SPECIAL REPORT

BALANCING DENSITY AND PERFORMANCE TRADEOFFS

By **Rick Nelson,** Interim Chief Editor

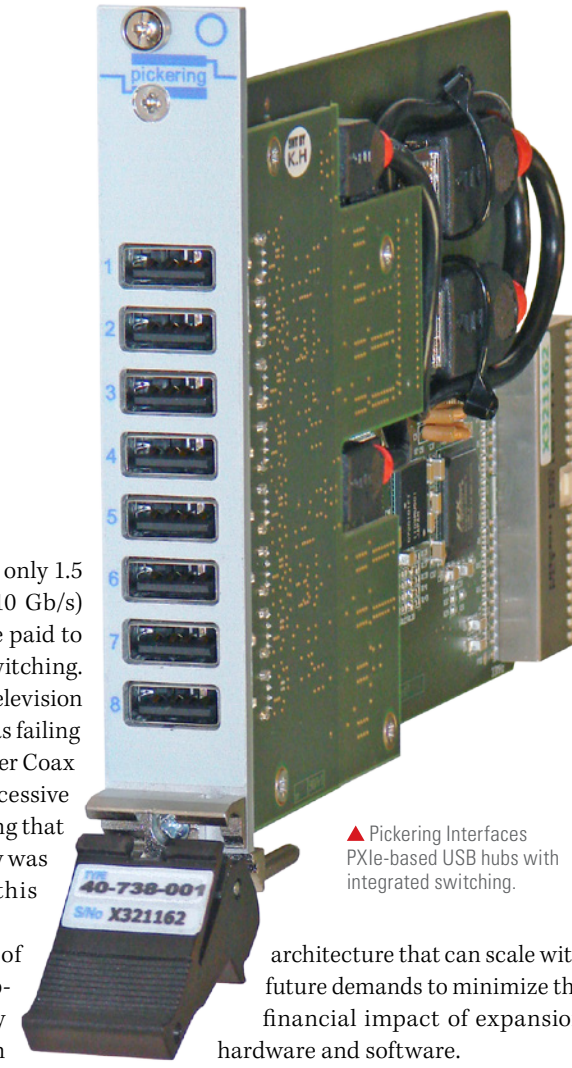
Low- to medium-density switching systems serve applications ranging from aircraft development to automated test, according to a selection of vendors surveyed for this report. Read on to find out what else they told us.

Emerging trends

What trends have you seen develop recently, and what trends do you expect to develop soon in low/mid-density switching systems?

Bob Stasonis, technical product specialist, Pickering Interfaces: There really is little new in terms of trends for low/mid-density switching, although we have addressed one new market. Typically, if you exclude high-voltage (standoff issues) and high-current applications (relay size), low/mid-density switches are specified for two reasons—budget and performance. Let me explain each separately. The budget issue relates to paying for "just enough test." In other words, I may never need a greater switching capacity for my application and my budget is tight, so why buy more switching than I need? If budget is not an issue, you go for more switching to future-proof the system.

In terms of performance, the higher the frequency of your signals, the greater possibility of lower isolation and higher crosstalk in a higher density configuration. Wider spacing between components makes it easier to design higher performance switching. As data rates get higher (for example, USB 1.0 was only 1.5 Mb/s, while USB 3.1 is 10 Gb/s) greater attention must be paid to the performance of the switching. We recently had a cable-television testing application that was failing the MoCA (Multimedia over Coax Alliance) signal due to excessive crosstalk. Special switching that was more of a mid-density was designed to overcome this limitation.



▲ Pickering Interfaces PXIe-based USB hubs with integrated switching.

If you want to think of this as a trend, the developments in low/mid-density switching are being driven by new relay technology that is enabling higher density designs. The technology that is allowing us to continue to increase density in switch designs, including Pickering's 4-mm^2 relays, results in new definitions for what low/mid density is. In other words, what was medium density two years ago is likely considered low density now.

