall than cables. Thin copper traces allow them to be compact and of precise construction, but the tradeoff is signal loss. Connections can run into performance-robbing attenuation, reflections and crosstalk, and achieving reliable reach across a system becomes a serious challenge. Plus, the higher the data rate, the higher the signal loss. Designers can attempt to compensate by installing retimer chips along the signal path, which regenerate the signal and enable better reach. This adds materials cost, however, as well as design complexity.

Using a high-performing twin axial cable may allow designers to reduce or altogether avoid retimer chips. A high-performing twin axial cable (raw with no connector) typically exhibits 10-25 percent of the loss of laminate-based constructions. While all cables lose signal over distance, it happens much more slowly with a cable than with a flexible circuit or PCB, so reach is significantly longer.

With longer reach, higher performance and a multitude of routing possibilities, cable assemblies based on the new breed of flat twin axial cables can help PCIe-based system manufacturers create higher-density, higher-performing design while enabling lower total cost of ownership.