Industry Leaders Weigh In on Medical Electronics

Ken Nesteroff, Nick Lukianov, Paul Errico, Steven Dean, Chris Griffith

Question 1: In what sectors and devices are medical electronics emerging where they weren't seen in the past?

Ken Nesteroff
Medical & Industrial Imaging Business Development Manager, Texas Instruments

Over the last several years, new applications using optical coherence tomography (OCT) have emerged. Originally debuted in ophthalmology, OCT imaging is analogous to ultrasound, employing reflected near-infrared light to create its image instead of reflected sound. Updated OCT systems can use embedded multicore digital signal processors (DSPs) to process the coherently gated light in real time to achieve a depth-resolved axial scan. The multicore DSP engine performs at lower power levels than other compute methods enabling small form factor applications. OCT can typically resolve an image to a tissue depth of 3.0 to 5.0 mm at resolutions of less than 10 microns, producing faster high resolution images of the back of the eye, within the vein using microscopic catheters, and in dental diagnostic systems to identify early stage cavities and certain gum disorders.

Nick Lukianov

Technical Director, Business Development, Vertical Segments, Avnet Electronics Marketing, Americas

The increasing sophistication and application of implantable devices is a significant development within the medical device sector. The integration of micro-electromechanical systems (MEMS), microcontrollers, and wireless telemetry allow for continuously increasing degrees of diagnostic, therapeutic, and patient management capabilities. Applications include infusion pumps, neuro-stimulators, intra-cranial pressure monitoring, gastric bands, and incontinence devices. The benefits include continuous monitoring and adjustment capability, reduction of invasive surgical procedures, and improved patient quality of life.

Paul Errico
Strategic Marketing Manager, Analog Devices Healthcare Group

New medical electronics devices are emerging in all healthcare segments, including hospital/clinics, out of the hospital, and in the home. In hospitals/clinics, these new devices include handheld, smartphone-sized ultrasound systems, digital stethoscopes, and digital X-ray systems. Out of the hospital, there are now medical devices that ensure seamless vital sign monitoring with wireless connectivity from hospital to home. In the home, available today are healthcare systems that intelligently measure daily activity or detect falls, blood coagulation, continuous glucose measurement, and insulin delivery. A common requirement for all these devices is operation from a battery, small form factor, and a portable and lightweight design with intuitive user interface. The latest medical systems are delivering faster and more accurate diagnostic information, thus improving quality of life and reducing healthcare costs.

Steven Dean
Medical Segment Manager, Freescale Semiconductor

The pharmaceutical sector, with devices like injectors or inhalers, is now looking for more electronic integration. This integration can allow them to develop new ways of administrating drugs. Injected drugs can be inhaled and delivered through the lungs, and the efficiency of inhaled drugs can be increased thanks to electronic-assisted devices. Adding wireless connectivity allows doctors to remotely monitor and control patient compliance, preventing over dosages. Automatic dose counting can also enable the automatic ordering of drugs from the pharmacy. Advances like these promote better patient comfort with the potential for reduced healthcare costs. And, these emerging medical electronic advancements help to provide pharmaceutical companies with new differentiated benefits.

Question 2: What impact is the constant drive toward miniaturization having on medical electronics?

Chris Griffith
Medical Business Development Manager, Texas Instruments

Miniaturization continues to have a huge impact on medical electronics because it drives portability and accessibility. Areas like telemedicine and body area networks are completely dependent on the miniaturization of medical devices.

As medical designs continue to shrink in size, the design challenges and limitations within medical electronics become more pronounced. While up-integration can increase the functionality achieved with a single IC, redundant support for critical functions becomes less feasible should that IC fail. Similarly, the number of PC board layers needed to route the traces for the device can increase with smaller bond pitches and tiny wafer chip-scale packages. This can require hidden vias on the board, which create through-hole connections that cannot be visually inspected.

The good news is that these tradeoffs can be compensated for, if they are understood and defined early enough in the development process. Ultimately, miniaturization gives us the ability to save and improve lives worldwide because the right equipment can be easily transported whenever and wherever it is needed.

KN: In years past, ultrasound equipment has become more compact, with cart-based systems increasingly complemented or replaced by portable and handheld ultrasound machines. This reduction in size is enabling a wide variety of healthcare applications that illustrate how advances in medical technology and miniaturization are bringing care to patients instead of forcing them to travel. The need for small form factors and lower power levels impact the definition of multicore DSPs used for ultrasound imaging. These full-featured system-on-chips eliminate the need for large power consuming PCs and include a range of peripherals already integrated on-chip. These peripherals include interfaces to Ethernet, storage devices, high-definition displays, and miscellaneous connectivity.

