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Inside

EE Times branches out into market intelligence

EE Times has launched a Market Intelligence Unit, headed by Loring Wirbel (shown), who most recently was the publication's communications editor. Joining forces with

Semiconductor Insights, a CMP company, the new unit will offer in-depth technology reports starting this week. p. 4

Undergrad dilemma

While professions such as law, medicine and accounting have upped their educational requirements, engineering hasn't done so in 100 years. Should a fifth year of study be mandatory for engineering undergrads? p. 12

MIMO: a must for 4G mobile

Multiple-input, multiple-output antenna technology underlies all current 4G mobile broadband standards, including WiMax LTE and UMB. But MIMO's signal-reception performance must improve for mobile access to high-bandwidth apps. p. 25

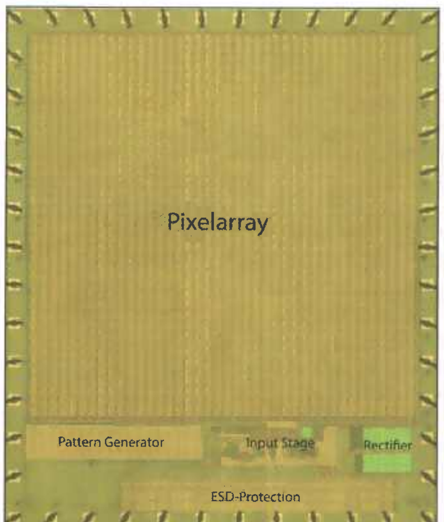
ICs poised to get under your skin

By Rick Merritt

San Francisco— A wireless silicon monitor that can be worn like a Band-Aid and then thrown away. A chip that could become one of the first commercial retina replacements. A device that measures waveforms still being discovered deep within the brain.

These advances were among a dozen diverse papers presented at last week's International Solid State Circuits Conference here. Collectively, they give credence to a rising belief that biology will be one of the next big application areas in electronics.

"I am actually recommending engineers get two degrees—one in electronics engineering and another in a natural-sciences field," said Mark McDermott, research fellow at the University of Texas at Austin. "The medical problems are getting very interesting for engineers," said McDermott, who has also worked as an engineering manager at Freescale and Intel.



University of Ulm artificial retina prototype packs 1,600 pixels in an implantable array.

In an evening presentation at ISSCC, Arto Nurmikko, a professor of engineering at Brown University, described the design of brain implants that involved work in electronics, optics and anatomy. "This is absolutely a cross-disciplinary world of computer science, engineering, biology and even the precision mechanics of drilling holes like a Swiss watchmaker. That's what it takes," said Nurmikko.

Chris Van Hoof, a researcher with the IMEC research institute who chaired a session on life science, put it succinctly in his opening remarks: "Silicon is interacting ever more closely with the human body."

In the near future, patients equipped with wireless wearable >>10

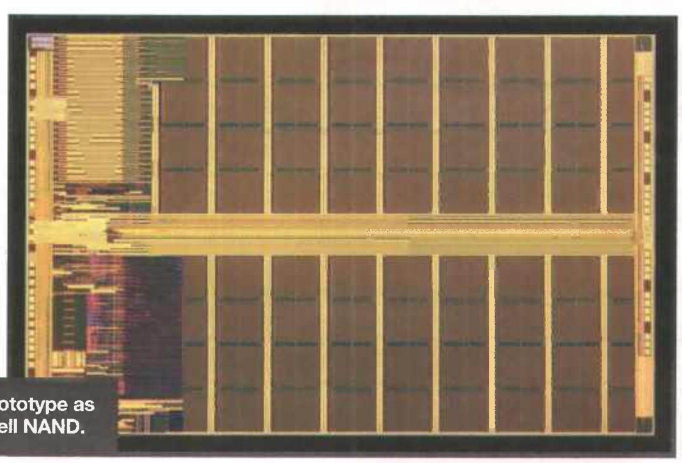
More from ISSCC

Is memory world ready for a (phase) change?

By Mark LaPedus

San Francisco — The next-generation memory race continues to attract competitors, as several more vendors push off the starting block. But when, or whether, today's exotic memories will become mainstream devices is an open question.

At the International Solid-State Circuits Conference here last week, Intel Corp. and STMicroelectronics Inc. reached a milestone, as they began shipping prototype samples of their phase-change memory (PCM) line. The 90-nanometer, 128-Mbit product is slightly late to market; it was supposed to ship late last year.



Intel, ST ship a 128-Mbit PCM prototype as others roll FRAM, NRAM, 3-bit/cell NAND.

Vendors such as Freescale and NEC have already rolled out rival magnetic RAM devices. And Texas Instruments and others claim to be shipping ferroelectric RAMs.

