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Make it smart: An alternative to AT command sets for Wi-Fi modules

Inks transform touch capacitive devices

Any way the wind blows

It's Time To Get SMART


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The greatest space mission

Space exploration is a crazy thing. After all, it was just 46 years ago that Buzz Aldrin and Neil Armstrong took a few pretty famous steps, and, as I sit writing this, the New Horizons has just passed Pluto. The probe now stands as the first spacecraft in the history of mankind to do so and is offering up unprecedented images of the dwarf planet.

Plus, we've got a rover on Mars learning that the Red Planet's continental crust is pretty similar to Earth and they've just announced the astronauts who will crew the first commercial spaceship. Seriously, space tourism is almost a legitimate option.

I guess what I'm trying to say is it's an incredible journey for just 50 years. High fives all around.

The best thing about space is that it remains as one of those rare topics that actually brings people together and provides hope that we're not all so different in our desire to learn. While you might get some grumbling about budgeting—which should eventually fade away with the partnership of public and private companies—people generally are very positive about space and interested in what else we can learn.

For some generations, the obsession is a result of a nostalgia for years gone by. For example, those who are old enough to remember watching the first moon landing on television never really lose that feeling of wonder. For others, it was the excitement of watching Curiosity land. For a younger generation, it might be hoping the SpaceX rockets will eventually get off the platform without exploding.

Space is a passion so widespread that it dominates pop culture. Star Wars ranks as the third biggest box office franchise ever, spanning ten movies from 1977 to 2019. Not to mention the massive universe of Gene Roddenberry that inspires entire conventions. Pop culture tends to reflect what a society values, so it says a lot that 10 years after being taken off the air, Firefly still has a cult-like following and that Gravity won seven Academy Awards. Hell, even Canadian astronaut Chris Hadfield is a rock star.

Space is one of those thing that we, humanity, can all get behind. The ISS functions only when it is a politics-free zone. It doesn't matter what your personal beliefs are or what country you are from, it only matters what skills you bring to the table. Space is something where everyone can find something to be excited about, whether it's the mineral makeup of a far off moon, the implications that we are not alone in the universe, or even just learning how you drink water with zero gravity. One hundred years ago, people could barely imagine a plane, but now we're taking rockets to space.

So, dear readers, I leave you with this: If we all work together and contribute what we can, we might just get, as my favorite toy astronaut would say, to infinity and beyond.

Kasey Panetta
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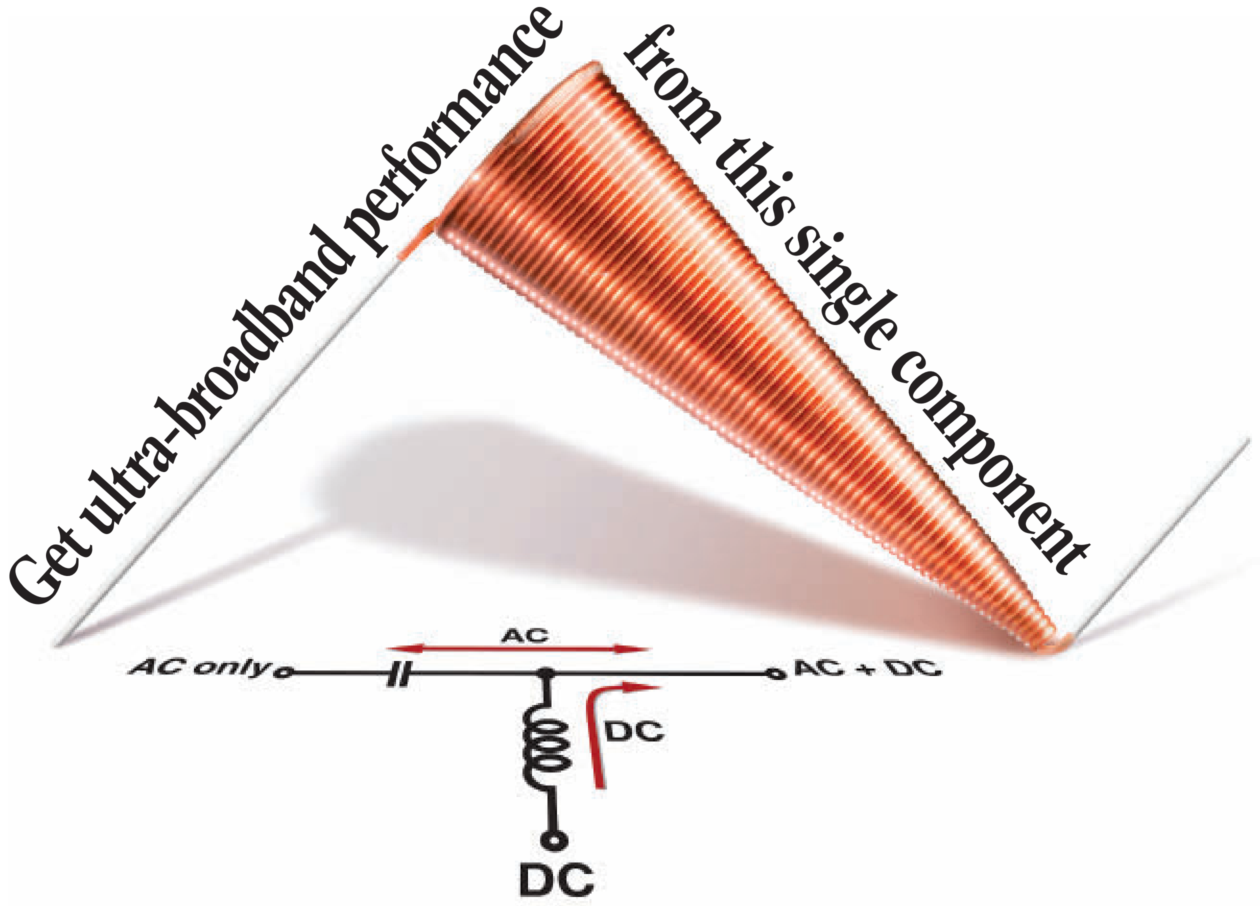

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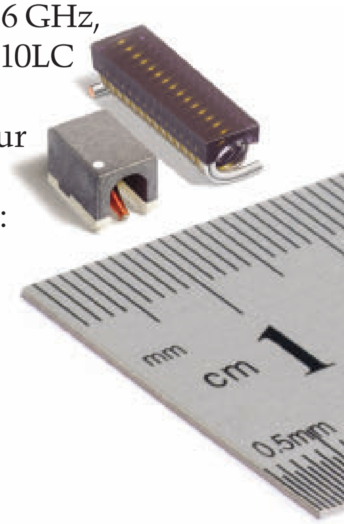

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Power inductors are ideal for high-current power supply applications

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For more information, visit www.coilcraft.com.

KEY FACT:
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KEY FACT:
The sealed terminals provide watertight wire sealing that withstands 500 hours of salt spray exposure.

Sealed terminals offer weight savings over copper options

TE Connectivity (TE) announces its new COPALUM Lite sealed terminals and splices that provide up to 60 percent in weight savings versus copper terminal alternatives, and up to 53 percent weight savings versus drop-forged aluminum terminals. The new terminals feature the time-tested dry crimp technology that has provided three decades of reliable connectivity to the commercial aerospace industry. The grease-free COPALUM dry crimp technology provides an efficient, reliable and clean crimp process using a single-step crimp for conductor termination and wire sealing. The terminal's screened crimp barrel cuts through aluminum oxides to form a long-lasting, oxide-free termination. The single-crimp process reduces applied cost by eliminating the need for a second crimp for wire sealing. Additional efficiency gains can be expected by an enhanced wire barrel design, making wire insertion easy with ample room for conductors.

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Engineering Update #117: Brick-laying robot can build a house in two days

- **Nanogenerator harvests power from rolling tires**
  A group of University of Wisconsin-Madison engineers and a collaborator from China have developed a nanogenerator that harvests energy from a car's rolling tire friction.
- **A rugged, throwable camera**
  In 2012, Bounce Imaging showcased a prototype of a throwable camera and they've just shipped 100 of them off to police departments.
- **Brick-laying robot can build a house in two days**
  This robot can lay 1,000 bricks an hour. With a building plan programmed in, a 3D CAD design calculates the location of each brick, then uses its telescopic arm to set them in place and secures them with mortar—all from one set position.