NL: Miniaturization provides advancement across a broad spectrum of medical devices. Large diagnostic imaging systems are now available for use in portable/mobile environments. Increasingly sophisticated patient monitoring and therapy systems are now “wearable,” and greatly improve patient mobility and

quality of life. Miniaturization also allows for an increased level of complexity/capability within the categories of implantable and ingestible devices. In addition, the rapidly expanding science of micro-fluidics is now found in applications such as genetics testing, combination pharma/device therapies, drug delivery, and implantable devices. One of the major issues, as miniaturization becomes more pervasive and implantables find a wider scope of applications, is the liability concern for semiconductor device manufacturers of Class III devices. This becomes a limiting factor as to what technology is readily available for integration in next generation implantable devices.

PE: The major impact miniaturization is having on medical devices is making possible the safe and accurate delivery of higher levels of diagnostic information in and out of a hospital or clinic. Miniaturization is obviously beneficial for body-worn or implantable devices but is also having positive impacts within CT, digital X-Ray, MRI, and ultrasound systems. For example, miniaturization of transmit and receiver subsystems in ultrasound devices allows hundreds of channels to be processed in a notebook-sized platform.

SD: Miniaturization allows portability within the medical sectors.In imaging, miniaturization is allowing portability—moving from the clinic or imaging centers to triage centers or in ambulatory situations. This allows first responders to actually “see” what the sustained injuries are, rather than to speculate. The most common portable imaging modality today is ultrasound.

In diagnostics and therapy, miniaturization is allowing the more traditional clinical equipment, such as ECG and pulse oximetry, to transfer into the home, actually blurring the lines of “clinical” and “consumer” applications. More sophisticated heart rate monitoring solutions, as well as pulse oximeters, can now be purchased for home use, where, not so many years ago, these monitoring modalities were reserved for the clinic.

Question 3: How are power concerns/considerations influencing medical electronics at the device, subsystem, or component level?

PE: Moore's Law predicted that every two years, silicon geometry would shrink in half, enabling the doubling of transistors and, therefore, digital processing capability. In the high-performance data converter market, there's the continuous trend to dramatically reduce the power consumption to enable new battery operated diagnostic quality devices. Data converters are a key signal processing block and used at the device, subsystem, and component level. They are integrated into a wide range of devices ranging from ISM band transceivers to ECG monitors to CT systems. Medical device engineers are leveraging this trend to create powerful diagnostic devices at a fraction of the power consumed just five years ago. This trend will continue into the future.

SD: At the component level, embedded processors are being enabled with several power modes and power saving options. Freescale’s Kinetis K10 family, for example, offers 10 low-power modes with power and clock gating for optimal peripheral activity and recovery times with stop currents in the nanoamp range and

run currents in the microamp range. System power performance is improved as Freescale offers full memory and analog operation down to 1.71 V for extended battery life.

Getting the power to the embedded processor is another critical need. One of Freescale's analog technologies—an ultra-low power DC to DC converter—enables IC startup thresholds to be reduced to 0.32 V and offers efficiencies of nearly 90%. A combination of these technologies has the potential to enable devices that are powered solely by the human body, for example, which would enable a paradigm shift in medical device system design.

Final Word: Any thoughts/comments on medical electronics, miniaturization, power, or another related area that you would like to share with medical device manufacturers?

NL: We, as suppliers to the medical device industry, must commit to supporting the next generation of implantable devices. The questions and issues of liability and indemnification need to be discussed, resolved, and perhaps, even legislated. Otherwise, the restricted availability of enabling and differentiating component technology will negatively impact progress in this key and truly disruptive segment of the medical device industry.

PE: Analog Devices is committed to innovation, quality, and reliability, and bringing to market high performance linear, mixed signal, and processor solutions to enable customers to deliver cost effective, diagnostic quality, small, and low power medical devices to improve the quality of life for all.

SD: Suppliers can aid medical device manufacturers by providing development tools that help them to speed time to market. Freescale, for example, provides medical OEM customers with a host of software and enablement tools. Tools like the MED-EKG: Electrocardiograph development kit for the Tower Development System, provides our customers with the hardware and firmware to begin developing and finalizing their EKG application in minutes rather than weeks.

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