# Trends in PC-Based Test and Measurement

*By James Borton*
*Product Marketing Manager*
*Keithley Instruments, Inc.*

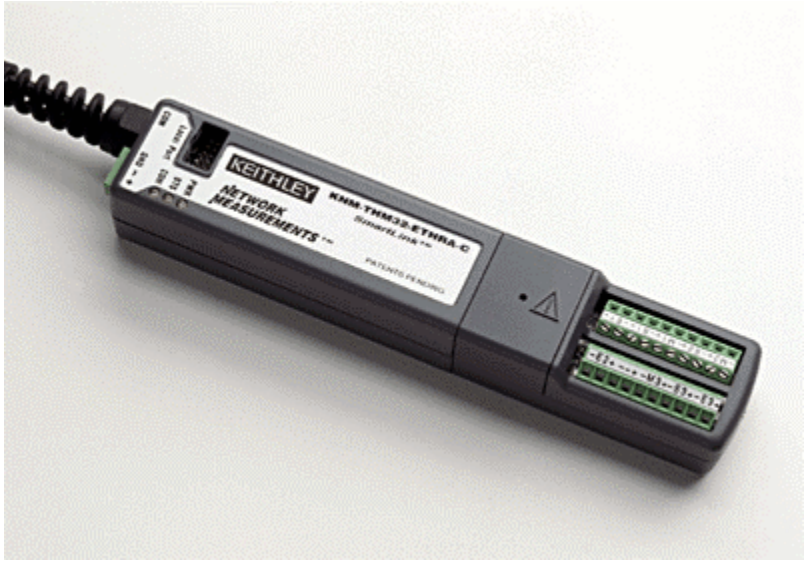
In today's test and measurement environment, developments in PC-based systems are rising to meet user expectations for greater capabilities. Continuous improvements in personal computers and operating systems provide the power for a much wider range of measurement and control applications. Instrumentation companies are also working hard to introduce high performance, easy-to-use products that capitalize on the power and flexibility of the PC. Both hardware and software capabilities are rapidly increasing, while the cost and size of products is falling. Each day, users are finding that PC-based test and measurement allows higher throughput and is more cost-effective than other alternatives.

While this is going on, product life cycles for PC-based test system products are getting shorter. There is a variety of new products and methodologies being offered. To help the reader keep up with these developments, six important trends in PC-based test and measurement are discussed below.

**1. Instrument Form Factors**

A key movement is towards smaller, smarter, and less expensive PC boards. Capabilities are increasing as size decreases. Correspondingly, there is renewed interest in PCMCIA cards for PC-based test. The portability features of notebook PCs allow users to bring this test technology to any field location.

The new 32-bit CardBus for notebook PCs is gaining attention because it allows data transmission over the PCMCIA bus at PCI rates (132 Mbyte/s throughput). The evolution from the PCMCIA bus to CardBus seems likely to follow a path similar to that of the migration from the ISA to PCI bus.




***Keithley's KPCI-PIO24 and -PIO96 boards provide 24 and 96 bi-directional TTL-level parallel digital I/O lines for control and monitoring under Windows® using a single 32-bit***

***PCI slot. These are examples of data acquisition products being introduced for higher speed and finer control in a wide variety of applications.***

In addition to notebooks, palmtop PCs have entered the market place to make PC-based field testing even easier. Palmtops are a convenient way for engineers to download data in the field for later analysis.

The move toward smaller and smarter devices is an evolution that has taken instrumentation designs beyond pc boards as the only form factor. Keithley and other vendors are now offering measurement devices so small they can be located right next to sensors. This distributed external I/O, with devices near the signal source, sharply reduces induced electrical noise and produces more accurate measurements. Rack-mounted, chassis-based distributed plug-and-play I/O boards are also gaining popularity because of the large number of points that can be remotely measured.

**2. Costs Fall While Throughput Increases**

In addition to better performance and smaller form factors, technological advancements also are lowering unit costs. For example, for digital and analog I/O, product costs on a per channel basis are expected to drop 25 to 30 percent over the next five years.

This hasn't been done at the cost of performance - throughput is increasing for all types of PC-based test systems. For example, CardBus enables portable applications to run at higher speeds, permitting portable PCs to operate at the same data rate as PCI bus-equipped desktop PCs.

Many manufacturers have also introduced boards containing their own digital signal processors (DSPs). DSP-based boards typically operate at much higher speeds than non-DSP boards.

The shift from ISA bus to PCI bus is another factor providing a tremendous increase in data throughput. For example, the theoretical peak throughput of the ISA bus is 2-3 Mbyte/s, while the PCI bus throughput is rated at 132 Mbyte/s. The growth of the PCI bus and plug-in boards is allowing a wider range of high-speed applications, with greatly expanded data collection and higher system performance.

**3. Dramatic Changes in Software**

The most important software trend undoubtedly is the emergence of Windows NT® as the operating system of choice for PC-based test. Windows NT is much more robust than Windows® 3.1/95 and is virtually crash proof. Windows NT fulfills the market's need for:

- Symmetric multi-processing, which allows operating system code to run on any free processor in a multiprocessor computer. This provides higher throughput and greater availability than does asymmetric multiprocessing.
- Stability, with full-memory protection for 32-bit applications.
- Preemptive multi-tasking, which enables the running of multiple applications with better sharing of resources.
- Multi-threading, which provides the capability to execute in two or more locations using multiple threads. (A thread is an executable entity that belongs to one process.)
- Real-time performance, with latencies of just 5 to 10 milliseconds.
- Outstanding reliability in a multi-user environment.
- Compliance with standards, such as Presentation Manager and POSIX applications.

