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CONTENTS SEPTEMBER 2011

BMW's Laser lighting can produce a near-parallel beam whose intensity is a thousand times greater than that of conventional LEDs. Laser headlights could have less than half the energy consumption of LED headlights, says the company. **16**

Chip vendors' struggles, strategies illustrate mobile TV's evolution

By Junko Yoshida

MOBILE TV WAS NEVER A BAD IDEA; it was just too narrowly targeted, aimed at cell phone users on the go. Increasingly, for the chip vendors supporting the market, mobile TV is about putting mobile receivers in anything you can think of—automobiles, media tablets, even set-tops for home TVs.

Siano Mobile Silicon (Netanya, Israel), a supplier of mobile digital TV receiver chips, recently announced a design win with an unidentified "major" German automobile manufacturer. The automaker is rolling out models equipped with Hirschmann Car Communication GmbH's new automotive TV reception system, which is powered by Siano.

In a recent interview, Siano CEO Alon Ironi made it clear the company is committed to the mobile TV market the world over. Siano's receiver chips are designed to support a range of digital TV standards, including DVB-T, used in Europe and Australia; the China Multimedia Mobile Broadcasting standard (CMMB); and ISDB-T, deployed in Japan and South America.

Siano is also expanding its target market well beyond mobile handsets, pushing its chips not just into automotive apps, but also into the home digital TV market in countries such as 2014 World Cup host Brazil.

Indeed, pursuing multiple standards and markets is becoming a matter of survival for some fledgling mobile TV chip companies. Once touted as the next big thing for phones, mobile TV seemed quickly to fade into oblivion, at least in the United States. Qualcomm shuttered its FLO TV operation last fall, and the Advanced Television Systems Committee's mobile DTV broadcast standard has yet to take off. Then last month, rumours began circulating that Telegent Systems Inc., a once-high-flying startup developer of mobile TV receiver chips for cell phones, was facing an uncertain future. Given Telegent's large engineering team in China, market watchers began to question whether even that country's enthusiasm for mobile TV was running its course.

Sources insist that the market remains healthy for digital mobile TV products based on the CMMB standard, which is backed by China's State Administration of Radio, Film and Television. Demand for analogue TV receivers, however, has waned. Telegent initially made its name by going against the grain; it released a mobile TV solution based on analogue technology, for which the infrastructure was already firmly in place. By the time Telegent floated a hybrid design, spectacular price erosion in China's highly competitive market left the company hard-pressed to turn a profit on the solution.

This summer, Spreadtrum Communications, a Shanghai-based fabless developer of baseband and RF chips for wireless communications, announced it had signed a defini-

> ## "Pursuing multiple standards and markets is becoming a matter of survival"

tive agreement to acquire Telegent, paying $1 million for the company.

Shortly after the Telegent acquisition announcement, Paris-based Parrot announced it was buying DiBcom, a leading mobile TV chip vendor headquartered in Palaiseau, a Paris suburb. Parrot, focused on the development of hands-free wireless systems for cars, motorbikes and scooters, is said to be interested in DiBcom's multistandard digital radio and DTV expertise - and its broad customer base - in the automotive market.

According to Parrot's July 28 announcement, the transaction included 15.9 million euros to purchase share capital and a net debt buyback (mainly convertible bonds initially) of approximately 12 million euros. Given the 60 million euros (approximately $80 million) that had poured into DiBcom by July 2007, the 15.9 million-euro share purchase price smacks of impatience bordering on desperation among DiBcom's investors.

According to Parrot, DiBcom is forecasting 2011 revenue of around 15 million euros, with a gross margin of approximately 45 percent; earnings before taxes and interest are expected to be in negative territory, at

–4 million euros. DiBcom has around 90 employees, roughly half of them in R&D, and has offices in Europe and Asia.

The fire sales at Telegent and DiBcom likely didn't do much to inspire confidence in mobile TV. But then came Siano's automotive design win announcement. Considering that DiBcom got its business off the ground through design wins in automotive apps, and that its new owner is interested in leveraging DiBcom's automotive technology and customer base, the Siano design win with the German automaker appears to bring developments in that segment full circle. Perhaps more surprising is that Siano's mobile TV chips are also being designed into home digital TV set-tops in Brazil, which has adopted Japan's ISDB-T broadcast standard. In the run-up to the 2014 World Cup scheduled in Brazil in 2014, Latin America is pushing the digital transition hard. Japanese chip companies such as Renesas Electronics already offer digital TV systems-on-chip integrated with ISDB-T demodulators. But Ironi claims Brazil is a growing market that offers opportunities for products at a range of price points. Siano is also expanding its business in the North American mobile ATSC market. While Ironi described the U.S. mobile TV broadcast market as "a risk," he said he's encouraged by U.S. TV broadcasters' push for it. Asked whether he believed mobile ATSC would ultimately become a huge market, Ironi said only that his company was investing in the technology, in exchange for $20 million in expansion capital financing secured in May from Jerusalem Venture Partners (JVP). Siano today claims to hold roughly 50 percent of the markets in China and Latin America for chip sets that allow the reception of digital TV on mobile, portable and handheld devices. The company thus far has raised $96 million, including four rounds of funding and the recent $20 million infusion from JVP. But juggling the multiple standards, varying regulatory considerations and differing deployment schedules of the far-flung geographical markets for mobile TV is a tall order. So expect some plot twists as Siano's mobile TV story plays out. ■

inside SECURE WINS PRESTIGIOUS GLOBALFOUNDRIES' LEADING IN INNOVATION AWARD

MicroRead NFC Product

Remy De Tonnac,
CEO of Inside Secure

"The GLOBALFOUNDRIES team is first rate, and has built a very effective working relationship with Inside Secure. We rely on GLOBALFOUNDRIES as a key partner and certainly recommend them to others."

"Inside has built a strong working relationship with GLOBALFOUNDRIES for more than 10 years and has introduced several generations of innovative products with them. We work closely together on IP and technology development. Our leading MicroRead NFC product line is poised for volume production in 0.35μm at GLOBALFOUNDRIES' Fab 2 in Singapore."

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News & TECHNOLOGY

Semikron rounds off e-mobility with motor company

By Christoph Hammerschmidt

COMPLEMENTING ITS DEVELOPMENTS in power semiconductors and driver modules for e-car motors, Semikron has acquired a company dedicated to designing and manufacturing motors for electric vehicles. With this set of engineering expertise and products, the company plans to tackle the emergent market for electromobility. Compact Dynamics is a small company based in Starnberg near Munich. The 70 engineers and manufacturing experts have significant experience in designing and producing KERS systems (Kinetic Energy Recovery System) for motor racing sports.

Along with parent company Semikron, Compact Dynamics now has a new target: developing and marketing complete power trains for electric vehicles. The company has designed a motor concept which General Manager Maximilian Eck believes is "disruptive". Based on a synchronous engine which includes the usage of rare earth materials, it offers a very high power density. "Despite all the problems the economy has with rare earth, it is not possible to reach such a power density and power weight with an asynchronous motor which would do without these materials", Eck said. Nevertheless, the Compact Dynamics design team has significantly reduced the rare earth content in comparison to competing designs, Eck said.

Compact Dynamics's design engineers managed to reach a high power density through advanced design concepts. In typical electric motors, the winding head makes up 15 to 30 percent of the stator length. Since this winding overhang does not contribute to the torque of a motor, engineers try to reduce this unproductive part of the windings, but they rarely manage to get it below 15 percent of the length. Compact Dynamics has managed to design a motor with zero winding overhang. "In this axial flow motor, the windings for the copper coils are completely put inside the stator. For this reason, the entire copper cross section is contributing to the thrust," Eck said.

The ring closure of the external rotor is implemented in plastic instead of iron. This helps save material - the motor uses 40 percent less magnetic material than conventional engines. The secret around the implementation of such a construction is the company's elaborate manufacturing process, Eck claims.

Another strategic advantage is, according to Eck that the motor works at a relatively low voltage of only 60V. Thus, this concept makes expensive battery monitoring redundant and allows a tight integration of motor and control electronics. In turn, "squeezing a power of 20 to 40 kW out of such a small motor is only possible if you are good at integrating", Eck said. In addition, such a motor could be serviced at a normal garage. In contrast, the high-voltage motors currently designed into electric vehicles require a specific and costly garage infrastructure.

With Semikron as a parent company, Compact Dynamics has the ability to manufacture small to medium volumes. With this concept, the company plans to provide the motors for pre-volume vehicles. Once the motor is designed into a volume vehicle, production could be outsourced to a manufacturing service provider. "With this motor, we can talk directly to OEMs" believes Eck. The time seems right: in many places carmak-ers are searching urgently for competent partners who could provide the motor expertise for electric cars.

Recently a large player in the field of electrical motors succeeded to put his foot into the door or the automotive industry: Siemens announced it will build motors and power electronics for Swedish carmaker Volvo. ■
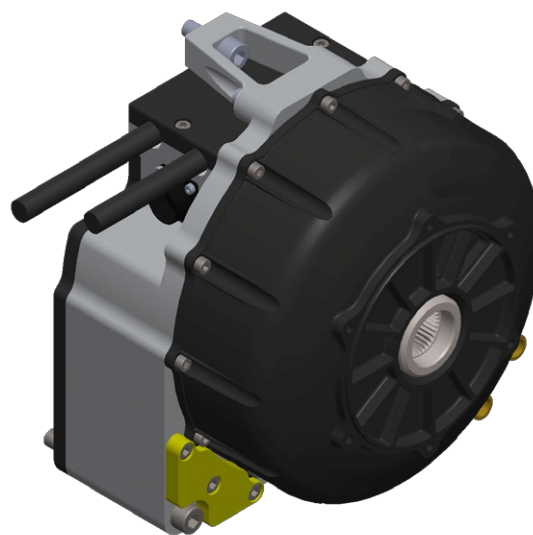

Fig. 1: The compact stator without wiring heads is key to high power density.

Fig. 2: Integrated power electronics and liquid cooling make a very compact motor for e-cars.

Power architecture gets a reboot

By Philip Ling

IBM IS BROADENING ITS Power architecture licensing program to include for the first time, a multi-use agreement that gives developers access to the entire lineup of Power cores with a single license.

Designers can now gain access to a blanket license for unlimited uses of the Power 470, Power 460 and Power 405 cores for a five-year period.

There will also be a new "no-barriers" license for the Power 405 core which drops the standard access fee. IBM will also work with Synopsys to make Power a staple architecture in university research and teaching for engineers. A synthesizable version of the Power 405 core will also be made available to qualified Synopsys University Program members at no charge.

The expanded program is intended to foster innovation using the Power 405 core for new applications around embedded intelligent systems. IBM also announced a Value added Reseller (VAR) agreement with C∗Core, the China-based designer of embedded-processor solutions, to expand market channels for Power architecture in China.

It is hoped that simpler access to Power technology will allow designers to more easily create embedded solutions for a range of applications, from supercomputing and games to networking and storage.

The Power Architecture is now being positioned for the smart-compute application landscape including embedded intelligence for machine-to-machine (M2M) communication and intelligent infrastructure for handling the vast amounts of data generated from billions of connected devices. ∎

Researchers aim for energy-harvesting CPUs

By Dylan McGrath

A TEAM OF RESEARCHERS from Virginia Commonwealth University (VCU) was awarded two grants totaling $1.75 million from the U.S. National Science Foundation and the Nanoelectronics Research Initiative of Semiconductor Research to create powerful, energy-efficient computer processors that can run an embedded system without requiring battery power.

The team of researchers replaces transistors with special tiny nanomagnets that can also process digital information, theoretically reducing the heat dissipation by 1,000 to 10,000 times, according to VCU. As engineers have shrunk the size of processors in accordance with Moore's Law, packing more and more transistors onto a chip, it has created a challenge in efficiently removing the heat that the transistors generate. Reducing the amount of heat dissipated when the transistor switches is considered to be the best approach to alleviating this problem.

According to Bandyopadhyay and Jayasimha Atulasimha, an assistant professor of mechanical and nuclear engineering in the VCU School of Engineering who serves as co-principal investigator on the project, this research could lead to a type of digital computing system ideal for medical devices such as processors implanted in an epileptic patient's brain that monitor brain signals to warn of impending seizures.
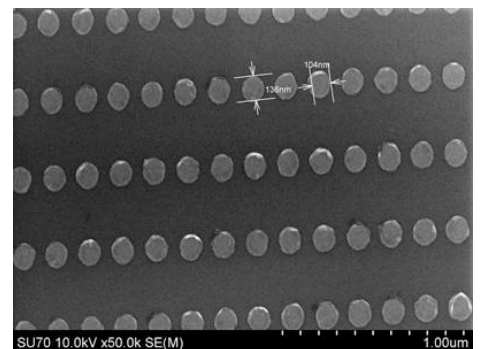
Scanning electron microscope image of tiny magnets with a diameter of ~100nm. Source: VCU.

This processor would run by harvesting energy only from the patient's head movements, without requiring a battery, they said. ∎

SD memory goes wireless

By Philip Ling

TOSHIBA ELECTRONICS Europe has announced that it will launch the world's first SDHC memory card with embedded wireless LAN functionality to meet the SD Memory Card Standard.

The new memory card, FlashAir, supports peer-to-peer transfers and uploads to and downloads from servers. It will initially be available in 8GB capacity.

At a time when digital cameras have achieved immense popularity, Toshiba believes users want a quick and easy way to share photographs with friends and to transfer them to and from online storage services and social media.

Its solution is the FlashAir, the world's first SDHC memory card with embedded wireless LAN functionality that is fully compliant with the SD Memory Card Standard. The card's embedded wireless communication function allows users to upload and download photographs to and from a server and to exchange photographs and other data with other devices compliant with this wireless format.

This can all be done without any need for a PC or cable connection. Toshiba plans to receive certification for FlashAir for wireless communication in Japan, North America and Europe. The company also aims to reinforce and extend its leadership of the memory business by further enhancing its SD memory card line-up. ∎

Triggering synergies in the automotive and consumer markets

By Christoph Hammerschmidt

GROWN UP WITH AUTOMOTIVE semiconductors, German chip maker Elmos AG is currently trying to generate synergies and tap markets beyond cars. Elmos Board member Juergen Hoellisch, who oversees R&D and sales, explains the company's intentions and strongholds.

EE Times Europe: Mr. Hoellisch, your company is a relatively small player in the automotive semiconductor business; your competitors are heavyweights such Infineon, STMicroelectronics or Freescale. What are your assets in this competitive landscape?

Juergen Hoellisch: In the first place, we have a longstanding experience in specific application areas such as, ultrasound-based parking assistance. Another example could be our driver ICs for stepper motors and airbag electronics. In all of these segments, we managed to constantly bring innovations and new features fast enough to the markets so that we could maintain our edge. Our technological lead is reflected in our sales figures. We have the IP to maintain our lead.

EE Times Europe: Elmos is involved in the RESCAR research project - a joint project of industry and research institutes aiming at improving the reliability of semiconductor devices. What is Elmos' contribution?

Hoellisch: Integrated circuits' reliability and robustness are paramount in the automotive industry. The increasing electrification of vehicle and the advent of electric cars make component reliability even more essential. The failure of electronic components is not an option, in particular in safety-critical systems. For this reason, semiconductor manufacturers need to have in-depth information regarding the real load conditions across a chip's life cycle. The RESCAR research project is instrumental to have an insight in what occurs during the chip's operational life. In the future, OEMs and tier ones will define robustness requirements by means of the RESCAR results. They will influence future design methodologies. In addition, worst case conditions can be defined more exactly. Overall, the project will help us to come closer to our goals of "1st Time Right" and "Zero Fault" designs.

Targets new horizons in the ASSP business: Elmos R&D board member Juergen Hoellisch.

EE Times Europe: Does Elmos manufacture all of its products in-house?

Hoellisch: Today, we manufacture about 90 percent of our products in our own fabs. We have a cooperation agreement with MagnaChip of Korea. Products aimed at the Asian markets are increasingly manufactured at MagnaChip's fabs. We recently transferred a leading-edge process to MagnaChip which enables us to manufacture some of our high-runner products in Asia. In this context, we talk about 0.5 to 0.35 micron processes. But we are working on smaller and more modern technologies which we integrate into our partnership.

Currently we are in the process of converting our 6" line to 8. By the end of the year we plan to manufacture 60 percent of our devices on 8" wafers. Because of the ongoing boom in the automotive industry we lag a little bit behind our schedule. We are fully utilized, and it is a challenge to bring all orders through the fab. But by the end of the year we will be back on schedule.

EE Times Europe: If we take a look into automotive technology, which developments do you expect for the segments Elmos is active in?

Hoellisch: One major trend: Things that have been options in the luxury class are now entering the medium segment and the compact class. Driver assistance systems, for example, but also safety systems such

The Elmos production line in Dortmund (Germany) has its roots in the market of automotive chips. Its future may be in consumer applications.

as active pedestrian protection, cameras, ultrasound, and additional sensor equipment - everything that makes driving more comfortable. And of course the entire efficiency improvement - CO_2 reduction is a huge topic for the industry. We were the first to support Partial CAN networking - a feature promoted by all European OEMs. Partial CAN is an important feature: it offers significant energy saving potential. We were the first company offering the silicon - even before the announcement of the "German Five" in June.

EE Times Europe: Elmos has aired its intention to break out of the relatively tight automotive market and serve other markets as well. But the consumer and the automotive markets are worlds apart. How can you bridge the gap?

Hoellisch: We are not entirely new in the consumer and industrial markets. We have supplied ASICs to these markets for many years; applications range from heating controls to cameras and motion detectors. Historically, we served these markets when we saw a good opportunity, but it was not our strategic focus. We have seen that some of our products are very fit for consumer applications. We want to play out our innovative strengths - and if we see an opportunity to sell into consumer markets, we'll do this.

EE Times Europe: Elmos manufactures mainly ASICs. Bringing ASSPs to the markets is a different business. One needs to establish a brand, and perhaps to change the sales system.

Hoellisch: Indeed, this was a massive challenge. We are not moving away from the ASIC business to focus on ASSPs in the future, quite the contrary; we are expanding our ASIC business thanks to the ASSP option. Of course, this requires different structures - in product lines, manufacturing organization, sales, application support, product management and the entire business management.

But we have quickly implemented all necessary changes once we decided to attack these markets. We have modified our sales structure, logistics and fab control. We also have created new jobs across all departments, we have set up two new chip design teams - all in all, these measures have been very significant for us. ■

An entrepreneur's view of solar
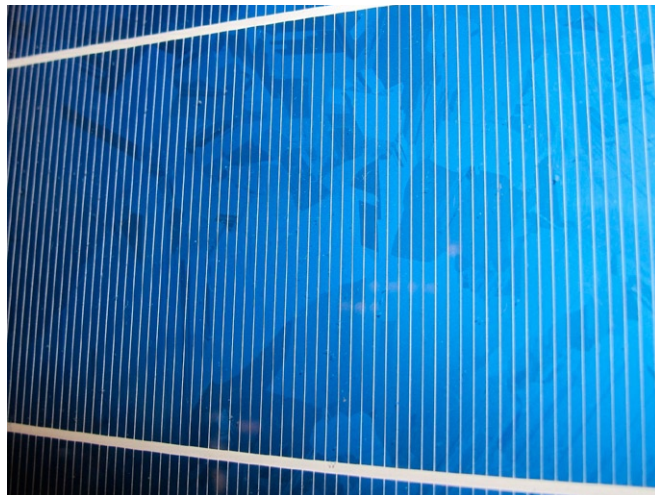
By Rick Merritt

"The solar panel business is all going to China," said Valdis Dunis, a long time entrepreneur and friend. It was July and we were having coffee in one of Hong Kong's snazzy upscale hotels. I was on my way to Taipei to write about Windows 8 on ARM and fabless IP companies, so I was just storing away his comments to a place somewhere in the far back of my mental filing cabinet.

