


SPECIAL REPORT

LET'S GET MODULAR

As 5G and IIoT keep evolving, the demand for modular instrumentation grows to new heights

By Mike Hockett, Editor-in-Chief

▶ With each passing year, modular instruments gain ever-more capabilities that were once only possible with benchtop instruments. Assembling a complete test system once required a rack-mount enclosure and multiple other rack-mounted benchtop instruments, along with separate benchtop instruments installed within the rack. Sometimes this required specialized software to operate everything together. Now, an equivalent test system can be formed by inserting instrument modules into one chassis.

As increasingly more test engineers have gained comfort with those modular capabilities and the flexibility such instruments offer, the market for modular technology is positioned for considerable

growth for quite some time as its demand rises in the electronic test field.

A report released in August 2018 by research firm MarketsAndMarkets stated the modular instruments market was valued at \$1.12 billion in 2017 and is expected to nearly double by 2023 to \$2.11 billion, growing at a CAGR of 9.6% from 2018 to 2023. Applications in 5G R&D and infrastructure, along with IoT and IIoT, appear ripe for testing with modular instruments, with one of the only market restraints being the increased penetration of rental and leasing services, as opposed to pure product selling.

We at *Evaluation Engineering* gathered commentary from a handful of vendors of modular instruments to get their thoughts on the topics of trends, customer

demands, vendor challenges, the outlook for PXI, LXI, and VXI, and what new solutions they've put on the market.

What's trending?

Here's what vendors told *EE* they're seeing as new or growing trends in the modular instrumentation market.

Bob Stasonis, technical product specialist for Pickering Interfaces: "Modular standards like PXI are implemented in virtually every test application in the electronics industry," Pickering Interfaces technical product specialist Bob Stasonis told *EE*. "There are also proprietary standards by instrumentation manufacturers that allow their products to be easily reconfigured and scaled. What is really interesting is that other nonmodular standards are going modular. Several companies are taking the LXI and USB interfaces and controlling modular switching and instrumentation. Such a trend extends the possibilities of modular test in areas like remote testing and diagnostics and isolation of high-power modules from more sensitive instrumentation."



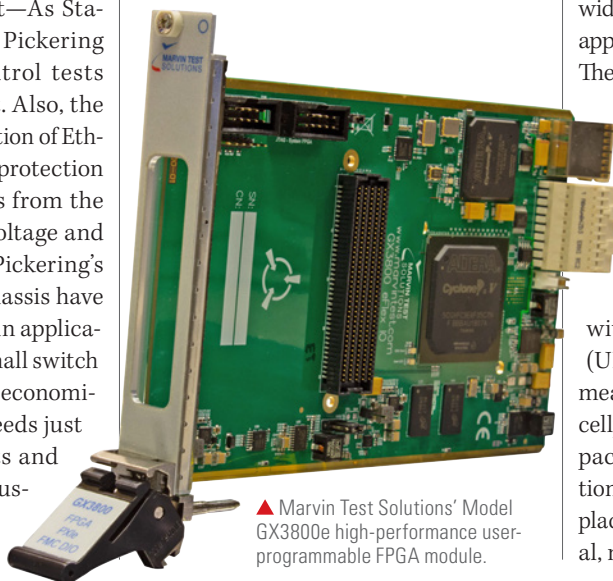
▲ An array of 11 different PXI modules from Pickering.

Stasonis elaborated on three other trends that affect the product roadmap from Pickering's standpoint:

- Higher current and voltage requirements—For example, as the automotive industry moves away from the internal combustion engine and toward autonomous and electric vehicles, they are requiring testing situations of 600 volts or more and even as high as 100 amps
- LXI & USB Modular test—As Stasonis mentioned earlier, Pickering customers want to control tests remotely via the Internet. Also, the transformer-coupled isolation of Ethernet provides that extra protection for sensitive instruments from the electrical noise of high voltage and high current switching. Pickering's 2- and 4-slot LXI/USB Chassis have found new opportunities in applications that require just a small switch set; they can also be quite economical when a test system needs just a few more modular slots and the test engineer cannot justify an additional 18-slot modular chassis.

