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Vol. 59 No. 2

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KASEY PANETTA | EDITOR
kasey.panetta@advantagemedia.com

It's the ECN IMPACT Awards! (starring you guys)

It's that time of year again, and here at ECN we're gearing up for the 2nd annual ECN IMPACT Awards! In case you missed it the first time around, these awards are designed with the idea that companies doing impressive work in the engineering world should be recognized for their achievements.

We have added a few new categories this year, catering specifically to a few different industries. Our new wireless categories include:

Antennas: This category is designed to include antennas in the application areas of mil/aero, broadband networks/WLAN, and cellular.

Material technology innovation: This category focuses on the field of material development, whether it's the materials used in batteries for wireless devices or the use of Galium Nitride.

Oscillators: This category focuses on all types on innovations in the world of oscillators from VCXO to OCXO and DTCXO.

RF Amplifiers: This category will look at wireless communications that increase the voltage, current or power of a signal in the areas of military, radar, and wireless systems.

Wireless charging: This category is designed for applications in medical, automotive, consumer, power, and green technology. The products include transmission, modules, batteries, wireless power transmitters and receivers.

We've also added six other categories including: medical design innovation, software design, passive components and discrete semiconductors, digital/logic ICs and rapid prototyping.

One category I'm particularly excited about is **Social Corporate Responsibility**. So many companies in our industry are doing amazing things for their communities and we would like to honor those companies for all the work they do on a local or global level.

My other favorite category is **Education Innovation**. I talk to a lot of companies that are offering great STEM programs and creating products that help kids learn engineering. I think this is a great way to honor what their effots.

But, the deadline is fast approaching. The final extended deadline to submit products for the 2015 IMPACT awards is February 13, 2015.

All the winners will receive their trophies during a ceremony at the Mirage Hotel on May 13, 2015. It really is a blast of a cocktail party, so get your entries in today.

We've tried to make it as easy as possible to submit your entries at www.ecnawards.com, and we've even supplied some helpful tips and tricks.

What I believe sets the ECNIA apart is our judging panel. We set up a group of industry experts from military to power to wireless experts and have them judge the products. It doesn't matter how big or small your company is, all the products are judged based on merit and industry impact.

I really encourage you to log on to www.ecnawards.com and take a look around.

Until next time,

Kasey

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NOTABLE PRODUCTS for your projects

KEY FACT: The AMC104 includes a temperature sensor, DIP switches for IPMI functionality, and a management RS-232 port.

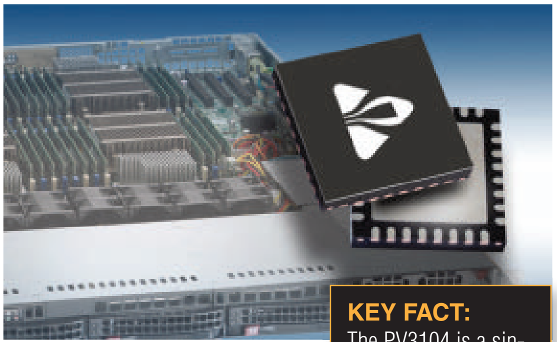
Carrier board designed for commercial video

VadaTech (Henderson, NV) now offers a PCIe Gen3 carrier board that allows high-performance commercial video or other boards to be used in a MicroTCA system. The AMC104 provides the versatility of using high-end commercial graphics cards, which typically have short shelf lives, as removable mezzanines. By providing a carrier, users can upgrade a PCIe GPGPU or other video board as needed. The AMC module routes PCIe Gen3 to the backplane as x4 or x8. VadaTech provides the full ecosystem of products, including AMCs, chassis platforms, MCHs, and power modules. The company also offers carriers and specialty products in AdvancedTCA, VPX, and CompactPCI.

For more information, visit www.vadatech.com.

Digital DC/DC controllers feature single and dual phase outputs

Powervation Ltd. (San Jose, CA) announced its latest series of digital DC/DC controllers for servers, high-end desktop, and embedded computing systems. The PV3103, PV3104, and PV3202 devices feature single-and-dual phase outputs and support both PMBus and Intel's VR12.5 Serial VID (SVID) bus. The highly flexible, fully programmable digital controllers provide precision regulation and telemetry to support the latest high efficiency computing system designs.



KEY FACT: The PV3104 is a single phase controller offered in the standard 5 mm x 5 mm QFN package and is footprint compatible with the PV3202.

The PV3202 is Powervation's latest full-featured VR12.5 dual phase digital controller with Auto-Control®, which provides superior transient performance and real-time adaptive loop compensation. Completing the family of SVID controllers is PV3103, a small, digital synchronous buck controller in the 4 mm x 4 mm QFN package – PV3103 is ideally suited to high density or compact design needs.

For more information, visit www.powervation.com.

How this biomedical engineer landed her dream job

Once a week, ECN features a student working on a degree (of any level) in engineering as part of our STEM Student of the Week. Though the section generally features students, this is a truncated version of an interview with recent graduate Michaelina (Micki) Dupnik, a biomedical engineer at Optimum Technologies, Inc.

Micki Dupnik is a 2014 graduate of Boston University. She was a biomedical engineering major, but didn't really consider it for a degree until she was chosen to go to Lockheed Martin's Women in Engineering day. After that, she was hooked. Her natural interest in medicine was what led her to consider a degree in biomedical and offered her the opportunity to work behind the scenes on designing and implementing medical technologies. She found it was the perfect combination of science and creativity and used those skills on her senior project to create a Sensory Substitution Glove for the Visually Impaired.

Her advice to girls looking to follow in her footsteps? We need you! Don't be embarassed about liking math or science, just enjoy it.

If you know a student who would like to be featured, email me at kasey.panetta@advantagemedia.com.

1.94 oz

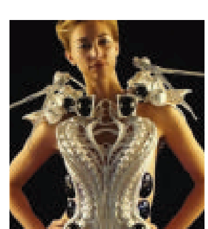
Total weight of the Nano drone

BLOG

This 3D-printed dress will fight off strangers

By Kasey Panetta, Editor, @kcpanetta

Germaphobes rejoice! There is, at long last, a clothing option designed especially with you in mind. Well, at least if you're okay with wearing a terrifying contraption.



Objectively speaking, the look of this dress alone should have people keeping their distance from you, but it also will reach out (and freak out) anyone who insists on coming closer. Dubbed the robotic spider dress, this contraption was created by Dutch Designer Anouk Wipprecht, who specializes in robotic couture.

TWEET

JasonECNmag:

One of the neatest drones at #CES2015? The Drone Fighter from @byrobot_rc. Watch it film the fire show at the Mirage http://bit.ly/1y5Kyok

Engineering Update:

CATS in space

➤ *CATS in space (sort of)*

The International Space Station is getting a shipment of CATS, not the feline, but the modules. The CATS are sensors that will be operational on the ISS for at least six months and up to three years.

➤ *Wireless charging pads in Starbucks*

Duracell Powermat and Starbucks announced that they have begun a national rollout of Powermat wireless charging in Starbucks beginning with stores in San Francisco's Bay Area.

➤ *Mercedes's new self-driving car*

Mercedes has a new car to showcase, and it'll drive itself. The car, called Luxury in Motion, isn't something you'll be able to find on the lot, but it might be something you'll be able to find in the future.

---

9 billion years

Age of the Andromeda Galaxy (containing 1 trillion stars)

TWEET

@kcpanetta :

Want to meet me @JasonECNMag @djamesmanny @ #EDS2015 AND maybe win an award? Consider the IMPACT Awards! http://www.ecnawards.com @ecnonline

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What's nice about having an engineering degree is everybody thinks you are smart.

