

ers that not so long ago the output was in the form of an analog voltage or current signal directed to a display, such as a moving-coil meter, potentiometric recorder, oscillographic recorder, or oscilloscope. With the addition of the necessary output interfaces, researchers progressed to recording on punch cards, punch-paper tape, and magnetic tape. Then a significant change occurred: The microprocessor chip was introduced as a manager, or controller, of the system—an innovation that also enabled the processing, analyzing, and storing of the acquired data. To exploit the advantages of what has now become a computer-based measurement system, users must choose among the many available I/O bus systems, all of which initially faced the problem of adhering to protocols that equipment manufacturers and their customers had agreed upon.

To provide guidance for users, the author then discusses how information may be transmitted. He delineates two types of transmission systems: serial or bit-by-bit and parallel, in which the information is transmitted in the form of multibit words. Nawrocki first logically and clearly presents a wealth of information on serial systems, beginning with the RS-232C. When installed in a PC, that serial interface can lead to a simple measurement system involving one digital instrument and one computer. However, the system has a serious transmission-rate limitation, the extent of which depends on the length of the transmission line. The now-popular USB (universal serial bus) allows a significantly increased rate and a new method of attaching and accessing peripheral devices. The author then describes the RS-449 and RS-530 serial systems, with their electrical-circuit parameters defined in the RS-223A, RS-422A, and RS-485 standards.

Nawrocki then turns to parallel interfaces, beginning with the most widely used IEEE-488, which is also known under the generic name of GPIB (general purpose interface bus). It offers much higher data rates than does serial data transfer and allows an instrument to operate either in interface systems or autonomously. The VXI system is used for setting up modular systems. Its designers were challenged to find a solution to the system control problem, one that could use software developed for IEEE-488. The reader will also find material on wireless measurement systems; other crate and modular systems, such as CAMAC and PXI; and the IEEE-1284

interface for printer control. Examples of the increasingly important computer network-based measurement systems include the LAN (local area network) types, of which the Ethernet is the most widely used.

The book includes descriptions of such system components as signal conditioners, A/D and D/A converters, computer measurement boards (more commonly referred to as data-acquisition boards), and virtual instruments. While no new ground has been broken on those topics, Nawrocki's approach is constantly useful for understanding the operation of measurement systems.

Although the author's coverage of sensors is sparse, he does describe some interface circuitry necessary to match the sensors to the system input. Readers who need more information on sensors can find books with detailed treatments, including the *AIP Handbook of Modern Sensors: Physics, Designs, and Applications* (AIP, 1993) by Jacob Fraden (see my review in PHYSICS TODAY, June 1994, page 74). The topics in the main part of *Measurement Systems and Sensors* should prove valuable to those trying to properly integrate, for example, a PC with a data-acquisition system. Nawrocki is adept at untangling the nuances of that process.

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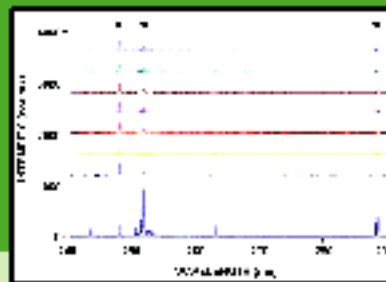
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LIBS spectra of silicon surface contamination samples, showing a 235 nm line. The LIBS spectra show a silicon-rich sample, which enhanced the feature of the graph.

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