- Pickering customers want the scalability/flexibility of working with any communications interface and still be a modular form/factor

Mike Dewey, director of marketing at Marvin Test Solutions: "In general, we continue to see advancements in what we call functional density, i.e., more channels, more functions, and more capabilities available in the same or smaller



▲ Marvin Test Solutions' Model GX3800e high-performance user-programmable FPGA module.

amount of real estate for a modular instrument or switch card. And in concert with this trend, we continue to see more and more test systems that are based on card modular architectures and, specifically, the PXI architecture—which is now the market-dominant card modular platform. The modular instrument market—and especially the PXI market—continues to exhibit a healthy annual growth rate that can be attributed to the wide range of available products from many vendors and continued advancements in instrumentation capabilities, particularly in RF and high-performance digital. We expect to see continued growth of the PXI market, driven by the need to update/replace legacy test systems, as well as support next-generation test requirements for factory, depot, and field test applications. In addition, we are now seeing PXI—with its small footprint—open architecture, and increasingly advanced instrumentation, moving into adjacent test markets such as semiconductor test. This represents a huge opportunity for future revenue growth.

Sausan Arebi, Technical Writer and Brandon Malatest, COO at Per Vices: "The shift to software-defined modular instruments is an important development in the field. Technology such as software-defined radio (SDR) and other flexible platforms provide the user with the power to use the instrumentation for multiple use-cases, including analog and digital, receive and transmit, varying data rates, varying frequencies and bandwidths, and applying different DSP for each application—all using the same hardware. These systems can be further used in near real-time and provide automated test suites that can be adapted as needed."

Brian Walker, senior RF design engineer at Copper Mountain Technologies: "Our vector network analyzers will continue to evolve with more sophisticated user interface (UI) software to simplify setup and RF measurement. Just as the RF modem in a cellphone became just one piece of a total package including imaging and navigation, modular USB instruments will find a place buried in larger systems for industrial, medical or agricultural applications."

What are customers asking for?

The customer demands that test instrumentation vendors face are constantly evolving. Here's what such vendors told *EE* their customers are asking for today in modular instruments.

Dewey, Martin Test Solutions: "As noted earlier, functional density is one key feature that helps customers achieve a compact footprint for the test system. Whether it's testing a component, a PCB, or system, there is an ever-increasing need for more channels of switching, analog, or digital test resources without incurring the penalty of a larger test system footprint. This is particularly important for applications requiring test system portability, but even on the factory floor, test engineers are looking to downsize their test assets. And for those systems with high channel count requirements, the ability to incorporate "wireless" interconnect methods that connect system resources to the UUT offers the customer a superior and reliable interconnect solution. With modular instrumentation, customers are also looking for flexibility to employ various program development environments. PXI vendors today offer a variety of Windows-based programming environments. Many PXI vendors (including MTS) also are now offering Linux as an alternate programming environment."

Arebi and Malatest, Per Vices: "Many of our customers have asked for similar features in their SDRs to enable advanced modular instrumentation. High bandwidths, number of channels, and wider operating frequency are all in high demand. In order to accommodate that, our solutions incorporate varying numbers of independent radio channels with

wideband RF operations and top-of-the-line sampling bandwidths. Additionally, by offering a flexible number of radio channels, customers requiring differing solutions can find it on one platform. Our customers have also made it clear that they are looking for high bandwidth capabilities in order to achieve improved data acquisition and spectrum maneuverability, ensuring that data can be sent and acquired efficiently to cope with increased data rates while making efficient use of the spectrum.