Jon Semancik, director of marketing, Marvin Test Solutions: Lower I/O pin-count applications typically drive low/mid-density switching requirements, and there really haven't been any significant applications or industry trends emerging specifically along these lines. Cost always enters into the equation when specifying a test system, and reducing the size of the switch subsystem can help control this; however, it is important to select an architecture that can scale with future demands to minimize the financial impact of expansion hardware and software.

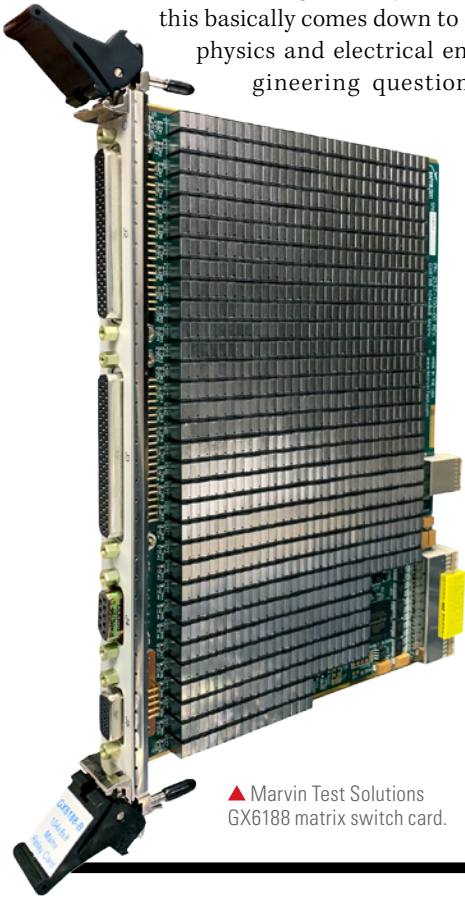
Norton Alderson, VP of marketing, Universal Switching Corp.: Universal Switching has its roots in the ATE industry but over the last 27 years has branched out into nearly every industry. This year we received a new type of application where in the development of an aircraft, the user wanted to switch in various devices on to a 1553 bus-loop. This automated the process of the client either physically connecting devices together with various cables or using patch cords with a patch panel. Automating this process eliminates mistakes, reduces wear on the devices, and saves a tremendous amount of time. A complete reconfigure of the devices takes seconds to accomplish rather than hours. This allows the user to quickly evaluate different aircraft/device configurations during the engineering phase.

Low/mid-density tradeoffs

Tradeoffs exist between low/mid-density switches and high-density. What are the key advantages/tradeoffs between low/mid-density and high-density switching systems?

Stasonis, Pickering Interfaces: As referenced above, it is a tradeoff of specification versus density. Of course, as stated, much of this is applications-driven. And in a modular platform like PXI, the limited slot space in a chassis means that test-system designers are looking at the densest switching system that meets their requirements. Too many slots used for switching may mean that the test engineer must specify an additional PXI chassis, which adds costs and takes up rack space. This is one of the reasons Pickering designed a series of low-cost 2-, 4-, and 6-slot LXI/USB chassis to accommodate additional switching slots when there is no space to supply the switching necessary in a single PXI chassis.

Semancik, Marvin Test Solutions: Without having the formfactor or definition of low/medium/high-density stated, this basically comes down to a physics and electrical engineering question.



▲ Marvin Test Solutions GX6188 matrix switch card.

Lower density switching typically means fewer relays for a specific board formfactor. This means the design has more layout space for traces and shielding, which can improve bandwidth, noise, and cross-talk specifications. Current-carrying performance can also be increased with larger footprint/higher current relays, but again, density will be compromised.

Higher density switching obviously increases the overall channel count, but it will impact the rated bandwidth, noise specifications, and the impact from unterminated stubs, as trace placement and spacing becomes more critical. There are definite advantages with high-density switching, such as being able to switch any resource to any pin and having the ability to extend this capability to thousands of channels for demanding applications."

Alderson, Universal Switching Corp.: The most common tradeoff between low/mid- and high-density switching has been crosstalk isolation, but given that problem, USC has continued to focus our product development in this strategic area. We have increased grounding, increased shielding, and utilized EMI gasketing for a variety of our products with impressive results. As product frequency capability increases, good isolation becomes even more critical.