When Silicon Valley's clean tech icon Solyndra publically crashed and burned, Valdis' comments flooded back to the forefront of my mind. As usual, Valdis' opinions were well informed. He had been working for some time as the founder of Solar Cities Asia, assembling the business plan for a company that aimed to be a leader in rooftop solar installations in this sun-drenched region.

Much of Valdis' time recently had been devoted to pouring over complex financing issues. He was jazzed he had found a way to make the numbers for installing rooftop solar on commercial buildings very compelling, essentially using creative ways a lowered utility bill could be factored into the equation of amortizing the hardware. I got the impression the solar rooftop business was all about how you ran the numbers, including what government incentives were available. But Valdis is an engineer at heart, so he kept a keen eye on the technology as well.

He had watched China sources of mainstream crystalline solar panels ramp up in volume and down in price over the last year or so. He was very curious about TSMC's plans for solar panels based on CIGS technology. He encouraged me to research how the initiative was going and expressed skepticism even they could master the complex technology behind it.

I didn't make the connection those giant Solyndra fabs along I-880 back in Fremont, Calif., were using similar technology and were in a similarly dicey position. But it didn't take long for market realities to catch up to what Valdis had already concluded.

Word is China has given away tens of billions of dollars to help its local manufacturers step on the gas in mainstream crystalline technology, essentially buying market share in solar. They were following the pattern set by Samsung and LG in DRAMs and LCDs a generation ago.

These days the big U.S. and Japan memory and display makers are consolidating to catch up with Korea's giants. Similarly a solar shakeout seems to be here in the wake of the rising China juggernaut Valdis saw coming months ago.

CIGS, thin-films and other solar technologies still have plenty of promise. Efficiencies of solar cells are abysmally low. A new approach could offer a performance breakthrough to leapfrog China in the market--someday. But that technology is not here today. The lesson of Solyndra, experts say, is solar alternatives deserve private and public funding at the level of lab research to pave the way for next-generation breakthroughs, but crystalline is the bet to make in mainstream manufacturing.

It is edging toward the dollar/Watt sweet spot and its competitors don't seem to be close at the moment. U.S. investors love to bet on leapfrog technologies that will become the next big thing.

But in solar China appears to have a smarter approach at this stage of just out-producing everyone in what the market wants today. I am headed back to Taipei shortly and thinking maybe this time I really ought to check into TSMC's solar plans. They may be digging in Hsinchu the next big hole in a consolidating solar industry. ■

GLASS-FREE 3D TV

4-camera system to tackle 3D TV

By Julien Happich

FRAUNHOFER RESEARCH SCIENTISTS are optimizing the technologies that make it possible to watch TV in 3D without technical aids such as 3D glasses. A new four-camera system will even be able to handle live transmissions. "The breakthrough for 3D television will only come when you don't need glasses. Wearing them is just too uncomfortable and tiresome," states Frederik Zilly from the Fraunhofer Institute for Telecommunications, Heinrich Hertz Institute HHI in Berlin.
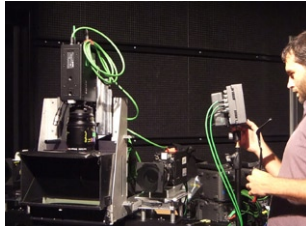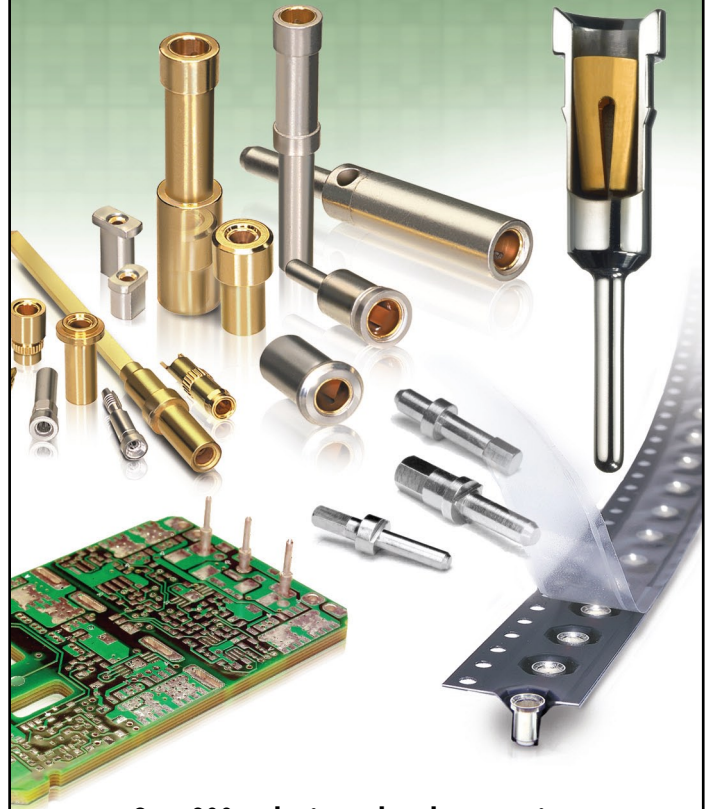
Research scientists at HHI are therefore working with twelve partners in the MUSCADE project on technologies which will make it possible to watch 3D TV without glasses. For this to happen, autostereoscopic displays are needed, which are coated with special optical foils. They create two different images for the left and the right eye, which is the basic principle of three-dimensional vision. To allow different viewing positions – for instance, when the viewer moves his/her head – these displays use five to ten different views of an image. In the future this number will be considerably higher. As conventional stereo productions only have two views, however, the captured images have to be converted before transmission, for which purpose depth information is extracted from them. In order to reliably determine the depth information, it is recommendable to use more than the usual two cameras. The MUSCADE project partners use four cameras, but this makes the already complex stereo production extremely intricate and expensive. "It can take days to calibrate four cameras to each other," explains Zilly.

Together with his colleagues the research scientist is therefore working on a four-camera assistance system which will reduce this timeframe to about 30 to 60 minutes. "The development is based on our STAN assistance system, which has already proved its value in conventional stereo productions. But with four cameras calibration is much more complicated," explains Zilly. This is because all positions and angles of the cameras must be set exactly the same so that the optical axes are parallel, all lenses have the same focal length and all focal points are on a common stereo basis.

To achieve this, the scientists have developed a feature detector which recognizes identical objects in the image on all cameras. Using their position, the assistance system then calibrates the individual cameras to each other. But even after calibration small inaccuracies remain. These occur if lenses with fixed focal lengths are used, which in most cases are subject to small fluctuations. Such residual faults can only be corrected electronically, for example using a digital zoom. This last correction stage is carried out by the new assistance system in real time – making even live transmissions possible. The HHI research scientists are currently working on an efficient video encoding system for compressing the huge volume of data that arises when four cameras are used so that the content can be transmitted on the existing broadcasting infrastructure. ■

When the smart money got into/out of manufacturing

By Peter Clarke

WHEN A STOCK MARKET index suddenly trends downward, or house prices plummet, it is very easy to focus on the sellers and talk about a sell-off, or people "getting out" of equities, commodities, property etc. But in every sales transaction there is a buyer.

This is one reason why the sale of a Hillsboro, Oregon wafer fab for $26 million offers an interesting microcosm of the global semiconductor industry.

With this move the vendor Integrated Device Technology Inc. moves from being a fab-lite chip company to being fabless. At the same time the buyer, Alpha & Omega Semiconductor Ltd., moves from being fabless to being fab-lite, as it boot-straps itself into a more prominent place in the industry.

So what is the difference between the two companies? IDT was founded in 1980, by solid-state design process engineers mainly from Hewlett Packard, and fundamentally linked into Silicon Valley. The company's initial push was to develop high performance circuits on the then emerging CMOS process variant.

The company developed its own proprietary CMOS process and chose military-grade SRAMs as its market entry vehicle and quite quickly moved up to offering high-speed RISC processors. In the absence of a mature foundry industry at that time manufacturing was a fundamental part of IDT's early value proposition.

However, as Malcolm Penn, chief analyst with Future Horizon's would say, fabless is usually the eventual conclusion of the adoption of a fab-lite strategy and IDT is now reaching that point. But A&O is going in the other direction. A&O was founded in 2000 as a fabless company with its origins in China, although it is now officially registered in Hamilton, Bermuda. The company stalled a Hong Kong stock exchange listing in 2008 but went public on Nasdaq in 2010 and has its main office in Sunnyvale, California. The company made a net income of $37.8 million on sales of $361.3 million in the year to June 30, 2011.

So who is the smarter: A&O which is spending $26 million to acquire a 200-mm wafer fab so that it is not always blown about by the whims of its supplying foundries, or IDT who is gaining $26 million while letting go the responsibility of feeding a fab?

At one level the answer depends on the detail of the fab, its equipment, staffing and on the price. But on another it reflects a philosophical position as to whether controlling the means of production is an inherently vital part of business. ∎

EnLight project focuses on lowering power consumption of interior LED lighting by 40%

By Paul Buckley

GERMANY'S SEVEN PARTNERS of the 'EnLight' (Energy Efficient and Intelligent Lighting Systems) research project - www.enlight-project.eu - are aiming to reduce energy consumption of today's LED systems by up to an additional 40 percent.

Germany's annual power consumption is approximately 500 terawatt-hours (TWh) or 500 trillion watt-hours, with lighting accounting for almost 12 percent of that figure. Even today, as much as 11.5 TWh or 20 percent of the electricity needed for lighting could be saved in Germany alone if incandescent lamps were consistently replaced by more energy-efficient LED (Light-Emitting Diode) technologies.

The potential saving is equivalent to the annual output of a large-scale power plant. The Enlight partners from industry and research are shouldering about Euro five million or approximately 45 percent of the project costs. Contributions of about Euro 4.1 million and Euro 2 million are made by the German Federal Ministry of Education and Research (BMBF) and the European Union, respectively. The EnLight project partners, alongside the German project leader Infineon Technologies AG, are BJB GmbH & Co KG, the Fraunhofer-Gesellschaft, Insta Elektro GmbH, NXP Semiconductors GA GmbH, Osram AG and RWTH Aachen University.

EnLight aims to exploit the full potential of LED-based lighting for saving further power through groundbreaking innovations in the LED lighting modules that include the LED and the driver electronics. The research is leveled at areas including changes to the socket standards. For example, at present the E27 base – the standard base of incandescent lamps across Europe – is not designed to be operated with light management systems, as is necessary for improved energy efficiency. Another goal pursued by EnLight is to develop programmable controls and innovative sensors for intelligent LED lighting solutions. In addition, the aim is for intelligent wireline and wireless networking of LED lighting systems and for enabling their energy-optimized operation to save as much as 40 percent electricity. The project will also explore entirely new light functions: On the basis of EnLight research, LED light sources will be able to automatically adapt their brightness to the ambient light.

The German partners' work is integrated into the European ENIAC Joint Undertaking project 'EnLight', headed by Philips. The European joint research project brings together 30 partners from six countries whose collaboration will further strengthen Europe's leading global position in the lighting system sector. ∎

CHIP DESIGN

Electronics enters era of 'systemic risk'

By Rick Merritt

THE ELECTRONICS INDUSTRY has entered an era of "systemic complexity" where growing ecosystems of companies need to collaborate closely, according to a panel of chief executives. "We're not just dealing with silicon scaling complexity but with a kind of systemic complexity where being best-in-class in one area is not sufficient to avoid risk and risks are going up," said Aart de Geus, chief executive of Synopsys in a panel at the annual GlobalFoundries conference.

Business success requires companies not only collaborate to develop chips but Web-enabled systems and network services. If any link in the chain fails, all the players risk failure.

"It's a winner-takes-all situation with whole ecosystems racing to high volume systems, so value chains become very important," de Geus said.

"As products get more complex, no one company can provide everything, but some can provide a great deal of the system," said Warren East, chief executive of ARM in a tip of the hat to Apple.

Under heated competition, "sometimes it's difficult to share information with each other but we have to have deeper cooperation and wider ecosystems," said Robert Hum, general manager of the deep submicron division at Mentor Graphics, standing in for CEO Wally Rhines.

In chip design, "data sets and process complexity are becoming enormous and the number of design-for-manufacturing rules is going through the roof," Hum said.

Process technology tolerances are edging closer to design rule margins, affecting chip yields which can be in single digits as new nodes first come up. That means changes in IC design can more readily impact manufacturing yields, said de Geus. The use of design abstractions and modeling has helped reduce complexity in the digital realm, but not in analog design, said Hum.

"We have to figure out what we can do to increase efficiency of analog design," he said. "The digital world has had tremendous progress, but there's still a lot to be done in the analog world," he added.

De Geus compared the job of companies like GlobalFoundries to high tech restaurants that must serve large numbers of guests meals from a diverse menu on a coordinated schedule. "The kitchen costs a few billion dollars so you want to make sure the food is really good, and people still don't always appreciate the difficulty of what you do," he said. "As long as they pay us, we don't mind," said Mojy Chian, a senior vice president of design enablement at GlobalFoundries who moderated the panel.

"Did anyone mention food poisoning," quipped Lip-Bu Tan, chief executive of Cadence, adding a dash of humor to the otherwise sober panel. ∎

BMW develops laser-based headlight technology

By Christoph Hammerschmidt

FOLLOWING THE INTRODUCTION of the full LED headlight, carmaker BMW regards laser light as the next logical step in the development of vehicle headlight technology. The development is already in an advanced stage, the company said. BMW said its engineers are already working on the introduction of laser light for series production within a few years.

Laser light could facilitate entirely new light functions for more safety and comfort and at the same time contribute significantly through its higher degree of efficiency towards a saving in energy and fuel respectively.

Laser light produces virtually parallel light beams. Thus it is different from sunlight, and also from the various types of artificial lighting in common use today. Because laser light is monochromatic and coherent, laser lighting can produce a near-parallel beam whose intensity is a thousand times greater than that of conventional LEDs.

In vehicle headlights, these characteristics can be used to implement new functions. Also, the high inherent efficiency of laser lighting means that laser headlights have less than half the energy consumption of LED headlights.

BMW said that for safety reasons, the light is not emitted directly. It is first converted into a form that is suitable for use in road traffic. The originally bluish laser light beam is converted by means of a fluorescent phosphor material inside the headlight into a pure white. Thus, the intensity of the laser light poses no possible risks to humans, animals or wildlife when used in car lighting, the company explained.

The resulting bright white light is described it as "very pleasant to the eye" and generated with very low energetic effort. Laser lighting technology is already in use in a variety of consumer products, though in many cases this is a product feature that goes unnoticed by the customer. That won't be the case when this technology is used in cars, however, as planned by BMW. Here the whole point is that the advantages should be noticeable and visible.

An important feature of laser technology is the size of the individual diodes. With a length of just ten microns, laser diodes are one hundred times smaller even than the small, square-shaped cells used in conventional LED lighting, which have a side length of one millimeter.

This opens up new possibilities when integrating the light source into the vehicle. BMW engineers have no plans to radically reduce the size of the headlights however, although that would be theoretically possible. Instead, the thinking is that the headlights would retain their conventional surface area dimensions and so continue to play an important role in the styling of the car, while the size advantages could be used to reduce the depth of the headlight unit, and so open up new possibilities for headlight positioning and body styling.

A further advantage of laser lighting technology, and one which the BMW engineers intend to use to full effect, is its high inherent efficiency. A single statistic will make this clear: whereas LED lighting generates only around 100 lumens (a photometric unit of light output) per watt, laser lighting generates approximately 170 lumens. Its first airing will be the laser lighting system designed in BMW's new i sub-brand, a brand the company created to test new concepts for a more sustainable mobility.

The company hinted at the possibility to use laser light to implement all familiar lighting functions such as Adaptive Headlights or the company's Dynamic Light Spot spotlighting system.

It will also be possible to use laser lighting to implement completely new functions, which will have only minimal power consumption. However, the company declined to elaborate on the new functions that this technology could enable. ■

DESIGN&PRODUCTS

Photo detectors and sensors designed to be flexible

By Christophe Premont

OVER THE LAST TEN YEARS, major players in the organic chemistry industry have significantly invested in R&D to create novel materials for companies attracted by the exceptional properties of printed electronics: large area, thin, light weight, flexible or conformable, and soon to be made transparent. A start-up of CEA Liten, Isorg is developing photo detectors and image sensors based on organic materials to be printed on plastic substrates. The company plans to industrialize these products by the end of next year.

This new generation of electronic materials brings disruptive innovation compared to the silicon industry because it is based on solutions of organic materials and plastic substrates or glass. It is a low carbon footprint industry; the manufacturing process takes place at ambient temperature and only requires a 10000 class clean room for the printing techniques, compared to the costly vacuum and high temperature environments required for traditional semiconductor materials. Most of these properties are already largely used for photovoltaic devices, but until now they had not been developed for photo detection.

In order to adapt these manufacturing capabilities to new market needs and to enable the fast prototyping of custom devices, various applications including a sheet-to-sheet manufacturing process have been selected by Isorg - see figure 1. In CEA Grenoble, Isorg has set up a new technology platform named PICTIC (French acronym for "Plateforme d'Impression de Composants pour les Technologies de l'Information et de la Communication et les Capteurs" which stands for printed components platform dedicated to information technologies and sensors). The 450m² of clean room facility is dedicated to the development of printing techniques for organic electronics on plastic and glass substrates. Printed light emitting diodes (PLED), organic thin film transistors

(OTFT) and organic photo detectors (OPD) will be prototyped for pre industrialization on this newly-equipped line and it is expected that by 2013, Grenoble's facilities will be capable of producing thousands of 320x380mm foils or glass plates.

Layered photo detector approach

The technology structure of the organic photo detector (OPD) is based on a multi-layer stack as shown in figure 2. Various organic semiconductors are being tested to achieve a large bandwidth for applications in the near infra-red, close to 950nm. The robustness of the device to humidity is linked to the device's structure. There are also a number of new developments ongoing in partnership with the chemicals supplier's equipment to reduce the photodiode size as well as to enable transparent electrodes.