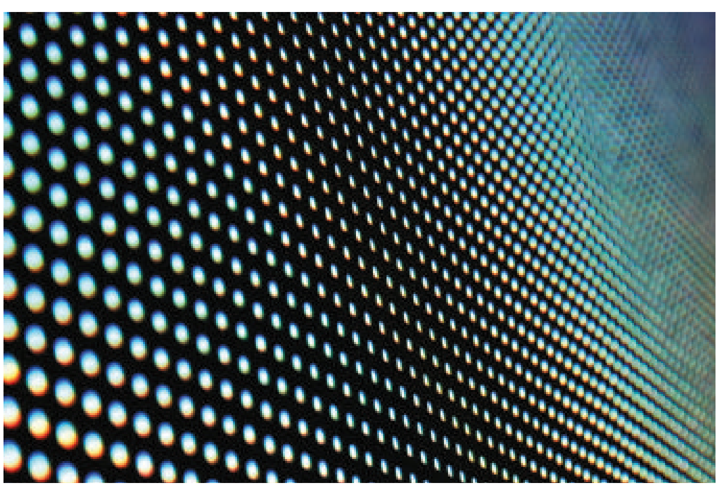
- Ato Essandoh

A bright future for outdoor displays

Silicone technology offers up solutions for outdoor displays.

By Rick Ho, North America Regional Marketing Manager, Dow Corning

Outdoor LED displays represent a global market that is on track to more than double by 2020, from $5 billion in 2015 to $12 billion, according to Transparency Market Research.



Silicone encapsulants and coatings offer several key benefits that specifically address the challenges particular to enabling surface mount LED displays to perform reliably outdoors. (Image courtesy of Oledsandr Pastukh/123rf.com)

The prevailing technology is based on through-hole technology (THT) LED modules, but demand for sharper images is fueling interest in higher resolution LED screens based on surface-mount technology (SMT) architectures. Today, SMT displays represent 40 percent of the outdoor display market. Adoption of the technology is projected to outpace THT to result in a nearly evenly divided market by 2020.

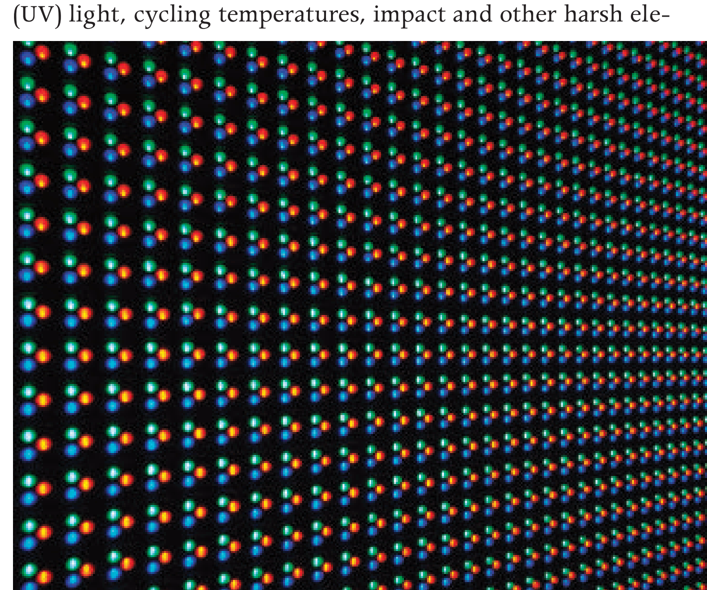
The comparatively higher LED density of SMT displays enables better quality images and video, and has helped establish the technology's firmer foothold in indoor applications. However, these displays will need to demonstrate they can reliably maintain superior performance under harsh outdoor environments in order to effectively compete for a share of that market.

Materials technology will not only play a critical role in this evolution, it will need to adapt as well — a trend that is already favorable for silicone. For decades, silicone gels and encapsulants have delivered proven protection of the LEDs and delicate electronics in outdoor THT displays. As LED display manufacturers sought to compete for this market, advanced silicone encapsulants and coatings offered protective solutions tailored to their needs. These versatile materials continue to evolve today to keep pace with industry innovation, and support expanding SMT design options.

A growing market for SMT displays

Higher image quality is the most immediately visible benefit for each new generation of LED display. But it is hardly the only factor that drives adoption. Sharper, more vibrant images may wow spectators watching the new screens installed at the sports arena, but this higher-resolution often comes at a premium. It's only natural that the sports venue would wish to ensure its expensive new displays will reliably deliver consistently high image quality for years to come.

The reliability of LEDs and assembled displays is an especially challenging quality to ensure for large outdoor display applications, which are under constant assault from moisture, ultraviolet (UV) light, cycling temperatures, impact and other harsh ele-



The dominant technology for outdoor displays, the through-hole LED module has an established record for delivering reliable, but relatively low resolution. (Image courtesy of Mrs. Areeya Slangsing/123rf.com)

Higher image quality is the most immediately visible benefit for each new generation of LED display, but reliability is also critical to broader adoption. Advanced silicone encapsulants and coatings promise to play a future role in supporting both market drivers. (Courtesy of Patti McConville/Alamy.com)

ments. Based on arrays of individually mounted, single-color LEDs, THT displays have an established record for delivering reliable — if relatively low resolution — images in outdoor scoreboards, signage lettering, and traffic signals. In these displays, each LED is firmly anchored to a pre-drilled printed circuit board (PCB) by through-hole mounting before its pins are soldered onto pads on the opposite side. Assembled THT display boards are generally encapsulated with clear or black-tinted silicone gels that flow around the LEDs to provide weather-proofing. Black tinted materials also help to enhance image contrast.

While the market for outdoor THT displays is expected to see a 13 percent compound annual growth rate over the next six years, analysts expect SMT technology's higher resolution to drive faster adoption, according to Transparency Market Research.

The basic architecture of SMT modules encloses a red, green, and blue LED into a single or multiple chip configurations that are then soldered or printed directly onto the PCB. Their compact architecture allows for smaller pixel pitches compared to. THT LEDs, and enables the higher image resolutions that helped establish SMT technology as a favored candidate for large indoor displays. The particular LED chip architecture and assembly technology also introduces new considerations when designing and assembling outdoor SMT displays.

More weatherable SMT displays

While LED chip manufacturers are working to enhance the outdoor stability of their products, innovators of advanced silicone encapsulants and coatings, such as Dow Corning, are also helping to enable more reliable, long-lasting performance for outdoor displays. The decision to choose a silicone encapsulant or coating depends on the design goals of a particular SMT display. Conformal coatings are typically applied in a thin layer to only one side of the display board to protect LEDs from outdoor environments. Encapsulants form a thick coat over the entire board to improve weatherability and impact protection and, ultimately, the display's durability. Clear, high-performance encapsulants can be applied either on top or around LEDs mounted on PCBs, enabling both excellent image quality and increased durability. Alternatively, black-tinted encapsulants dispensed around LEDs also provide outstanding protection.

As a class of materials, silicones can be fine-tuned to optimize cure time, hardness, and color. They also deliver greater physical flexibility compared to other encapsulant chemistries to counter mechanical strains from thermal cycling. More importantly, they deliver higher UV resistance than epoxies and other organic materials, and they exhibit significantly greater thermal stability. These properties are both becoming an increasingly important design consideration as outdoor SMT display applications expose encapsulant materials to ever higher temperatures. Silicones have demonstrated long-lasting, reliable physical performance from –45°C to 150°C. Most can also withstand short exposure to 200°C to support soldering operations.

In fact, many silicone products from suppliers enjoy recognition under subsections of Underwriters Laboratorie's UL 746 standard — and specifically UL 746B, where many grades demonstrate a relative temperature index (RTI) of 150°C. Recognition under this standard means a silicone can perform at that temperature for ten years before losing 50 percent of its important physical or electrical properties. Many silicone materials also commonly receive recognition under UL 94, which evaluates flammability, and UL 746C (F1), which indicates the material offers resistance to the UV and moisture exposure typically seen in outdoor applications.

Future displays, future silicones

Silicone gels, encapsulants, and coatings have delivered proven outdoor displays and signs protection for decades, and are widely recognized in highly demanding automotive, solar and energy applications. The weatherability, thermal stability, UV resistance, and tailorable formulation of these versatile materials make them the material of choice for SMT displays targeting outdoor applications. As the market for these displays evolves and expands, so will silicone technology. Today, industry leaders are collaborating closely with top display OEMs to innovate higher performing grades of clear durable encapsulants and coatings with improved thermal stability and LED chip compatibility that will further expand SMT design options in the years ahead. ECN

Comparing **touch switch technologies**

By **Steve Sheard,** ON Semiconductor

Specifying touch switches as an alternative to conventional electro-mechanical devices, such as pushbuttons, toggles, or membrane switches, is becoming increasingly commonplace in modern system designs within domestic, office, medical, and industrial spheres. The choice is between two core technologies when implementing touch switches, self capacitive or mutual capacitive sensing.

