Electronic Design

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Medical Equipment Design Reaps Benefits of Improved Semiconductors

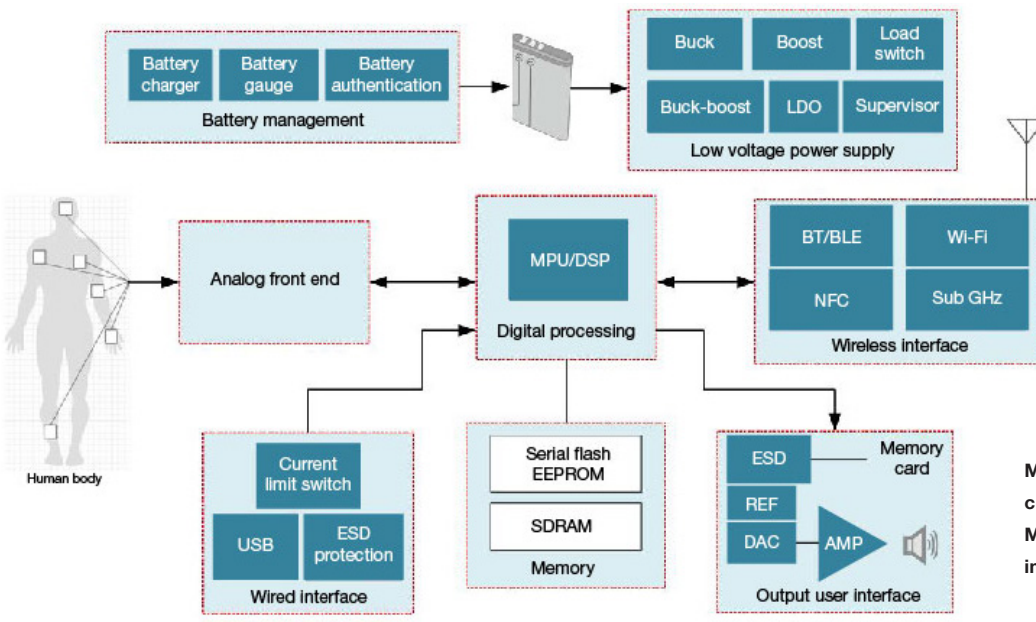
Sponsored by Texas Instruments: The Internet of Things comes to medical monitoring and diagnosis thanks to multifunction ICs that facilitate implementing the required subsystems.

The medical and healthcare fields rely on electronic equipment more than ever these days. One recent trend in the industry is making monitoring equipment smaller and more portable. Another developing movement is to include diagnostic capability in portable medical devices. Both trends offer major benefits to patients and physicians. In this new age of telemedicine, fewer office visits, and increased outpatient care, these advanced devices help deliver superior healthcare.

The Challenge of Remote Patient Monitoring

Whether it's sensing emergency conditions or providing healthcare solutions to rural remote areas, patient monitoring has become an ever-more important tool in the medical field. Some of the more common monitors are temperature, heart-rate monitors, afib patches, blood glucose monitors, pulse oximeters, ECG, and general fitness monitors. Real-time monitoring is the preferred approach, and the latest improved semiconductor devices assist engineers in designing such equipment.

Some of the advantages of these new monitoring devices include time savings for both patient and physician, improved patient mobility, an increase in outpatient care, and providing a means for rapid emergency-response capability. Two monitoring modes are common.



Most modern patient monitors contain these core subsystems. Multifunction ICs are available to implement all of them.

In one case, vital signs are measured and stored for later retrieval. The other mode offers immediate wireless transmission of vital sign data.

Remote patient-monitoring devices are miniature data-acquisition systems. They include multiple sensors, signal conditioning, data conversion, storage, data processing, and wireless transmission capability. And all of it is battery powered. The figure shows one such example. Obviously, critical design issues must be addressed:

Battery

The battery and its related power-supply components may be the most critical subsystem. Since most patient monitoring is continuous, long battery life is essential. Once a battery type has been chosen, a battery-management system is included to keep track of battery usage, charging, and status. Battery modes such as sleep, standby, power save, hibernate, and shutdown must be considered when selecting an MCU.

The battery-driven power supply consists of switch-mode power circuits (SMPS) like regulators, and dc-dc converters will provide the efficiency to extend battery life. But don't overlook linear low-dropout (LDO) devices that are also suitable for portable supplies. Another design option is the incorporation of load switches that make it possible to disconnect selected parts of the system when not in use.

Portability

For continuous monitoring, the patient-monitoring device must be small, lightweight, and comfortable. Integrated circuits should be selected to reduce PCB size. Seek out ICs that integrate two or more functions or reduce the need for external components. Examples include a wireless MCU that uses an internal bulk-acoustic-wave (BAW) device in place of a crystal to set clock frequency as well as multifunction SMPS devices.

Patient Safety

All patient-monitoring equipment must ensure patient safety from any electrical or electronic side effects. This generally implies prevention of shock or other negative results that may occur if a patient comes into contact with electrical components. Safety is usually achieved by isolation from the power-supply circuits. Some power ICs include capacitive isolation features that facilitate the related safety measures.

Secure Data

Patient monitors collect data that's unique to the patient—such data must be secured for privacy. The transmission of patient data is usually accomplished via wireless methods and are thereby subject to theft or damaging incursions. Most wireless ICs include encryption and other measures to ensure valid, uncompromised data.

Integration

A beneficial feature of a medical monitoring device is to provide multiple integration methods. These will typically include wireless connectivity via Wi-Fi or Bluetooth as well as interfaces to USB and other communications services. The new patient monitors are advanced IoT devices that should offer convenient connectivity to multiple cloud infrastructure services.

Semiconductor Solutions

A variety of medically targeted ICs are now accessible to help improve the design of medical monitors. One of the most critical needs concerns biosensors that provide the inputs to the monitoring device. Most of these sensors come with integrated analog front-end components to simplify signal conditioning and interfacing.

Semiconductor manufacturers such as Texas Instruments are supplying devices like the AFE4400, which offers on-chip optics and diagnostics for sensing and LED fault detection for implementing pulse oximetry. The TMP117M digital temperature sensor exhibits exceptional accuracy and may be used for direct skin contact measurements.

Another helpful IC is the TPS22916 load switch, which can significantly boost battery life. The MCU also is a critical choice. TI's Sitara AM3358 is an Arm Cortex derivative that not only meets the low-power requirements, but also offers built-in graphic display features that are incorporated on some monitors. The TI WiLink devices furnish low-power wireless connectivity via Wi-Fi or Bluetooth. Robust security features protect the patient's proprietary health data.

Integrating Diagnostic Features

While improved monitoring devices deliver data to physicians to make a diagnosis, usually the patient must wait days or weeks for the data to be interpreted and an accurate and workable diagnosis to be achieved. Major improvements in treatment accrue with integrated diagnosis capability. One recent development is point-of-care molecular diagnostics. The monitoring devices capture the measurements and special on-chip circuitry analyzes the data and provides an immediate diagnosis that can lead to quicker treatment.

One example is an approach that acquires a physical sample of DNA by way of optical fluorescence. Most DNA samples are too small to analyze, thus requiring the implementation of special amplification techniques. These techniques require a thermoelectric heater cooler and precise temperature measurement. TI offers multiple components that support the design of portable monitors with this integral diagnosis capability.