

Optoelectronic Sensors Help Eliminate Human Error while Providing Exact Readings, Faster Results in Medical Applications

Both Institutional and Home Care Medical Applications Benefit from Integrated Optoelectronics Sensors such as Light-to-Voltage and Light-to-Frequency Converters

Electronic components have been incorporated into medical equipment designs for years. An aging and expanding population is not only accelerating the development of medical equipment with a higher electronic content, it is also driving the need for different types of medical equipment. Until recent years, medical electronics has been focused primarily on creating technology for the institutional side of the medical market -- expensive diagnostic equipment such as MRIs and CAT Scans for use in hospitals and clinics. Aging baby boomers are now putting a strain on the conventional medical system. Medical experts are changing the way they think about and design medical equipment and demanding new devices that both minimize cost and maximize performance. The high cost of health care is demanding medical equipment that is appropriate for home care and ambulatory treatment. Such equipment must be patient friendly, both technically and physically. Ambulatory medical devices must be smaller, lighter and more energy efficient.

Because electronic systems operate on electrical signals, electronics-based medical equipment requires sensors to convert the various types of stimuli (optical, mechanical, etc.) into electrical form. Many different types of sensors have always been included in medical equipment designs. However, in order to meet current and future medical equipment needs, today's sensors need to be highly reliable, small in size, packaged with surface-mount technology, high-temperature range, have no lead content and be low in cost. Based on these attributes, one particular type of sensor -- the optoelectronic sensor -- is beginning to gain an increased acceptance in both institutional and home care medical equipment designs. This editorial backgrounder will address why optoelectronic sensors not only work well, but also thrive, in the medical equipment environment.

The definition of an optoelectronic sensor is a device that is capable of producing an electrical signal proportional to the amount of light incident on the active area of the device. There are a number of devices that meet this definition, but none is more prevalent than the semiconductor photodiode. This photodiode evolved early on in the development of semiconductors with the discovery that, when light is incident on a pn junction, intriguing things happen to the transistor circuits. Over the years, this two-terminal device has become the mainstay for light sensing.

To meet the medical electronics design requirements outlined above, it has been necessary to integrate more functionality around this semiconductor workhorse. The result: integrated optoelectronic sensors that help eliminate human error while providing exact readings and faster results. Integrated optoelectronic sensors are also non-contact sensors. That is, they are able to perform their sensing or measurement functions without the need for physical contact with the medical specimens such as blood, urine or other bodily fluids. In a medical environment, this is especially important because, if the specimens are tainted in any way, the resulting readings and measurements are not accurate.

At present, integrated optoelectronic sensors are used in a variety of institutional and home care medical applications including:

- Pulse Oximetry
- Heart Rate Monitors
- Treadmill Finger Tip Monitors
- Blood Diagnostics including Blood Glucose Monitors
- Urine Analysis
- Other applications such as dental matching

Two types of integrated optoelectronic sensors -- light-to-voltage converters and light-to-frequency converters - - serve as the platform on which other integrated optoelectronic sensors used in the above medical applications are built. Light-to-voltage converters produce a linear output voltage proportional to light intensity. Light-to-frequency converters convert light intensity to a digital format for direct connection to microcontrollers or digital signal processors. Both light-to-voltage converters and light-to-frequency converters serve as the platforms for infrared optoelectronic sensors, which are designed to perceive light the human eye cannot.

The Texas Advanced Optoelectronic Solutions®, Inc. (TAOS) TSL260R, TSL261R, TSL262R and TSL267 Infrared Light-to-Voltage Optical Sensors and the TSL235R, TSL237, and TSL238 Light-to-Frequency Converter are currently used in pulse oximetry systems, personal heart monitors and treadmill finger tip monitors. All seven devices help medical equipment designers eliminate unnecessary circuitry, resulting in smaller, less costly and more reliable diagnostic systems. TAOS, Inc. internal market intelligence estimates that more than one million pulse oximetry systems are produced annually for use in hospitals and clinics.

TAOS, Inc. light-to-voltage converters and light-to-frequency converters also serve as the platforms for the TAOS, Inc. color sensors. For example, the TAOS, Inc. TCS230 Programmable Color Light-to-Frequency Converter is currently used in blood glucose monitors designed for home care use. Blood glucose monitors utilize two different methods for measuring specimens: (1) the optoelectronic sensor method; and (2) the electrochemical method in which a drop of blood is put onto a strip of paper that provides an electro-resistive measurement to determine glucose levels. The optoelectronic sensor method is proving to be a more effective and less costly approach for the following reasons:

- Reagents used in strip with the optoelectronic sensor method are less costly;
- The optoelectronic sensor method is faster: 5 seconds vs. 30 seconds;
- The optoelectronic sensor method is more accurate because the color sensor measures the color components exactly;
- The optoelectronic sensor method enables extremely low specimen volumes; it is less painful for the patient and minimally invasive;
- With the electrochemical method, other things in the system can effect the accuracy of the reading; and
- The number of red blood cells can also affect the accuracy of the reading; the optoelectronic sensor method takes this into account.

The exacting accuracy and speedy results enabled by the TAOS, Inc. color sensors also make them the optoelectronic sensors of choice for urine analysis and dental matching applications.

Bishop & Associates Inc. (St. Charles, IL) estimates that total global sales of medical electronic equipment in 2002 were \$48.5 billion, up 6 percent from 2001. These analysts definitely expect medical electronic equipment sales to continue to grow. "Given the overall growth forecast for this market, it seems only reasonable to expect that medical electronic equipment designers will continue to demand sensors that help eliminate human error while providing exact readings in less time," says Ray King, TAOS, Inc. medical market specialist. "At TAOS, we are confident that Lumenology® - our light sensing technology -- will play a significant role in lighting the way to the medical electronic equipment designs of the future."