Technical Article

The Top 5 Design Challenges of Remote Patient Monitoring

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The wearable patient monitor market is growing fast. Remote patient-monitoring equipment provides a glimpse into the future of the Internet of Things in health care by enabling physicians to monitor patients in real time.

Saving patients' and physicians' time, remote patient monitoring provides critical patient information on an outpatient basis. Patient mobility has also become a trend. Using a secure connection to a wireless network, remote patient monitoring devices enable patients to leave the hospital sooner and forego excessive cables. Today's wearable medical products not only measure vital signs but can also act as personal emergency-response systems. Although it is a complex type of end equipment, there are five main design challenges common to patient monitors: power consumption (or battery life), portability (or size), patient safety, secure delivery of data, and integration.

Figure 1 shows a high-level block diagram of a wearable patient monitor, highlighting subsystems like battery management, a nonisolated DC/DC power supply, isolation and a wireless interface. An example reference design from TI is the Wireless ECG, SpO_2, PTT and Heart Rate Monitor Reference Design for Medical and Consumer Wearables.

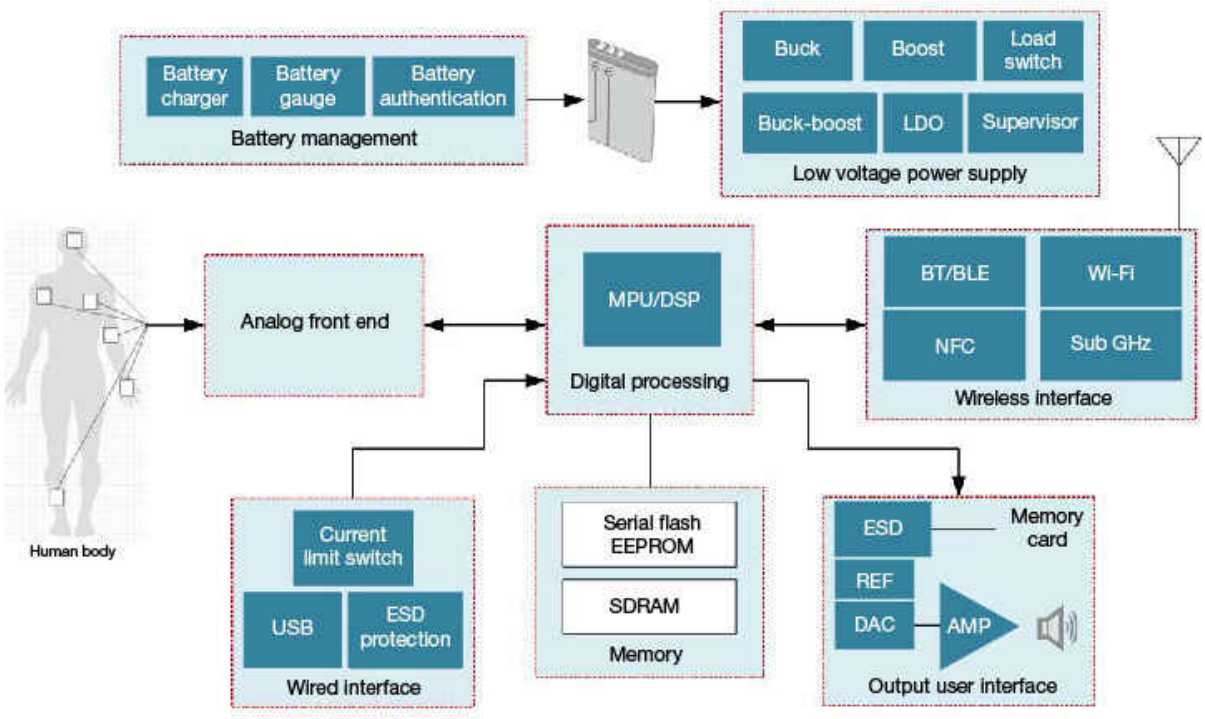

Figure 1. High-level Block Diagram of a wearable patient monitor

Let's review the top five design challenges when designing wearable patient monitors.

Challenge No. 1: Battery life

Portable and wearable patient monitors are typically battery-powered, and for consumers, battery life is one of the key purchasing considerations. Battery life is critical because most patient monitors measure and monitor continuously. Battery-powered systems require careful partitioning, tight space utilization and efficient use of the available charge. It is important to enable more functionality while delivering power more efficiently in a tight space for a longer time. Functions like standby, sleep, power save, hibernate and shutdown are critical in order to reduce power consumption and extend battery life. Wake-up times and standby power consumption also play a vital role for wireless connectivity solutions.

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You can select low-power microcontrollers (MCUs) and analog integrated circuits, but it won't be possible to leverage most of the latest technologies in your design without optimizing power management. It is important to choose the right power architecture for the application to be more efficient and achieve extended battery run times.