Principle of operation

Each photo detector cell can be read measuring the photo generated current, using a resistor-based Trans Impedance Amplifier (TIA) as shown on figure 3, or collecting the photo-generated charges using an integrator as shown on figure 4. From an electrical point of view, running an organic photo detector in an application doesn't add any design complexity compared to using silicon-based devices. All the "usual design tricks" to get rid of noise or speed-up reading
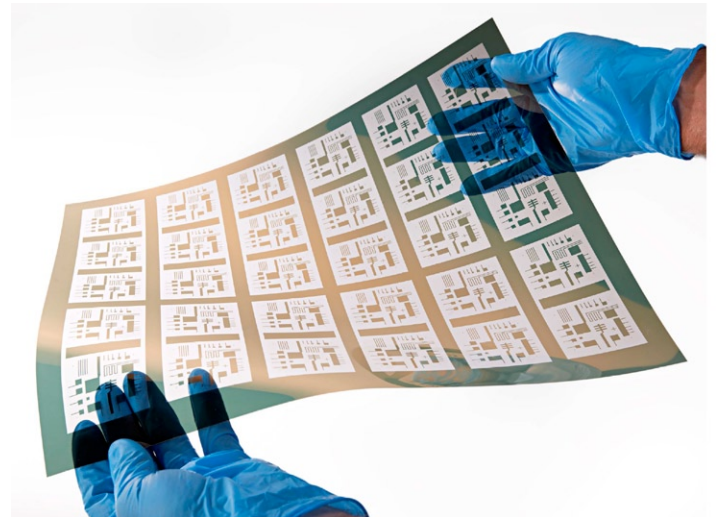

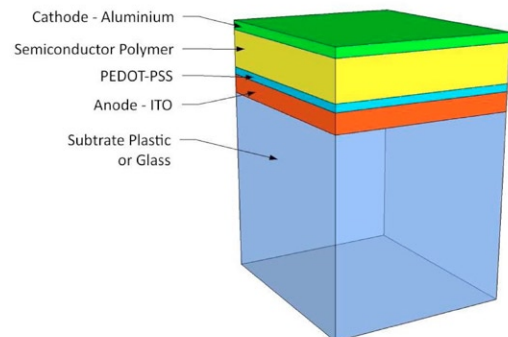Fig. 1: Plastic foil with printed photo detectors.

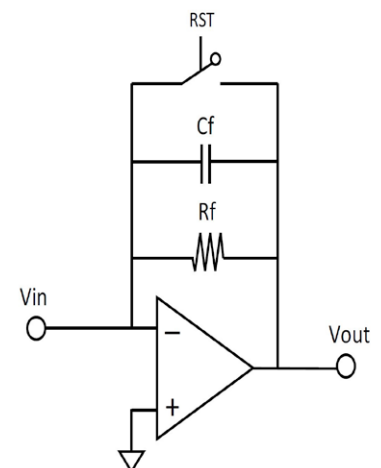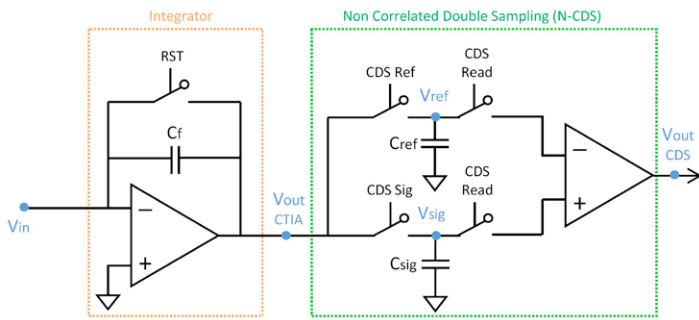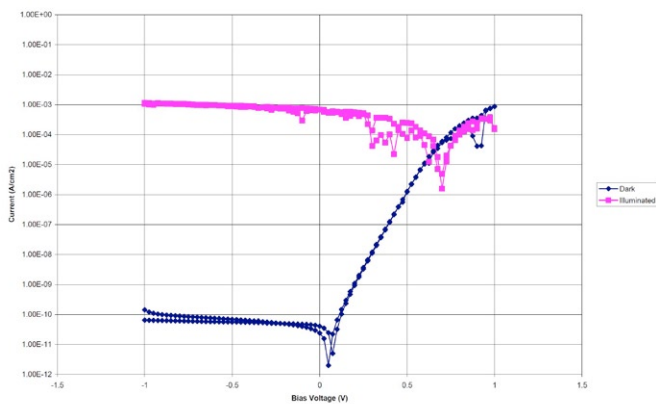Fig. 2: Layer construction of Isorg's organic photo detector.

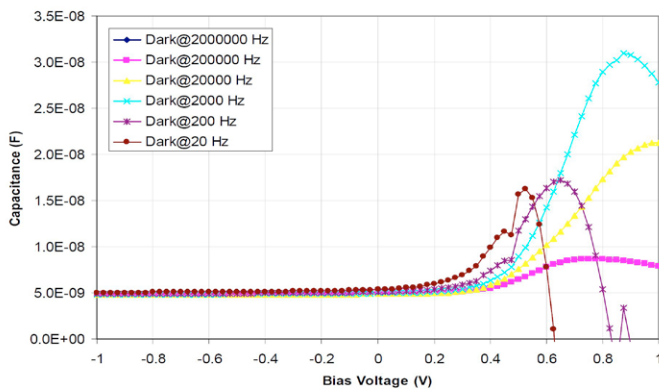Fig. 3: Example of a transimpedance amplifier for organic photo detector reading.

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Fig. 4: The integrator used for charge transfer in the OPD reading.

Fig. 5: I-V measurement of dark and photo current of an OPD.

Fig. 6: C-V measurement of an organic photo detector.

can be implemented. Considering power consumption, it is expected that the image sensor applications will run at a power lower than traditional silicon-based alternatives. Energy harvesting techniques may also be combined to further reduce overall power consumption.

Designing reading circuitry for new application based on organic photo detectors is quite similar to what is required for CCD or CMOS image sensors, hence design efforts are minimal with of-the-shelves standard products. Only for high volumes, an application specific integrated circuit (ASIC) may be worth designing. Printing techniques allow for very fast prototyping and only three days are required to

fabricate brand new organic photo detectors, with custom shapes that adapt the sensors to specific applications. This compares favorably with the lengthy and costly development and prototyping steps for silicon-based devices. This means that even small and medium size volume applications could get a dedicated sensor product design. The current-voltage characteristic (shown in figure 5), sensitivity and dark current levels are quite similar or fare better compared to some silicon counterparts. One potential technical limitation could be due to a higher capacitance versus photo diode's area. This point may be partially overcome using a larger biasing operating point for a specific application - see figure 6.

Passive pixels

Currently, only passive pixels may be designed because only the photo diode is present on the plastic foil, so Isorg is working on several industrial and consumer applications where passive pixels are more than enough. But CEA Liten and Isorg are working on a hybrid structure combining organic photo detectors with organic thin film transistors, which may be available for prototyping within a year. To promote its large area, thin, lightweight and flexible image sensors, Isorg has developed an attractive demonstrator, the Magic Pad. The prototype platform is able to sense 3D activity in a range of 30cm, with a resolution of 100 pixels on a 80x80mm active area. The Magic Pad is providing exciting and new functionalities such as multimedia 3D navigation without contact (for instance to browse music tracks on a computer).

Through optical sensing, the Magic Pad's surface is able to detect the user's hand position or motion. The photo sensors enable 3D functionality by measuring the height of the hand over the Magic Pad's surface. Overlaid on a display, the integrated optical sensors can not only provide a convenient user interface but also offer scanning capabilities, with character recognition. Like other optical sensors, the Magic Pad is sensitive to ambient light conditions and it is able to auto calibrate when needed. The development platform features a FPGA from Altera, on which different sensor's topologies can be tested with the associated processing software. Additional features, like backlighting with white or infrared LED and video outputs (VGA or LCD color screen display) are also available. Isorg's target for the near future is to design photo sensors with a 80μm pitch for a 300dpi scanning resolution. ■

Fig. 7: The Isorg Magic Pad demonstrator.

Lightweight piezo-based autofocus lenses beat motorized versions

By Nicolas Tallaron, Francois Vieillard, Pierre Craen

AS EVERYONE KNOWS, the mobile phone market is huge and will represent this year more than 1.5 billion units sold. Most of the phones today are equipped with a camera system from 2Mp up to 12Mp and with increasing sensor resolution, the autofocus function becomes essential.

Today, most of the camera modules designed in mobile phones rely on Voice Coils Motor (VCM) technologies to focus the image. VCM systems have brought a lot of benefit to the camera phone photographers all around the world, enabling high image quality at very reasonable prices.

Nowadays, camera phones requirements are getting more and more stringent in terms of performances, power consumption and overall dimensions and the inherent characteristics and performances of VCM are being challenged.
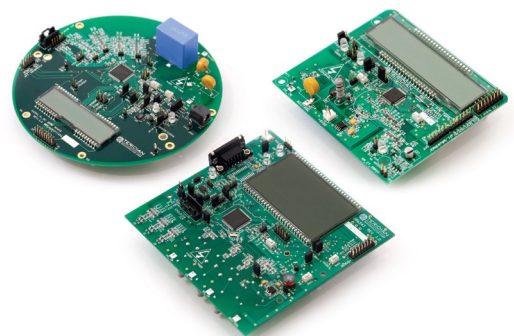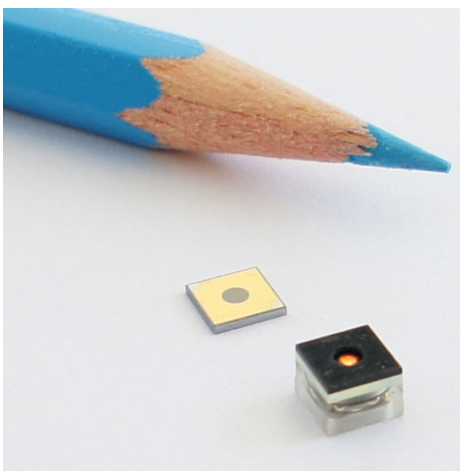poLight TLens (Tunable Lens) technology leverages MEMS factories to overcome the VCM weaknesses, namely power consumption, speed of autofocus (A/F), size and cost.

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Pierre Craen is Vice President of System Engineering at polight and can be reached at pierre@polight.com
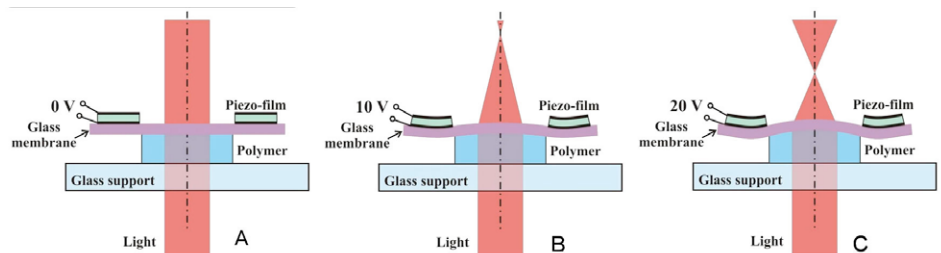
Fig. 1: The focusing effect obtained at various voltage levels applied to the piezo-electric ring.

How does the TLens work?

In poLight's TLens, a circular piezo-electric crystal plays the role of an actuator, embedded on a thin glass membrane, with a polymer layer sandwiched between the glass membrane and the glass support underneath. At "zero" volt, the piezo element is in standby mode and does not apply any force to the thin glass membrane. The light going through the two elements of glass and through the polymer, is not deviated (focus is on infinite).

When applying a voltage to the piezo element it immediately forces the thin glass membrane to bend, generating an optical power variation that allows focusing - see figure 1.

Comparing two technologies is not always easy, but VCM and poLight technology can be seen as actuators which tune the focus distance of an imaging lens accordingly to the object distance. The VCM are moving the imaging lens away/closer to the sensor to adjust the focus. An example of a VCM camera module structure is given in figure 2, with the TLens to compare with. The poLight technology is an optical ele-
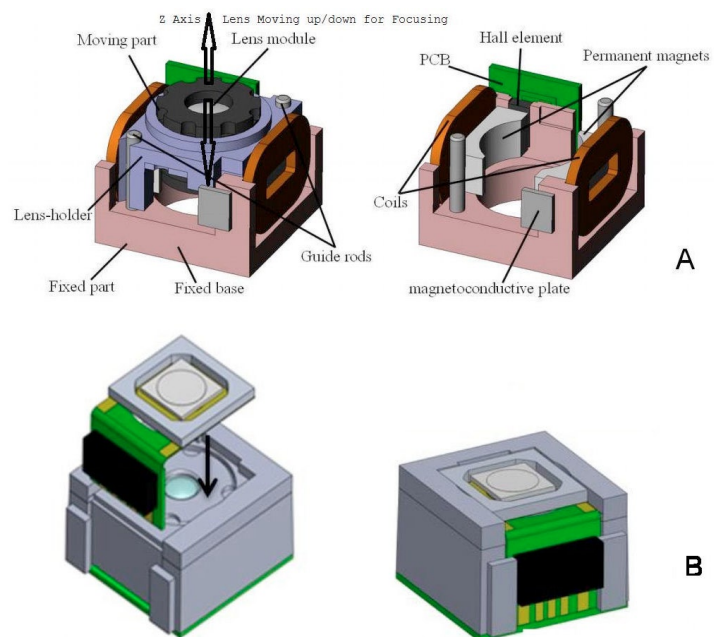
Fig. 2: VCM principle and module schematics (A) compared to the TLens module (B) only added on top of the imaging lens.

ment that is added in/on the imaging lens and the focusing is achieved with no motion by changing the curvature of the deformable membrane.

Optical power variations

The technologies can be expressed in term of optical power variation. The VCM is introducing optical power variation by moving the imaging lens along the optical axis while the poLight technology is tuning the optical power of an optical component.

The temporal behaviour, in the object space for both technologies can be represented with a good approximation by a differential equation of the second order of the optical power (in diopter, equation 1):

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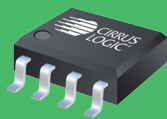
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$$\frac{1}{(2\pi f_0)^2} * \frac{d^2\delta(t)}{dt^2} + \frac{2m}{2\pi f_0} * \frac{d\delta(t)}{dt} + \delta(t) = \delta_\infty$$

Where: f_o is the Eigens frequency in Hertz; m is the damping factor (m > 0 for a stable solution); δinfinite is the targeted focus position in dioptrie (object distance in meter)$^{-1}$; t is the time.

Since the optical power expressed in diopter d (unit: 1/meter) is not always easy to understand, let's explain this interesting concept through an example. Considering an imaging system focus at Hyper-focal distance (only the object/scenery located at the distance bigger than the hyper-focal of the camera module are sharp), if the user wants to focus on an object/scenery located at 1m from the module, the actuator will have to introduce an additional optical power to the imaging lens to have a sharp focus of that object on the sensor.

If the user wants to focus on an object located at 10, 20, 50cm, the actuator will have to introduce an additional 10, 5 or 2 diopters of optical power respectively. For the VCM the displacement will be driven by the amount of current drawn in to the solenoid and the lens displacement can be expressed in optical variation through the equation 2:

$$\delta_{vcm}(A) \cong \frac{dz(A)}{EFL^2}$$

Where dz is the displacement introduced by the VCM actuator and EFL is the effective focal length of the imaging lens (all units in meter); z is a function of the current A.

For the poLight AF technology, the optical power variation can be expressed by equation 3:

$$\delta_{poLight}(V) \cong \frac{n-1}{R(V)}$$

Where n is the index of refraction of the polight polymer and R(V) is the curvature of the membrane for a given voltage.

By resolving the differential equation (1) and using the equation (2) and (3), we can approximate relatively well the time needed to achieve a new focus position for the two technologies. For a reasonable good VCM, we can approximate the behaviour with f_o = 70 Hz and m = 0.2. For the poLight actuator the behaviour can be simulated with f_o = 2000 Hz and m = 1.5.

The graphs of figure 3 represent the response to 1, 2, 5 and 10 diopters steps:

One can observe that the poLight technology is faster than the VCM. In addition
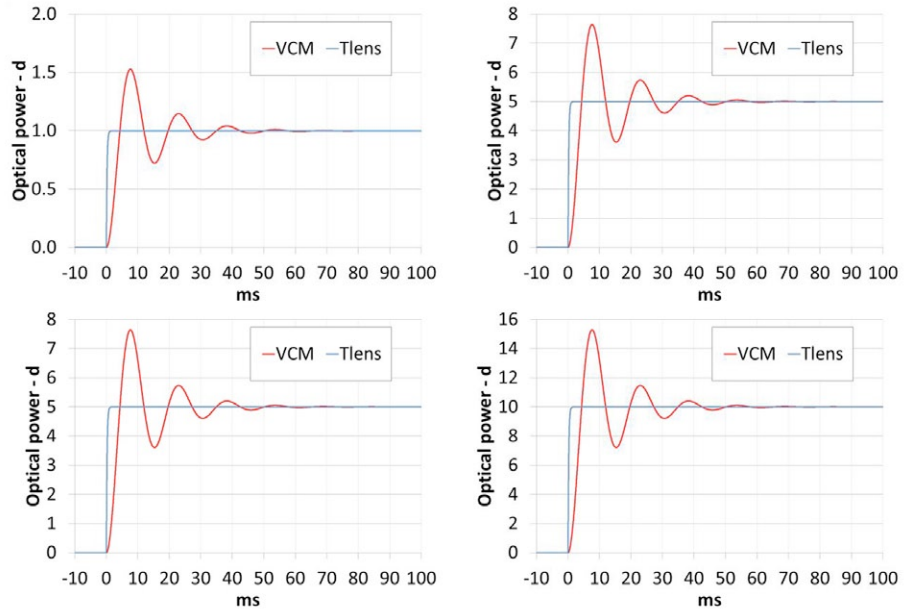
Fig. 3: TLens and VCM response to a 1, 2, 5, 10 optical variation steps

while the VCM is oscillating along the optical axis it is also wobbling (+/- 0,16°degree tilt for the best VCM) which is creating image blurr while the TLens stay stable (poLight technology is 20 time more stable than VCM). The settling time during a 10cm focus swipe is about 1 to 2ms for the TLens compared to 20 to 40ms for a VCM.

In order to find the best focus, the complete depth of field need to be scanned therefore the actuators are swinging through the optical power range to find the best focused image. It is usually accepted that to find the best focus image of an object with a mobile phone camera module, 10 good images (in average) at 10 focusing steps are needed. Each of these images is processed and a sharpness core value is estimated. The best focus position is then achieved when the sharpness function is optimum. Depending of the strategy of focusing method, the 10 focusing steps can
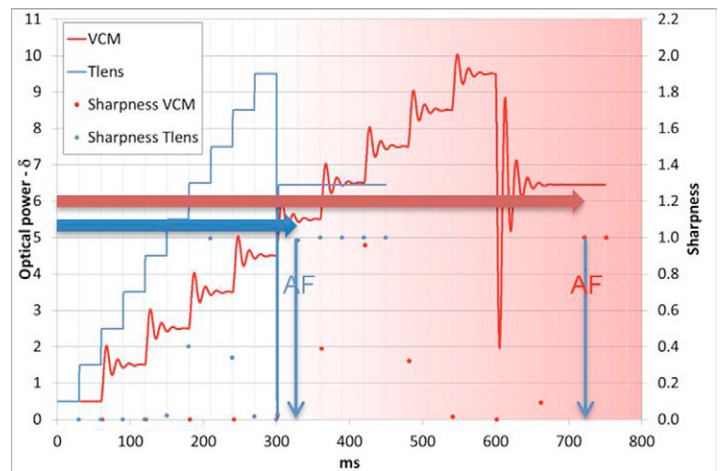
Fig. 4: AF full scan search and stability for TLens and VCM.
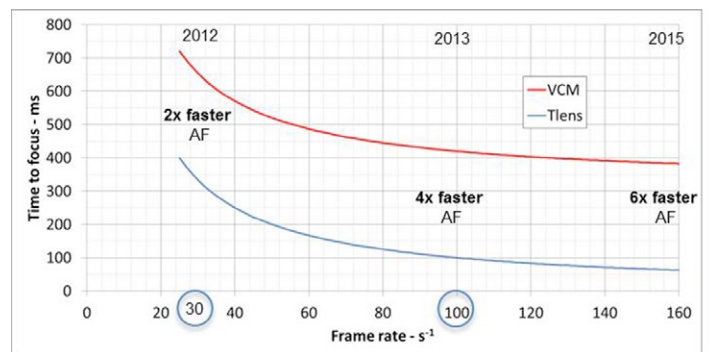
Fig. 5: AF speed comparison (TLens-VCM versus frame rate)

be split in a few coarse and fine steps.