"With shifts in standards, customers are looking for machines that are able to easily adapt, by offering both flexible radio front ends along with high digital backhaul data rates and a programmable software base. We ensure that our SDRs are able to meet these needs and further perform (de)modulation using multiple standards available from our IP library. Perhaps the most requested feature in our modular instruments is for advanced digital signal processing resources. We are able to do so through on-board FPGAs that incorporate a high number of logic resources that allow processing to be done on the unit and therefore reducing the number of necessary components and bench space. With these features, our SDRs are able to provide a modular

instrumentation answer for current and emerging needs, offering an adaptive solution that is well suited for future connectivity."

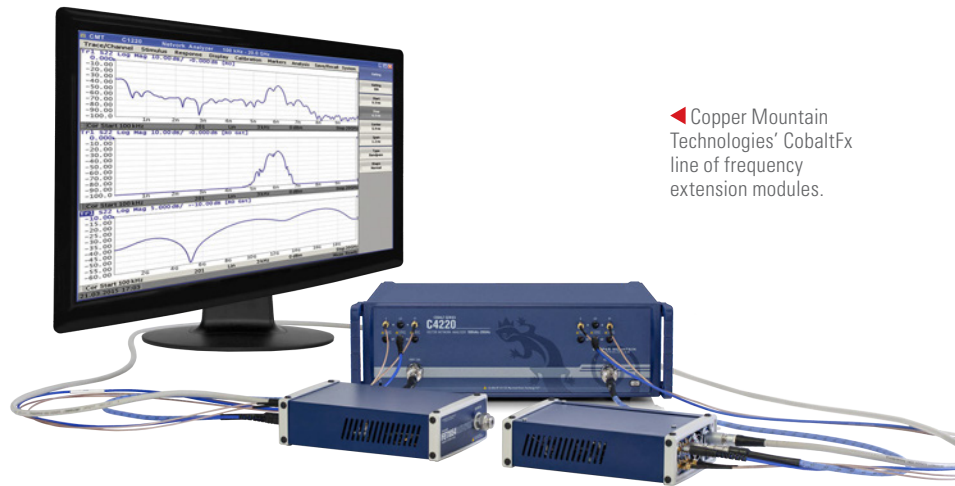
Stasonis, Pickering: "The majority of our customers prefer modular test because of its flexibility and scalability. As PXI is an industry standard, they know that it is supported by many vendors, which adds to the flexibility. That flexibility also gives our customers a standard that will work in all their applications. As it has been for decades, customers want more features and more technology in less space... and at a lower price compared to conventional instrumentation. Support features are becoming more critical, especially when system uptime is crucial, so robust diagnostics to ensure that a test system is working correctly are a must."

Walker, Copper Mountain Technologies: "Customers are looking for solutions to problems. They don't have the time or inclination to become measurement experts. They want devices that detect problems and point to immediate solutions in as direct a way as possible."

Challenges

We know that customers ask for a lot out of their modular instruments. So, can vendors keep with their requests? Here's what they told us.

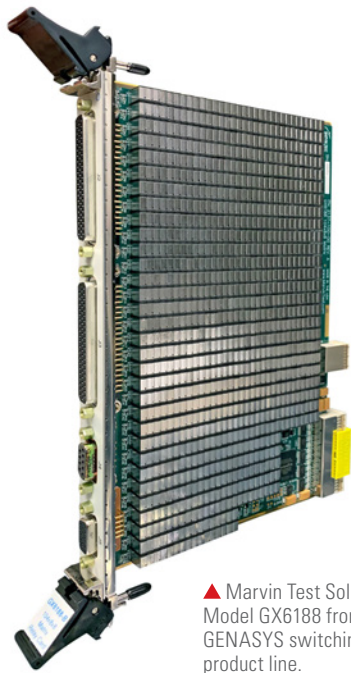
Dewey, Marvin Test Solutions: "PXI modular instrumentation leverages both the PCI and PCIe standards, which means it can take advantage of the pricing volume associated with PCI and PCIe components. This, in turn, helps to mitigate



◀ Copper Mountain Technologies' CobaltFx line of frequency extension modules.



▶ Per Vices' newest software-defined-radio, Cyan, is a high-gain transceiver and signal-processing platform.