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@kcpanetta

Great panel on 3d printing #CEWeek thanks @shapeways @notimposs @NEA3D @HP @ecnonline

Mach 1.6

Top speed of civilian jet S-512

TWEET

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Watch this MiG-29 come way too close to another aircraft ow.ly/Pfu98 @kcpanetta

This is why you shouldn't shoot down a drone

By Kasey Panetta, Editor, @Kcpanetta

Shooting down a drone that's hovering over your property might seem like a good idea, but as a recent court case shows, it's definitely not. Presenting the case of Eric Joe and Brett McBay. A few months ago, Joe took a ride out to his parent's rural property to fly his homemade hexacopter drone. After about three and half minutes of flying, the drone hit the dirt, courtesy of a 12-gauge shotgun.

These 10 women should replace Hamilton on the $10 bill

The U.S. Treasury Department recently announced that they would be replacing Alexander Hamilton with a woman (at least on the $10 bill.) The ECN and PDD editors had a few ideas on who that replacement should be. Here are our picks for the newest member of the money club.

Just because the F-35 can't dogfight doesn't mean it's a bad aircraft

By Jamie Wisniewski, Associate Editor, @JamieECNmag

A report released earlier this week of the F-35A's (lack of) dogfighting capability is making its rounds and has people up in arms about the aircraft's credibility (including many of you who commented on our original news report). The evaluation focused on the overall effectiveness of the aircraft in performing various specified maneuvers in a dynamic environment, according to the F-35 tester. This consisted of traditional Basic Fighter Maneuvers in offensive, defensive and neutral setups at altitudes ranging from 10,000 to 30,000 feet.

Make it smart

An alternative to AT command sets for Wi-Fi modules.

By Dave Burleton, Vice President, LS Research (LSR)

Converting traditional consumer and commercial products into wireless-enabled, "smart" products is one of the biggest trends shaping the pipeline of projects being assigned to electronic design engineers today—with very good reason. Regardless of whether your company makes toasters or oil well drills or home security systems or children's toys, there is big money to be made in offering customers a wirelessly-enabled product line that has all the bells and whistles that come with smartphone controllability, real-time data and other "gee whiz" features.

That is leading to an avalanche of high-priority projects for electronic design engineers related to the Internet of Things (IoT) and Machine-to-Machine (M2M) capabilities. Regardless of whether it is labeled as IoT, M2M, "wirelessly-enabled," or just "smart," these re-design projects are coming fast and furious at electronic design engineers in industries across the spectrum—all with aggressive timelines driven by companies' desire to improve user experience, respond to customer needs, and capture market share.

This probably isn't news to most readers of *ECN*. For many engineers, that flood of product re-designs isn't on the distant horizon. It's a reality today, and it is creating major challenges because making a traditional product wirelessly-enabled isn't as easy as folks up the food chain might imagine. It's not simply a matter of "slapping an antenna" on the product and "getting one of those iPhone app thingies" to run it. It's a lot more complicated. But there are some key ways that engineers can shorten the development cycle and also get an elegant final design—which is always a bonus.

Figure 1. Example of an ASCII command set approach for a common device-to-cloud Wi-Fi translation. (Figures courtesy of LSR)

Faster and more elegant

One key way to get your connected product design project across the finish line faster is to take advantage of an IoT Platform-as-a-Service (PaaS), which allows you to offload a significant amount of work that would ordinarily go into the product itself, placing it instead in the cloud with pre-built infrastructure and software. Taking advantage of an existing platform saves time, minimizes risks, reduces the drain on internal resources, and gives the product itself far fewer "moving parts" in terms of its wireless connectivity.

Figure 2. Comparison of an ASCII Command Set approach and TiWiConnect's LIFT Client approach for a common device-to-cloud Wi-Fi transaction.

Utilizing the cloud is a topic for another piece, though. This article focuses on another huge time saver and simplifier for your connected product project: Avoiding the use of AT Command sets for addressing a number of key functions such as Wi-Fi control. Most product re-designs to add wireless connectivity will look to utilizing a product's existing MCU as a host controller of the RF module to minimize the design efforts—rather than replacing the MCU and making the redesign much more complicated in the process—and for many engineers their comfort-level will nudge them towards an AT Command set approach to that serial communication.

AT Command sets were first utilized in the early 1980s as a creative solution to the challenge of transmitting commands between embedded systems and communications devices that act as a go-between with the world at large. AT Command sets have been popular ever since because they utilize very small data packets, allowing a lot of work to be done with very small batches of instructions and data. In the 1980s, that was really, really important, given the computing

power and memory constraints and data processing capabilities that systems had at the time. Anyone who had a Commodore 64 or other early PC can attest to that. For that era, AT Commands were an elegant solution that worked around the miniscule memory and single serial ports that were the apex of technology at the time, allowing engineers to communicate sophisticated commands with very short ASCII strings that started with the iconic two-character AT script that gives AT Commands their name.

More than 30 years later, AT Commands remain very common in product design, and they are often the immediate strategy that engineers think of when they are working on a wirelessly-enabled product and need to facilitate serial communications between an MCU and key components like a Wi-Fi module. AT Commands seem like the natural solution, but the reality is that they introduce unnecessary complexities, create delays, and are poorly suited to the specific functionality that IoT/M2M products today are aiming to deliver.

The limitations of AT commands

AT Commands are not an ideal approach for IoT/M2M projects because of the inherent limitations of traditional ASCII-based command for supporting the communication of data to and from the device itself out to the cloud, where it can then be accessed and interacted with by users. AT Commands were created in a pre-Internet world, which means that designers need to do some clever things in order to write AT Commands in a way that successfully, reliably communicates data from the device, to the web-based language that a Wi-Fi network uses, and on to the cloud where it can then be accessed anytime/anywhere by the user.

Yes, it can be done. But should it be? Is it worth the investment in time and brain power to figure out that puzzle? Or is there a way to bypass those ASCII-to-Wi-Fi hurdles so that there is a simpler, cleaner, more elegant solution for getting data out of the device and out to users? There is and it results in a stronger, more flexible end product, which is why I hope this article encourages ECN readers to think twice before taking the AT Command approach. That alternative approach is to use a human-readable, object-oriented approach to embedded code in an IoT/M2M design product, which is much better suited to the task of creating that product-to-the-cloud link. Another way to think of it is, if the design problem is not just to get the data from the MCU to the Wi-Fi module but to get that data up to the cloud, newer innovative software can be leveraged that abstracts all the minutiae of facilitating Wi-Fi through AT Commands for the developer.

With a minimal increase in on-chip memory, a design team can utilize a much more modern and much better-suited approach to creating the instructions and communication that is needed in a product that is enabled with Wi-Fi connectivity. By using formats such as JSON and XML, design teams can dramatically reduce the timeline for a project while also minimizing the programming headaches that come from traditional AT Commands. The key is that these more modern, object-based languages are compatible across each of the platforms that a connected product utilizes: the embedded technology inside the product itself, the cloud server that the product communicates with via Wi-Fi and the web/smartphone app that the end user utilizes to interface with the product.

The scenic route should be the path less taken

JSON-RPC (Remote Procedure Call) is an example of a human-readable solution that is well suited to IoT/M2M design projects. JSON-RPC is inherently an object-oriented approach to data communication. Rather than having one command per parameter, groups of related parameters are supplied to function calls. The result is a much simpler, cleaner and more intuitive interface for the developer. In addition to the benefits of human readability, JSON-RPC integrates seamlessly into existing server infrastructures and web services platforms. This provides crucial benefits for connected products with remote data-sharing requirements, and it does so in a way that would be nearly impossible with traditional AT Commands.

