Optoelectronic Device Facilitates Spectral Measurement

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A novel module integrates the optical and electronic components of a line array spectrometer, simplifying development of spectral measurement systems that can make application-specific computations.

Optoelektronisches System erleichtert spektrale Messungen
Ein neuartiges Modul integriert die optischen und elektronischen Komponenten eines Linien-Spektrometers und vereinfacht die Entwicklung von spektralen Meßsystemen, die anwendungsspezifische Berechnungen durchführen können.

Un dispositif opto électronique facilite la mesure spectrale
En intégrant les composants optiques et électroniques d'un spectromètre à réseau, un nouveau module simplifie le développement des systèmes de mesure du spectre qui peuvent effectuer des calculs d'applications spécifiques.

Un componente optoelettronico facilita le misure spettrali
Un nuovo modulo integra i componenti ottici ed elettronici di uno spettrometro a sensore CCD lineare e semplifica lo sviluppo di sistemi di rnisura spettrale che possono eseguire calcoli ottimizzati per un'applicazione specifica.

Because spectrometric equipment has become smaller and less expensive, it is being used in an ever-increasing number of applications, such as colour measurement, quality control, medical and pharmaceutical testing, plant growth characterization, pollution measurement, food control and light source testing. Process control – in chemical plants, in the semiconductor industry, in dye works and in electroplating – is another area taking advantage of the improved equipment. Also on the rise are applications that require simultaneous measurement of several spectra, such as multiangle colour measurement of paint work, control of LED-equipped printed circuit boards, burn-in tests of lamps and high-throughput pharmaceutical screening.
To meet these demands, a developer typically searches the market for a suitable spectrometer, tests it with regard to his application and develops the appropriate readout and processing electronics, starting with the line array readout. He integrates the normal spectral calculation procedures, such as dark and reference measurement, transmission calculation and averaging, into the software. In most cases, the pixel-number-to-wavelength relationship also must be integrated. All of these setup procedures have to be performed in case of every application. The final steps – addition of specific calculations, arrangement of data transfer and implementation of the instrument in a system – are highly application-dependent.
Most line array spectrometers are delivered without information about the pixel-wavelength relation or, at most, with such data in written form. Some companies deliver spectrometers with specific electronic boards featuring USB, RS232, PCI or ISA interfaces.
JETI Technische Instrumente's spectraprocessor SDC combines an optical bench with readout/processing electronics in a small, dual inline pin housing (Figure 1). The design enables its use as a standard electronic integrated circuit with optical input. Data access takes place similarly to the way it does in an RAM-based device. The input of application-specific information – such as desired wavelength range, number of averages, referencing, and calculation of reflection, absorbance or colorimetric data – is done via standard electronic interfaces.

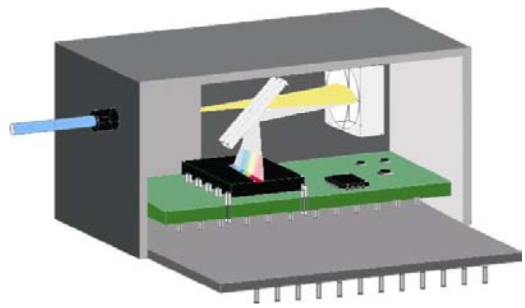

Figure 1
The spectraprocessor SDC comprises
an optical bench and an electronic readout and
processing component.

Flexible system
The user doesn't have to be concerned with the pixel-wavelength relationship. The device, which has internal processing capability, stores this information and uses it for internal calculations. The memory onboard stores not only the fit data, but also measured spectra and results of spectral calculations. For example, it is possible to obtain the absorbance figures directly from the spectraprocessor.
The device can be used in cascade mode for efficient arrangement of systems with several channels, each measuring the whole spectrum. The system is mainly deployed in mobile spectrometric equipment, such as

colorimeters, spectroradiometers and analytical instrumentation.

The first version of the spectraprocessor offers a spectral range of 380 to 760 nm, with an optical resolution of 9 nm FWHM. Optical input is via a step-index fibre with a core diameter of 100 µm (Figure 2). Stray light is typically lower than 0.1 per cent, measured at 420 nm with a Schott Glass GG 495 filter and a halogen lamp. The internally stored pixel-wavelength relationship can be determined simply by entering the desired wavelength range. Interpolations can be selected between different step widths; e.g., 5 nm for colour measurement in accordance with CIE regulations.