▲ Marvin Test Solutions' Model GX6188 from its GENASYS switching product line.

some of costs that are part of the price equation for PXI products. However, the challenge for modular instrumentation vendors, in many ways, is no different from other instrumentation vendors when one is looking to deliver test solutions that can test state-of-the-art products—high-performance test requires high-performance components, which drives the cost of instrumentation. In particular, the challenge for modular instrumentation suppliers can be the high cost of key components such as FPGAs, which are essential to achieve the desired performance and form factor or functional density required by customers. To help mitigate these high costs, modular instrumentation vendors need to take the long view when it comes to pricing products—essentially looking at a product's ROI that extends over several

years and includes the ROI, not only for the initial product, but for its derivatives, which can extend well beyond the initial product's life cycle.”

Stasonis, Pickering: “As I am also the president of the PXI Systems Alliance, let me put on my PXISA hat. Users of the PXI modular standard want all of the key features I mentioned earlier. But for defense contractors and military branches, backward compatibility is equally important. So, in addition to faster demands and higher bandwidths, it all must work with older PXI Modules. In the past year, the PXISA has updated virtually every section of the PXI and PXIe specifications to improve power capabilities and adopt the newer generation of the PCI Express bus, and to have these newer products “play nice” with their predecessors.”

Arebi and Malatest, Per Vices: “By shifting the focus from hardware to software, SDRs are able to provide multifunctional equipment that can easily be altered through simple software modifications to offer a solution for various use cases. Companies like Per Vices are able to meet the demands of a wide range of customers through a customizable platform that is both frequency agile and scalable. Through a combination of multifunctional abilities and the integration of various components into one platform, the overall cost is limited to a single unit. Furthermore, having one platform that addresses many needs allows companies like Per Vices to realize the economies of scale and offer solutions at a lower cost than those built for a single purpose.”

PXI vs. LXI and VXI

PXI has become the industry modular standard over the past 20+ years and

LXI has also had strong growth, while it appears VXI's

time is now long-past.

Still, with many legacy systems still operating

on VXI modulation, it will

likely keep a notable market presence for a while longer. Here's what

vendors shared as thoughts regarding the PXI/LXI/VXI market balance.

Dewey, Marvin Test Solutions: “PXI is the dominant card modular standard today. We don't have visibility into the current VXI market numbers, but with only (four) dominant VXI vendors remaining, we believe the modular instrumentation market share for VXI has been decreasing, whereas PXI, according to Frost & Sullivan, has been increasing more than 10% CAGR. Projections are that the PXI market will see revenue of \$1 billion by 2020. The remaining strength for VXI is in specific-military programs that have a strong need to maintain compatibility with legacy VXI test systems and associated legacy test programs. For commercial/industrial ATE test needs, we see an increasing demand to convert from the VXI to the PXI platform. LXI is not a card-modular standard and is rather the successor of GPIB. Some instruments, especially those that support high-power applications, will remain 19” rack boxes, and those are all LXI instruments.”

Arebi and Malatest, Per Vices: “LXI provides flexibility and freedom for host systems, the capabilities of Linux (or other)-based systems are growing and therefore leaving behind the PXI architecture, which is dependent on PC (Windows) systems. We strongly recommend using a Linux operating system when using our modular instruments. Providing users with access to high-performance computing environments, including a variety of applications for programming purposes, and a more comprehensive development environment is essential for the full utility of modular systems to be realized.”