There is another reason why this alternative to AT Commands makes sense, and it is not a trivial one. When a company is working on a cloud-connected design project that brings together a wirelessly-enabled product, cloud servers and mobile apps into an integrated solution, using JSON-RPC creates a common ground that the web and app developers will already be familiar with. This is significant because not having that common ground can cause a development project to immediately bog down when it comes time to create the mobile apps and web-based user interface. An alternative like JSON means everyone will be speaking the same language, literally, when that phase of the project arrives.

Does this mean that design team should have their team members run out and sign up for JSON certification classes? Thankfully, no. That is because there are pre-built software platforms built on JSON and XML that are ready to plug into this aspect of IoT/M2M design projects, alleviating the need for designers to tackle this themselves and giving designers a potent alternative to traditional AT Commands for creating a link between a product's existing microcontroller and the new wireless module.

Every engineer I have ever worked with believes in the power of design elegance. Oftentimes, the simplest design with the fewest moving parts and the least complexity ends up being the most effective, and the most reliable. At one time ASCII-based AT Commands were the most elegant solution to the design challenges of that day and they still are relevant for many tasks, but IoT/M2M projects have requirements that take the simplicity of AT Commands and twist them into unrecognizable shapes that are neither elegant nor effective. AT Commands still have their place, but a human-readable, object-based strategy—especially one that utilizes the pre-built platforms that are available for design projects—will remove one of the major bottlenecks for your IoT project. Sometimes the scenic route makes sense, but for these projects this alternative route will get you much faster and much more reliably. ECN

It’s time to get smart

Adding features using the Internet of Things.

By Mike Justice, President, Grid Connect

When I go home tonight, I’ll be able to turn on the lights in my house, adjust the thermostat and put up the garage door all with one simple command on my smart phone. I also can disarm my alarm system and open my door using an app.

I’m not alone. The number of smart products continues to rise and capture the attention of both consumers and businesses. With 26 billion smart units predicted to be installed by 2020, Internet of Things (IoT) growth is expected to exceed that of cell phones and tablets.

Making products that can connect to the Internet is one way that product manu-facturers are staying competitive within their industries. However, the benefits go beyond the “cool factor.” IoT allows manufacturers to easily

add new features to products through a simple software update. Gone are the days when consumers have to purchase a new product in order to get new features.

Connected products offer advantages for manufacturers. Smart products can deliver maintenance reminders, special offers, recall notices and other notifications at prescribed intervals. The data captured by these devices can help manufacturers get to know their customers better. For example, by gathering usage data, washing machine manufacturers can know which of the functions owners use most, helping with future product development. Sensors in the appliances can trigger alerts when a component is about to fail, allowing customers to set up service calls proactively, which boosts customer loyalty. Even information about how much detergent customers use, water temperature preferences and wash cycle choices could be packaged and sold to detergent companies as consumer insight information.

At the same time, connected devices are becoming fairly inexpensive to manufacture, and they can be sold with a higher price tag. In general, connectivity can be added for a material cost of about $10, plus the cost for app development and cloud hosting. While lower cost devices, such as coffee makers or toasters, may not be able to support the added cost, larger ticket items (i.e. washers/dryers and refrigerators) can. Much of it depends on the added convenience and value the connected device brings to the consumer.

The possibilities presented by smart products are very attractive, so designers are thinking of ways to add connectivity to products. Along with adding the Inter-net component, smart products present other unique design considerations.

Look and feel

It's tempting to simply modify existing product designs to make products smart and a number of compact networking modules are available for manufacturer's existing products. Still, some design modifications will likely be needed. Designers must consider the space they have available on their circuit boards and in the product's enclosure to accommodate the networking technology.

There are a variety of options for networking modules, and each will impact the type and number of antennas needed. Module manufactures often provide multiple op-tions for antennas, such as on-board chip or ceramic antennas. They may also offer a wire or whip antenna, a trace antenna, or a pin-out, which allows the manufacturer to add their own antenna elsewhere on the circuit board. When selecting between internal and external antennas, designers must consider the material of the housing and the potential placement of the product within a home or business. For example, metal housings almost always require an external antenna because the metal in the housing greatly diminishes the quality of radio frequency (RF).

Power considerations also will affect design. Consider where the product will be used and if untethering it from a wall outlet makes the product more useful. If the device needs to be "on" constantly, a traditional battery won't work because it will drain quickly. Some products, such as motion sensors, are able to sleep and wake, reducing power consumption and enabling the device to be battery powered.

Finally, think of how customers will interact with the smart device for programming, updates and other reasons. The product can have a visual interface or display, or it can be controlled through the Web or via an app. If there is no visual interface, consider how the customer will know if a device is "on." It may be necessary to add an "on" light to a product that previously didn't have one. Also, think about a manual on-off switch. The apps to monitor and control connected devices can be web-based or available as smart phone apps, or both.

Network considerations

Some devices can be directly connected to the Internet using existing networks, such as Ethernet and Wi-Fi. Other standards require a "gateway" to convert the network to either Ethernet or Wi-Fi, which adds cost and one more potential point of failure. The easiest devices to connect will use Wi-Fi, Ethernet, cellular or Bluetooth. Wi-Fi and Ethernet are available in most homes and businesses and Bluetooth connects through smart phones and tablets, using their existing cellular network. None require the addition of hardware or gateways. Other protocols include ZigBee, Z-Wave and Thread.

In the home, many different standards are emerging for interoperability between products from different manufacturers. Devices should support more than one of these standards to ensure their products will be able to work with and communicate with a variety of manufacturers' products. Some of the best known interop-erability standards include: Brillo (supported by Google/Nest), Alljoyn (supported by Qualcomm) and HomeKit (supported by Apple).

Security

Many smart products transmit sensitive information. For example, home thermostats provide clues about when a home owner is away at work or vacation. It's important to understand how data can be compromised and what the potential outcome is if there is a breach. Product manufacturers must employ best practices and security protocols to ensure the safety of data, and should educate us-ers about how they can help ensure their own security. For example, users need to take appropriate precautions to secure their IoT apps on smart phones and tablets.

The U.S. market for connected homes is expected to quadruple to $44 billion from 2014 to 2017, according to the GSM Association trade group. The Industrial Internet of Things should reach $500 billion by 2020, according to Accenture. With the appetite for connected devices surging and costs plummeting, it's time for products to smarten up. ECN

NEW PRODUCTS

Automotive hall effect latch features wide range of sensitivity options

The AH376xQ family of AECQ100-qualified Hall effect latches introduced by Diodes Incorporated offers eight magnetic sensitivity options to cover the requirements of numerous automotive applications. Such uses include commutation, encoding and position control of the various motors, pumps, fans and valves found in vehicle cabins for operating windows, sun roofs, seats, tailgates and air-conditioning. These Hall effect latches can also be used in the engine bay for steering and sensing the speed and position of the crankshaft, camshafts, cooling fans, and water, oil and fuel pumps.

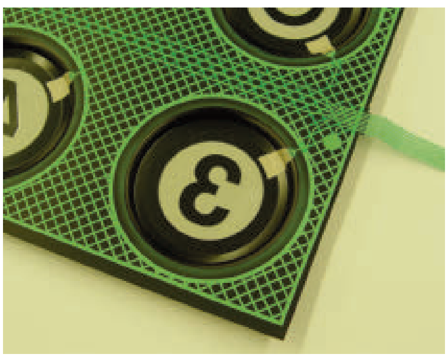
For more information, visit www.diodes.com.

Printing transparent conductive ink

Transparent, conductive inks to transform touch capacitive devices.

Kaylie Duffy, Associate Editor, PDD

Carbon nanotubes (CNTs) are tubular cylinders of carbon atoms that possess incredible mechanical, electrical, thermal, and chemical properties. In fact, the structures are 200 times stronger than steel and experience very little physical corrosion typical of other metals.



Thermoformed Buttons using SWeNT Carbon Nanotube Ink. (Photos courtesy of SouthWest NanoTechnologies)

CNTs come in three main forms and are distinguished by how many walls of carbon exist within each tube. A single-wall CNT has a single tube; a multi-wall CNT typically has 10 to 20 walls nestled inside each other; and a few-wall CNT has two or three walls.