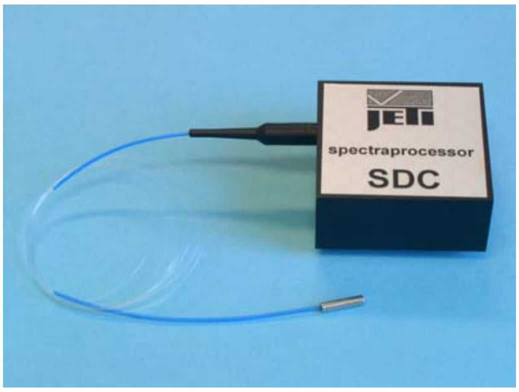

Figure 2. The device has fibre optic input and electronic output via 24 pins. It measures 40.5 x 42 x 20 mm and weighs approximately 50 g.

Measured data stored in the spectraprocessor can be used as a reference for measurements to follow. Data processing can be combined with dark signal correction and an averaging mode. Absolute calibration data, for application in spectroradiometers, can be stored. Simple processor commands perform internal calculations of photometric values and of colour coordinates, including transmission, reflection and absorbance. Results are rendered in physical units directly from the output; for example, luminance in candela per square metre.

The automatic integration time finding allows the user to increase the dynamic range of the measuring system. Measurement starts with a fixed integration time; it will be optimized with regard to a proper exposure and repeated. Finally, the instrument performs a dark-signal measurement in the optimised time.

The spectraprocessor includes three electronic interfaces: synchronous serial peripheral interface (SPI), parallel 8-bit and simple universal asynchronous receiver-transmitter (UART) (Figure 3). The UART is a computer component that handles asynchronous serial communication. Every computer has one to manage the serial ports.

The device offers a busy output, which is useful mainly for multichannel applications to signal the measurement status of a channel. A power-down input reduces the 100-mA operation current to 2 mA during standby periods. Finally, the surrounding system releases a measurement scan via an external trigger input. The electronic resolution is 16 bits with noise of ±l least significant bit. Integration time can be selected between 1 and 65,000 ms.

Near-IR and broadband UV/VIS versions of the device are in development, and additional models will be designed with higher optical resolution.

The optical bench is a Seya-Namioka mount, a spectrograph with only one optical element – the imaging holographic grating. The spectraprocessor is available with original gratings made in epoxy or as a substantially more economic version with a grating replicated in a polymer by an embossing technique. The electronic part is made in a surface-mount device based on printed circuit board technology, providing sufficient miniaturization, flexibility for modifications and reliability. The line detector is a photodiode array. Optic and electronic components are actively adjusted to each other and are fixed by stable adhesive.

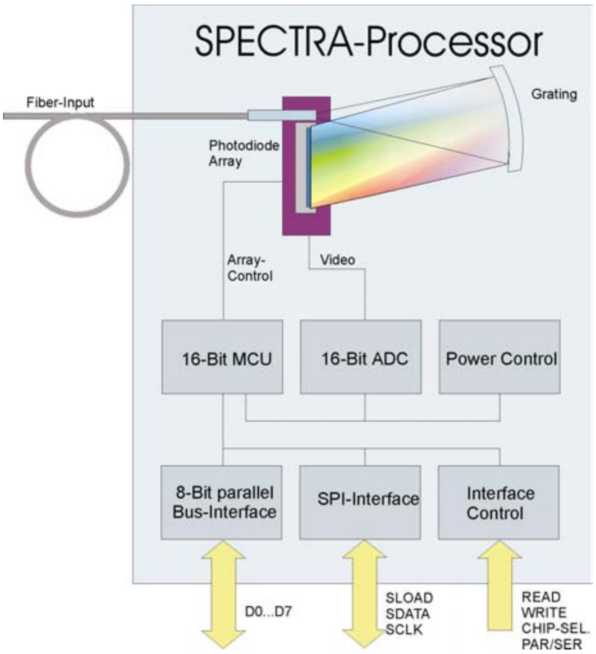

Figure 3. The spectraprocessor SDC has three interfaces: synchronous serial peripheral interface, parallel 8-bit and universal asynchronous receiver-transmitter.

The spectraprocessor enables the designer of spectral measuring equipment to reduce development time and to lower costs. It can easily be integrated to customer specific developments, including multichannel applications. Besides performing spectral calculations, it features internal algorithms for wavelength interpolation, integration time adaptation and data calibration. Testing of the optoelectronic device is performed by a special evaluation kit with a serial interface.