In recent years, engineer's approach to user interface development has radically changed. Touch-based sensor mechanisms now make up the vast majority of human-machine interfaces within the consumer portable electronics sector, as well as an ongoing proliferation into various other sectors. Among the products in which touch switches are starting to bring multiple operational benefits are white goods, cooking appliances, printers, PCs, game consoles, and vehicle infotainment systems. With this technology, OEMs are presented with a higher degree of design freedom. They can also develop products with strong appeal to consumers thanks to greater durability (resulting in longer operational lifespans), more aesthetically-pleasing external appearance, resilience against the environmental conditions to which they are subjected (waterproofing and ability to endure high temperatures, etc.), as well as the relative ease of keeping them clean. As engineers begin to grasp a better understanding about the key elements affecting touch switch technology, more effective product designs will be achieved and the quality of user interaction.

Self and mutual capacitive sensing

In reality, the majority of mutual capacitive sensing solutions are only a single detection, self-sensing implementation applied to 8 x 8 wire arrangements.

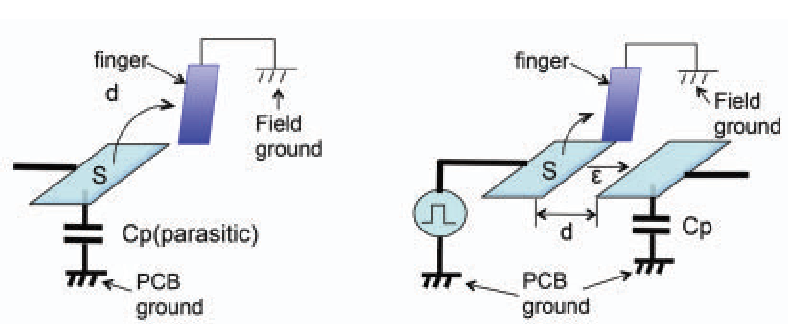


Figure 1: Comparison between self and mutual differential sensing (All images credited to OnSemi)

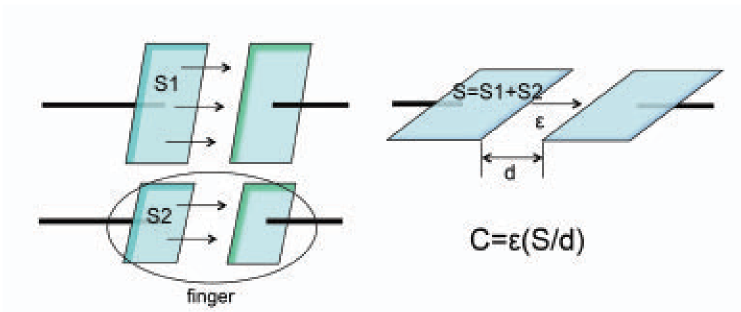


Figure 2: Simplified model of self-capacitive sensing.

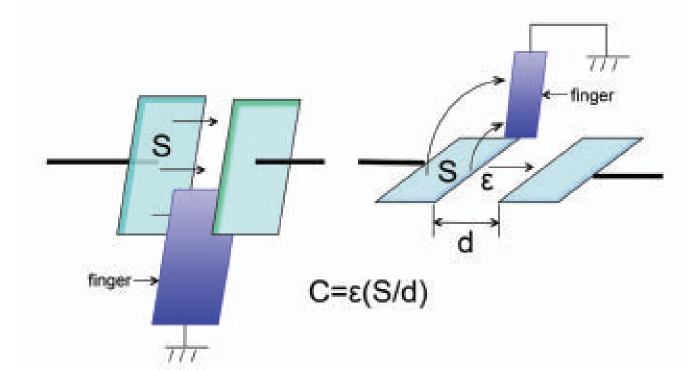


Figure 4: Simplified model of mutual differential sensing.

For self capacitive sensing arrangements, capacitance is formed between the sensor pad and the ground. When an object, such as a finger or stylus, comes into close proximity with the sensor, the capacitance begins to increase. With mutual differential sensing the capacitance is formed between the sensor and excitation pads. In contrast to self -capacitive sensing, when a finger (or some other object) comes closer to it, the capacitance decreases.

Self-capacitive sensing has two capacitances (signified by S1 and S2 in Figure 2). When connected in parallel, S1 and S2 are added together. Then total area S becomes S = S1 + S2. S increases, with the consequence that capacitance (C) is also raised. Under the condition that a constant current is applied, the gradient of voltage decreases proportionally as C increases. When a material is inserted, S will decrease and hence, C decreases.

When the user touches the sensing pad, C is added to parasitic capacitance (Cp). The total capacitance C, which is C = Cp + C, thereby increases.

$V = (i/C)t$

The time (t), to charge the capacitance (C) until the voltage reaches to Vt, is changed by the amount of C.

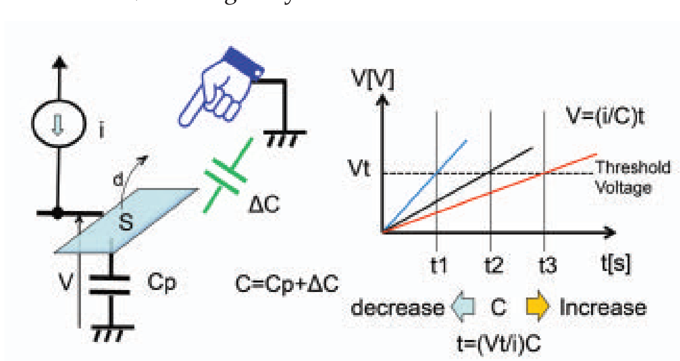


Figure 3: Quantifying a touch event using time of charge.

$t = (Vt/i)C$

From this, touch events can be determined and accurately quantified by measuring the time to charge (t) (Figure 3).

Mutual differential sensing offers better touch performance than self-capacitive sensing. The basic principle of this is when a finger comes closer to the sensor input pad (CinX) the line of electric force emitted from the excitation pad (Cdrv) is terminated. It reduces the number of lines of electric force, with the capacitance between Cdrv and CinX decreasing to some degree (this is signified by ΔC).

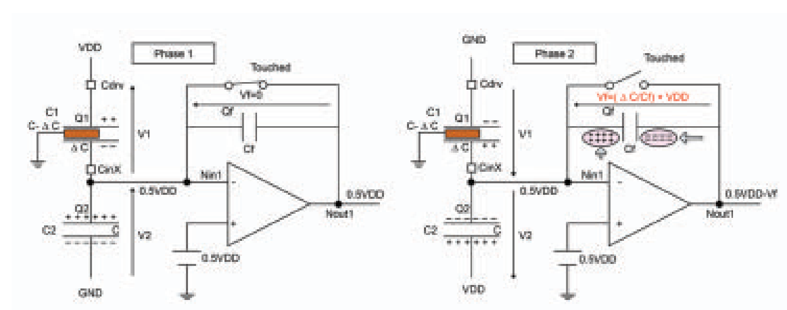


Figure 5: Operation of CV amplifier when touch event occurs on sensor pad.

The change ΔC is detected and converted into voltage, Vout, which relates linearly to ΔC. It is possible to detect touch events by measuring Vout. When it exceeds threshold voltage (Vt), then a registered touch event takes place.

The CV amplifier realizes the CV conversion through a state change of two-phase (Phase 1, Phase 2) that are synchronized to Cdrv signal. Figure 5 shows the circuits of CV amplifier when the finger is not touching the sensor pad. Since sensor capacitance (C1) does not change (C1 = C), reallocation of charge among C1, C2, and Cf does not occur between in Phase 1 and in Phase 2. As the result, amplifier output is also unchanged, it remains zero (Vf = 0).

Since a part of the lines of electric force are terminated by a finger, sensor capacitance C1 decreases (C-ΔC). Because of this change, reallocation of charge among C1, C2 and Cf occurs between in Phase1 and in Phase2. As the result, amplifier output decreases.