Multi-wall CNTs are easier to produce than single-wall CNTs, while few-wall CNTs are still a relatively new category. SouthWest NanoTechnologies (SWeNT) distinguishes itself as one of the only companies that produces all three types at a commercial scale. Recently, the company demonstrated the use of carbon nanotube inks as a material for specific touch capacitance and membrane switch replacement applications.

Last November, SWeNT had the opportunity to showcase the technologies at the Printed Electronics USA Show in Santa Clara, CA. The company exhibited a transparent conductive ink material, which is commercially available, and a semi-conducting ink material, which is currently in the R&D stage. The former is used for touch sensor applications, transparent electrodes for display products, and for smart windows. The latter is typically used for printing transistors and various types of sensors.

Printability

What makes the company's transparent conductive inks unique is that they're printable. Manufacturers must usually etch away at a transparent conductive film to form patterned circuits, but by using this approach, manufacturers can print the transparent conductive ink exactly where it is desired on the circuit. "There is no waste of material," explains Dave Arthur, SWeNT CEO. "You don't have the associated cost with etching away the material and dealing with waste."

SWeNT's design philosophy has been to formulate the inks so they are printable with standard industrial printing equipment. For example, the company has developed a screen-printing ink that can be printed on any screen-printing press and a slot die coating ink that can be coated in any slot die coater.

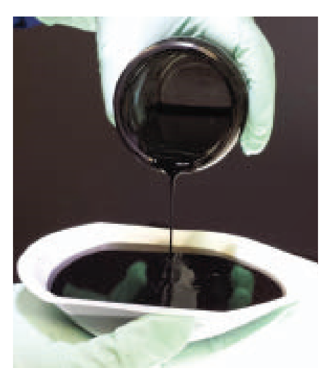
Stretchability

Aside from the transparent conductive ink's printability, the ink is also stretchable. "This capability of nanotubes to stretch and still maintain their electrical properties is very exciting from a design standpoint," says Arthur. "It's consistent with wearable electronics, flexible electronics, and 3D-formed electronics."

The ability to form a three-dimensional shape after it's been printed would allow touchscreens to have curved touch buttons. For instance, a 3D button on a car's display screen could guide a driver's finger where to touch. Taking one's eyes off the road would no longer be an issue.

V2V technology

When first put on a screen, inks must have a consistency like paste so they don't drip through. Then when the squeegee passes over the ink to force it through the screen, it must become thinner to flow. After it flows through the screen and the ink is printed onto the surface of the desired substrate, the ink must stop immediately so it doesn't lose precision of the image that was just printed. "Essentially, you need a material that is a paste, and



SouthWest NanoTechnologies demonstrating 3D capacitive touch sensor using transparent thermoformed carbon nanotube ink at PE USA 2014.

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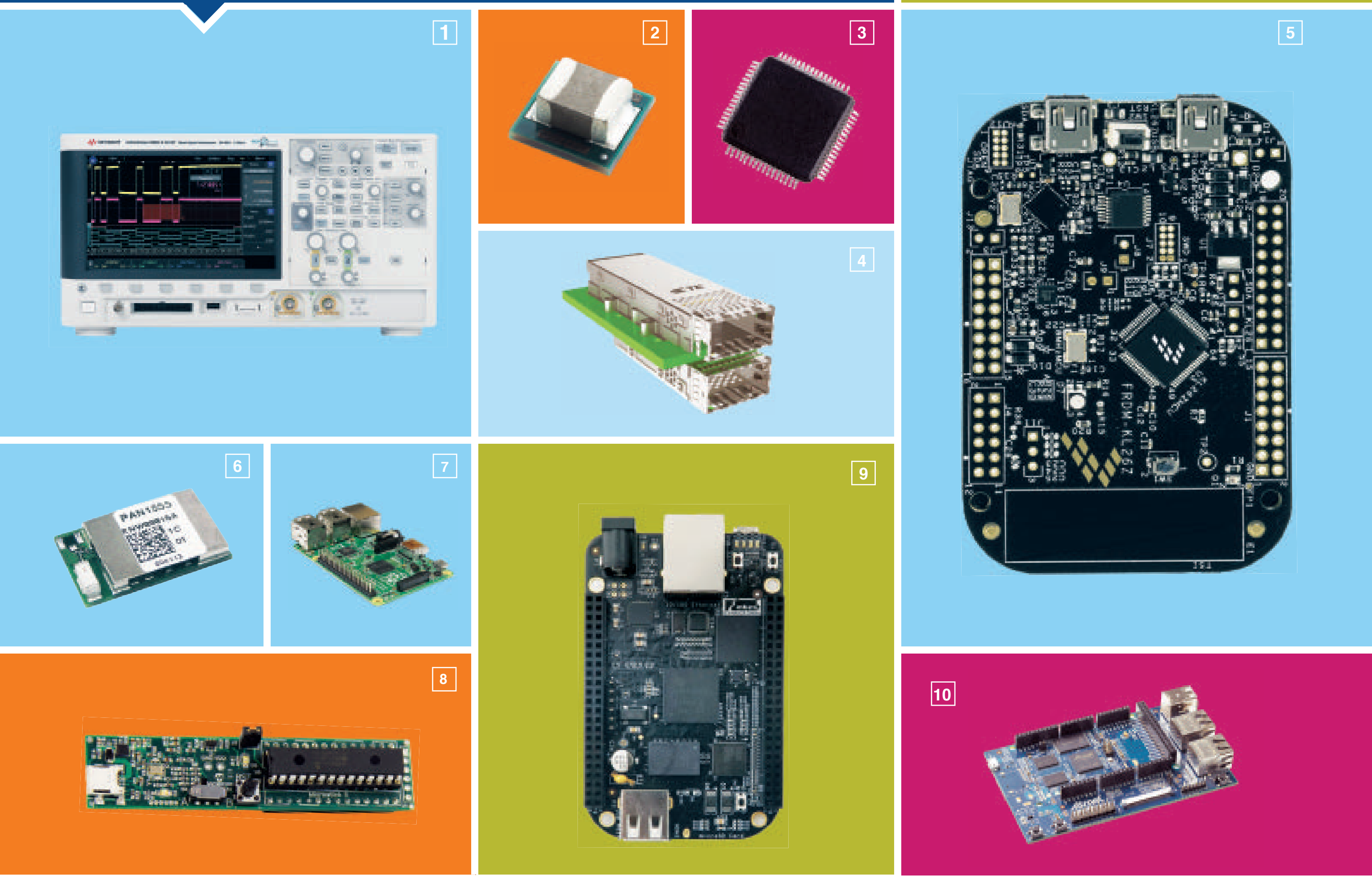

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SouthWest NanoTechnologies Demonstrating 3D Capacitive Touch Sensor Using Transparent Thermoformed Carbon Nanotube Ink at PE USA 2014.

can quickly transform into a flowable fluid, and then quickly recover to become paste-like," Arthur says. "That's challenging to do."

For materials like nanotubes, dispersing agents must usually be added. Otherwise, nanotubes will clump together and form a big ball, as opposed to uniform distribution. However, SWeNT uses viscous fluid transitioning to vapor (V2V) technology. The company puts nanotubes with no dispersing agent into a proprietary fluid that they then synthesize.

Most importantly, after the printing process is completed, it can be put into a standard oven and dried. The viscous fluid breaks down into smaller fragments at normal drying temperatures that are just vapor. "You don't have to clean up the printed material to try to remove these processing aids," says Arthur. "You print it, dry it, and then you're done."

The demonstration at Printed Electronics showcased SWeNT's CNT inks, based on V2V Ink Technology. The company's screen printing ink is currently gaining the most commercial traction due to the cheap cost of tooling for a screen printing press.

Applications

When many people hear "touch sensor technology," they think of touchscreens on mobile phones and tablets. However, with SWeNT's technology, it is also possible to print transparent touch sensors and shape them to a 3D shape—a technology that allows membrane switches to be replaced by capacitive touch technology.