Most designers assume that switching controllers or converters contribute to highly efficient power schemes, and that low-dropout regulators (LDOs) have bad efficiency. But LDO topologies have changed; they can provide very low dropout voltages. After optimizing the front-end power path of the battery charger and mid-rail DC/DC converters and LDOs, there is still a way to use a load switch to reduce the shutdown current of any load. For example, a radio module might consume over 10 µA in deep sleep or hibernation mode. A load switch can reduce the shutdown current to just 10 nA (see Figure 2).

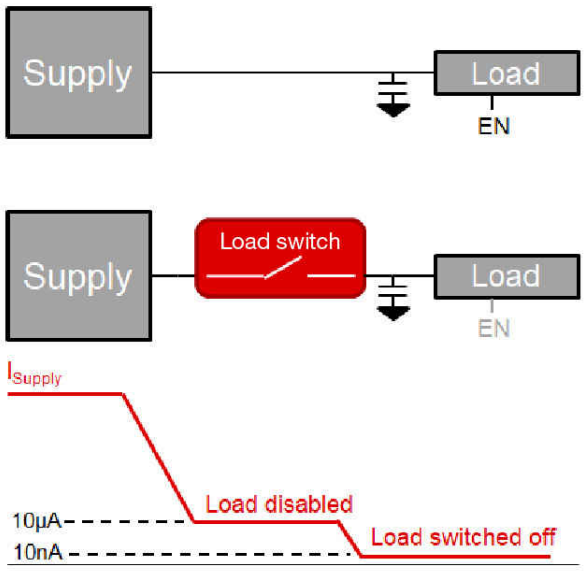

Figure 2. Adding a Low-leakage Load Switch Reduces Shutdown Current

Challenge No. 2: Portability or size

Devices like heart-rate monitors, multiparameter patches, continuous blood glucose monitors, handheld pulse oximeters, fitness monitors and activity monitors can be portable and wearable. Many of these devices are disposable, or use batteries that need replacing. Thus, the overall form-factor requirements are tight.

The selection of battery type and battery charger device; the choice of buck, boost or buck-boost converters; and the package selection for wireless (or radio-frequency) devices all contribute in reducing the size of the final product.

There are new technologies available that integrate a crystal inside the wireless MCU. TI bulk acoustic wave (BAW) technology can remove the external crystal footprint from the printed circuit board (PCB), decreasing the layout size and easing the layout routing. The package technology improvements can also help accommodate more integration and facilitate space savings.

For remote patient monitoring, TI BAW technology can provide reliable, real-time data transfer of a patient's vitals over a secure wireless network.

Challenge No. 3: Patient safety

Patient safety is a global health priority. Portable multiparameter patient monitors measure vital signs and use power and data isolation to achieve patient safety. The data and power are isolated using digital isolators and isolated power supplies, respectively. There are critical design challenges associated with isolated power and data, including output regulation, feedback mechanisms, the input voltage range, and output power and size considerations, along with suitable power architectures. Many newer isolated power modules such as the miniaturized UCC12050 DC/DC converter from Texas Instruments can support 500 mW of output power with reinforced isolation.

Challenge No. 4: Secure data delivery

Medical sensor patches and portable patient monitors with wireless connectivity need to have best-in-class security. The patient data being delivered to nurse stations or doctor's offices is proprietary information. Data theft is a very critical aspect here.

A multitude of security measures protect the intellectual property and data from patient to doctor. These measures should have support to protect against attacks and secure patient data transmissions – not only while processing and converting to vital-sign parameters for display, for example – but during transfer as well. This is called over-the-air security.

Challenge No. 5: Integration

The development time for medical patient monitors is critical because time to market involves many standard lab tests and approvals (both global and regional). It is possible to enable in-home patient monitoring data transfer with minimal integration effort by enabling connectivity to a variety of cloud vendors. Uploading patient data directly to the cloud can save space for onboard memory cards.

Code compatibility between platforms like *Bluetooth*®, Bluetooth Low Energy and Wi-Fi® can ease the number of recurring attempts to code. Integration in terms of multiple cores, universal asynchronous receivers-transmitters, interface standards and multiple general-purpose inputs/outputs provide support for a variety of system-level needs and ready-made interfaces while communicating with additional processors. See the "Wireless Connectivity Technology Selection Guide" for more information.

Conclusion

The next big wave in medical patient monitoring is coming in a very small size. As designers of wearables and remote patient monitors resolve challenges and deliver better devices to market at a more affordable price — and in a smaller size, but still with connectivity — the medical world will witness the rapid adoption of newer patches. From a hospital in a developed country to a telemedicine center in a developing country to diagnosing injured soldiers in the field, the rapid evolution of wearables is changing the health care landscape and helping provide better care.

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