Based on those observations and simulations we have estimated that the TLens could reduce the shooting time for real-time photography especially thanks to a customized auto focus algorithm that will take advantage of the sensor and TLens speed

Fig. 6: example of all in Focus across 3D

capabilities.

Figure 4 gives the behaviour of the two technologies with their associated sharpness core value. For a sensor working at 30 frames per second, the VCM actuator will require two images/frames at each focus step in order to obtain a sharpness core function with an optimum while the TLens speed allows evaluating the sharpness core value for each image. The best focus (at 30fps) will be found in less than 300ms with a TLens, compared to over 600ms for a VCM. The TLens speed will even be efficient when the frame rate is increasing – see figure 5.

What's more, poLight technology is enabling an "All-in-focus across 3D" picture by taking one shot at different focus distances – see figure 6. This is achieved by taking four images on the fly at a different focus which is not possible with a VCM solution (without giving a sluggish user experience) and combining/processing the four images to generate one image all-in-focus.

Thanks to that speed performance, a user could decide after shooting where to focus and define the depth of field across which he/she wants to have a sharp and focused image. Moreover, the TLens speed has the potential to improve user experience for document scanning at high resolution and instant bar-code reading.

In term of power consumption the poLight technology can cut power consumption by 20% compared to a VCM solution (twice in a dual-camera implementation for 3D), extending the video shooting sequence. Drastic AF actuator power consumption reduction is achieved with the Tlens, about 2.5 times at infinity and 40 times at close distance (18 times in typical continuous AF mode).

This extends camera usage to a very low battery range, consuming 7mW versus 134mW from a VCM in a typical Continuous Auto Focus mode. In addition, the poLight low power consumption will translates into a better image quality with long run shot and low light condition since the energy dissipated by the actuator will not increase the sensor's temperature, enabling a better signal-to-noise ratio.

In term of real estate, the poLight AF technology is offering a competitive transverse XY dimension compared to VCM.

Indeed the poLight can be as small as 3.5x3.5mm for a 1/3-inch sensor while a VCM solution will hardly achieve 8.5x8.5mm since the VCM is built around the imaging lenses.

The poLight technology is not limited in pixel resolution since the optical quality of the TLens is close to being limited by diffraction, which is a physical limitation that no classical optical system can exceed. ∎

IR transmission beats RF links on BOM

By Markus Oberascher

YOU MAY WONDER why many companies still invest in developing new IR products for remote controls, although RF is growing so much. IR could be perceived as an old and antiquated technology which is soon to be replaced by RF. Well, in fact IR technology is still not antiquated and not so easily overtaken by RF. The reasons are clear: IR technology remains the best solution for most remote control applications because of good functionality, ease of implementation and, last but not least, cost efficiency.

But what has changed over these years since the first IR remote control was established? Basically, remote controls and the addressed devices work in the same way as before. The user presses a button on the remote control and something will happen on the receiving device. The part which has been improved the most in recent years is the Infrared Receiver Module (IRM). The requirements on the IR receiver have become more and more challenging because of newly developed IR protocols, especially those for set top boxes, and higher requirements regarding optical noise immunity.

In order to reduce the power consumption of the remote control and to increase the data rate, some manufacturers developed new IR protocols with shorter burst times to reduce the envelope duty cycle and reduce the power consumption during IR transmission. Additionally the data overhead has been reduced because some old protocols transmit the data twice, for example once normally and once inverted to increase the transmission security. The improved operating stability of new IR receivers makes this redundancy no longer needed.

Another step to further reduce the power consumption is to code more than one single data bit into a single IR pulse. Normally each single data bit is represented by one burst/gap combination, which means that each single bit requires one burst. For recent IR protocols, this has been increased to two

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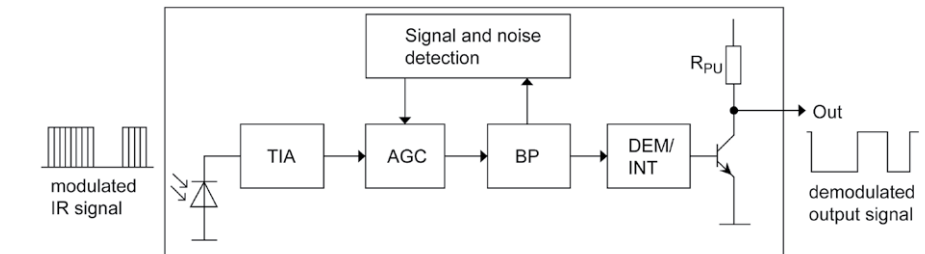
Fig. 1: Simplified block diagram of IR receivers.

and four bits coded into one burst/gap combination. This means that instead of having eight bursts for one data byte, with operating current for each one of them, some new protocols only have four or two bursts representing the same amount of data. Previously developed IR protocols often had an envelope duty cycle between 10% and 50%, whereas new IR protocols are often below 5%. These steps helped to increase the battery lifetime of remote controls dramatically.

Fig. 2: The pulse width of this TFT backlight is around 1.2ms, which is in the range of IR burst widths. The spectrum (lower half) shows a strong peak at 72kHz, which can interfere IR receivers, especially those for 56kHz carrier signals.

Another benefit of the reduced burst times is the higher data rate. For some applications, like set top boxes, keyboards and mice, it is necessary to provide a comfortable and smooth operation. Beside all these improvements on the IR protocols, there is also a disadvantage: such special protocols require faster IR receivers and those are always more sensitive to optical noise than slower types.

Implementing noise immunity

Let's look at how IR receivers operate and how they accept valid data but suppress noise. A very important part for the protocol compatibility and noise immunity is the AGC (Automatic Gain Control) amplifier. The AGC is always adapting as good as possible to the environment. In case of noise free or very low noise environment the AGC sets the gain to the highest level to provide maximum reception distance. But high gain will also cause that noise to be strongly amplified and output glitches might occur

on the output of the IRM and corrupt the data. So in noisy environments a lower gain is required to avoid the output signal of the IRM from being interfered. Figure 1 shows a simplified block diagram of IR receivers. The gain of the AGC amplifier is controlled by the noise detection circuit. The noise detection circuit is continuously analyzing the output from the band pass filter and if any invalid signal reaches or exceeds the detection threshold (which will cause the signal to be forwarded to the output) it reduces the gain of the AGC amplifier until the interference signal is below the detection threshold and the output signal is not corrupted.

IR protocols are pulse code modulated signals with burst times from around 100us up to 9ms and data low times from a few milliseconds up to normally around 100ms. The noise detection block is checking the timings, especially the data low time, of the signals to differ between valid and invalid signals. The IR radiation of most interference sources (like lamps) is coupled to the power

grid frequency of 50Hz and 60Hz. As a result the IR emissions will also have a repetition frequency of 50/60Hz or 100/120Hz, which means that the period will be between 8.33ms and 20ms. Based on this, high immunity receivers, which are able to suppress any kind of lamp, require a data low time which is longer than 20ms to ensure that any kind of lamp is detected as interference and suppressed.

Such receivers work well with most common protocols like NEC and RC5, but for some protocols, especially for set top boxes, these receivers are not suitable because of the low data rate. To increase the data rate, the acceptable timings of the receiver must be adjusted to shorter values. The problem with this step is that the IR interferences from some lamps might be within the acceptable timings and are no longer suppressed. In multimedia applications lamps are not the only problem for IR receivers. TFT and plasma TVs also radiate modulated infrared emissions. Especially TFT screens are critical because their backlight lamps produce IR interferences which look quite similar to IR data signals. The reason is because the CCFL lamp for the panel illumination is pulse width modulated with timings which are close to, or similar to IR data signal. Figure 2 shows an example of a TFT backlight noise. The signal shape looks very similar to an IR data signal and the modulation frequency is also in the range of IR protocols. Early developed high data rate receivers have not been able to suppress the TFT backlight noise.

The first important thing is to enhance the algorithms in the noise detection block. It is necessary that the signal is analyzed more detailed and not only by the data low time. Figure 3 shows the behavior of the previously developed IRM-3636 and the new developed IRM-3636M receiving a high data rate and short burst IR protocol under TFT noise. The old part is not able to suppress it and the data is corrupted. The new developed IRM is able to suppress the noise and provides a precise output data signal. But
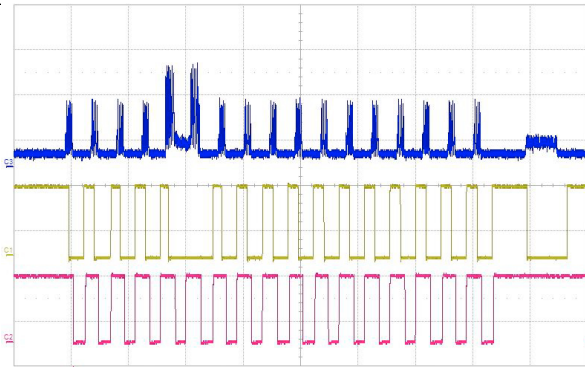
Fig. 3: The first signal is a short burst data signal interfered by TFT backlight noise. Previous AGC algorithms of the IRM-3636 could not identify the TFT noise as invalid signal, which results in corrupted data and output glitches. Due to improved AGC algorithms the new IRM-3636M can easily suppress this noise.
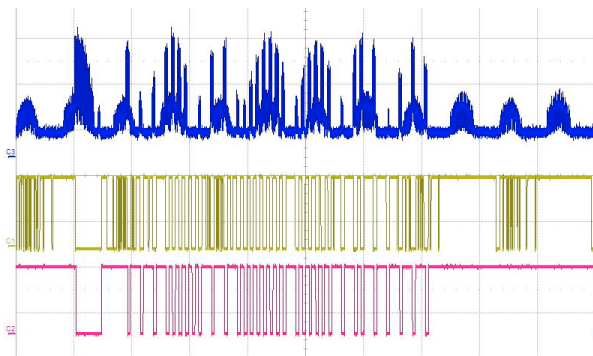
Fig. 4: The first signal shows the NEC protocol interfered by a fluorescence lamp. Due to the reason that IRM-3638M is suitable for high data rates and continuous data transmission, the AGC algorithm cannot identify this lamp noise as invalid signal. The algorithm of IRM-3638M3 does not allow continuous transmission therefore the lamp noise is suppressed.

when using some critical lamps, high data rate receivers might also not able to suppress the noise. Figure 4 shows the output signal of the high immunity type IRM-3638M3 and the high data rate type IRM-3638M receiving a common protocol (NEC code) under strong noise from a fluorescent lamp.

The high data rate type is not able to suppress the lamp noise, whereas the high immunity type works without any problems. So, basically these examples show, that the new parts have an improved immunity against TFT noise, but high data rate and high immunity is still a conflict which might cause malfunction under some critical interferences.

The second step to further improve the noise immunity and reception range under interferences is the band pass filter. Although the AGC might be able to suppress the noise, the reception range could be below the customer's requirements. To reach a better distance, the S/N ratio must be improved. This is done by the band pass filter. The narrower the band width, the better the reception range under noise (except for the noise that is exactly at the carrier frequency).

But here also a goal conflict arises. The higher the Q-factor of the band pass filters the more time it needs to engage and to settle, thus the minimum burst and gap times of IR protocols are the limiting term for the Q-factor. Usually there are so called short burst and standard burst receivers. Short burst receivers are able to handle bursts with a length of down to 6 carrier cycles and standard burst receivers can handle down to 10 cycles. Short burst receivers require a lower Q-factor than standard burst receivers which reduces their performance in noisy environment. With recent designs the Q-factor of new short burst receivers could be increased but it is usually, because of physical facts, lower than from standard burst types because they also have been improved. Hence, although the IRM-3638M is improved compared to previous high data rate receivers and based on the enhanced AGC algorithms it can suppress the TFT interferences, the high immunity type IRM-3638M3 still has a better reception range because of the more narrow band pass filter.

With the recent introduction of 3D TVs another problem came up. The active shutter glasses also use IR for the synchronization. Usually they are using another wavelength (850nm instead of 940nm) and different carrier frequencies (20kHz and 25kHz, normal IR protocols are above 30kHz) but there is still an influence on the remote control systems. Also for the 3D TV application a narrow band pass filter is required to reduce the influence on the remote control operation.

Specifying the right protocol

After analyzing all the requirements and possible issues with interferences sources, the question is how to choose a suitable IR receiver? First, let's summarize our main findings. TFT screens, plasma screens and fluorescent lamps are critical interference sources which might affect the operation of the IR receiver. The timing of the IR protocol defines if a high data rate or high immunity receiver can be chosen. High data receivers are always more sensitive to noise than standard types. Based on this, the first and most important rule is: don't use a high data rate and short burst protocol if it is not really required. The selection of the IR protocol is the first and most critical step for the whole design-in phase of IR receivers and will have big influence on the remote control system's performance and stability. Most applications

only need quite simple functions which have low data content and don't require high data rates. A standard remote control doesn't need a data rate of a few kBit/s as a single button press normally has around 2 to 4 data bytes per package and human might not be able to press the buttons more than 10 times a second. This means an average data rate of 320bit/s is enough. As high immunity receivers cannot receive streaming data, the data must be transmitted in packages with a pause between the packages. As shown before IR receivers use this pause time to differ between valid and invalid signals. We recommend using an IR protocol with at least 25ms data pause time between the packages, a burst length of at least 10 carrier cycles and a gap time of at least 14 carrier cycles, which allows the usage of high immunity receiver types.

We have seen applications using special protocols which require short burst and high data rate receivers, but basically the same application would also work similar with some standard protocols or in noisy environment even better. So the first step is to verify the requirements of the protocol and choose a suitable protocol. This can avoid many problems in advance. When the protocol is decided, it is important to know the minimum burst and gap times, as well as the minimum data low time. With these parameters a suitable IRM can be chosen.

Table 1 shows the acceptable timings of Everlight's multimedia IR receiver series. M is a short burst and high data rate type, M2 is a high data rate type and M3 is a high immunity type. It can be seen that M and M2 can handle very short data low times in case of the burst is less than 500μs (M-type) or 1.2ms (M2 type), but require 22ms if these timings are exceeded. With this kind of enhanced algorithm the receivers offer high data rate combined with improved noise immunity, but as some noise signals might still be within the acceptable time limits, there is the possible of output glitches and corrupted data. M3 requires always at least 22ms independent from the burst length, which ensures that any kind of noise will be suppressed.

	IRM-36xxM IRM-37xxM	IRM-36xxM2 IRM-37xxM2	IRM-36xxM3 IRM-37xxM3
Minimum burst length	6 carrier cycles	10 carrier cycles	8 carrier cycles
Minimum gap length	10 carrier cycles	14 carrier cycles	12 carrier cycles
Minimum data low times	1ms if burst < 500us 22ms if burst >500us	1ms if burst <1.2ms 22ms if burst >1.2ms	22ms

Table 1: Acceptable timings of Everlight's multimedia IR receiver series.

After choosing the best matching receiver it is important to develop a proper decoder.

The output pulses of IR receivers always have jitter, depending on the data signal and interference strength. A good IR receiver has less jitter and provides an output timing which is close to the input timing. Typical values for the maximum jitter are ±100μs up to ±200μs. The decoder must accept these timing variations to use the full potential of the IR receiver. The jitter is also the reason why the burst and gap times of the IR protocol should not be too short. If the jitter becomes bigger than the timing difference between two logical states (e.g. a pulse width coded protocol has 300μs burst for logical 0 and 600μs for logical 1) the bit might be decoded wrongly, because the logical 0 can become up to 500μs long (+200μs worst case) and the logical 1 can become down to 400us short (-200μs worst case). So there is an overlap between 400μs to 500μs where it might not be possible to detect the bit correctly. To avoid this, the acceptable timing for the decoder can be set narrower than the jitter. For example every pulse between 100us to 400us is logical 0 and every pulse between 500μs and 800μs is logical 1. But with this action, the full potential of the IR receiver is not used, especially for very close and very far distances the jitter becomes bigger and therefore either for very close or very far distances the remote control might not work. The better way would be to use longer bursts to avoid an overlap. A burst with 400μs for logical 0 and 800μs for logical 1 would solve this issue.

For this kind of problem, pulse distance coded protocols are less sensitive than pulse width or bi-phase coded protocols, because the total bit time (burst and gap together) is more stable than the single burst and gap times. When the IR protocol and the right receiver module has been chosen and the decoder optimized, the biggest part for a well operating remote control system is over. ∎

MICROCHIP
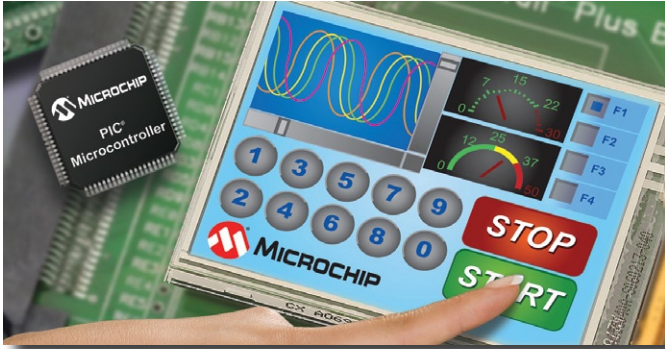
Human Interface Solutions

Graphics Display

Segmented LCD

Touch Sensing

Audio

www.microchip.com/humaninterface

Human Interface Solutions

Adding a modern, intuitive user interface to your design improves its ease-of-use, functionality and aesthetics. Graphics displays, touch interactivity and audio prompts add a modern, updated look and feel to any design.

Engineering teams that are tasked with creating human interfaces for new or legacy designs need solutions that create a high-impact user interface incorporating the latest in touch sensing and graphical display technologies. These solutions must be easy to integrate and lower total system cost.

Touch sensing interfaces such as keys/sliders and touch screens are fast becoming an alternative to traditional push button switch user interfaces owing to their many benefits – elegant and stylish designs, lower manufacturing costs achieved by lowering costs of molds, tooling and assembly, and increased reliability via fewer moving components. Application designers migrating to touch sensing interfaces require robust, low-cost and power-efficient solutions that are easy to integrate.