Membrane switches are found on various home appliances, electronic devices, and the interiors of most automobiles. SWeNT envisions replacing these with printed thermoformed polycarbonate, transparent capacitive touch sensors. "The expectation is that within the next 10 years, membrane switches will be replaced by these transparent capacitive touch sensors," predicts Arthur. ECN

Enabling a new era of display technology

The enormous potential behind P-Cap touch control technology.

By Ian Crosby & Dr Andrew Morrison, Zytronic

Over the last decade the uptake of projected capacitive (p-cap) touch sensor technology has been phenomenal. It has helped shape a new era of human-machine interaction and enabled the derivation of more fulfilling user experiences. Further proliferation of p-cap touchscreens seems certain, with the enormous potential for it to benefit many different application scenarios. If this is to be achieved, however, advances in the supporting touch control electronics will almost certainly be required.

Almost everyone, from adults to small children, is now very familiar with touchscreen interaction in handheld electronic devices, and increasingly in domestic appliances, gym equipment, self-service terminals and bank ATMs. It has become so pervasive that people, presented with a display will often attempt to control it by touch first, whether or not it is capable of this. Given the intuitive control that touchscreens offer in

Image 1: Mutual capacitive touch technology is very well suited to touchscreen applications requiring multitouch functionality, as each cell within the conductive matrix is capable of registering a touch. (All images courtesy of Zytronic)

comparison to push buttons and keyboards, there is now a growing demand to apply the technology in more and more areas, and in increasingly demanding environments. This, as we will discuss, puts certain operational pressures on the touch controller electronics that accompany them.

The implications of touch control

There are two basic sensing methodologies associated with p-cap touchscreens. The most widely used to date have been based on mutual capacitive touch sensing - which is seen extensively in the portable consumer market. This has been the foundation, for example, of the touchscreens found in tablet computers, and smartphones. Most mutual capacitive touch sensors have two separate patterned conductive layers (with a matrix of discrete cells formed from Indium Tin Oxide, or ITO), which are each directly connected to the touch control electronics. A small charge is applied to one layer of cells and passes to the second layer through capacitive coupling. Touch events, caused by the approach of a finger or suitable conductive stylus will draw some of the charge passing between the layers. Detection algorithms embedded within the touch controller firmware are then able to mathematically determine the cells on the matrix where the most acute capacitance change occurs and supply the host PC with details in the form of XY coordinates.

In contrast, the less widely used self-capacitive sensing technique relies upon the detection of minute changes in frequency. A known oscillation frequency is applied to the XY grid on the rear side of a suitable substrate. The known oscillation frequency is affected by the presence of the capacitance of the human body or a suitable conductive stylus. If a user's finger comes into proximity with the touchscreen's surface it is possible to determine which conductors (in both X and Y axes) experience the greatest alteration in frequency, and a suitable set of output coordinates are provided to the host computer.

Mutual capacitive touch technology is very well suited to touchscreen applications requiring multitouch functionality, as each cell within the conductive matrix is capable of registering a touch. However, at relatively low voltages, it is difficult for this approach to detect a touch through more than a couple of millimeters of glass. Whereas self-capacitive touch sensing is an inherently more sensitive method, and therefore can typically detect touch through far greater thicknesses of overlying material. However, it has the drawback of normally only being able to detect one or two touch points, as the entire conductor in each axis is monitored, rather than each individual cell in a matrix.

Key issues defining next generation P-Cap touch controllers

Whether the touchscreen is for consumer electronics or commercial/industrial use, there are four fundamental areas where research and development has been focused to advance both touch performance and user interface design. These are:

Faster speed – Particularly with larger touchscreen systems the size of the conductive matrix in the touch sensor will have a negative effect on the registration of touch coordinates. To counter this, the associated touch control electronics must possess substantial processing capabilities - otherwise lag or latency will be evident as a touch point is moved across the screen, detracting from users' overall satisfaction.

Heightened accuracy – If the touch points cannot be determined with suitable precision then user frustration may result. It is important that both the design of the touch sensor matrix and its controller be optimized for the screen size and application.

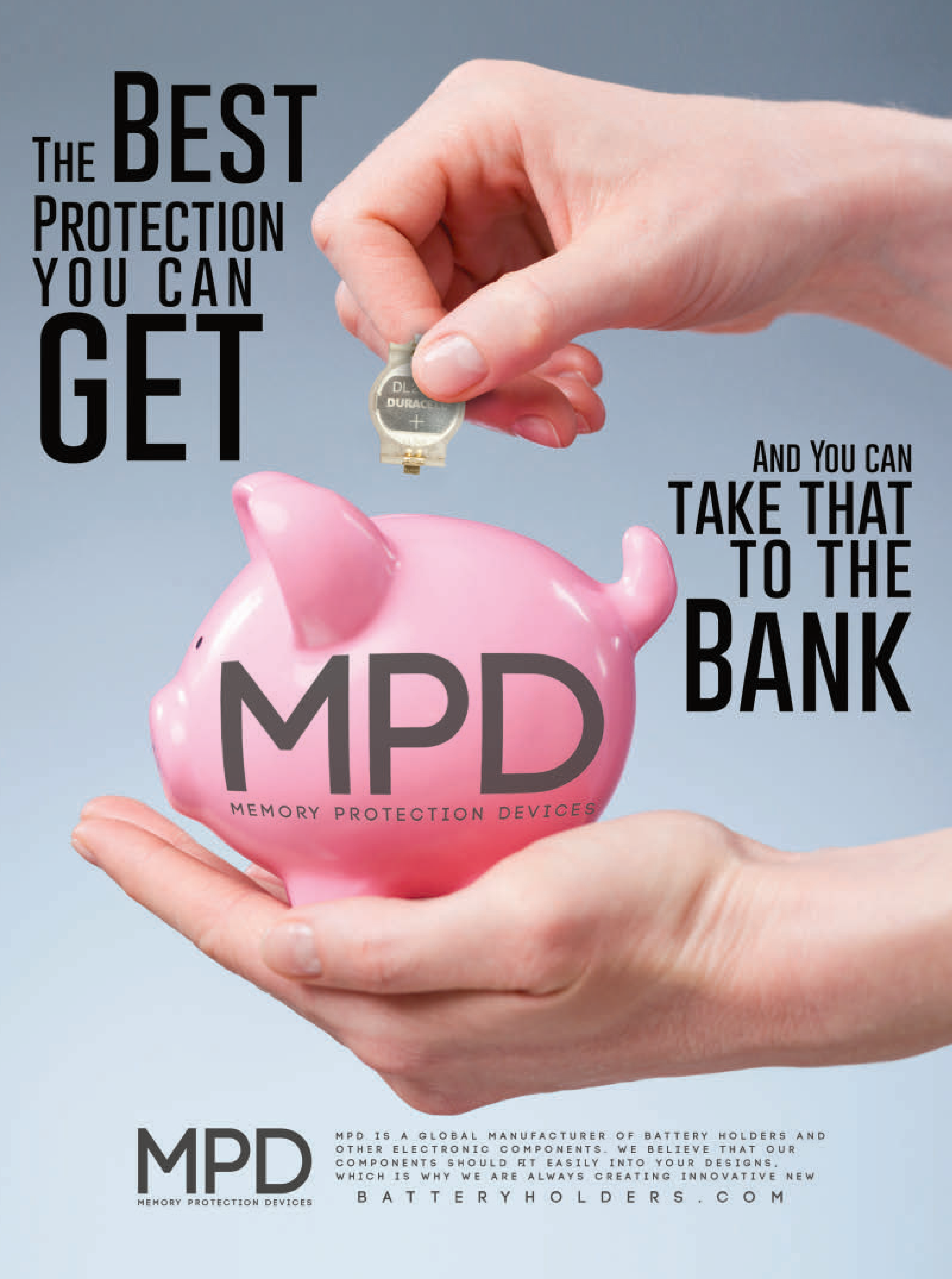
Improved immunity to EMI - Though it might be assumed that this was only an issue for touchscreen systems placed into industrial environments, there are in fact a wide variety of commercial applications where exposure to electro-magnetic interference (EMI) can have a detrimental effect on touch operation. For example, self-service kiosks such as ticket and vending machines located in train stations will be subjected to surges in EMI as trains pass. Similarly, touchscreens deployed in areas where the power supply is inconsistent or not well regulated will also be affected by transient interference coming up the power cable from the mains supply. Major improvements to the electronic design and touch detection firmware employed by the touch controller are needed in these circumstances to ensure that signal integrity is maintained at a high level.