$Vf = (\Delta C/Cf)VDD$

The upshot of mutual differential sensing is that detection of the changes in the capacitive field is quicker and more precise,

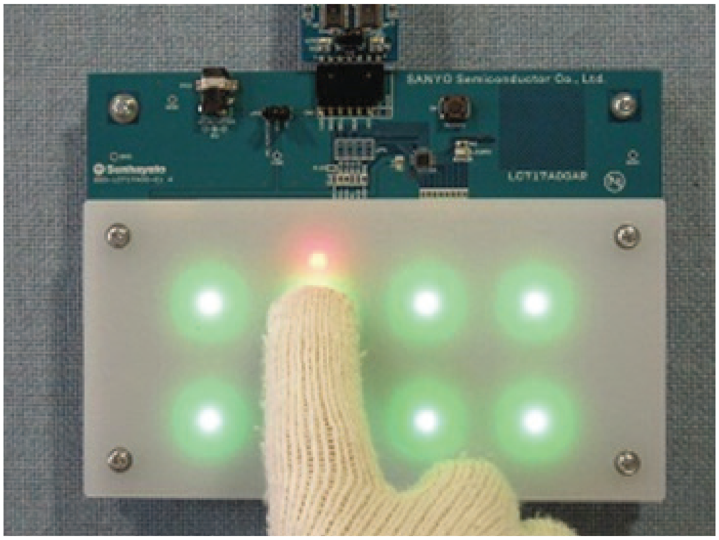


Figure 6: Operation of touch switch while wearing gloves.

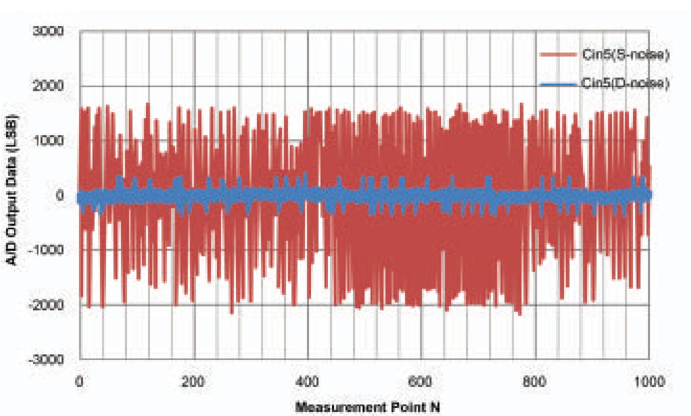


Figure 7: Superior noise performance of mutual differential sensing.

resulting in better sensitivity levels.

Since differential detection offers much better signal-to-noise ratio over single detection, it permits operation using a gloved hand (as shown in Figure 6) something that can be highly advantageous in industrial applications or outdoors in the winter. Furthermore, differential sensor deployments are less susceptible to electro-magnetic interference (EMI), making them better suited to demanding application scenarios, such as automotive and industrial (Figure 7).

The superior noise rejection supported by differential sensing allows more flexiblity in the sensor pattern utilized. Long routing sensor patterns can be tolerated, as the CV amplifier can cancel out Cp through negative feedback. The improved noise rejection offered by this approach also means that it is possible to amplify small differences in capacitance. This allows simplified sensor implementations to be achieved without the need for adhesive between the overlay and sensor PCB resulting in substantial cost savings.

As engineers begin to recognize the full appeal of contemporary touch switch solutions, these devices are certain to see greater uptake and their true potential will be realized. It is clear however that ensuring the suitability of sensing technology utilized can have major implications on the effectiveness of the user interface that results. A wide range of factors and design issues, including power consumption, susceptibility to EMI, response time, available engineering resources, time-to-market, and system integration, need to be given extensive consideration when looking to deploy touch switches. ECN

Multi-display controller board designed for driver desk displays

MEN Micro Inc. (Blue Bell, PA) now offers the CC10S, a multi-display controller board based on a Freescale ARM i.MX 6 Series processor. Providing full HD resolution to LCD TFT panel PCs from 7 to 15 inches, the CC10S combines graphics and a compact form factor that make the board a good choice for driver desk displays or in-seat infotainment in trains or public buses, as well as for medical devices and HMIs in automotive applications. The module is scalable from low-end to high-end graphics requirements, depending on an application's needs. Its Cortex-A9 architecture supports different types of the i.MX 6Solo, 6DualLite, 6Dual, and 6Quad processor families. Features include:

- Dual-channel LVDS with a maximum resolution of 1920 x 1200 pixels.
- Onboard memory of up to 4 GB DDR3 SDRAM and a soldered eMMC.
- Up to 1080p60 decode, 1080p30 encode, and 3D video playback in HD.
- -40°C to +85°C operating temperature.

For more information, visit www.menmicro.com.

Signaling tester provides multi-operator support

Anritsu Company (Morgan Hill, CA) announces that its MD8475A signaling tester with SmartStudio Manager Windows-based control software now provides multi-operator support for Commercial Mobile Alert System (CMAS) Carrier Acceptance Test (CAT) packages. With the capability, the tester is a comprehensive solution for analyzing CMAS, providing device manufacturers with the necessary CAT test capability to verify that their wireless devices are correctly receiving emergency cell broadcast messages and properly alerting users based on the messages' contents and severity. Three separate CAT packages are available, allowing the platform to specifically address the ecosystems of leading North American carriers. Features include:

- 2G, 3G, and LTE radio technology support.
- A complete network-in-a-box, simulating the radio access as well as the core network and server functions.
- Support for LTE, LTE-Advanced, W-CDMA/HSPA/HSPA Evolution/ DC-HSDPA, GSM/EGPRS, CDMA2000 1X/1xEV-DO Rev. A, and TD-SCDMA/TD-HSPA.

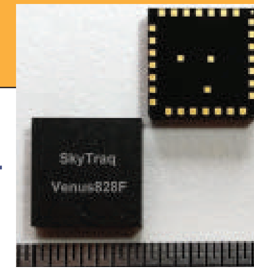
For more information, visit www.anritsu.com.

VCO features typical phase noise of -102 dBc/Hz @ 10 KHz offset

The CVCO55CXT-5685-5780 VCO (Voltage Controlled Oscillator) from Crystek (Fort Myers, FL) operates from 5685 MHz to 5780 MHz with a control voltage range of 0.3 V~4.7 V. This VCO features a typical phase noise of -102 dBc/Hz @ 10 KHz offset and has excellent linearity. Output power is typically +0 dBm. The model is packaged in the industry standard 0.5-in. x 0.5-in. SMD package. Features include:

- Input voltage of 5 V.
- Typical current consumption of 25 mA.
- Pulling and Pushing that are minimized to 0.5 MHz and 1.5 MHz/V, respectively.
- Second harmonic suppression of -30 dBc typical.

For more information, visit www.crystek.com.

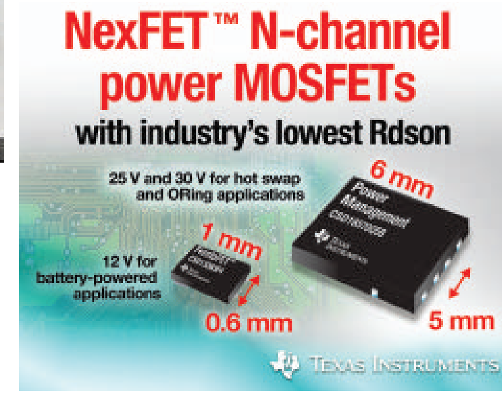


Receiver module offers small form factor

SkyTraq Technology Inc. (Hsinchu, Taiwan) introduces Venus828F, a stand-alone multi-GNSS receiver module in small 7mm x 7mm form factor. It works with multiple satellite systems and tracks up to 28 satellites concurrently. Designed with the performance and footprint in mind for wearable and IoT applications, the module integrates all the necessary components forming a complete working GNSS receiver, including GNSS chipset, 0.5ppm TCXO, Flash memory, LDO regulator, DC/DC switching regulator, and passive components. It only requires external antenna and power supply to output accurate position/velocity/time information in standard NMEA-0183 format. Features include:

- Low power consumption, 29sec cold start TTFF, and -165 dBm tracking sensitivity.
- 10 nsec 1PPS timing accuracy, on-board geo-fencing, and 8 Mbit ~ 512 Mbit external SPI Flash data logging.
- Industrial operating temperature range of -40 to +85°C.