Still others are pushing the limits of current technology. At ISSCC, SanDisk Corp. >>18

<<1 **BIOCHIPS** sensors will receive regular checkup reports from their doctors without having to visit a hospital, Hyung Kyu Lim, chief executive of the Samsung Advanced Institute of Technology, said in an ISSCC keynote.

"Health care devices and service robots are prime examples of emerging consumer products for such new services," said Lim. "However, the system complexity and implementation of these future services will be costly due to the high level of machine intelligence required."

For example, startup Toumaz Technology (Abingdon, England) described at ISSCC a custom chip designed to power a wireless monitor that could be worn on a disposable patch. The chip is one of an emerging group of smart wearable devices that help patients and consumers get medical monitoring from the comfort of home.

University of Ulm prototype artificial retina comprises an implantable chip and a controller worn behind the ear.

"We not only have an aging society, but one that does not have a healthy lifestyle," said Alison Burdett, director of technology for Toumaz. "There are increasing numbers of people with chronic ailments, and that's putting an enormous burden on health care systems worldwide."

A large U.S. health care company is said to be working with Toumaz, aiming to field the silicon-backed patches in a hospital setting before the end of 2009. Companies including GE and Philips are reported to have similar projects in the lab.

To keep power down and reliability up, Toumaz developed custom hardware and protocols for the 800- to 900-MHz wireless network the devices use at data rates up to 50 kbits/second. The chip draws 2.5 milliamps when communicating, but its digital control portion dissipates just 100 microwatts.

"A custom media-access controller is crucial, because in short-range communications there is always interference, and we have many layers of mitigation," Burdett said.

Despite the custom design, the active patch is expected to cost as little as $5 when it hits the market next year. The chip, which measures 16 mm^2, will account for a small fraction of that cost. It will be made in a 130-nanometer process by Infineon Technologies.

"When this is in volume production, the silicon doesn't really cost anything," said Burdett. "The big cost is in the assembly and manufacturing, because this requires new processes."

The chip can interface to sensors for an electrocardiogram; a three-axis accelerometer; or blood-glucose, pH-level and pressure monitors. It can measure from only one sensor at a time, but can switch among three sensors.

In a paper on its Life Thermascope, Hitachi showed how such devices could be consumer products. The project uses a more off-the-shelf design, integrated into a wristwatch or badge that records the user's temperature and a set of daily evaluations of the person's mental, physical and social states.

Field trials with 200 users showed how even a single sensor could help track nuanced patterns in daily life, Hitachi engineers said. The monitor is packed in a 30-cm^3 module that uses a 32-bit H8S processor operating on a ZigBee network.

Silicon eye

Representing the world of implants, Albrecht Rothermel, a professor at the University of Ulm, Germany, described a chip that could become one of the first commercial artificial retinas. The university worked with Retina Implant AG (Reutlingen, Germany) on the 1,600-pixel, 3 x 3.5-mm array.

The device, which had come back from the fab just days before Rothermel's presentation, is a follow-on design from work on a 1,450-pixel array at the Institute for Microelectronics in Stuttgart. The CMOS imager with a 170-dB dynamic range was implanted in a handful of patients as part of a hospital experiment lasting a few weeks.

The retina was made in a 0.8-micron technology and machined to a 20-micron thickness. It uses a broad voltage swing for retina stimulation, a new power supply architecture and a digital controller to address pixels sequentially. It let some blind patients perceive reflected light, Rothermel said.

"We hope this next chip will help people distinguish forms, but we don't know how a real retina will perceive the information yet," said Rothermel. "We also think there could be a learning process" for a blind person regaining sight, he added.

Among other implants discussed at ISSCC, researchers from Medtronic described a prototype chip for recording deep-brain signals. The 0.8-micron chopper amplifier consumes just 8 μW from a 2-volt supply and measures 5 mm^2.

The company already makes a deep-brain stimulator to mitigate the symptoms of Parkinson's disease and epilepsy. The new device is part of an effort to add a closed-loop capability for the systems to record, process and respond more flexibly to brain signals.

"Just getting one [stimulating] electrode approved for implanting in the brain takes years and years," said Reid Harrison, an associate professor at the University of Utah, who chaired the session at which the device was described. "Now that their device has been OK'd, it makes sense for them to see what else they can do with it, such as recording brain signals."

Researchers are still finding new kinds of signals and ways to measure them. The Medtronic chip goes beyond the traditional tracking of signal spikes to record bandpower fluctuations. It also measures not only alpha, beta and gamma waves but also emerging phenomena at 500 Hz.

"Researchers are finding very fast ripples in the hippocampus," said Tim Denison, a senior principal IC design engineer in Medtronic's neural division. "These frequencies don't show up in surface measurements, but once you dive deep into the brain you get access to these interesting biomarkers. This is an area of fruitful research yet to come, because we don't know all the signals to look at."