Greater integration - For compact touchscreen designs, there is a clear advantage if the footprint of the touch controller can be kept to a minimum. Reducing the PCB size is therefore important, as is making available the controller chip-set, so that designers can consider embedding the touch controller onto an existing system motherboard.

Commercial applications now demand a new generation of touch sensor systems which are capable of achieving higher degrees of responsiveness and precision, as well as maintaining greater EMI stability and overall compactness.

To meet the challenges raised by increasing demand for larger format touchscreens that both match the fast touch performance of small consumer devices and continue to function effectively in environments with high levels of electrical interference, companies will need to be smarter about the control electronics they employ in systems. Fortunately, touch sensor developers are continuing to push the boundaries of performance and resilience and can provide solutions for even the most demanding applications. ECN

Image 2: Commercial applications now demand a new generation of touch sensor systems which are capable of achieving higher degrees of responsiveness and precision, as well as maintaining greater EMI stability and overall compactness.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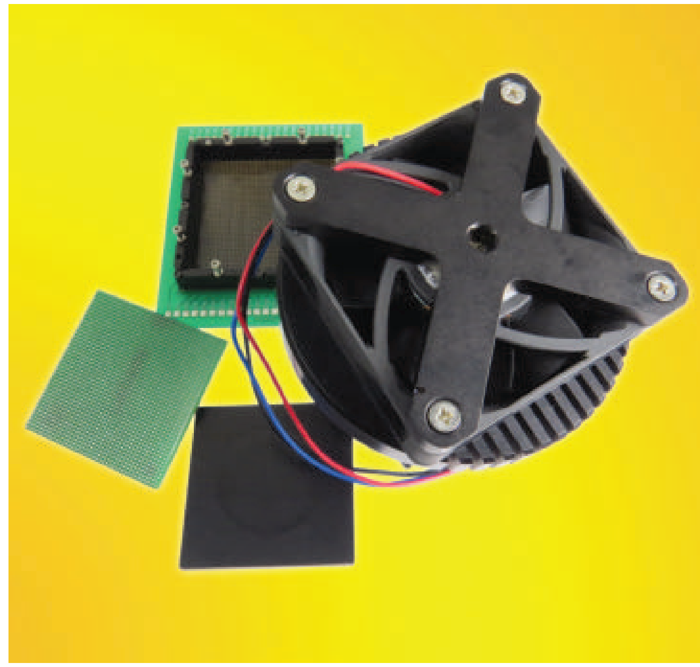
BGA socket designed for 1 mm pitch

Ironwood Electronics has recently introduced a new high performance BGA socket for 1mm pitch, 1600 pin BGA IC's. The SG-BGA-6433 socket is designed for IC size - 42.5x42.5mm package size and operates at bandwidths up to 27 GHz with less than 1dB of insertion loss. The sockets are designed to dissipate 60 watts using a heatsink compression screw with axial flow fan. The contact resistance is typically 20 milliohms per pin. The socket connects all pins with 27 GHz bandwidth on all connections. The socket is mounted on the target PCB with no soldering, and uses industry's smallest footprint. The socket is constructed with shoulder screw and swivel lid which incorporates a quick insertion method so that IC's can be changed out quickly. The socket comes with ball guide for the precise alignment of BGA balls to PCB pads.

The SG-BGA-6433 socket is constructed with high performance and low inductance elastomer contactor. The temperature range is -35 C to +100 C. The pin self inductance is 0.15 nH and mutual inductance of 0.025 nH. Capacitance to ground is 0.01 pF. Current capacity is 2 amps per pin. Works with IC's such as 1600BGA, 42.5 mm square package with 40x40 array and 1 mm pitch.

For more information, visit www.ironwoodelectronics.com.

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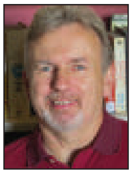

By **Paul Pickering,** Technical Contributor

With over 200,000 wind turbines now operating worldwide, and global installed capacity expected to reach 663MW by 2020, wind power is on a roll. Accordingly, I thought I'd take a look at some of the key engineering issues affecting wind power technology, and which new developments might grow important over the coming decade.

Regardless of the design, the maximum power that can be extracted from the wind can be calculated by Betts's law. According to the law, no turbine can capture more than 59.3% of the kinetic energy in the wind, for a theoretical maximum power efficiency of 0.59.

Current generation wind turbines have power efficiencies between .35 and 0.45. After taking other losses into account (generator, bearings, power transmission, etc.), only about 10 to 30 percent of wind power is actually converted into usable electricity.

Since the wind does not blow continuously, the annual capacity factor—the ratio of actual output to output at 100 percent capacity—of a wind site is much lower than unity.

In a 2009 study, it was estimated that the average capacity factor of Germany's wind farms was 18.3 percent. In Britain, a windier country, it was 26.1 percent, so each 10 GW of installed capacity delivered about 2.6 GW on average.

Unsurprisingly, the wind farm power output varies widely over any given year: in Germany, for example, the maximum instantaneous wind power output in 2013 was 26GW at 6pm on December 5th, in contrast to the minimum power output of 0.128 GW at 2pm on September 4th, only .5 percent of maximum. This is true over shorter time periods, too: in Britain, total output during the course of a single day (June 16th) went from around 2.5 GW down to almost zero.

These figures naturally represent extremes, and improved forecasting can predict short-term fluctuations to some extent, but unpredictable variation in power output means that wind farms cannot completely replace more conventional systems such as fossil fuels or nuclear power plants. Instead, they should be viewed as a means to save fuel and reduce CO2 emissions during times when they are generating power.

Recognizing this, Germany, the country with the highest installed wind power capacity in Europe (over 39 GW), is planning on opening 14 coal-fired power stations and 27 gas-fired stations by 2020, with a total capacity of 56 percent of the country's power needs. Incidentally, 39 GW, while impressive, only gets Germany to the number three position on the worldwide windpower list behind China (115 GW) and the US (66 GW).

This rise in windpower installations has not been without problems, though. On the technical side, issues include lowered efficiency due to the build-up of dead insects, forced shutdown due to high winds, ice buildup, lightning damage, oil leaks, and fire due to overheated bearings.

In addition, the average load factor steadily declines with age. A 2012 analysis of wind farm performance in UK and

Denmark found that after correcting for wind variability and other parameters, the load factor for UK onshore wind farms declined from a peak of about 24 percent when new to 15 percent after 10 years and 11 percent after 15 years. For Danish onshore wind farms the decline was slower but still significant, falling from a peak of 22 percent when new to 18 percent at age 15.

To add to the technical issues, local opposition to onshore installations has led to the formation of numerous protest groups, with protestors citing a variety of concerns including possible effects on health, lowered property values, visual & noise pollution, and birds or bats falling victim to turbine blades. The ensuing lawsuits can cause years of delay to projects—or even lead to their cancellation.

To migitate community problems and take advantage of stronger, more predictable ocean winds, wind farms are increasingly moving offshore, starting with coastal areas and migrating further afield as technical problems are surmounted.

There are several options for the turbine base, depending on the depth of the water, including: a single column (up to 100 feet); a gravity base structure (65 to 250 feet); a tripod structure (65 to 250 feet); and a tethered floating system (deep water use).

The turbine itself represents 33 to 50 percent of the costs in offshore projects, the balance being infrastructure, maintenance, and oversight. Larger turbines with increased energy capture make more economic sense due to the extra infrastructure in offshore systems.

For example, the Thornton Bank wind farm, constructed 19 miles off the Belgian coast in water ranging from 39 to 89 feet deep, contains 54 turbines for a total capacity of 325 MW. The most recent turbines, manufactured by REPower, have 6.15 MW rated output, a rotor sweep of 413 feet, and weigh 470 tons (nacelle plus rotor). The turbines are connected together by 33 kV cables; a 150 kV cable connects the whole installation to shore.