For more information, visit www.skytraq.com.tw.



N-channel power MOSFETs achieve industry's lowest resistance

Texas Instruments (Dallas, TX) introduced 11 new N-channel power MOSFETs to its NexFET product line, including the 25 V CSD16570Q5B and 30 V CSD17570Q5B for hot swap and ORing applications with low on-resistance (Rdson) in a QFN package. Features include:

- TI's new 12 V FemtoFET CSD13383F4 for low-voltage battery-powered applications.
- A 0.6 mm by 1 mm package.

For more information, visit www.ti.com.

3 trends in passives for 2015

How polymer and hybrid capacitors, high density resisters, and higher current magnetics are changing passives.

By Larisa Miles, Newark element14

Like any evolving technology in recent years, the electronic components industry has seen a shift toward passive components that are smaller, more reliable, and more powerful. Distributors and manufacturers are heavily investing in the development of these features, and we will see three distinct trends in passives continue to play out in 2015 as a result. Higher density resistors, higher current magnetics, and polymer and hybrid capacitors will take center stage in 2015.

Polymer and hybrid capacitors

Polymer and hybrid capacitors have made their way into industries ranging from IT to automotive for several reasons: they are compact, offer higher ripple currents, operate at lower ESRs, and last longer. Moreover, polymer capacitors offer an additional competitive edge in regards to stability, safety, and overall lifecycle cost.

Needless to say, the design implications of polymer and hybrid capacitors are countless. For example, polymer capacitors have great frequency characteristics with a lower ESR. Polymer capacitors also have lower impedances at their resonance point. This in turn reduces AC ripples in power circuits and, in many cases, reduces peak-to-peak voltage changes by up to five times when compared to tantalum capacitors.

Additionally, hybrid capacitors can offer greater stability. In their most common operating environments, conditions in which frequencies are high and temperatures are low, hybrid capacitors can keep a stable capacity against the more conventional liquid electrolytic capacitors that will experience a drop in performance. Relatedly, polymer capacitor capacity does not drift in response to temperature changes. This is a major advantage over ceramic capacitors, which are known to experience instability. For industrial and automotive industry applications, in which operating temperature is much more likely to fluctuate, this feature is critical.

Finally, polymer and hybrid capacitors offer engineers enhanced safety. Conventional tantalum capacitors, which normally de-rate in use by 30 to 50 percent from their labeled voltage in order to ensure safer operations. This results in upsized capacitors and increased costs. Hybrid and polymer capacitors offer better endurance against and resistance to higher temperatures, in addition to a higher tolerance for large ripple and inrush currents. On average, this leads to a 20 percent reduction in cost by boosting the overall capacitor lifecycle, and a 50 percent cost savings compared to aluminum capacitors.

High-density resistors

These components can better operate in the increasingly restricted space that is the reality of electronics design today. Device embedded substrate technology makes high density mounting possible by laying out components in three dimensions, embedding electronic devices into a substrate, or leveraging printing technology. The demand for higher density mounting has also led to the demand for higher power at traditional product sizes.

Higher current magnetics

Changes in cell phones, cameras, and disk drives have influenced the need for high-performing, smaller-sized inductors. While high-current designs do generally lean toward solutions and packages with larger footprints, emerging applications are managing the best of both worlds.

Chip SMD inductors are designed specifically for power management applications and their small size makes them ideal for low power needs. Downsizing limits the maximum current level and is also suited for the low profile and miniaturization applications within the magnetics market. At a basic level, choosing the right supplementary design materials can also help to manage larger footprints without compromising higher currents. ECN

Graphene-based supercapacitors: The future of electric cars

A new discovery could boost the power and range of electric vehicles.

By Janine Mooney, Editor-in-Chief, Wireless Design & Development

A breakthrough in nanotechnology research could result in electric cars that are powered by their own body panels.

Electric vehicles rely on lithium-ion (Li-ion) batteries for propulsion. Researchers at the Queensland University of Technology (QUT) in

Queensland University of Technology's Professor Nunzio Motta with one of the university's powerful nanotechnology microscopes. (Photo credit: Erika Fish, QUT)

Australia are looking to change that using lightweight, graphene-based supercapacitors. The discovery was made by Postdoctoral Research Fellow Dr. Jinzhang Liu, Professor Nunzio Motta, and PhD researcher Marco Notarianni from QUT's Science and Engineering Faculty, and PhD researcher Francesca Mirri and Professor Matteo Pasquali, from Rice University in Houston.

Electric car companies are still working on improving the capacity of Li-ion batteries, but if QUT researchers have anything to do with it, Li-ion batteries in electric vehicles may soon be a thing of the past. The researchers are confident this new technology could dramatically boost the power and range of all-electric vehicles, blowing Li-ion batteries out of the picture completely.

Conventional supercapacitors offer only 28 watt-hours per kilogram, which is much less than the average 200 watt-hours per kilogram held by Li-ion batteries. The new graphene-based supercapacitors hold just eight to 14 watt-hours per kilogram, even less than conventional supercapacitors.

Graphene-based supercapacitors have substantially higher power density and are made from flexible material that can be structured and molded to become part of the vehicle's body. Because the material is made up of one single atomic layer, the material is much lighter.

The supercapacitors are made from a "sandwich" of electrolytes placed between two strong sheets of graphene that allows them to release energy in a much shorter period of time than conventional Li-ion batteries. The flexible material allows the supercapacitors to be embedded in the vehicle's body panel and it can actually store energy that can be used to both accelerate and supercharge the vehicle. The graphene-based supercapacitors also boast the ability to operate at higher frequencies because of its naturally high conductivity. The hope is that researchers can, one day, develop graphene-based supercapacitors that can store more energy than a regular Li-ion battery, and the Li-ion battery will be omitted from the design completely.

Marco Notarianni, a QUT researcher says, "Vehicles need an extra energy spurt for acceleration, and this is where supercapacitors come in. They hold a limited amount of charge, but they are able to deliver it very quickly, making them the perfect complement to mass-storage batteries. Supercapacitors offer a very high power output in a short time, meaning a faster acceleration rate of the car and a charging time of just a few minutes, compared to several hours for a standard electric car battery."

As for the automotive industry, this technology has many benefits, particularly financial and environmental. The carbon materials are cheap, which will make the supercapacitors and the price of industry scale production low. The price of Lithium is high, therefore the price of Li-ion batteries will not decrease much over the next couple of years. Graphene is essentially just graphite, which is a form of carbon and environmentally friendly, unlike most other forms of energy storage. The graphene-based supercapacitors do not rely on metals or other toxic materials, so they can be disposed without harming the environment.

Electric vehicles aren't the only application for these supercapacitors, as the technology could potentially be used for rapid charges in other battery-powered devices.

Rice University scientists claim the supercapacitors could be important for portable, flexible electronics as well. For instance, mobile electronic devices can be powered by supercapacitors, and the results will be far better than those from the current Li-ion batteries. The phones will actually charge faster and much quicker with the use of supercapacitors.

The potential uses for this technology are endless, including seeing supercapacitors being designed into some vehicles. One Chinese company uses them for energy recovery systems in buses. When the bus brakes, energy is stored and then converted to power.

So what does the future hold for graphene-based supercapacitors? Once the efficiency and energy density increasest, the technology will surely take off, especially with the increase demand for energy. It wouldn't be a surprise if in five to 10 years this technology is incorporated into multiple consumer and industrial applications, from electric cars to electronic devices. The lightweight dimensions of the material, along with the elastic properties and mechanical strength, not to mention the low-cost of production, all help position this technology for a bright future. ECN

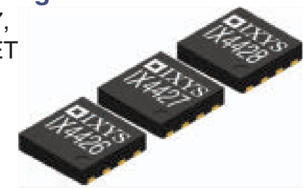

Online tool complements Microwave/RF Assembly Builder

W. L. Gore & Associates (Landenberg, PA) has introduced an online tool designed to complement the existing GORE Microwave/RF Assembly Builder. The new GORE Microwave/RF Assembly Calculator is used to calculate insertion loss, VSWR, and other parameters of assemblies for different cable types. The Calculator is particularly useful when the initial cable type is unknown and needs to be specified independent of the connector. Features include:

- A main Calculator section, which enables the user to select a market (Aerospace and Defense, Spaceflight, Test & Measurement) and category (General Purpose, Ruggedized and Phase Stable, etc.).
- A conversions page with everyday conversions, including distance, frequency, power, temperature, VSWR/return loss, and weight.