Stasonis, Pickering: “While LXI is a growing market as is PXI, the VXI market—with a few exceptions—has been relegated to legacy test systems. The majority of the big players in test have obsoleted their products. There are very few companies producing VXI products at this time, and we don't see VXI holding on much longer. This is the primary reason that we have promoted our PXI products as replacements for VXI switching applications. We have cross-referenced the popular VXI switch modules to the equivalent PXI switching from Pickering. As for LXI, this

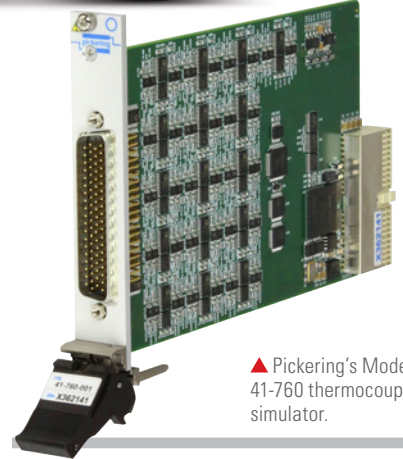


▲ Pickering's 2- and 4-slot modular LXI/USB chassis.

market continues to grow because there are some test resources that just won't fit in a PXI Chassis. Take for example, a 1000-watt power supply in an 18-slot PXI chassis—it's just not practical. Some test resources can't go into a modular standard that was not designed to accommodate such high-power applications. But remember, many power supply vendors produce



▲ Copper Mountain Technologies' 2-port USB vector network analyzers.



▲ Pickering's Model 41-760 thermocouple simulator.

power supplies with plug-in modules based on a proprietary modular standard to allow for custom configurations. In other areas of LXI Instruments, there is still a huge market for full-featured instruments that can be used manually with front panel controls as well as being controlled by an LXI interface.”

Now on the market

Here's the recent solutions vendors told *EE* that the modular instrument market should have top-of-mind.

Recent solution introductions out of **Marvin Test Solutions** include additions to its GENASYS switching product line, with the GX6188 and a new, high-performance user-programmable FPGA module—the GX3800e—which supports the industry standard FMC interface and enables end users to easily create specialized instrumentation by employing off-the-shelf, commercial FMC modules. Upcoming July 9-11 at SEMICON West, MTS will exhibit its PXI-based TS960e semiconductor test system and TS-900 for MEMS testing.

Along with **Pickering's** aforementioned 2- and 4-slot LXI and LXI/USB Modular Chassis, the company's other recently-introduced modular instruments include a new family of PXI programmable resistors (40-251/2/3); a

thermocouple simulator (41-760); and a strain-gauge simulator (40-265). Pickering will be showing their products off at IMS Boston and SEMICON West.

Copper Mountain Technologies'

Walker stated that, "CMT pioneered the USB Vector Network Analyzer. The compact design and intelligent off-loading of the computing platform resulted in a focused and lower-cost device. CMT has a product line of frequency extension modules called CobaltFx, which are a scalable solution so that engineers can meet the requirements of their measurements and budget. CMT already offers more than models of VNAs, and we will continue to add features and functionality while maintaining high quality and low cost."

▼ Keysight's new Model M9383B VXG-m PXIe Microwave Signal Generator supports signals up to 44 GHz and 2 GHz bandwidth



Keysight Technologies highlights the company's February 2019 launch of the industry's first integrated dual-channel microwave signal generators that support up to 44 GHz signals and 2 GHz bandwidth in a single instrument. Keysight said the VXG is ideal for the most advanced 5G design and test scenarios in a compact design, offering both benchtop (M9384B, VXG) and PXI form factor (M9383B, VXG-m) with the same performance and user interface which can be used from design verification to production tests. "The VXG's low phase noise, high output power, excellent modulation, and distortion performance make it an ideal signal generator for a wide breadth of applications in wireless communications, for commercial and aerospace defense industries," Keysight vice president of high frequency measurement R&D Joe Rickert said in the company's product announcement on Feb. 19.

Per Vices has recently released its newest SDR, Cyan, which it describes as a high-gain transceiver and signal-processing platform that is ideal for modular instrumentation applications and tailored to meet the requirements of current customers while offering the adaptability to conform to future needs—all in a compact form factor. "Cyan offers the solution

for many test scenarios and facilitates the process of retrieving data and converting it into information to provide users with useful insight," Per Vices said, adding that it is especially well-suited for applications where high channel count and RF sampling rates are required, and has the highest bandwidth and most channels available on the market." 