Despite the daunting technical issues, projections for 2020 predict a wind farm capacity of 40 GW in European waters, providing 4 percent of the European Union's demand for electricity. And China is aiming for 30 GW offshore by 2020, which would make it the world leader.

U.S. offshore wind projects, however, have struggled to reach completion. The $2.6 billion Cape Wind project off Massachusetts has been under development for 13 years, stalled by legal battles with local fishermen and Native American tribes. And in January two local utilities, NSTAR and National Grid, announced they would cancel power-purchase agreements with the 468-megawatt project after it missed a Dec. 31 deadline to complete financing.

In a more encouraging development, however, Deepwater Wind LLC received $290M in financing to start building its Block Island offshore wind project in Rhode Island, the first one in the US. The relatively small 30 MW wind farm will use 56 MW turbines and is scheduled to be operational by the end of 2016. **ECN**

Paul Pickering has over 35 years of engineering and marketing experience in the electronics industry, including time spent in automotive electronics, precision analog, power semiconductors, flight simulation and robotics. Originally from the North-East of England, he has lived and worked in Europe, the US, and Japan. He has hands-on experience in both digital and analog circuit design, embedded software, and Web technologies. He has a B.Sc. (Hons) in Physics & Electronics from Royal Holloway College, University of London, and has done graduate work at Tulsa University. In his spare time he plays and teaches the guitar in the Phoenix, AZ area.

Exploring power-efficient inductance-to-digital proximity sensor solutions on ultra-low-power microcontrollers

By Rafael Mena, systems architect, Microcontrollers (MCU),
Texas Instruments Incorporated (TI)

Analog integration on embedded MCUs has resulted in unique system-on-chip (SoC) solutions that drive extremely efficient system solutions. Analog integration can include analog-to-digital converters (ADCs), programmable internal reference sources, digital-to-analog converters (DACs), comparators, analog switch matrix, and integrated LCD drivers. These analog modules can be used to directly sense the incoming analog signal, buffer the signal or carry out signal conditioning prior to conversion to a digital bit stream. These analog modules can also be combined to facilitate special system-function solutions. These modules manage the entire system solution which may include excitation of the sensor, data collection, signal conditioning, data logging, data processing, system management, and communication with the internal host processor.

System and performance benefits of special system-function solutions

As most analog blocks are digitally controlled in mixed-signal ICs, the analog block represents a significant challenge in the design, integration, and verification of the mixed-signal solution. This is further exacerbated by increasingly smaller feature size reductions and the overall complexity of the system-on-chip (SoC) design. Functional verification must be carried out across many different modes of operation, driving a need for behavioral models that accurately model the transient behavior of the transistor-level analog blocks. Special attention needs to be paid to verification across process, voltage, and temperature drift and in many cases random mismatch as analog circuitry is more susceptible to these non-idealities compared to digital circuitry. In addition, mixed-signal designs can be highly susceptible to noise associated with power supply, substrate coupling, cross talk, and random noise (burst, flicker, shot, thermal, etc.). Design layout must be optimized to assure proper signal and power integrity without excessive isolation, which can significantly increase component size.

Once the design challenges are overcome, the benefits of mixed-signal solutions are significant and lead to innovative special-function system solutions. Analog integration in MCUs results in better system power consumption as functionality is distributed in a single-chip solution. This also leads to an increase in throughput with faster system switching times and a reduction in system noise. Inherently these mixed-signal designs also lead to simplified system designs with pre-verified aspects of the component integration. Signal and power integrity conformance to device specifications is verified through specification-based functional validation. In addition, special function system solutions incorporate analog components that can be fully controlled by software through intelligent connections enabled internally by the IC. This functionality also provides for a programmable internal reference source for the analog modules. Overall the single-chip solution results in a reduction of the bill of materials (BOM) and PCB board size which translates to a significant potential system-cost savings.

Inductive proximity sensing

In proximity-sensing solutions, the LC tank circuit is used to detect whether a metallic object is in proximity to the magnetic flux generated by the inductive component. Eddy currents generated by the magnetic flux on the surface of the conductive material will decrease the effective inductance of the LC tank circuit. This in turn increases the attenuation factor of the resonant voltage signal. By monitoring the change in the attenuation factor, you can effectively monitor the position of a metallic object in the vicinity of the LC sensor.

A simplified block diagram of the Enhanced Scan Interface ESI module is shown in Figure 1. The module drives an LC sensor and monitors the change in inductance to determine the position of conductive elements within the vicinity of the sensor's magnetic flux. The integrated analog block module of the ESI unit consists of a comparator, a 12-bit DAC and a Vcc/2 generator along with digital circuitry to process the digital representations of the measurement sequence without the need of the host controller. The ESI unit measures the effects of eddy currents generated on the conductive object near the LC circuit and transforms it to position. The LC sensor is biased for a period of time, as defined by the user, to excite a resonant voltage signal across the inductor and capacitor. The effective resistance of the tank circuit drives a damping effect of the observed signal.

The representative equation of the resonant signal is given by the following equation:

$$v(t) = vI\,(\omega o/\omega d)e^{-\alpha t}\cos(\omega dt - \tan^{-1}(\alpha/\omega d)) \quad (1)$$

where

$$\omega o = 1/LC \text{ (resonant frequency)} \quad (2)$$

$$\alpha = 1/2RpC \text{ (attenuation factor)} \quad (3)$$

$$\omega d = (\omega o2 - \alpha 2)^{1/2} \quad (4)$$

The value of Rp is the equivalent parallel resistance of the series inductor resistance which is given by:

$$Rp = L/RsC \quad (5)$$

The corresponding signal waveform is shown in Figure 2. The waveform represents a capacitor value of 245pF, an inductance of 440uH, an attenuation resistance of 750KΩ and a Vcc of 3.6V. The resonant signal is shifted to Vcc/2 by the ESICOM pin as shown on the curve.

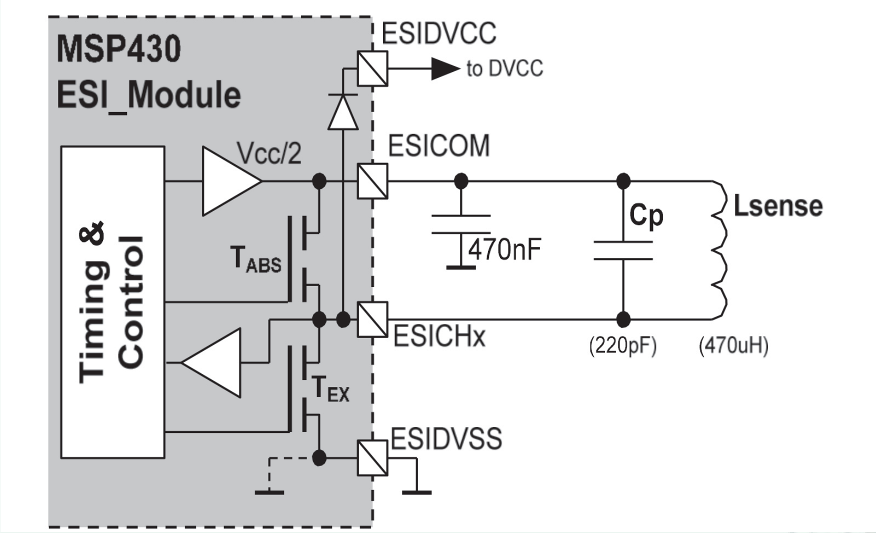

Figure 1. Example of a special-function ESI module.
(All figures courtesy of TI)

There is a change in the attenuation factor when a metallic object is placed in proximity to the LC sensor. This leads to a faster decay of the resonant frequency. A decrease in the effective inductance also leads to an increase in the resonant frequency. The ESI module