Digital displays improve the user interface of just about any application. Segmented LCDs have historically been a popular choice of display technology and continue to grow in a variety of medical and industrial applications. In recent years there has been a significant rise in the use of graphical displays such as TFT, OLED and CSTN in consumer, appliance and automotive applications. Users prefer intuitive menus, vivid graphics, touch panel interaction and in some case the ability to interact remotely with a system. Designers migrating toward graphical displays face several challenges such as cost of components associated with driving the display, complexity of software needed for updating graphics, battery life and remote connectivity.

If you are looking to add newer and feature-rich interfaces to your products in an aesthetically pleasing manner, Microchip has a broad portfolio of solutions that include touch sensing and display technologies. Microchip delivers these latest advancements as complete hardware and software solutions to get your design to market faster at a lower total system cost.

Key Highlights

TOUCH SENSING SOLUTIONS

Keys & Sliders
- Longer battery life with eXtreme Low Power MCUs
- Sensing through metal, plastic or glass
- High noise immunity and low emissions
- Lower system cost with broad MCU portfolio
- Free software library enables easy integration and touch-sensing GUI speeds up development
- Get started quickly with low cost development kits

Touch Screen Controllers
- Turnkey analog resistive controllers for lowest system cost
- Highly flexible projected capacitive solution with low cost MCU implementation
- Fully processed and reliable touch coordinates
- Multi-touch and gesture capable
- Low power solutions with wide operating voltage
- Royalty-free source code solutions with complete starter kits

DISPLAY CONTROLLER SOLUTIONS

Segmented LCD
- Direct drive of inexpensive displays
- Up to 192 segments
- Integrated analog for sensor applications like temperature sensing in thermostats
- Integrated touch sensing function

Graphical Displays
- Up to WVGA (800x480) resolution
- Up to 24 bit per pixel
- Free Graphics Library and Graphics Display Designer GUI
- PIC24 "DA" family features integrated graphics acceleration and display controller
- High performance 32-bit MCUs with integrated Ethernet and CAN for remote interfaces
- Integrated USB OTG and mTouch sensing

AUDIO PROCESSING SOLUTIONS
- Generation of tones, alarms and musical notes
- Recording and playback of audio information
- Graphic equalizer

mTouch Solutions – Keys & Sliders

Expanding beyond the consumer market, touch sensing is now taking hold in medical, industrial and automotive applications. Examples include:

- Battery applications: automotive, cell phones, medical devices, remote controls and thermostats
- Line-powered applications: home appliances, printers, set top boxes, smart energy monitors and television

Microchip offers a broad portfolio of low power, low cost and flexible solutions to enable two types of touch-sensitive interfaces:

- Keys and sliders
- Touch screen controllers

mTouch™ Solutions – Keys and Sliders

User interfaces with push buttons have several moving parts which significantly decrease the reliability. They also require complex design and assembly as well as a major investment in tooling. Capacitive Touch technologies allow designers to create a high impact user interface at a lower total system cost. mTouch solutions provide a free and easy method for designers to add touch sensing keys to applications utilizing PIC® MCUs. You can integrate touch sensing functionality with your application code in a single, standard microcontroller, thus reducing the total system cost.

Capacitive Touch Sensing

How Capacitive Touch Sensing Works?

A capacitor is simply two electrically isolated conductors which are in close proximity to one another. The conductors can be wires, traces on a PCB or even the human body.

The capacitive touch sensor is a copper pad area, that is capacitively coupled to grounds located elsewhere in the system creating a parasitic capacitance. A covering plate material such as glass is used to provide the user touch surface. The introduction of the user's finger then produces an increase in capacitance which will be detected by the system.

$$C_S = C_P + C_F$$
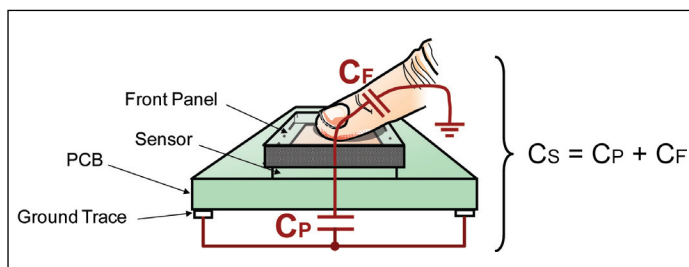
Lowest Power Capacitive Sensing

mTouch solutions offer longer battery life and lower standby current. Using award-winning eXtreme Low Power technology, mTouch solutions bring you the industry's lowest power consumption for touch-sensing.

- Capacitive sensing in less than 5 µA
- Proximity sensing down to 1 µA
- MCU Sleep current down to 9 nA
- MCU Active current down to 50 µA/MHz
- MCU Real-time Clock down to 470 nA

Broad MCU Portfolio for Capacitive Sensing

Microchip offers a variety of PIC MCUs enabling you to dedicate an MCU for touch function or integrate touch sensing with other application functions onto a single MCU:

- 8, 16 and 32-bit PIC MCUs for touch sensing
- 6-pin to over 100-pin devices
- Up to 512 KB Flash memory
- High noise immunity and low emissions: IEC61000, EFT, BCI
- On-chip integration options include USB, CAN, IrDA, wireless protocol stack, segmented LCD and graphics accelerator and LCD driver for TFT/STN displays
- Up to 32 capacitive touch channels
- No external components needed

Dedicated Touch Controllers (PIC10/12/16/18)
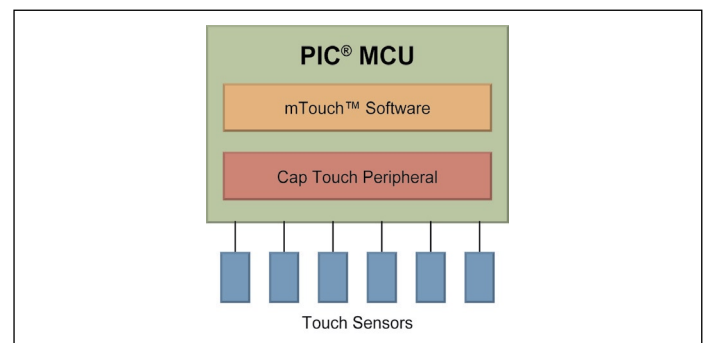
Highly Integrated Touch Controllers (PIC16/18/24/32)
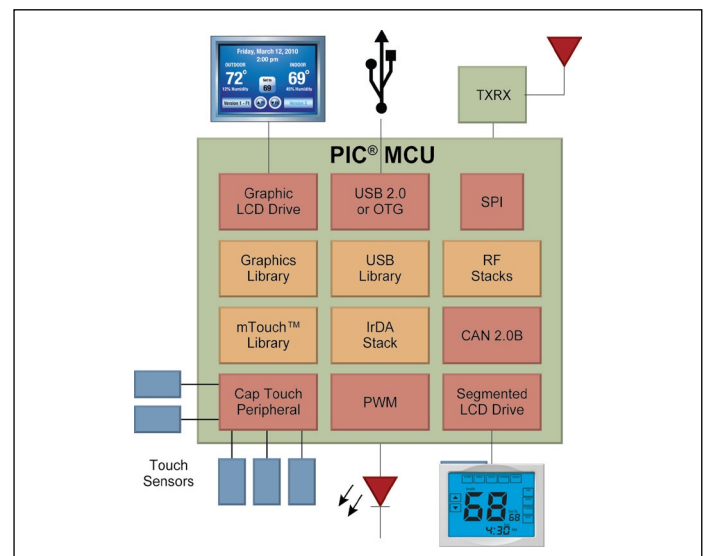
mTouch Solutions – Capacitive Sensing for Keys & Sliders

Development Tools for Capacitive Touch

Enhanced mTouch Capacitive Evaluation Kit (DM183026-2)

The Enhanced mTouch Capacitive Evaluation Kit provides a simple platform for developing a variety of capacitive touch sense applications using 8, 16 and 32-bit PIC microcontrollers. The kit contains:

- 8-key sensor board direct interface
- 12-key matrix sensor board
- 4-channel slider sensor board
- 2-channel slider sensor board
- Four PIC MCU processor boards:
  – PIC16F1937
  – PIC18F46J50
  – PIC24FJ64GB106
  – PIC32MX795F512H
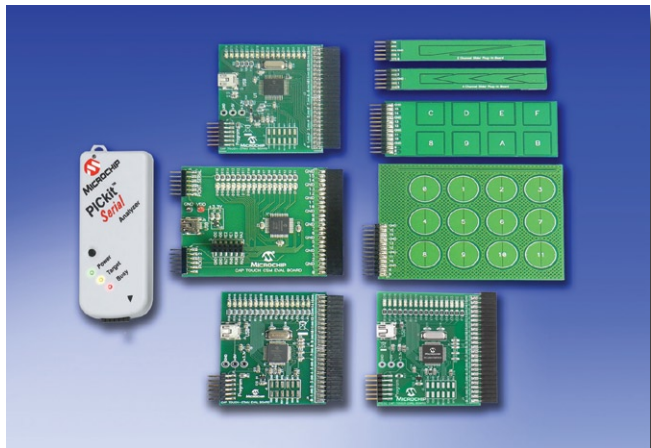- Diagnostic GUI to analyze touch sensor data real-time via USB
- PICkit™ Serial Analyzer

In addition, a separate processor board – the PIC24H mTouch Capacitive Touch Evaluation Board* (AC243026) is available and enables the PIC24H family to work with the Enhanced mTouch Capacitive Evaluation Kit.

mTouch Capacitive Touch Software Package

The mTouch Software Package enables designers to easily integrate touch technologies into their application. It allows the implementation in a small dedicated controller as well as integrating the complete application in a single MCU. Two packages are available depending on the microcontroller: mTouch PIC16F Framework or mTouch PIC18/24/32 library. Software package features include:

- Multiple demo projects
  – Swiping gesture
  – Proximity detection
  – Direct key sensing
  – Matrix key sensing
    · 2-channel sliders
    · 4-channel sliders
- Graphics integration with keys (runs on DM240312 board)
- Interoperability with Microchip Graphics and USB libraries

Demo projects can be run directly on the enhanced mTouch Capacitive Evaluation Kit.

Application Notes for Capacitive Touch

- Techniques for Robust Capacitive Touch Sensing, AN1334
- mTouch™ Metal Over Cap Technology, AN1325
- mTouch Conducted Noise Immunity Techniques for CTMU Peripheral, AN1317
- Capacitive Touch Using Only an ADC (CVD) (suitable for PIC10/12/16/24H/32 MCUs), AN1298
- Microchip CTMU for Capacitive Touch Applications (suitable for PIC18 and PIC24F MCUs), AN1250
- Capacitive Touch Algorithm Simulation, AN1254

*Code also supports dsPIC33 DSC.

# mTouch Solutions – Metal Over Cap Technology For Keys

Metal Over Cap Technology

mTouch capacitive touch solutions allow users to work with a variety of plastic or glass overlays to finish their user interface designs. With metal over cap technology users can also:

- Use polished or brushed metal surfaces including stainless steel and aluminium
- Sense through gloves
- Create water-proof designs
- Deploy Braille-friendly interfaces

How Metal Over Cap Technology Works
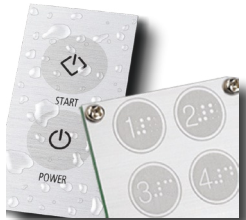
The front panel and the sensor create a capacitor. When the user presses the key, the distance between both plates will decrease slightly, increasing the capacitor value. Thanks to their high SNR (Signal to Noise Ratio) and stability over voltage and temperature, Capacitive Voltage Divider (CVD) and Charge Time Measurement Unit (CTMU) techniques allow the detection of deflection as low as 10 µm.

Metal Over Cap Technology can be implemented with the same hardware, PCB and electronics, and SW as capacitive touch technology.
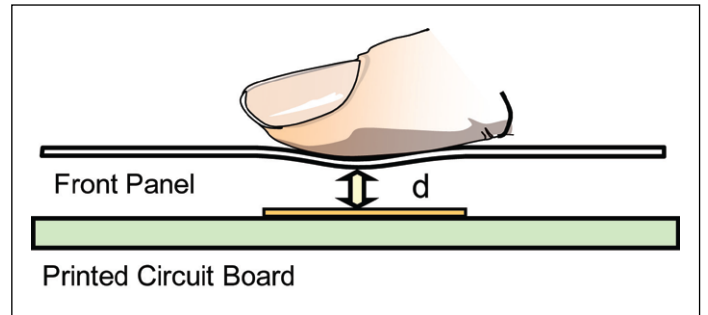
Mechanical Construction

The only difference in mechanical construction between designing a capacitive touch interface and an interface that uses Metal Over Cap technology is the introduction of a spacer layer to allow the deflection of the front panel.

- The spacer layer should be non-deformable
- Thickness of the spacer layer should be between 50 µm and 150 µm
- Commonly used materials for the spacer layer include glue, FR4 or mylar
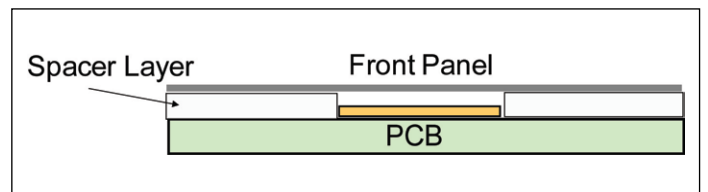
Getting Started with Metal Over Cap Technology

- Download App Note mTouch™ Metal Over Cap Technology AN1325
- Download the Metal Over Cap deflection tool

mTouch Solutions – Analog Resistive Touch Screen Controllers

Microchip offers a broad portfolio of touch screen controller solutions for resistive and projected capacitive applications that make it easy to add touch to your design without extensive development time, risk or cost.

Microchip's advanced touch screen controllers offer:

- High flexibility, low cost, low power
  - To reduce total system cost and increase flexibility
- Sophisticated, proprietary touch screen decoding algorithms
  - To send your application fully processed and reliable touch coordinates

Projected Capacitive vs. Resistive

Microchip offers resistive and projected capacitive solutions to allow you to choose the best fit for your touch screen design.

- Projected capacitive technology provides high durability, good optics and multi-touch capability which enables gestures
- Resistive touch is a good choice for a low cost, easy to integrate solution that accepts finger, stylus or glove input

Touch Screen Technology Comparison

	Analog Resistive	Projected Capacitive
Cost for screen < 6	Lowest	Low
Cost for screen > 10	Lowest	High
Optics	75%	90%
Screen Life	Good	Better
Ease of Integration	Easy	Moderate
Multi-Touch	Limited	Yes
Touch Object	Finger, Stylus/Glove	Finger

Analog Resistive Touch Screen Controllers

Microchip's AR1000 Analog Resistive touch screen controller solutions feature:

- Turnkey touch solution
- Built in decoding and advanced filtering
- Controller driven calibration
- Power-saving Sleep and Wake modes
- Low cost with few external components
- Universal 4, 5 and 8-wire support
- 4x4 QFN package
- SPI, I²C™, UART or USB interfaces

How Analog Resistive Works

- Two conductive coated polyester layers separated by a spacer layer
- When touched, top (flex) layer moves past spacer layer and contacts bottom (stable) layer
- Point of contact creates voltage divider in the X and Y directions
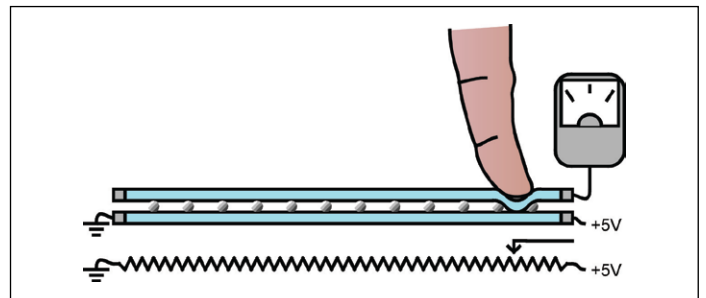
Development Tools for Resistive Touch

AR1000 Analog Resistive Development Kit (DV102011)

Provides everything designers need to get started:

- AR1020 development board
- 7 four-wire touch screen
- PICkit Serial Analyzer
- Technical documentation CD
- GUI-enabled AR1000 configuration utility

mTouch AR1000 Series Resistive Touch Screen Controllers

mTouch Solutions – Projected Capacitive Touch Screen Controllers

Projected Capacitive Touch Screen Solution
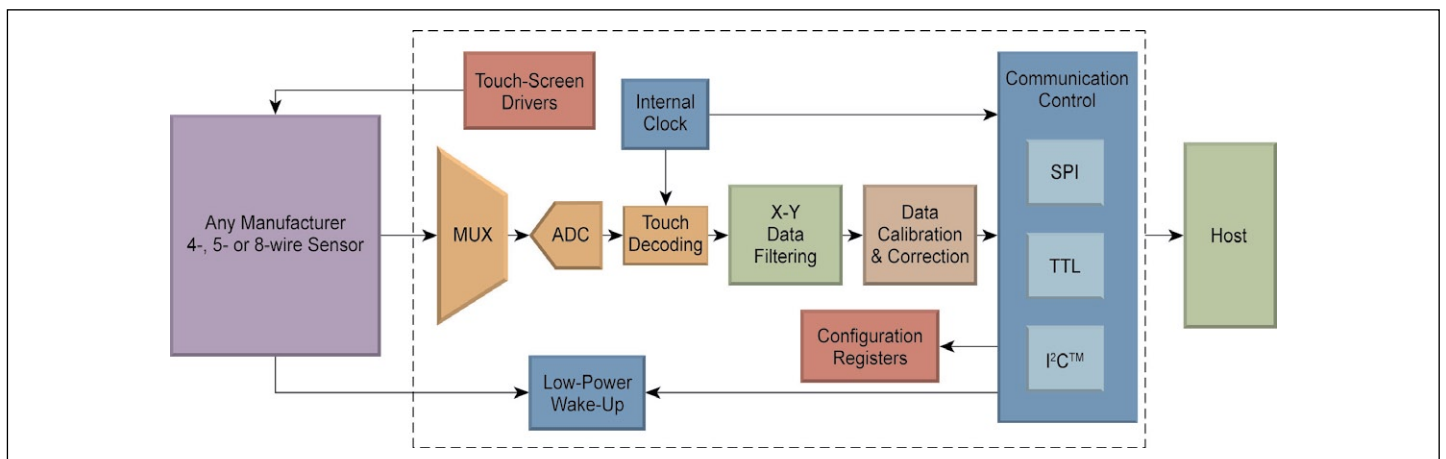
Microchip's mTouch projected capacitive touch screen sensing technology has the following features:

- Supports 3.5 touch screen, independent XY tracking for two touches in real time
- Gesture capable
- Royalty-free source code supports sensors with up to 32 channels
- Fast response time of <15 ms typical
- Report rate of 65 pps single, 55 pps dual
- Low operating power 1.5 mA typical
- Wide operating voltage 1.8V-5.5V
- 40-pin 5x5 mm uQFN package
- UART communication
- Auto adjusts for environmental changes (baseline, calibrate, drift)

How Projected Capacitive Works

- One or two thin layers of glass patterned with conductive coating, typically Indium Tin Oxide (ITO)
- Screen is configured as rows and columns
- Point of contact identified by change in capacitance of row and column cells