Josh Brown, Keithley factory applications engineer, Tektronix: A denser system may end up having greater switched or carry-current restrictions. Along with many more switching channels, a high-density system tends to also want to try to offer a small footprint, allowing a user to maximize their rack or bench space. However, there is only so much you can pack onto a printed-circuit board before surface area and physics remind you of your limitations. A lower-density system might offer higher signal levels; you will simply have less of them to work with.

Key technologies

What key technology or innovation challenges are manufacturers or marketers of low/mid-density switching systems facing?

Stasonis, Pickering Interfaces: In modular test, connector technology can be a challenge. For example, PXI's 0.8-in.-wide front panel limits what kind of connectors can be used, whether it is high power or high frequency. The other option is a 2-slot-wide front panel, which takes up valuable slot space. Connector designers need to step up and improve present connector technology to get smaller while still staying robust.

Alderson, Universal Switching Corp.: We have continued to push the technical boundaries of automated switching, and one of the keys to doing this is to keep abreast of the continuous component development and integrate this into the current product offering. This manifests itself in the release of a new product, or an update to an existing product to improve performance and/or reduce costs.

Brown, Tektronix: Increasing switching speed helps to reduce overall test time. One way in which we realize this is by moving away from traditional electromechanical relay switching to using either reed or solid-state relays. A user may have to consider some of the tradeoffs when it comes to adopting these faster-switching means, which could include settling for a lower voltage threshold per channel, a lower current capacity, or both.

One of the additional hurdles we continue to address is the ability of switching systems to work well with other pieces of test equipment in a rack. Traditionally there are some external trigger lines—input and output—that are used to sequence operations between a switch and another piece of equipment. As the demand for shorter test times increases, we either respond with lower trigger latencies or find other means to expedite the instrument interactions. Most of our newer systems boast < 500-ns latency on external input/output triggering, but we can achieve the same results with digital I/O and Keithley's TSP-Link interface.

Features and attributes

What key features or attributes are customers asking for in low/mid-density switching systems?

Stasonis, Pickering Interfaces: "Beyond what I have stated earlier, customers are always looking for reliability at the lowest price. As system uptime is critical, the ability to diagnose and locate switching faults quickly is a must—in functional test, it is always possible that a bad DUT can damage the tester's switching. To address this need, we introduced eBIRST (external Built-In Relay Self-Test). In addition, there are spare relays mounted on most of our switching offerings and we allow our customers to perform simple repairs without voiding their warranty.

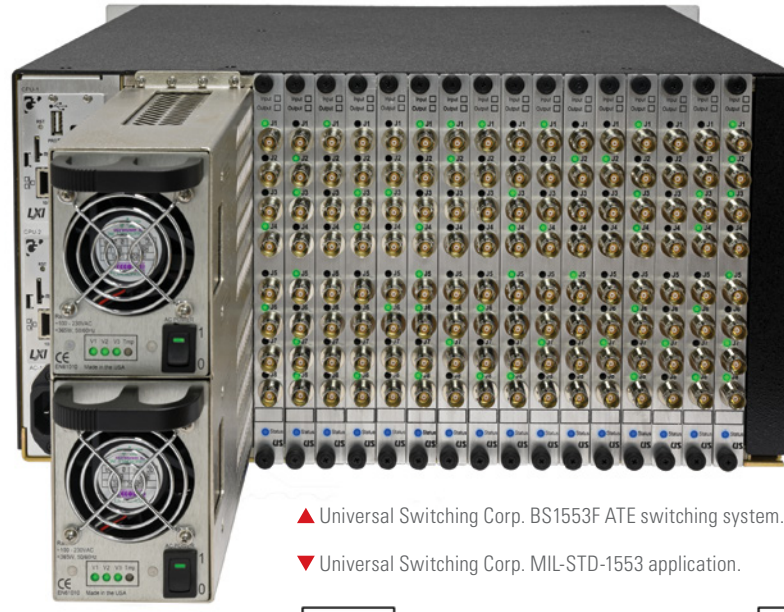
Alderson, Universal Switching Corp.: A common request is for Ethernet control, and while some other switch manufacturers are new to this, USC has been delivering Ethernet-controlled products for nearly 20 years. USC has recently upgraded our control capability to 1 Gb. Our plug-in C3 controller provides not only 10/100/1Gb capability, but also includes a multiserial port (RS232/422/485) as well as a USB port. We have also provided an update to our rugged 70000 Series relay modules for Ethernet control and POE (power over ethernet) for embedding a small automated switch function within other hardware.