Another important software trend is wider use of ActiveX controls, which allows easy call-up of word processing and spreadsheet applications. Using ActiveX to provide canned modules for the most common applications dramatically reduces a programmer's workload. Also, ActiveX controls are independent of the programming language. This means they can be used many different

programming environments.
On the horizon, we see industry software leaders introducing 64-bit operating systems and microprocessors. These new operating systems are expected to be available within the next year or two. They will continue the evolution to Windows platforms that provide greater resolution, accuracy, and throughput for PC-based test applications. As a result, we will likely see 64-bit PC-based test hardware that takes advantage of these faster operating systems.

**4. Web Applications**

Beyond E-commerce and information gathering, the Internet and Intranets will play important roles in the processing and display of real-time information. In addition to other uses, ActiveX controls enable these remote control data acquisition functions with web-based systems. Consider how exciting it would be for a division manager located in Chicago to remotely monitor the operations of a plant in Belgium. This capability exists today.
For a nominal cost, it is now possible for an entire company to have its information linked together in cyberspace. This means it is now easier to monitor and control from any location. Surely, companies who are early adopters of this technology will leap ahead of their competitors in terms of performance and cost structure.

**5. Networking Buses**

Clearly, the trend in PC-based test is moving away from discrete, separate networks connected to only one, or at most, a few PCs. Today, users want data access from anywhere in the enterprise - they want to connect applications to wide area networks. Remote access allows important functions, such as ISO 9000 or production control, to be conducted by staff located at a headquarters facility rather than locally. Some of the most exciting new networks and communications standards for PC-based test include the latest Ethernet protocols, Universal Serial Bus (USB) and Industrial Fieldbus.
According to a Keithley study completed in 1998 (Table 1), most test and measurement applications today use the serial port, 4-20mA, and IEEE-488 bus communication protocols. Though the survey respondents indicated that use of these protocols will decline, some observers feel that they will continue for applications not requiring remote access. However, users who also need control capabilities are likely to migrate to faster protocols, such as Ethernet, USB and Firewire.

**Table 1**
**Communication Protocols Used to Capture Measurement Data**

| Type of Protocol | % in 1997 | % in 1998 | % in Future |
|---|---|---|---|
| Serial Port | 71 | 74 | 54 |
| 4-20mA | 52 | 39 | 29 |
| IEEE 488 & 488HS | 48 | 52 | 48 |
| Ethernet | 37 | 38 | 38 |
| USB | 7 | 7 | 18 |
| HART | 7 | 7 | 7 |
| DeviceNet | 5 | 4 | 8 |
| Interbus S | 3 | 2 | 2 |
| Field Bus H1 | 3 | 3 | 7 |
| IEEE 1394 - FireWire | 1 | 6 | 8 |
| Profibus | 1 | 3 | 6 |

***Source: Keithley 1998 Measurement Needs Tracking Survey***


***This Keithley KNM-THM32-ETHRA-C thermistor measurement module has an Ethernet interface and is small enough to be located right next to the sensors. These two features allow error-ree temperature measurements to be communicated anywhere in the plant.***

**Ethernet**

To access a PC-based test system from anywhere in the enterprise, or on the Web, users increasingly are turning to Ethernet-based networks. Because such networks have no distance limitations and are common in most enterprises, it is not surprising that Ethernet has evolved into the communications network of choice. Ethernet's installed base is enormous. In Keithley's earlier (1997) study, 72 percent of the respondents reported that Ethernet was their facility's data communication standard, and 37% used it for measurement and control applications. A similar percentage are still using it for these applications and expect to continue this level of usage in the near future. While the most popular version of Ethernet is still 10Base-T operating at 10 Mbps, a faster 100 Mbps version has been deployed that enables significantly higher throughput for the most demanding PC-based test applications.

**Universal Serial Bus**

Originally designed to simplify peripheral connections for consumer applications, USB has become an important standard for PC-based test systems. For those not requiring enterprise access, but requiring a localized network that is simple, fast, and easy to connect, USB is a viable alternative. Connecting to peripherals today is often difficult, requiring switch settings and hardware drivers. Yet, connecting to a USB port can be as easy as plugging in a toaster. A connecting cable simply plugs into the PC's USB port and that of a USB equipped peripheral. PCs running a Windows operating system (Windows 95-OSR2 and Windows 98) easily recognize and accommodate USB. Plug-and-play, hot swapping, and speeds up to 12 Mbps are some of the features that make USB so attractive to end users.

**Industrial Fieldbus**

The Industrial Fieldbus is a network communication standard that allows products from different manufacturers to talk with one another over a communication bus using a common protocol. Compared to what is available with proprietary networks, a fieldbus capability provides users with a wider range of equipment choices. Today, many competing fieldbus standards-such as those from ISA-SP50, Profibus, CAN, and DeviceNet-compete for viability. It may be some time before a common fieldbus standard evolves. Eventually, users may become frustrated with the myriad of fieldbus choices and revert to a de facto standard such as Ethernet.

**6. Product and Application Lines are Becoming Blurred**

The trends described above have caused a blurring of previously distinct applications and products for data acquisition, test and measurement, and process control. Both new players and existing manufacturers are creating hardware and software that crosses old boundaries. This means a larger number of alternatives are available to end users. However, this could make it

more difficult to locate the best solution for a particular application, since the functions and features you need are contained in products designed for the widest possible appeal.

---

**About The Author**

James Borton, is a data acquisition product marketing manager at Keithley Instruments, Inc. in Cleveland, OH. Since graduating from Youngstown State University with a BSEE degree, he has gained more than 19 years of experience in data acquisition, industrial control, and automation with Keithley, Reliance Electric, and Allen-Bradley. His professional society membership includes IEEE and ISA.