Development Tools for Projected Capacitive Touch
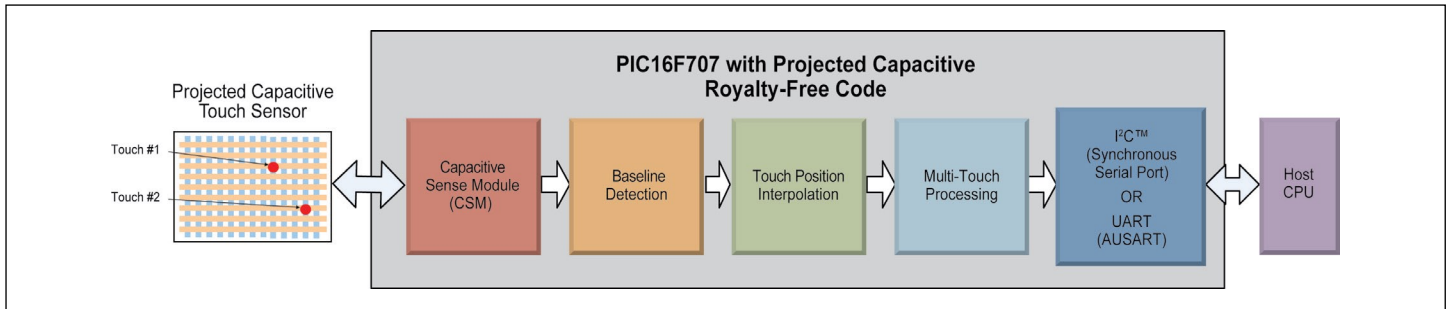
Projected Capacitive Development Kit (DM160211)

- Projected capacitive board with fully functional firmware on PIC16F707
- Includes sensor board with 3.5 projected capacitive 12 x 9 touch screen
- GUI-enabled projected capacitive configuration utility

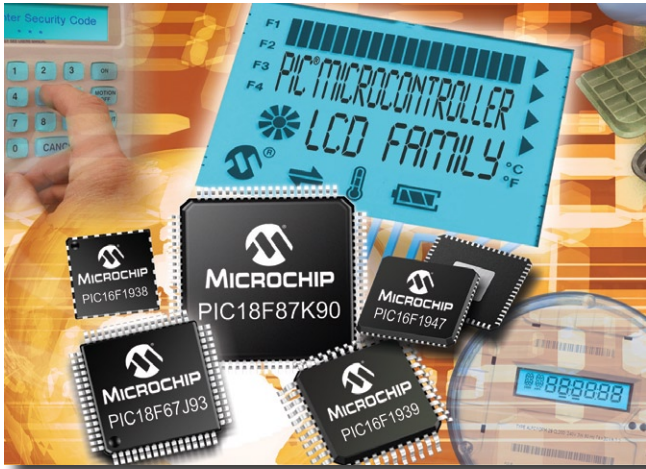## PIC16F707 Programmed with Projected Capacitive Source Code

## Implementation of Projected Capacitive Touch
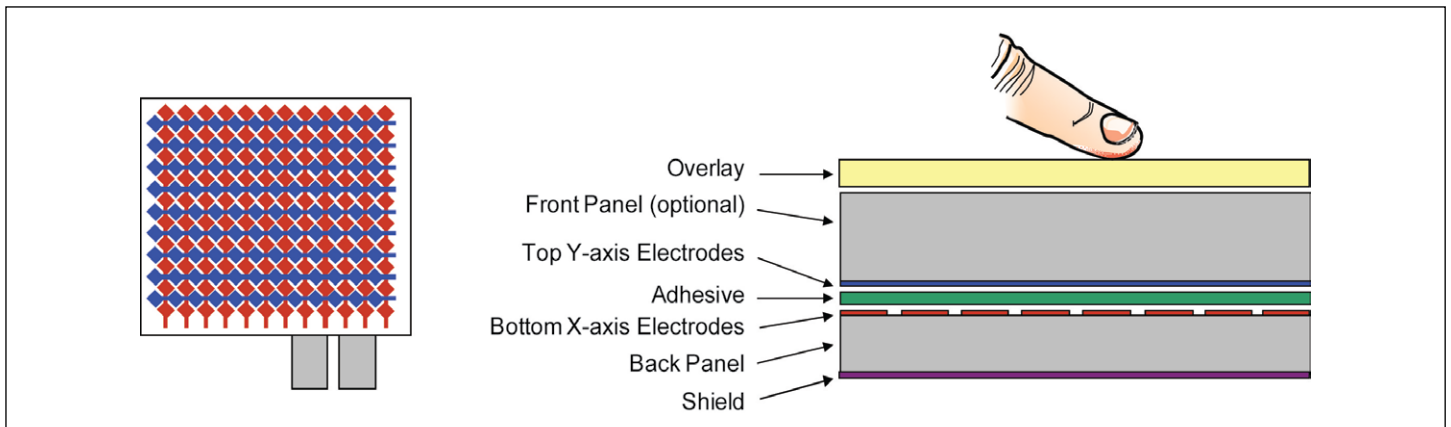
Display Controller Solutions – Segmented LCD

Display Solutions for Segmented LCD

Segmented displays are used in a wide variety of applications, ranging from meters to portable medical devices to thermostats to exercise equipment. PIC microcontrollers with integrated LCD drivers can directly drive segmented displays with letters, numbers, characters and icons. The main features of Microchip's LCD portfolio include:

- Flexible LCD segments
  - 28 pins - up to 60 segments
  - 44 pins - up to 96 segments
  - 64 pins - up to 184 segments
  - 80 pins - up to 192 segments
- Variable clock inputs
- Integrated voltage bias generation
- Direct drive for both 3V and 5V powered displays
- Software contrast control for boosting or dimming for different temperature or lighting conditions
- Drive LCD while conserving power in Sleep mode
- Integrated real time clock and calendar for displaying time and date information
- mTouch capacitive touch sensing capability
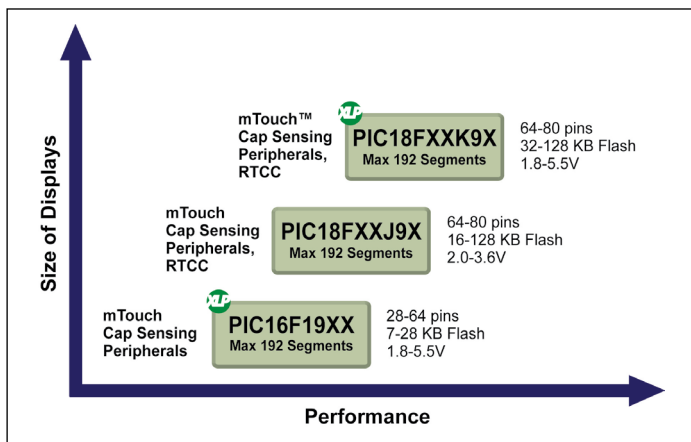
Direct Drive for Segmented Displays

The LCD PIC microcontrollers support direct LCD panel drive capability with no external components needed, lowering total system cost. They have integrated voltage bias generation which allows the MCU to generate the different voltage levels that are required to drive the LCD segment pins and provide good contrast for the display. The LCD MCUs support a range of fixed and variable bias options as well as variable clock inputs that enable the flexibility to work with many different glass vendors.

Contrast Control

Software contrast control is a key feature using firmware to either boost or dim the contrast of the display. Boost the contrast up to V_{DD} or beyond if you are using one of the MCUs with an integrated charge pump. Software contrast control allows the designer to vary the contrast on the LCD to account for different operating conditions such as temperature, lighting and humidity. Also, software contrast control can be invaluable for portable applications. As the battery level starts to drop, the firmware can apply a boost to the contrast, helping extend the battery life while still seeing a crisp image on the display.

Development Tools for Segmented LCD

PICDEM™ LCD 2 Demo Board (DM163030)

- Illustrates and supports the main features of Microchip's 28-, 40-, 64- and 80-pin LCD PIC microcontrollers
- LCD glass with icons, numbers, alphanumeric and starburst display
- Demonstrates booster capability for contrast control and dimming
- Separate Processor Plug-in Modules (PIMs) are available to evaluate all of the LCD products
  - PIC18F87J90 PIM (MA180025)
  - PIC18F87K90 PIM (MA180027)
  - PIC16F1947 PIM (MA160016)
  - LCD PIM Pack (PIC16) (MA180019)

Application Notes for LCD Displays

- Interfacing PIC® MCUs to an LCD Module, AN587
- Low-Power Real Time Clock, AN582
- Four Channel Digital Voltmeter with Display and Keyboard, AN557

Display Controller Solutions – Graphical Displays

Microchip offers varying levels of solutions to drive everything from simple monochrome LCDs to full color WVGA user interfaces.

Graphics support includes the following approaches:

- PIC24F "DA" integrated graphics controller
- PIC32 controllerless graphics
- Support for PIC MCU with external graphics controllers

The silicon offering is complemented with powerful, free and easy to use graphics library, display designer GUI and hardware development kits with flexible interface to various glass sizes.
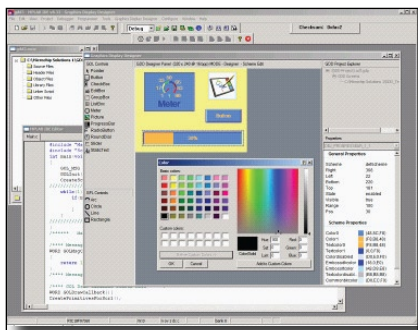
FREE Microchip Graphics Library

The Microchip Graphics Library is highly modular and is optimized for Microchip's 16- and 32-bit microcontrollers. It is easy to use and has an open documented interface for driver or controller support. The library supports the following features:

- Pre-made graphics objects
- Multiple fonts and languages
- User interface for mTouch™ sensing
- Includes buttons, charts, check boxes, scroll bars, list boxes, images and basic animation

FREE Microchip Graphics Display Designer

The Microchip Graphics Display Designer (GDD) is a visual design tool that provides customers with a quick and easy way of creating Graphical User Interface (GUI) screens for graphical interface applications on Microchip MCUs.

It provides the following advantages to the developers:

- Simplifies coding for the GUI screens with an ability to draw, resize and delete screen objects
- Eliminates the need to manually calculate the X/Y coordinates for on-screen object placements

- Generates output source files
- Ability to import various graphical resources, including custom fonts and bitmap images

Supported Screen Sizes and Colors

Microchip graphics solutions support various screen sizes and colors ranging from small monochrome OLED displays up to WVGA displays with vivid color. The table below shows the bits per pixel required to represent color.

Display Representation	Color Examples	Color Depth (bits per pixel)
Mono	Black and White	1
Grayscale	4 shades	2
	16 shades	4
Color	256 colors	8
	65K colors	16
	16 million colors	24

As the color depth and display resolution increase, the frame buffer grows. Depending on the size, the frame buffer can be stored in the microcontroller RAM, in external SRAM or integrated into an external graphics controller. The table below shows examples of the frame buffer sizes required for some popular resolution and color depths.

- PIC24 "DA" family supports up to 96KB on chip
- PIC32 MCUs support up to 123KB on chip
- External SRAM can be used for larger frame buffers
- For advanced graphics, external graphics controllers have additional frame buffer storage

Display Resolution Typical Sizes			Color Depth/ Memory Requirement in (bytes)				
			1 bpp (Mono)	2 bpp (4 shades)	4 bpp (16 shades)	8 bpp (256 colors)	16 bpp (65K colors)
WVGA	800x480	7″	48,000	96,000	192,000	384,000	768,000
VGA	640x480	5.7″	38,400	76,800	153,600	307,200	614,400
WQVGA	480x272	4.3″	16,320	32,640	65,280	130,560	261,120
QVGA	320x240	3.2″	9,600	19,200	38,400	76,800	153,600
Common for OLED	128x64	1″-2.7″	1,024	2,048	4,096	8,192	16,384

- Internal SRAM   - External SRAM

Target Applications

Applications that benefit from attractive and easy to use graphical displays include:

Consumer: Thermostats, Cordless Phones, Remote Controls

Home Appliance: Coffee Makers, Washing Machines, Ovens

Industrial: Digital Instrument Gauges, Storage Controls, Remote Terminals

Portable Medical: Glucometers, Blood-Pressure Monitors, Portable ECGs

Application Notes for Graphical Displays

- Fonts in the Microchip Graphics Library, AN1182
- How to Use Widgets in Microchip Graphics Library, AN1136
- How to Create Widgets in Microchip Graphics Library, AN1246
- Using a Keyboard with the Microchip Graphics Library, AN1227

Graphical Display Configurations

PIC24F with Integrated Graphics Controller: Low Cost, Easy to Use
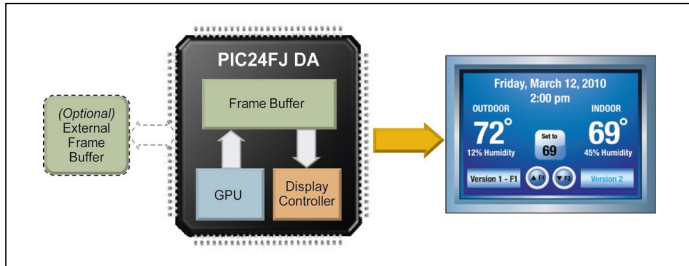

The PIC24F "DA" family makes it easy and cost-effective to add advanced graphics to your application by eliminating the need for external frame buffers or display controllers.

- Dedicated graphics clock for a continuous, clean display
- On-chip display controller provides direct interface to TFT, STN and OLED displays
- Easy to use Graphics Processing Units for hardware acceleration
  - Move and copy rectangles with smooth, fast memory transfers
  - Decompress images without CPI intervention
  - Render text without CPU intervention
- Color look-up table and 96 KB frame buffer to support multiple colors
  - Supports QVGA 8 bpp with internal frame buffer
  - Supports WQVGA 16 bpp with external frame buffer using PMP (Parallel Master Port)

With the hardware acceleration, this family is able to process and render graphics without using any MCU MIPS. The dedicated graphics engine is able to continuously drive a display without being shared with any other function.

PIC32 Low Cost Controllerless Graphics: 32-bit Performance, Flexibility, Integration
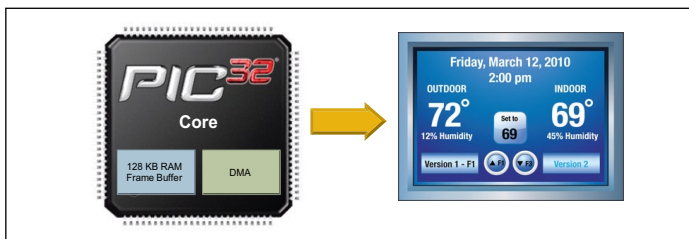

Microchip's PIC32 line of 32-bit microcontrollers offers 80 MIPS and high performance DMA to render graphics directly to displays. This enables PIC32 devices to drive a display without an external graphics controller.

- Uses <5 MIPS and DMA to render graphics
  - Direct interface to STN, TFT displays
- Integrated 128 KB frame buffer
  - Supports QVGA 8 bpp with internal frame buffer
  - Supports WQVGA 16 bpp with external frame buffer using PMP (Parallel Master Port)
- Works with any PIC32 80 MIPS 32-bit microcontroller

With devices offering up to 512 KB Flash and 128 KB RAM, developers have plenty of space for application code, communications stacks and data buffering. In addition to the graphics capabilities, PIC32 MCUs also have integrated peripherals for USB, CAN, Ethernet and capacitive touch sensing.

External Graphics Controller: PIC24 or PIC32 with Parallel Master Port (PMP)

PIC24 and PIC32 MCUs can also work with an external graphics controller to support larger screen sizes or more advanced graphical features.
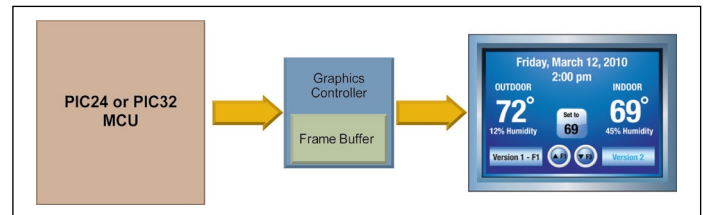
The Solomon SSD1926 Graphics Controller has hardware graphics acceleration to free up the MIPS of the PIC MCU. This controller includes a SD Card interface and JPEG decode engine as well as 256 KB RAM. The Graphics PICtail™ Plus SSD1926 Board (AC164127-5) includes serial Flash for data storage and interfaces to either Explorer 16 or PIC32 Starter Kits.

The Epson S1D13517 Graphics Controller includes alpha blending, picture-in-picture and supports up to WVGA (800x480) at 24 bpp. This controller has an SDRAM interface for connection to low cost external memory. The Graphics Controller PICtail Plus Epson S1D13517 Board (AC164127-7) includes 128 Mb SDRAM frame buffer and 64 Mb serial Flash and interfaces to either Explorer 16 or PIC32 Starter Kits.

	PIC24 "DA" Integrated Graphics Controller	PIC32 Controllerless Graphics	External Solomon Graphics Controller SSD1926	External Epson Graphics Controller S1D13517
Display*	WQVGA 480x272	WQVGA 480x272	WQVGA 480x272	WVGA 800x480
Graphics	HW Acceleration: Rectangles, Characters, Images	DMA on PIC32 + <5 MIPS	HW Acceleration, SD card, I/F, JPEG engine	SDRAM, I/F, Alpha-blending, Picture-in-picture
Frame Buffer	Color Lookup Table + 96 KB on MCU + Ext SRAM	128 KB on MCU + Ext SRAM	256 KB on Solomon Controller	Ext SDRAM
Core MIPS	16	80	–	–
Power	Better	Good	Good	Good
Cost	$	$	$$	$$$

*Max size at 16 bpp, 60 Hz

Tools for Designing Graphical Displays

Development Tools for Graphical Display Controllers

Low Cost Solution Without External Graphics Controller

PIC24FJ256DA210 Board (DM240312)

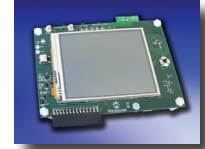**Low-Cost Controllerless Graphics PICtail™ (AC164144)**

Solutions with External Graphics Controllers

Graphics LCD Controller PICtail™ Plus SSD1926 Board (AC164127-5) (Includes Solomon SSD1926 Controller)

Graphics Controller PICtail™ Plus Epson S1D13517 Board (AC164127-7)

Multimedia Expansion Board (DM320005) (Includes Solomon SSD1926 Controller)

Family	Display Boards Supported				
	QVGA 3.2 Graphics Display Truly 240x320 Board (AC164127-4)	WQVGA 4.3 Graphics Display Powertip 480x272 Board (AC164127-6)	VGA 5.7 Graphics Display Truly 640x480 Board (AC164127-8)	WVGA 7 Graphics Display Truly 800x480 Board (AC164127-9)	Prototype Boards Connect Your Glass (AC164139)
PIC24 "DA" Family	PIC24FJ256DA210 Board (DM240312) + Display Board				Yes
PIC32 "LCC" Graphics	PIC32 Starter Kit (DM320001 or DM320003) + LCC Graphics Board (AC164144) + Display Board				Yes
PIC24 + Solomon SSD1926	Explorer 16 (DM240001) + Solomon GFX Board (AC164127-5) + Display Board				Yes
PIC32 + Solomon SSD1926	PIC32 Starter Kit (DM320001 or DM320003) + Multimedia Expansion Board (DM320005) Display Integrated on MEB				
PIC32 + Solomon SSD1926	PIC32 Starter Kit (DM320001 or DM320003) + Solomon GFX Board (AC164127-5) + Display Board				Yes
PIC24 + Epson S1D13517	Explorer 16 (DM240001) + Epson GFX Board (AC164127-7) + Display Board				Yes
PIC32 + Epson S1D13517	PIC32 Starter Kit (DM320001 or DM320003) + Epson GFX Board (AC164127-7) + Display Board				Yes

Speech & Audio Solutions

Adding audio capability, whether in the form of music playback or voice guidance, greatly improves the user experience of a product. Audio is useful in product language localization and providing assistance to the visually impaired. Audio prompts are very useful in applications requiring the end users visual attention elsewhere, such as automotive.