Recent products

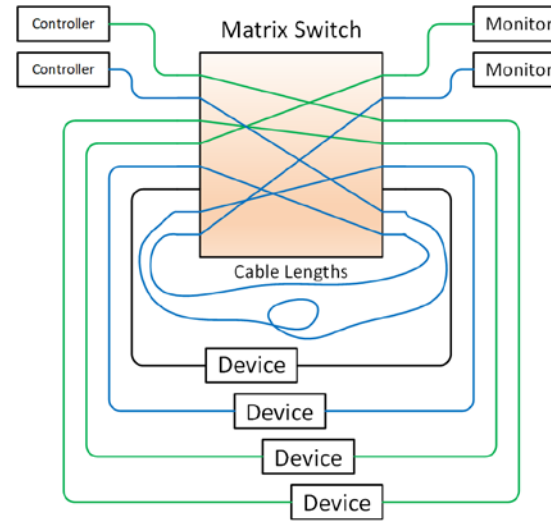
What low/mid-density switching solutions has your company introduced recently? What are their key features?

Stasonis, Pickering Interfaces: "We created a family of PXIe-based USB hubs with integrated switching for testing the integrity of USB channels on a unit under test. The switching allows the programmer to open and close the power and data lines on each USB channel to programmatically inject faults.

Semancik, Marvin Test Solutions: This is dependent on the formfactor and channel count considered as low/medium density. MTS has recently introduced the GX6188, which we categorize as a high-density matrix switch card, but others may refer to this as medium density. It incorporates a 104x8x8 architecture that can accommodate multiple resources and multicard configurations, and it includes integral bleed relays and built-in-test functionality.



▲ Universal Switching Corp. BS1553F ATE switching system.



▼ Universal Switching Corp. MIL-STD-1553 application.

The GX6188 features an integral, 3-dimensional switching architecture which provides the flexibility to connect test-system resources to multiple UUT connections as well as supporting an expansion bus connection without sacrificing I/O matrix connections when building multiple switch-card configurations. The GX6188 can connect to 104 UUT switching points, eight external resources, and an 8-channel global bus via front panel connectors. Multiple GX6188 cards can be connected, and the matrix extended, using the global bus.

There are also 14 general-purpose digital I/O signals, which are accessed via the card's I/O connectors and can be used for cable ID, external reset of matrix relays, or for creation of a PXI bus interrupt.

Alderson, Universal Switching Corp.: Earlier this year we developed a new BS1553F ATE switching system that is scalable in the field from an 8x8 matrix to a full 64x64. It utilizes our unique tri-stage design architecture to reduce the physical size, increase frequency range, and lower costs while being scalable. The user can start smaller and add either input or output modules to increase the switch matrix. While this product is differential and utilizes a triaxial connector, USC is currently developing a single-ended BNC version to be released in the next three months and is expected to operate up to 300 MHz.

Brown, Tektronix: Tektronix introduced the DAQ6510 in April 2018, and while its primary application is for datalogging, the flexibility of the module cards it supports lends itself to general-purpose switching as well. The user can command-control any of the multiplexer card options to provide up to either 1-to-40 or 2-to-20 2-pole switching. Additionally, we provide a 40-channel single-pole switching option as well as a 6x8 matrix option. The DAQ6510 provides two card-module slots so a user can mix-and-match to better meet a diversified set of needs.