For more information, visit www.gore.com.

Dual 1.5A MOSFET gate drivers come in small DFN package



The IX4426, IX4427, and IX4428 MOSFET gate drivers from IXYS (Milpitas, CA) come in a small 3x3 DFN package. The outputs of the IX4426/7/8 M are capable of sourcing and sinking 1.5 A and can switch a 1000 pF load in less than 10 ns. For higher current requirements, the two outputs can be paralleled for a total of 3 A peak sourcing and sinking current. The IX4426/7/8 M devices have an operating voltage range of 4.5 V to 35 V. The inputs are TTL and CMOS compatible and are virtually immune to latch-up. Features include:

- A 3 mm x 3 mm DFN package.
- Almost twice the power dissipation capability while needing only 20 percent of the PCB area.
- An extended operating temperature range of -40°C to +125°C.

For more information visit www.ixys.com.

JOSHUA ISRAELSOHN | DIRECTOR JAS TECHNICAL MEDIA , @IZ_TECH

Smart meters and the data-directed grid

Smart meters are physically located on the periphery of smart grids, but from a data perspective, they are at the heart of data-driven electric-energy distribution systems. At a time when computational resources are small, cheap, readily available, and easily deployed, smartness isn't the most salient smart grid feature, data-directedness is.

Grid-power distribution networks service large, growing, and highly dynamic loads with transmission — and distribution-infrastructure equipment that provide service lifetimes as long as 35 years. Such long operating periods paired with high equipment costs means that electric-energy providers must make equipment selection and deployment commitments in the context of timescales that far outstrip even the most far-reaching energy-demand forecasts. Consequently, with aging power infrastructure in much of the developed world, grids experience growing strain that can reduce customer power-supply reliability and provider-cost predictability.

Illustrative of this trend, the increase in US electricity demand has significantly outpaced population growth over the 60-year period from 1950 to 2010. This trend continues with some degree of mitigation in the last decade after significant efforts by the electronics industry to improve energy efficiency and campaigns to encourage energy-use awareness among end-users.

Annualized grid-utilization data, however doesn't tell the whole story. Electric energy demand peak-to-average ratios (PARs) have been climbing, according to the U.S. DOE's Energy Information Administration. For example, the New England region's peak electrical-energy demand hit 89 percent above its average in 2010 and Southern California peak struck 96 percent above its average in the same year (Table 1). Since then preliminary data suggest PARs beyond 2.00 in both areas.

Consequently, grid capacity has to exceed twice the average utilization. Basic economics have run in opposition to the old central-generation model of electric-power production. The alternative is distributed generation, requires active management that, at the network level, is driven by real-time geographically specific data. Intelligence on that topic derives from more spatially fine-grained sources, with smart meters being the obvious choice.

In the beginning… or sometime thereafter

More than a century after the first true watt-hour meter entered the electric-utility equipment market in 1889, meter makers introduced the earliest electronic (non-electromechanical) meters. The first electronic models brought the promise of expanded functionality beyond simply totalizing energy use for monthly billing.

Electronic metering resulted from advances in integrated ADC designs and semiconductor processes that made single-chip multiple, synchronized ADCs possible. The ADC advancements also increased conversion rates and resolution sufficiently to satisfy utility metering requirements. Since then, those requirements have broadened as metering standards expanded to accommodate comparatively wideband artifacts. These terms have become increasingly important as the load profile moved away from tungsten lighting devices, which do not degrade the line power factor, and non-switching motor controls, for which simple capacitive power-factor correction suffices.

The proverbial last mile

Since metering technology has addressed the broader scope of measurements, the measurement function is not necessarily the primary challenge to smart meter designs. For example, deployments do not allow for a one-technology-serves-all approach to the communication link, so manufacturers must often take a modular approach, particularly in selecting physical media and communication protocols for last-mile service.

Utilities exploit a variety of communication technologies for data transfer and control signaling between the distribution system's head end and individual customer locations. As in other large scale point-to-multipoint networks, such as those for telephone, internet, or video services, utilities consider a variety of factors when choosing communication technologies for smart-meter deployments. These include terrain, population density, and access to various physical media. Available physical media and communication technologies include wire-line, fiber, radio mesh, and cellular networks. Notable is that these include both utility-proprietary and public-network infrastructure — an issue that affects implementation and operating costs as well as data security requirements. Some deployments take advantage of IEEE 802.15.4g Smart Utility Networks or EN 13757 M-Bus.

In locales where smart meter rollouts have enjoyed large market-penetration rates, smart meters provide energy use data logs between once and four times per hour. Aggregated data helps coordinate distributed power-generation capacity with demand in ways that reduce stress on transmission and distribution networks, where generation resource and load distributions allow. In this regard, intelligence gleaned from smart-meter data flows can dynamically drive smart-grid-resource allocations in real or near-real time. The fine granularity of temporal and geographic energy-use data coupled with sensor-based monitors on transformers and switches also allows utilities to maintain awareness of patterns of use; health of distribution-equipment; and status of solar, wind, and other renewable power-generation resources.

Failure to communicate

Given importance of smart metering in realizing the full value and capability of smart grids, the electric-power distribution sector needs to address technical marketing issues, not just technology issues. Customer perception has reached sufficiently low points as to engender ratepayer resistance to smart-meter deployments.

One issue, data security, is an oft-mentioned concern. Utilities frequently claim they use encryption methods similar to those employed for banking transactions. This, however, may offer little consolation to consumers who read with worrisome regularity of credit card data security breaches, such as those at Target and Home Depot or the massive data security failure at Sony. To those well steeped in data security practices, these examples may not be interchangeable with risks to energy use data, but to the average ratepayer, the distinctions are likely less than apparent.

Another issue, raised by a small, but loud cadre of RF-phobes is that of exposure to radio frequency energy emanating from smart meters.

Region	PAR			Year		Trends		
	Min	Max	2012	Min	Max	Avg	Peak	PAR
New England	1.52	1.89	1.78	1996	2011	↓	↔	↑
New York	1.56	1.83	1.75	2004	2006	↔	↔	↔
Mid-Atlantic	1.52	1.82	1.74	2000	2006	↔	↑	↑
Midwest	1.56	1.77	1.76	1994	2006	↔	↑	↑
Southeast	1.63	1.78	1.75	2003	2005	↑	↑	↔
Texas	1.70	1.84	1.80	1994	2003	↑	↑	↑
Southern CA	1.76	1.96	1.84	2003	2010	↓	↓	↓
Northern CA	1.61	1.87	1.73	1994	2010	↓	↓	↓
Northwest	1.45	1.71	1.47	2003	2011	↔	↔	↔
Min	1.45	1.71	1.47	Data source: US Energy Information Administration				
Max	1.76	1.96	1.84					

Table 1: U.S. grid power: average, peak, and PAR data, 1993 through 2012 (Data source: Energy Information Administration, US Department of Energy)

These groups often quotes WHO statements — that they've evidently not read —about RF exposure and its relationship to human health.

WHO states that current research literature reports no correlation between long-term exposure to low-level RF fields and human health problems.

Meanwhile, studies of smart meters that use RF links indicate that, when active, they emit no more RF energy than a cell phone — often less. Due to their low duty cycles, their transmitters are typically active for a total of no more than three minutes per day. Additionally, rarely does one see a homeowner or business operator with their head pressed against their electric-energy meter. Please send pictures if you do.