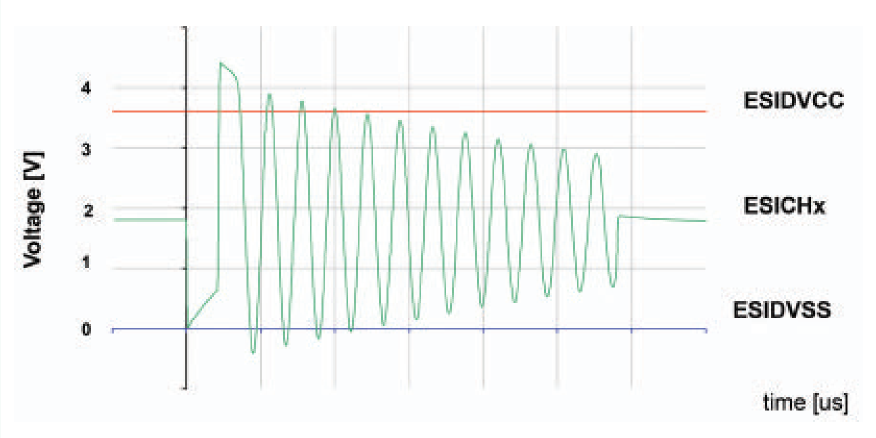

Figure 2. Inductive sensor signal waveform.

enables the resonant signal to be sampled by an integrated comparator. By defining the crossover point of the signal below a certain threshold value at a predefined period of time after excitation, it is possible to determine whether a conductive object has come in proximity to the LC sensor. This threshold value is defined by calibrating the LC sensor without a conductive object in the vicinity of the LC sensor. The comparator threshold voltage is set by the 12-bit DAC on the ESI module. By monitoring a threshold value instead of completely digitizing the entire sensed input signal, the overall power consumption is minimized. The unit is only active during excitation and during the sampling phase. After the comparator input is sampled, the resonant signal is fully damped by the ESI module.

The motion or rotational measurement can also be carried out by sensing the position of a wheel via these inductance-type measurements. Rotation and direction detection using two inductive-capacitive sensors is shown in Figure 4. A single LC sensor allows only for rotation detection. This configuration is used to measure fluid flow by transforming the flow into rotation; this is particularly useful for designing smart water meters. The mechanical construction in the form of a screw wheel or worm wheel transforms the flow into a corresponding rotation. The plate sitting underneath the two LC sensors has a metal surface on half of the plate while the sensors themselves sit 90 degrees from each other. The metal surface acts as a damping factor during half the period of the rotational sequence; the rotation measurement is carried out by detecting the different attenuation factors. The ESI module on an ultra-low-power microcontroller can detect the amplitude of the sensor input signal and define the relative position of the wheel. Speed is obtained by a continuous sampling of the LC sensors and correlates to fluid flow.

This LC resonant circuit implementation can also be used in contactless door switches where the damping factor or change in the LC tank's oscillation amplitude provides position information. By properly tuning the LC circuit, this method can also be used as a proximity sensor in industrial applications. It can be used in place of mechanical buttons where a metal plate can be placed on the button and the distance to the LC circuit is detected via the ESI module. It can also be applied as a method for detecting different types of metals in a factory setting or in the consumer space such as in coin counters or portable metal detectors. In general, this technique can be used in any solution that measures a damping factor to determine a physical parameter. The ESI module approach provides the lowest power implementation.

Other sensor configurations can be enabled with the deactivation of the excitation mode while sensing either an analog or digital input sensor signal. This allows the ESI unit to be interfaced with other electromechanical, optoelectronic and magnetic sensors also used to measure linear position or angular motion. The output of the incremental encoders or angle transducers provides information on the motion of the rotating element which can then be converted to speed, distance and position. These motion or rotary encoders are used in system solutions that require exact and unconstrained shaft rotation. Inside of industrial sensor solutions, typical examples include robotics, industrial controls and process controls. In consumer electronics, this technique can be used in wheel-based game consoles, special-purpose photographic lenses, and manual volume or tuning controls. In all these applications, the encoders come in the form of optical, mechanical, Hall Effect or capacitive types. Encoding of motion or rotation occurs by physical, magnetic, through capacitive measurements or optical detection of the element in motion. ECN

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Q: What's the biggest medical design breakthrough of the decade?

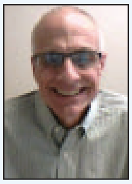
Mike Levis, Senior Manager, Surgical Portfolio

During the last decade, the latest technology trend enabling breakthroughs in patient care is minimally invasive surgery.

Minimally invasive surgery eliminates the need for large, invasive incisions through multiple layers of tissue. Instead, small incisions are used through the outer layer of the skin to create an opening for the surgeon to insert a probe for treatment.

Minimally invasive techniques first appeared in endoscopic and arthroscopic treatments, and were initially used to allow the physician to visually inspect very localized areas of tissue and organs. Current capabilities now allow the surgeon to insert surgical tools and catheters as well as imaging devices and actually perform surgical procedures. Moreover, flexible endoscopic probes are now available that allow the surgeon to use natural body openings (e.g. the mouth) and have eliminated the need for any incision at all in many cases.

Evolving enhancements in tube and shaft technology, fiber-optics, sensors, and stamping and molding technology will continue to enable the benefits of minimally invasive surgical techniques to be applied to more surgical approaches in the future.



Mark Russell, Global Market Manager, Medical Electronics

In the world of medical electronics, the title for biggest breakthrough goes to closed loop functionality. This technological milestone has helped device designers achieve new levels of active implantable performance, and it has driven change in three crucial areas: power conservation (providing stimulation only as needed through neural feedback), improved patient efficacy (adjusting therapy based on changing patient condition), and better feedback tools (communicating real-time information via wireless to doctors).

Closed-loop devices, such as those used to control epilepsy, use implantable multi-electrode arrays and amplifiers to record electrical signals. These signals can be used to predict a seizure, and can even apply preventative electrical stimulation in advance.

This closed-loop functionality in active implantables requires optimal power efficiency and signal isolation, and much of this is dependent upon the performance of electrical contacts and contact systems used to connect leads to batteries and electronics. Highly conductive and space-efficient components are supporting advanced connection arrays and signal isolation requirements of closed-loop, high-connector-count arrays.

With the use of closed-loop devices becoming more widespread, the ability to support smaller footprint connections for active implantables in a proven and reliable design will become increasingly critical.

By Kasey Panetta, Editor

What is The IMPACT of Counterfeit Components and the DANGER They Pose to Engineers?

We asked 730 design engineers the total cost of counterfeit components in: budget overruns, time-to-market delays, and in some cases, job losses. Every year, counterfeiters become more sophisticated, making the battle with bad components all the more complicated.

SALE

COUNTERFEIT COMPONENTS can ruin a company's credibility, which leads to:

- LOSS OF SALES
- COST OF REPLACEMENT
- LEGAL LIABILITY
- PERMANENT DAMAGE TO YOUR REPUTATION

35% of engineers have had a run-in with precarious parts.

65% were off the hook, but still cautious.

12.5% of engineers didn't know that they had been duped until after the new product launch.

At least **59%** caught it before production, be it

3% Before delivery

17.5% As they opened the box

or **21%** During the initial QC inspection

THE FUTURE...

looks bleak, as only **4%** of engineers think that our global counterfeit problem is improving.

THE SOLUTION...

BETTER TRACEABILITY.

We need to know where our parts come from.

Remember the counterfeit filters that were installed in Navy Helicopters?

1. *Raytheon* bought the filters from *Texas Spectrum Electronics*
2. Which bought them from *Technology Conservation Group*
3. *TCG* received the filters as e-scrap from *Thomson Broadcast*, but because they arrived in the original package, they were resold as new
4. *Thomson* bought them from *E-Warehouse* which purchased them from *Pivotal Electronics*
5. Which, in the final piece of this supply chain puzzle, bought them from *Huajie Eletronics Limited* in Shenzhen, China, an area infamous for counterfeit components

How much time is lost on the production cycle?

How much in real dollars are counterfeit components costing companies?

Read *The Impact of Counterfeit Components: Improvements, Setbacks, and the Danger They Pose to Engineers*, presented by *ECN*, at **www.ecnmag.com/counterfeit-impact**

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