Microchip's microcontroller and digital signal controller products, software and tools allow the designer to include speech or audio interfaces, enabling functions such as:

- Generation of tones, alarms and musical notes
- Recording and playback of audio information

Featured Products

Most 8/16/32-bit PIC microcontrollers can generate tones, alarms and musical notes in various applications. The dsPIC DSCs and PIC32 MCUs have DSP libraries included in their respective compilers to enable higher performance and more efficient processing of high quality audio. The dsPIC DSCs offer certain specialized peripherals for audio applications, including:

- 16-bit D/A Converter
- Codec/Data Converter (I^2S) Interface module

Microchip also offers a wide portfolio of low power, high performance operational amplifiers which can be used to buffer audio signals or drive small speakers.

Audio Application Support

Functions	Development Board	Accessories	Device Families Supported	Libraries Supported
Recording & Playback	MPLAB Starter Kit for dsPIC DSC (DM330011)	–	dsPIC33F DSC	ADPCM G711, G726A, Speex dsPIC DSC Automatic Gain Control Library
Recording & Playback	Explorer 16 Development Board (DM240001)	Audio PICtail™ Plus Daughter Board (record & playback) (AC164129)	PIC24F, PIC24H, PIC32 MCUs, dsPIC33F DSC	ADPCM G711, G726A, Speex, Audio Library for PIC32MX, dsPIC DSC Speech and Audio Fast Forward (SAFF) Tool, dsPIC DSC Automatic Gain Control Library
Playback	Explorer 16 Development Board (DM240001)	Speech Playback PICtail Plus Daughter Board (AC164125)	PIC24F, PIC24H, PIC32 MCUs, dsPIC33F DSC	G711, G726A, Speex, Audio Library for PIC32MX, dsPIC DSC Speech and Audio Fast Forward (SAFF) Tool
Recording & Playback	Audio Development Board for PIC32 MCUs (AC320011)	Accessory development Platform for iPod/iPhone	PIC32 MCUs	G711, G726A, Speex, Audio Library for PIC32MX, MP3 Audio Decode, Sample Rate Conversion

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Microchip is committed to supporting its customers in developing products faster and more efficiently. We maintain a worldwide network of field applications engineers and technical support ready to provide product and system assistance. In addition, the following service areas are available at www.microchip.com:

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- **Sample** link offers evaluation samples of any Microchip device: http://sample.microchip.com
- **Forum** link provides access to knowledge base and peer help: http://forum.microchip.com
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If additional training interests you, then Microchip can help. We continue to expand our technical training options, offering a growing list of courses and in-depth curriculum locally, as well as significant online resources – whenever you want to use them.

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- eLearning: www.microchip.com/webseminars
- Resources from our Distribution and Third Party Partners www.microchip.com/training

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Electro-absorption laser
1.3-micrometer band supports 40Gbit/s data

Mitsubishi Electric has announced a compact 1.3-micrometer band 40Gbps Electro-Absorption Modulator Laser (EML) module for optical signal transmission up to 10 kilometers. As chromatic dispersion at 1.3 micrometers is almost negligible, the company's new 1.3-micrometer band EML chip delivers high signal quality for 40Gbps optical transmissions over long distances. Transmission penalty is less than 1dB after 10km using single-mode fiber. Other specifi-

cations include a high extinction ratio (10dB, typical) and a high mask margin (10%, typical) at 43Gbps operation. The device uses a general-purpose interface for 40Gbps electrical connection and dual SMPM connectors for differential connection between modules and digital signal circuits. Output power ranges from 0 to 4 dBm. The unit comes in a XLMD-MSA compliant package.
Mitsubishi Electric
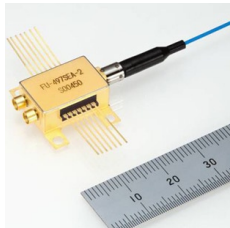
UV and remote-head cameras
for industrial endoscopy

PPT Vision has added two high-performance JAI cameras to its M-Series embedded machine vision system line, including an ultra-violet (UV) camera for inspections that benefit from this shorter wavelength of light, as well as a remote-head "industrial endoscopy" model for special applications. Additionally, the manufacturer released the IMPACT 10.2 software to support the growing M-Series vision system family with streamlined functionality and expanded image management capabilities. The UV camera (model CM-140GE-UV) offers seamless integration with PPT Vision's M Series vision system and IMPACT software. This GigE Vision-compliant monochrome camera delivers 1392x1040-pixel resolution at 16 frames per second in continuous operation to capture images of UV-sensitive materials, or objects that can only be imaged with ultra-violet light.

The remote-head camera (model CM-030GE-RH) represents the first mobile imaging capability in an integrated machine vision system. This compact model, 17mm in diameter and 46 mm in length with a 2-meter connector cable, provides 656 x 494 resolution at 120 fps, with a 1/3" progressive-scan CCD sensor. It is designed for inspections where electronics must be positioned away from the camera, such as connector inspection or microelectronics assembly operations. The IMPACT 10.2 software enables all images to be stored in a temporary circular image history file so that the operator can step forward and backward through images and run inspections under controlled circumstances. A robust communications fieldbus protocols and new tool setups make Data Matrix, Serial and TCP/IP tools easier to use.
**PPT Vision**

High speed InGaAs linear image sensors
for industrial detection in the near infrared

The high speed G10768-1024D InGaAs linear image sensors and the C10854 multichannel detector head from Hamamatsu Photonics have been designed to meet increasing industrial requirements for the detection of foreign bodies on-line in the near infrared range (wavelength range from 800 to 1700nm). The G10768 devices features 1024 individual InGaAs photodiode pixels, combined with a low noise CMOS trans-impedance amplifier and multiplexor readout circuit, to simplify operation. In addition a selectable feedback capacitance is available allowing to choose the on-chip
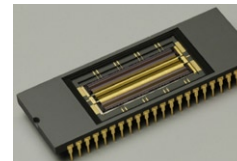
gain to increase dynamic range. The device has a pitch of 25mm and is capable of very high speed readout rates, in excess of 40,000 lines per second. The C10854 allows easy operation of the G10768, offering a high-speed readout, single +5V supply voltage, 16-bit AD converter and simple CamerLink interface. Not only is the combination of the G10768 series and C10854 more cost effective, but also it is smaller than many other products on the market, says the manufacturer, making it more suited for integration into an existing system.
Hamamatsu Photonics

Robust power conversion for demanding automotive environments

By Bruce Haug

AUTOMOTIVE AND HEAVY equipment vehicle environments are very demanding for any type of power conversion devices. Wide operating voltage ranges coupled with large transients and wide temperature excursions combine to make reliable electronic system design difficult.

To further complicate design considerations, the number of rails within an electronic system is also increasing. For example, a typical navigation system can have six or more rails including 8.5, 5, 3.3, 2.5, 1.8 and 1.5V. At the same time, as the number of components increases, space requirements continue to shrink, making high efficiency conversion critical due to the space limitations and high temperature conditions.

As a result, a good automotive and truck switching DC/DC regulator needs to be specified to work over a wide input voltage range. A 60V rating gives good margin for a 12V system, which is usually clamped in the 36V to 40V range. In addition, double battery applications found in trucks and heavy equipment require an even higher operating voltage due to their 24V nominal battery voltage. Most are clamped to 58V, so a 60V rating is usually sufficient. The onboard automotive and truck over-voltage clamp is required to maintain a maximum transient voltage caused by the inductive kick back voltage from the starter motor, which can cause a much higher transient voltage when left unclamped.

There are many automotive and truck systems that require continuous power even when the vehicle's motor is not running, such as remote keyless entry and alarm systems. It is essential for these types of "always-on" systems to have a DC/DC converter with low quiescent current in order to maximize the battery run time when in sleep

mode. In such circumstances, the regulator runs in normal continuous switching mode until the output current drops below a predetermined threshold of around 30-50mA. Below this level, the switching regulator must go into burst mode operation to lower the quiescent current into tens of micro amps, thereby lowering the power drawn from the battery in order to extend the battery run time.

With 60V input DC/DC converters in short supply, designers have resorted to a transformer-based topology or external high side drivers to operate from up to 60V. Others have used an intermediate bus converter, requiring an additional power stage. Both of these alternatives increase the design complexity and, in most cases, reduce the overall efficiency. Linear Technology has come up with the LTC3890, a 60V input capable step-down switching regulator controller that addresses many of the key issues required in automotive and truck applications as outlined above. Figure 1 shows a schematic of the LTC3890 operating in an application that converts a 9V to 60V input into 3.5V/5A and 8.5V/3A outputs.
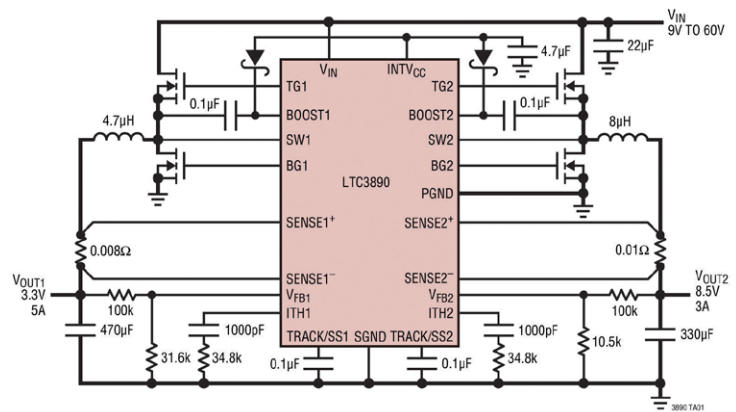

Fig. 1: LTC3890 schematic with 9V to 60V input to 8.5V/3A and 3.3V/5A outputs.

The LTC3890/-1 is a high voltage dual output synchronous step-down DC/DC controller that draws only 50μA when one output is active and 60μA when both outputs are enabled. With both outputs shut down, the LTC3890/-1 draws only 14μA.

The 4V to 60V input supply range is designed to protect against high voltage transients, continue operation during automotive heavy equipment and truck cold cranking along with covering a broad range of input sources and battery chemistries. Each output can be set from 0.8V to 24V at output currents up to 20 amps, with efficiencies as high as 98%, making it well suited for 12V or 24V automotive, truck, heavy equipment and industrial control applications.

The device operates with a selectable fixed frequency between 50kHz and 900kHz, and can be synchronized to an external clock from 75kHz to 850kHz with its phase-locked loop (PLL). The user can select from continuous operation, pulse skipping and low ripple
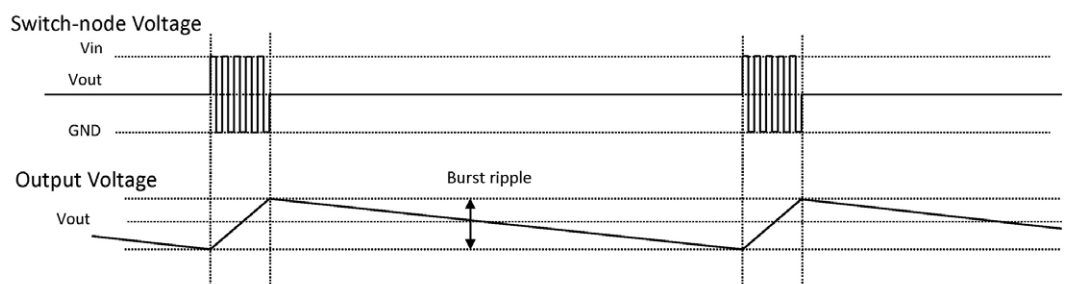

Fig. 2: Burst mode operation voltage diagram for the LTC3890.

Bruce Haug is Senior Product Marketing Engineer at Linear Technology – www.linear.com

Burst Mode operation during light loads. The LTC3890's 2-phase operation reduces input filtering and capacitance requirements. Its current mode architecture provides easy loop compensation, fast transient response and excellent line regulation.

Output current sensing is accomplished by measuring the voltage drop across the output inductor (DCR) for the highest efficiency or by using an optional sense resistor. Current foldback limits MOSFET heat dissipation during overload conditions. These features, combined with a minimum on-time of just 95ns, make this controller suitable for high step-down ratio applications.

The device is available in two versions; one in a 32-lead 5x5mm QFN package including a clock out, clock phase modulation, two separate power good outputs and adjustable current limit; and another device that does not have those extra features, delivered in a 28-pin SSOP package.

Burst mode operation, pulse skipping or forced continuous mode

The LTC3890/-1 can be enabled to enter high efficiency burst mode operation, constant frequency pulse skipping, or forced continuous conduction mode at low load currents. When configured for burst mode operation and during a light load condition, the inverter will burst out a few pulses to maintain the charge voltage on the output capacitor. It then turns off the converter and goes into sleep mode with most of its internal circuits shut down.

The output capacitor supplies the load current and when the voltage across the output capacitor drops to a programmed level, the converter starts back up delivering more current to replenish the charge voltage. The action of shutting down and turning off most of its internal circuits significantly reduces quiescent current, thereby helping to extend the battery run-time in an "always-on" system when the system is not running. Figure 2 shows the conceptual timing diagram of how this works.

The burst mode output ripple is load independent so only the length of the sleep intervals will change. In sleep mode, much of the internal circuitry is turned off except for the critical circuitry needed to respond quickly, further reducing its quiescent current. When the output voltage drops low enough, the sleep signal goes low and the controller resumes normal Burst Mode operation by turning on the top external MOSFET.

Alternatively, there are instances when the user will want to operate in forced continuous or constant frequency pulse skipping mode at light load currents. Both of these modes are easily configurable but will have a higher quiescent current and a lower peak to peak output ripple. In addition, when the controller is enabled for burst mode operation, the inductor current is not allowed to reverse. The reverse current comparator, IR, turns off the bottom external MOSFET just before the inductor current reaches zero, preventing it from going negative. Thus, the controller also operates in discontinuous mode when configured for burst mode operation.

Furthermore, in forced continuous operation or when clocked by an external clock source, the inductor current is allowed to reverse at light loads or under large transient conditions. Continuous operation has the advantage of lower output voltage ripple and results a higher quiescent current.

Overcurrent protection

Fast accurate over current limit protection is essential in a high voltage power supply. Because of the high voltage across the inductor when the output is shorted, designers must either use a sense resistor in series with the output or use the voltage drop across the output inductor to sense the output current.

Either way, the output current is monitored continuously and provides the highest level of protection. Alternative designs might use the RDS (ON) of the top or bottom MOSFET to sense the output current. However, this creates a time frame within the switching cycle where the controller is blind with regards to what the output current is and can cause a failure of the converter.

Strong gate drive

Switching losses are proportional to the square of the input voltage and these losses can dominate in high input voltage applications with an inadequate gate driver. The

LTC3890/-1 has powerful 1.1Ω on-board N-channel MOSFET gate drivers that minimize transition times and switching losses thereby maximizing the efficiency. In addition, it is capable of driving multiple MOSFET's in parallel for higher current applications.

Fast transient response

The LTC3890 uses a 25MHz bandwidth operation amplifier for voltage feedback. The high bandwidth of the amplifier, along with high switching frequencies and low value inductors, allow for a very high gain crossover frequency.

This allows the compensation network to be optimized for a very fast load transient response. Figure 3 illustrates the transient response of a 4A step load on a 3.3V output with a less than 100mV deviation from nominal. As discussed along this article, the LTC3890 enables safe and efficient operation in a demanding high voltage transient environment. It can be applied to a wide variety
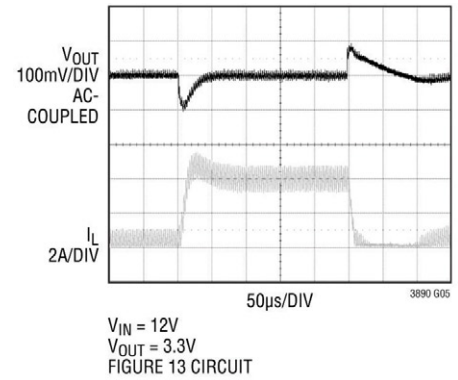
Fig. 3: LTC3890 transient response curve for a 4A load step.

of output voltages with up to a 24V output voltage. Alternatively, its low minimum on-time enables the LTC3890 to be used in high step-down ratio applications.

The ability to directly step-down input voltages from 60V without requiring a bulky transformer, or external protection, makes for a cost effective, compact and reliable solution. ■

# Step by step... confidently through the AUTOSAR round trip

By Michael Seibt and Guido Sandmann

ELECTRONIC DEVELOPMENT in the automobile industry has always been an iterative process – even long before the implementation of AUTOSAR. In the course of a project, requirements are amended or refined; decisions about design are revised and architectures adjusted. Through the standardization of specification formats of different design artifacts, AUTOSAR has explicitly defined how these process steps are carried out. Meanwhile, thanks to advanced tool support, the AUTOSAR standard is being successfully utilized in many areas of product development. The challenge of these projects is to ensure consistent data exchange between tools without losses of design information. Particular attention is being paid to the interaction of architecture and Model-Based Design tools for the devel-

opment of individual software components along with functional software. Both top-down and bottom-up design approaches are supported.

Using the example of MATLAB, Simulink, and Embedded Coder by MathWorks, as well as the AUTOSAR Authoring Tool VSA by Mentor Graphics, this article is intended to demonstrate the interaction and the interoperability of architecture- and Model-Based Design environments in five steps under consideration of the mechanisms defined by AUTOSAR.

Top-down versus bottom-up workflows

In practice, both top-down and bottom-up workflows are found. The two approaches are generally not used separately, but mixed
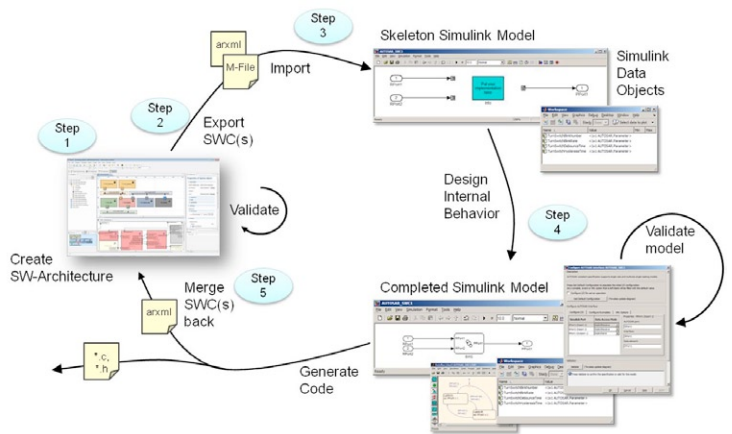
Fig. 1: AUTOSAR round-trip engineering with Simulink and VSA.

because of iterative processes mentioned above.