The behavior of technical markets, however, is not that different from nontechnical ones, where perception all too often is reality. The industry has done a poor job in answering either concern effectively, as frivolous as they may seem to insiders. Most of the utilities' statements I've found on these topics have appeared either on company or industry-association websites or in fliers like those that accompany monthly energy bills. Admittedly, mine has not been an exhaustive search on the subject, but what I've found thus far reminds me that if McDonalds only placed their advertising messages on hamburger wrappers, they'd still be looking forward to serving their first million.

MODERATED BY JASON LOMBERG
DIGITAL EDITOR

Military

Doubling DSP efficiency with high-performance SRAM

By Suhail Zain, Director of New Product Development Strategic Marketing for Aerospace & Defense, Cypress Semiconductor Corp.

With well-defined architecture and deterministic processing, DSPs accelerate the performance of a wide range of military and defense applications, including radar, software defined radio (SDRs), aircraft imaging, and target detection systems. By removing memory bottlenecks by using high-performance quad data rate (QDR) SRAM as compared to traditional SDRAM, overall DSP system can be doubled.

Applications like radar systems use DSPs to perform compute-intensive functions, such as pulse compression, signal filtration, and pulse modulation. The efficiency of DSPs enables these systems to accurately detect objects at long range. A primary difference between DSPs and general-purpose microprocessors is how DSP architectures are designed for the fast mathematical calculations most commonly used to design filters like FFTs and FIRs.

Two main hardware approaches are used for implementing DSPs: programmable DSP processors and field programmable gate arrays (FPGAs). DSP processors, like TI's multicore DSP processor, have specialized hardware to compute multiplication operations in one cycle. The instruction set of modern DSP processors allows programmers to specify several parallel operations in a single instruction. These efficient instructions often require multiple memory transactions to be made in parallel with the main arithmetic operation. Furthermore, advanced DSP architectures now include additional multipliers and adders that encode parallel operations in a single instruction.

FPGAs like Xilinx's Virtex efficiently implement algorithms using dedicated hardware-based functions, such as multiply, multiply accumulate, add, shift, compare, bit-wise logic functions, and pattern detect. More complex functions are implemented by cascading multiple blocks together.

Addressing memory throughput requirements

Because each DSP instruction can access memory multiple times, high-memory bandwidth is essential to maximizing DSP performance. DSP processors and FPGA-based DSP blocks use an internal cache memory architecture (L1/L2) to enable multiple memory accesses per cycle. A super Harvard architecture can be used when there are separate instruction and data memory banks. With this arrangement, the processor can fetch instructions and data operands in parallel, every cycle.

Because DSP-based algorithms typically access memory in a predictable pattern, throughput is dependent upon how well the memory can fit the pattern. For example, FIR filter coefficients are accessed sequentially and in a circular fashion. For deeper external storage, hardware-based external memory interfaces (EMIF) supporting various SDRAM memories (DDR2/3, RLDRAM) are typically employed. To improve DSP performance by a factor of 2, a new and innovative technique using QDR SRAM for external storage can be implemented.

QDR SRAM is a high-performance memory device optimized for high throughput. These memories have multiple independent data ports equipped with double data rate (DDR) interfaces. Port accesses are concurrent and independent of each other. The address bus is common and runs at either single or double data rate, depending upon the configuration. The highest density product available today is 144 Mbit and can be configured as either x18 or x36.

The benefit of using QDR-IV SRAM can be shown in an SAR radar application. SAR radars observe the earth's surface in high resolution. They need corner-turn memory access where the range direction and the azimuth direction are transposed for reconstruction processing. This is done for efficient FFT and IFFT (DSP) execution between range and azimuth compress processing. The architectural benefits of QDR SRAMs can improve SAR radar's performance by allowing fast and uniform memory access times.

Using a conventional SDRAM memory, writing of the SAR picture data ends up in a discontinuous address space, leading to a reduction in processor performance (in this case, estimated at roughly five times). QDR-IV's independent ports for reading and writing enable concurrent operations and random memory access, mitigating this processing penalty.

QDR SRAMs provide a beneficial performance alternative to conventional SDRAMs for off-chip data storage in DSP-based applications. QDR SRAM density limitations can be mitigated by cascading multiple devices. This approach is ideal for applications where higher throughput with random access is required to speed memory access and improve overall DSP performance.

Environmental improvements to passenger aircraft drives component innovation

By Julian Thomas, Engineering Director, TT Electronics Power & Hybrid

Civil aircraft that are quieter and more economical will deliver benefits for operators, travellers, communities on the ground, and the environment. Technology advancements hold the key to progress, according to initiatives such as Europe's Clean Sky joint undertaking. Improvements being considered include not only new materials and aerodynamics, but also changes that will drive increased use of electrical technologies in the aircraft of the future.

Robust processes for silver sintering overcomes issues associated with melting conventional solder-based interconnects. (Image source: TT Electronics)

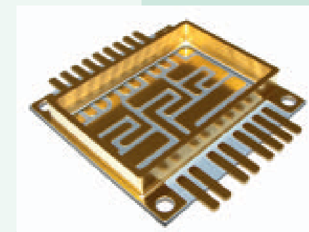
Some of today's most modern aircraft are already implementing advances, like "bleedless architecture," which replaces traditional engine-driven pneumatic systems like wing ice protection and cabin air conditioning with more lightweight and efficient electrically driven alternatives. In addition to improving fuel economy, this architecture reduces noise- and drag-to-weight ratio.

The electrification trend places extra demands on the design of the aircraft's electrical architecture and systems. More electrical power is required, which demands a new approach to the entire electrical design. One example can be seen in the use of multiple remote power distribution units, which help minimize the overall weight of the electrical infrastructure. In addition, new electrical subsystems must be designed to operate safely and reliably in the harsh aircraft environment as well as wide-ranging temperature extremes – from -60°C to more than 200°C, and rising to 300°C in the future as equipment is located closer to the engines. Other hazards include high levels of vibration and a risk from lightning strike.

Fast-acting solid-state power controllers (SSPCs) improve protection against surges caused by ESD events, such as lighting strikes, by replacing slower-acting mechanical circuit breakers. SSPCs have response times on the order of nanoseconds, compared to the typical 100 µs actuation time of a conventional circuit breaker and are now feasible for aircraft applications thanks to new silicon carbide (SiC) technology. SiC devices in ratings high enough to divert short, high-energy transients away from sensitive electronic circuitry are significantly smaller than conventional silicon devices and subsequently enable SSPCs to become smaller and lighter than mechanical circuit breakers. A number of active SiC development programs focus on high-reliability assembly and including packaging for ±270 V SSPCs. Work is also being done with SiC device manufacturers using the latest fabrication technologies to drive improvements in thermal characteristics and thus increase system performance and reliability.

Where electronic modules are deployed in the harshest environments, such as within close proximity to the engine, extremely high-peak temperatures can promote unwanted chemical interactions between materials used in the assembly or with gases in the immediate environment. It can also melt conventional solder-based interconnects and exacerbate known issues such as differential thermal expansion. Solving these challenges can require extensive research in order to identify combinations of materials that will coexist benignly and develop suitable assembly processes.

In general, greater reliability is the overriding target of today's advanced design projects as typical commercial aircraft become increasingly dependent on electrical systems to perform important functions. Even where systems are not directly exposed to extremely high temperatures, improving thermal characteristics helps to enhance reliability. TT Electronics has developed a process to enhance power-module reliability by helping maintain co-planarity and robustness of the interface between the baseplate and substrate where ensuring correct alignment has always been a challenge. Innovation by our engineering teams now allows this technique to be used in aerospace applications, achieving high quality, high production yield, and extending life. Increasing the energy efficiency of high-power modules, through advanced device and circuit design, also helps improve thermal performance and hence reliability, by minimizing internal power losses and dissipation.



Silicon Carbide (SiC) technology enables smaller, lighter devices to improve safety and reliability in aircraft electronic circuits. (Image credit: TT Electronics)

Also, with increasing electrification, the importance of in-house environmental testing, such as accelerated life tests and environmental stress tests, is growing. The data gathered provides vital process validation and information that can be used to direct future research and thereby help to reduce time-to-market.

The drive for more efficient and environmentally friendly aircraft is opening exciting new frontiers in the design of high-reliability electronic devices and systems for aerospace applications. Current progress suggests everyone can look forward to safer, quieter, and more economical air travel.