An off-the-shelf microprocessor in the design helps conduct a spectrum sweep that might pick up new waveforms. Engineers also added new filters and gain control mechanisms to compensate for varying noise levels.

"When you are trying to tap into different people's brains with different noise conditions, you can really throw off your algorithm," said Denison.

Researchers must also strike a balance on where they take measurements. Traditional electroencephalographs struggle to resolve 2- to 3-microvolt signals from the surface of the head, often distorted by noise from a patient's movements. Probing near a nerve cell can tap into stronger, 100-μV signals, but at a cost.

"The entire brain and spinal column are shrouded against infection by a thin membrane called the dura," said Harrison. "This is like nature's holy >>50

IEEE mulls body-area nets

A relatively new IEEE group has put out a call for proposals for body-area network technology to serve both worn and implanted medical and consumer devices. The group aims to set a networking standard that operates on extremely low power at data rates up to 10 Mbits/second, while taking into account issues of signal propagation around and within the body.

The 802.15.6 task group will meet in March in Orlando, Fla. Organizers hope top medical and consumer electronics companies will weigh in on what they see as the big apps and requisite technologies for such a network. To date, the effort has mainly been driven by academic researchers from as many as 60 organizations, said Arthur Astrin, a Palo Alto, Calif.-based engineer who chairs the group.

"They have a hard problem, because their application space is not only all medical but all consumer as well," said Alison Burdett of Toumaz Technology. "They are also talking about data rates up to 10 Mbits/s, which is way out there for us."

Toumaz, which makes chips for a wearable wireless monitor, will get involved with the effort, but Burdett said it's unclear whether the standards group will deliver something useful for the startup. Toumaz has developed its own media-access controller and protocols for a low-power link of just 50 kbits/s.

Other applications have very different requirements. At last week's International Solid-State Circuits Conference in San Francisco, Wentai Liu, a researcher at the University of California at Santa Cruz, described his plans to use ultrawideband links at data rates up to 90 Mbits/s for a neural recording system.

"Ultimately, we may need 100 channels at 100 Mbits/s, or maybe even 400 channels and close to a gigabit," said Liu. "We looked at all sorts of transports and found UWB was a good approach for this."

— Rick Merritt

<<10 BIOCHIPS of holies. Breaking through this protective barrier adds a lot to surgical risks."

In a separate evening session, another Medtronic engineer presented an update on efforts to build an artificial pancreas. Medtronic already provides an implanted insulin pump that's activated manually, but the new device would automatically check blood-sugar levels and provide insulin as needed.

"We're working on a new algorithm, and we are confident this is the one we will put our chips on," said senior research manager Barry Keenan.

Keenan discussed ways of using redundant sensors with adaptive filters and algorithms that can compensate for hardware error rates up to 30 percent.

"We have large-scale trials this year to demonstrate this fail-safe system so we can start unsupervised studies," Keenan said. "We have to show these systems are 100 percent effective to go into an FDA submission."

Better test gear

In other sessions, presenters described chips aimed at improving medical test equipment while cutting its cost and size.

> Presenters described chips aimed at improving medical test gear while slashing size and cost.

A team from Harvard showed a module the size of a small paperback that could drive a nuclear magnetic-resonance-imaging system. At its heart is a 1.9 x 2-mm chip that can drive a system 60 times more sensitive, 60x lighter and 40x smaller than conventional equipment, which can weigh 260 pounds and cost as much as $70,000.

The increased sensitivity means doctors will be able to detect pathogens at an earlier stage of a disease, said Harvard's Nan Sun, who presented the paper. "The integration level of this device is higher than anything reported to date," Sun said.

For his part, Bruce Rae, a researcher at the University of Edinburgh, Scotland, described a device that handles photonic analysis of molecules in silicon. It aims to replace large, expensive DNA testers that use laser sources, optics and filters to do that job today.

The 4 x 16 micro-LED array could supplant equipment the size of a large printer that can cost as much as $200,000, including the separate PC to which it is connected. By cutting the size and cost of the system by more than half, the 350-nm device could power a box that could be used in a doctor's office rather than a distant lab, Rae said.

Separately, Refet Yazicioglu of IMEC showed an ASIC that could shrink the electronics of an EEG system down to a module about 1 cm^3. By replacing the bulky, halter-worn boxes used today, the eight-channel chip would be easier for patients to wear and would likely collect better data. "The presence of these devices with so many wires is disruptive and puts patients in an unnatural situation, which impacts the effectiveness of the tests," said Yazicioglu. ■

— Nicolas Mokhoff contributed to this report.

Correction

Because of an editing error, photos were placed incorrectly in the Planet Analog products section of the Jan. 21 issue. An image from Linear Technology appeared in a Maxim brief (page 42), and a Maxim image appeared in a brief on Analog Devices (page 44).

Showcase