Q: What driver assistance system will change the way we drive?

Davide Santo, ADAS Microcrontroller Product Line Manager at Freescale Semiconductor

On long drives, I often fantasize about my car taking the wheel — monitoring the distance between cars, adjusting speed, and steering automatically — while I take in the view and spend time with family.

As a Freescale engineer and an automotive enthusiast, these thoughts cross my mind on a daily basis. The road environment is populated with hazards — vehicles, people, weather, changing situations — and autonomous cars must be in constant communication with each other in order to keep the driver safe. From a communication/infrastructure perspective, which communication link and protocol will emerge to make this V2V/V2I system a reality?

Dedicated short range communication (DSRC) was conceived for auto in the form of 802.11p, which can theoretically handle up to 2,000 connected vehicles with a total bandwidth. Although contained and manageable, the absence of a standardized infrastructure has left the technical community skeptical of this technology.

LTE and 5G technologies bring the promise of capturing a large amount of data with shorter, more controlled latency. The technical community has raised questions whether 5G providers will allow part of their highly profitable bandwidth to be used to ensure safe operation, essentially trading safety for profit.

Even the common GPS signal can be challenging. GPS signals must secure a resolution of one meter or less, and the algorithms must use the statutory quality of the signal to be able to infer decisions before having a legitimate safety aspect.

Developing an electronic control unit (ECU) for autonomous vehicles implies using state of the art standards, like ISO26262, but product liability and legal relevance remain the holy grail. We need platforms that can enable multiple partners to develop products and innovative ideas behind the initial concept. It is not only the hardware but the entire ecosystem that counts.

Wim Van Thillo, Program Director Wireless Technologies, imec

Would you trust an autonomous car? Would you trust its extra pair of eyes identifying the objects all around, in all circumstances, including pitch-black night, heavy rain, or deep fog? Would you trust your car to adapt its speed and change lanes according to the traffic situation, and hit the brakes when a vulnerable pedestrian crosses your path? Sure, road users and insurance companies would need some time to adapt to it, but if I could choose between driving a car to the south of Italy myself, or leisurely being driven in my smart car (reading ECN magazine behind the steering wheel), I know what I would choose.

In the research institute where I work, we develop key technologies that enable autonomous cars. One of these is radar technology. It is based on the use of electromagnetic waves, the same we use for mobile communication. More specifically, it uses 79 GHz waves. When these waves are transmitted, they are reflected on the surrounding objects. If we can receive that echo and compute the distance the signal has traveled, we have a radar: a means to sense the objects around us.

Most of today's radar chips are fabricated in low volumes and in dedicated technologies that make them expensive. They are mainly used in military applications, but have begun to find their way into high- and mid-end cars. Our researchers make radar chips in today's mainstream chip technology so they can be mass-produced at low cost. Radars that are so small they easily integrated invisibly into a bike helmet, a detection camera, or in infrastructure such as automatic lights or door openers. In autonomous cars, the technology offers hundreds of integrated eyes and ears, and peace of mind, ensuring a safe and comfortable trip.

Jun Kawaguchi, Senior Business Development Manager, Toshiba America Electronic Components

Driver assistance and safety systems are constantly undergoing enhancements and adding functionality. Many convenience items, such as cruise control, have become standard on most passenger vehicles, while safety features, such as antilock braking systems and tire-pressure monitoring systems, are now mandatory.

The automotive industry is undergoing a major evolution in driver assistance systems as improvements in the underlying technologies make new developments possible. High-performance semiconductor and computing technologies, low-cost sensor technologies, advanced motor and actuation devices, and manufacturing technologies all enable driver assistance and safety systems that were previously cost-prohibitive or simply just not feasible to mass manufacture. Here are some of the most current developments in driver assistance systems.

Drive for safety

- Both active and passive safety systems will prevent, minimize and reduce the effects of an accident.
- New solutions — such as blind-spot detection, pedestrian detection, vehicle detection, and adaptive cruise control. All contribute to driver safety and reduce the burden on the driver.
- Automatic braking, also called automated emergency braking, can prevent or minimize injury and damage. Newer collision avoidance systems may go further, actually steering the car out of danger.

Drive for comfort

- Many driver convenience technologies are being developed to enhance the driver experience and contribute to overall safety. V2V enables vehicles on the road to communicate with each other, helping ensure safety, and providing various other services as well.
- Automated parking — thanks to various on-vehicle sensors and drive-train actuators, vehicles will indeed be able to actually park themselves. In addition to enhancing driver convenience, automated parking may also improve efficiency and save time by enabling the vehicle to valet park itself.

Don't drive at all

Technically, ensuring safety and proper operation under all imaginable road conditions is a challenge and autonomous vehicles will also need to meet various legal and administrative challenges.

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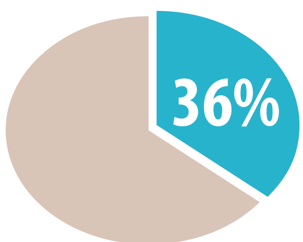
The White Board

The state of STEM

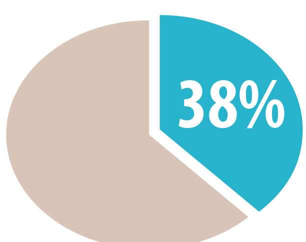
By Kasey Panetta, Editor

What exactly is the state of today's STEM education? We often hear about this study or that study in the news, but it's rare to see the statistics laid out in one place. When it does happen, it's astonishing how few students acknowledge, pursue, and maintain an interest in science, technology, engineering, or mathematics for long enough to establish a career. The gender gap within the field is a well known problem, but what about keeping the interest alive through high school and into college so those with an interest have an established path to their dream career? That won't be easy. The international competition is heavy and the U.S. will have to work hard to keep up.

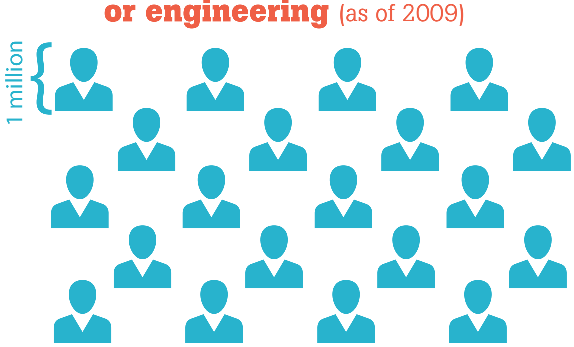
Only 36% of high school students are ready for college-level science



38% of STEM students won't graduate with a STEM degree



20 million people hold a degree in science or engineering (as of 2009)



How we stack up internationally:

26 nations outperformed the U.S. students in math

19 nations outperformed U.S. high school students in science

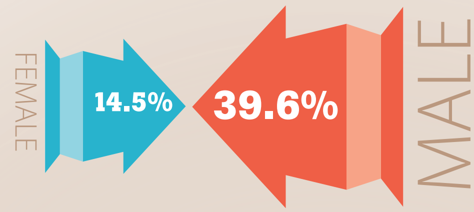
Where's the focus?

↑ Engineering + Technology are on the rise

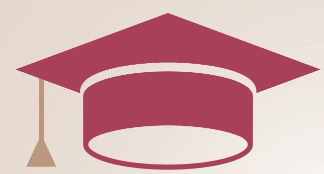
↓ Science and Mathematics are decreasing

Sources: National Math + Science Initiative, STEMConnector

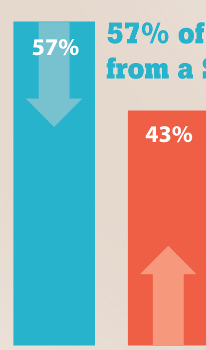
14.5% of female students express an interest in science versus 39.6% of male students



21% of high school seniors are interested in STEM



50% of those pursue a STEM-related college major



57% of high school students move from a STEM field to non-STEM career paths

43% maintain the interest

Preferred Fields:

Male students:
Mechanical Engineering,
Game Design/Development,
Computer Science

Female students:
Biology,
Chemistry,
Marine Biology,
Science

designed by Eileen Whitmore, Art Director