If a function is newly developed from scratch, the top-down approach is usually utilized. This means that initially, a software architecture including its software components and the interface specifications are described using an authoring tool. Depending on the requirements and data availability, the internal behavior (meaning the runnable

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Guido Sandmann is an automotive Marketing Manager, EMEA at MathWorks – www.mathworks.com

architecture) may be developed as well at that point. Consistency checks and design rules that are both built-in as well as user-defined help to check imported data sets for correctness and completeness. The resulting exported specification formats are then imported into a design tool such as Simulink. In the course of this import of software component specifications, model frameworks that contain all relevant information like interfaces or runnables are automatically generated. With the generated model framework, the software engineer can model the functional behavior as usual in Simulink based on the functional requirements. After the model is finished, the AUTOSAR-compliant C code generation takes place with the help of Embedded Coder. At the same time, a new software component specification is exported, which in turn can be imported by VSA for further integration.

On the other hand, if models for a function already exist and have been used in production, they can be reused. They must be augmented with AUTOSAR-specific infor-

mation. Once done, an AUTOSAR compliant C code as well as respective AUTOSAR software component specifications are generated, which the authoring tool, in turn, can import for further processing. Thus, the bottom-up approach primarily addresses the reutilization of existing IP (Intellectual Property).

As described in the beginning, different steps of a process are repeated several times in order to implement refinements or modifications. Therefore, the tools utilized have to support the iterative development process. In this particular context, they have to support round-trip engineering, which means that architecture- and Model-Based Design tools have to be able to further process the updated data of each other. In

Fig. 2: VSA – AUTOSAR authoring tool.

the following paragraphs, all the steps that are carried out in the course of round-trip engineering are described in detail.

Step 1: Software architecture and component generation

In an AUTOSAR authoring tool like VSA, the software components are generated and connected into a software architecture. Depending on the required granularity, the
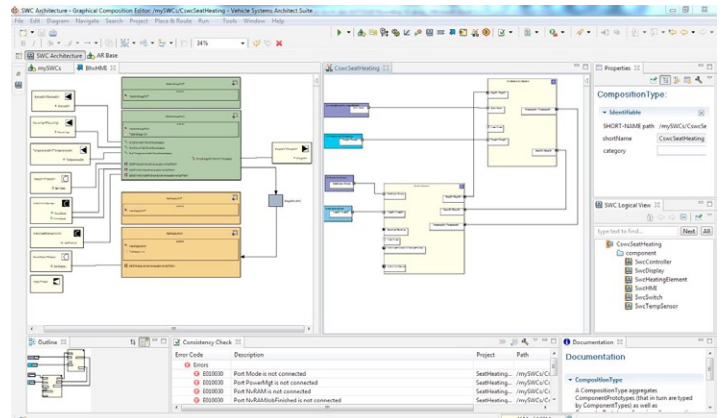
internal behavior of the individual software components can also be modeled in the form of runnables, access points, and RTE events.

The following figure shows software architecture (software composition) based on the example of a seat heating system, including an excerpt of the SWR behavior. Different domain-specific editors are available for creating designs of varying levels of complexity.

Depending on the requirements, the user can choose between a tree-based editor, tabular editor, or graphic editor.

Numerous pre-implemented consistency checks allow the continuous checking of the design for completeness and plausibility during the architectural modeling process.

They can be supplemented with self-defined consistency checks or design rule checks (DRCs). Existing software components, interface specifications, and other design artifacts can also be imported in the form of libraries and reutilized in the new design. Each AUTORSAR object receives a unique stamp through the automatic generation of UUIDs (Universally Unique Identifiers) and the assignment of short names in order to be recognizable during the design iterations.

Step 2: Data export from authoring tool

Through the metamodel technology used in VSA, a complete AUTOSAR model specification is available to support a complete export. Different AUTOSAR versions can be accommodated with the respective model-to-model transformations. Once defined inside a software architecture in VSA, the particular software components can be exported in AUTOSAR-defined standard specifications. A MATLAB script, which supports the subsequent import into MATLAB and Simulink, is also exported.

Step 3: Import of the software component specification to Simulink

Simulink contains interface functions that allow the import of the artifacts generated in step 2. The respective interface and port specifications, the inter-runnable variables, or the information regarding the runnables (internal behavior) are imported. Then, a model framework including the structure of the software component is generated as function-call subsystems. The variables, including their data types, are generated from the specification and automatically created in the workspace. The following figure shows an imported software component with runnables and inter-runnable variable of the seat heating system:

Step 4: Modeling of the functional behavior and code generation

In the next step, the functional behavior is realized through Model-Based Design. Little by little, a model is created and refined with Simulink and Stateflow, and in the course of the project, the model is used for various purposes.

In the very early stages, the functional behavior is validated by simulation. Later, a refined version can be tested directly in the vehicle with the help of Rapid Prototyping Hardware until the model is finally mature enough for production code to be generated with Embedded Coder in an AUTOSAR-compliant manner. In the process, conventional Simulink elements can be used, which can be intuitively mapped onto AUTOSAR artifacts. The crucial point is that Model-Based Design and the relevant design and verification tools can be applied as usual. This step concludes
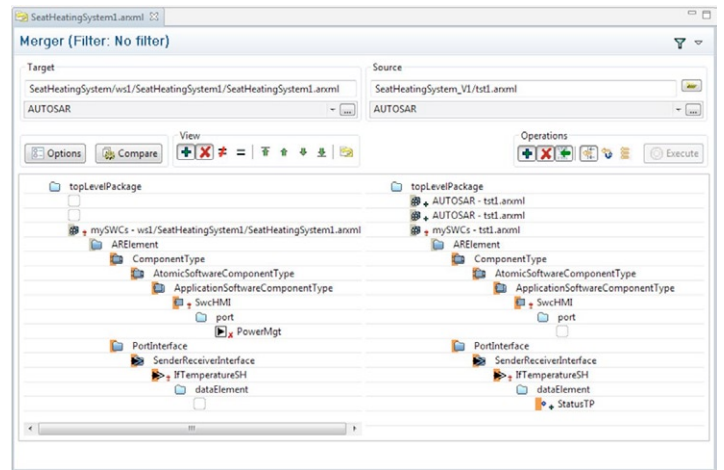
Fig. 4: VSA compare and merge tool.

with the generation of AUTOSAR-compliant C code and the AUTOSAR software component specification in arxml format, which are imported for the integration with VSA in the next step.

Step 5: AUTOSAR compare and merge

In order to complete the round trip, an option to feed the amended design data back to the AUTOSAR authoring tool and synchronize them with the original design data is required.

For this purpose, VSA provides an AUTOSAR Compare and Merge functionality, with which design objects can be compared and specifically merged on the AUTOSAR object plane. This can be done on the basis of either UUID (Unique Universal Identifier) or short name.

Additional "rules"

Reliable round-trip engineering is already being implemented at various companies using AUTOSAR and well-coordinated tools. However, this is only possible by observing additional "rules."

User roles and rights must be coordinated under consideration of existing and newly defined processes. Internal "style guides" such as modeling guidelines and naming conventions must be applied to specifically limit the degree of freedom within the AUTOSAR framework.

Eventually, these style guides have to be coordinated with Tier-1 suppliers to implement round-trip engineering not only internally but also between companies in a supply chain. Once again, software tools play a key role in the exchange of AUTOSAR artifacts between OEM and its suppliers as well. ∎
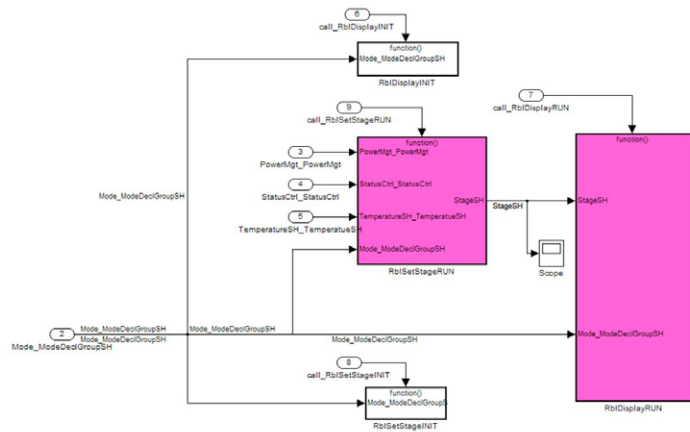
Fig. 3: Import of the SWC specification into Simulink.

LIN$_{2.1}$ compatible motor driver
integrates LIN interface with PWM interface with data pre-processing

With the E523.01, Elmos presents an EC motor driver with all the functions required for the configuration of a complete, low-cost system. Apart from the high-performance bridge driver, for communication purposes the semiconductor features a LIN2.1 compatible interface as well as a PWM interface with data pre-processing.

For an external microprocessor, optional 3.3 or 5.0V voltage supply (70mA), reset, and a configurable window watchdog are provided. The motor driver powers 3 external NMOS half-bridges for BLDC or DC motors, optionally with 3 or 6 PWM input signals. Small loads can be directly controlled. The dead time between the high-side and low-side FETs can be precisely adjusted.
Elmos

> **www.elmos.com**

Non-synchronous boost controller
automotive grade chip has wide input range from 3.2 to 44V

ON Semiconductor has introduced a new adjustable output non-synchronous boost controller for automotive systems. The NCV8871 is a wide input voltage device, with a range of 3.2 to 44 V, which can be used to drive an external N-channel MOSFET. The device incorporates an internal regulator that supplies charge to the gate driver. It has a 3.0μA quiescent current when in sleep mode, allowing power consumption to be minimized. It features a synchronizable switching frequency, with two available versions that can be set at 170 kHz typical, or 1 MHz typical. Peak current mode control with internal slope compensation ensures device stability over the wide automotive battery range. This also ensures the device is protected during a current fault condition by turning off the power switch for the remainder of the cycle if the current limit is exceeded. Further protection is provided by a thermal shutdown mechanism (with a 170 degree C threshold) and a 3.1 V undervoltage lockout. The NCV8871 is highly programmable with various other frequency options available upon request. Additional options include different slope compensation values, current limit set points and different gate drive voltages for interfacing with various MOSFETs. The device also supports multiple topology configurations, including boost, flyback, SEPIC, and multi-phase. Output power ranges from a few watts up to 200 W in a boost topology.
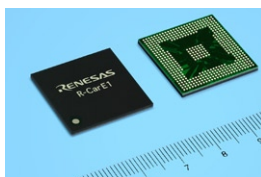**ON Semiconductor**

> **www.onsemi.com**

SoC targets entry level infotainment applications
delivers up to 1,330 Dhystone MIPS at 533MHz

Renesas Electronics announced a new member of the R-Car series of automotive systems-on-chip (SoCs), the R-Car E1, offering low power consumption and high system integration targeting the cost-sensitive market of car navigation and multimedia systems including high-end car radios. With the R-Car E1 SoC, Renesas intends to strengthen its position in entry navigation systems, as this device offers a good balance between system integration and cost. The R-Car E1 is powered with a single ARM CortexTM-A9 32-bit RISC CPU core (enhanced with NEONTM extension) running at 533MHz, which achieves a maximum processing power of 1,330 Dhrystone million instructions per second (DMIPS). The Graphics Processor Unit (GPU) is Imagination Technologies' PowerVRTM SGX531 and processes up to 14M triangles/s and is capable of delivering up to 1.4 gigaflops for accelerated graphics.
Renesas Electronics

> **www.renesas.eu**

Partial in-vehicle networking solution
helps reduce CO2 emissions and improve efficiency

NXP Semiconductors N.V. has unveiled the first NWP ISO 11898-6 and AUTOSAR R3.2.1 compliant solution supporting CAN Partial Networking which will help reduce CO2 emissions from vehicles and produce environmentally-friendly solutions. The stand-alone TJA1145 CAN transceiver and system basis chip UJA1168 give design engineers precision control over a vehicle's bus communication network. By intelligently de-activating those Electronic Control Units (ECUs) that are currently not needed, engineers are able to reduce vehicle fuel consumption and CO2 emissions without sacrificing performance or consumer experience.
In current in-vehicle networking architectures, all ECUs are always active and consuming power when the vehicle is in use. This is the case even if the applications they control aren't continuously required, such as seat positioning, sun roof operation, window lifting etc. CAN

Partial Networking changes this model by activating only those ECUs that are functionally required, while the other ECUs remain in a low-power mode until needed. CAN Partial Networking is also extremely beneficial for electric and hybrid vehicles as it helps extending their operating range and optimizing charging time. TJA1145 and UJA1168 are next-generation networking solutions, which combine analog circuitry and high-density digital circuits. TJA1145 is a high-speed CAN transceiver, while UJA1168 is a CAN system basis chip with 5 V/100 mA microcontroller supply.
Both support CAN Partial Networkingby enabling "Selective wake-up" and "Selective sleep" functionality. Both chips come with a small footprint based on the HVSON14 package. The TJA1145 is also available in the SO14package.
NXP Semiconductors

www.nxp.com

1W surface mount metal strip resistor
offers a very low resistance range of 0.5 ot 5mΩ

Vishay Intertechnology has introduced a surface-mount Power Metal Strip resistor that is the industry's first 4-terminal, 1 W current sensing resistor in the compact 0612 package size to offer a very low resistance range from 0.5 mΩ to 5 mΩ. The small size of the WSK0612 resistor allows it to replace larger current sensing resistors, saving space on the circuit board that in turn will enable creation of smaller and lighter products for the consumer.
The WSK0612 is intended for current sensing, voltage division, and pulse applications in DC/DC converters for computers, VRMs for laptops, Li-Ion battery safety and management,

and LCD TVs; and electronic automotive systems, including engine controls, multi-media electronics, climate controls, and anti-lock brakes. Manufactured using proprietary techniques that result in extremely low resistance values, the WSK0612 features a durable all-welded construction with a solid metal nickel-chrome or manganese-copper alloy resistive element with low TCR (< 20 ppm/°C). Compliant to RoHS Directive 2002/95/EC, the resistor offers high-temperature performance to + 170 °C and low thermal EMF of < 3 μV/°C.
Vishay Intertechnology

www.vishay.com

Automotive LED driver
with hysteretic control and high-side current sensing

Supertex has introduced an LED lamp driver IC, designed specifically for solid-state lighting applications in automobiles, such as head lights, tail lights, brake indicator lights, dome lights, and panel backlights.
The AT9919 is AEC-Q100 compliant, and drives LEDs using a buck topology. The chip comes in a compact eight-lead DFN package. The IC maintains a constant output current to the LED string at all times, thereby improving the reliability and lifetime of the LEDs. LED brightness is achieved through a PWM control signal. The IC drives loads of up to 1.0A at over 90% efficiency from input voltages ranging from 4.5

to 40 V. According to Supertex, the LED driver chip provides a constant current to LEDs in automotive applications, thus ensuring consistent brightness and prolonged LED lifetimes. Its high

switching frequency reduces the need for many external components, which helps to shrink the size and reduce the cost of the assembly. The AT9919 is RoHS compliant.
Supertex

www.supertex.com

Aluminium busbar
halves weight of battery power cabling

Cable system provider Leoni AG offers a solid aluminium conductor for motor vehicle applications to wire the battery as an alternative to the common copper cable. It can be shaped in three dimensions and weighs only about half as much as the conventional component. Of the roughly 3,000 meters of cable that today's motor vehicles contain, the connection between the battery and the engine is one of the bulkiest single cables. The potential for saving weight on this component is all the greater when the battery is located in the rear of the vehicle. Leoni has therefore replaced the copper battery cable with a round aluminium busbar, which can be fitted directly on or underneath the vehicle's chassis. It has a variable diameter depending on the application and is insulated with a halogen-free

polyethylene jacket. Depending on the type of vehicle, it can have a length of more than four metres and be deployed in either a single or twin track version. The aluminium busbar weighs only 40 to 60 percent as much as the common copper cable. Its solid structure and a special manufacturing process considerably reduce the busbar's diameter. Compared with a multi-core copper cable with a 15.5 millimetre diameter, the aluminium busbar of identical conductivity has a diameter of less than 14 millimetres. The technology thus also helps to address the issue of reducing installation space.
The busbar's round shape makes continuous bending in all directions easily possible.
Leoni AG

www.leoni.com

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Innovation from tradition

Wireless mesh nets offer bright prospects for lighting control

By Peter Rand

SMARTPHONES AND TABLETS are becoming omnipresent, and there is rapid growth in user acceptance of these devices as interfaces to anything electronic. That makes smartphones and tablets a natural extension of a lighting control system.

A simple gateway from Ethernet/ Wi-Fi/USB to low-power wireless can ensure that users have access to all features of their lighting control system through their smartphone or tablet. Texas Instruments demonstrated the concept at Mobile World Congress this year using the Android-based ZigBee Home Automation lighting application running on a mobile platform.

The low-power requirements of the network and regional nature of RF regulations make it unrealistic to design a wireless lighting network topology that requires all nodes (lights, switches, sensors and remotes) to be in the RF range of a single coordinating node in the network. The solution is an even distribution of routing nodes throughout the building to extend range without increasing power—that is, mesh networking.

Lamps constitute the ideal backbone for a wireless mesh network. A good mesh network is self-forming and self-healing, and can deal effectively with a high number of nodes in diverse topologies.

Compared with a radio at 2.4 GHz, sub-1-GHz radios yield longer range and better penetration for the same amount of power. For that reason, sub-1-GHz solutions are often preferred for outdoor applications such as street and city lighting. There is also generally less interference to deal with in the sub-1-GHz bands, as Wi-Fi gear and microwave ovens do not operate in that range. Radio interference is present in all the open ISM bands, however, and it is thus important that the radio have sufficient output power and a receiver with good selectivity (adjacent channel rejection) and blocking to filter out unwanted signals.

Peder Rand leads strategic marketing efforts for Texas Instruments' lowpower RF IEEE 802.15.4 and ZigBee products. He holds a master's degree in computer science from the Norwegian University of Science and Technol-

But there is no globally available sub1-GHz band. That forces development of regionally specific end products—supporting, for example, 868 MHz in Europe or 915 MHz in the United States.

Commissioning with traditional lighting is intuitive but expensive; whichever lights are connected after a breaker switch will be controlled by that switch. Wireless adds flexibility in terms of which switches and remotes control which lights, but it also adds complexity in the installation process that must be mitigated by offering an intuitive procedure for connecting lights, sensors and switches.

For professional installations, a USB dongle and a good graphical PC software tool can enable complex connections to be made in an intuitive manner, but such an approach generally requires the services of a trained installer.

User-installed systems, available off the shelf, must be based on simpler, more intuitive methods. One approach, proximity-based commissioning, involves holding the switch or remote control close to the light(s) to be controlled, while pressing a button. The receive signal strength of the packets sent from the light to the switch or remote control is used to determine proximity and qualify the commissioning. The Philips SmartLink system represents a successful implementation of this approach.

Security

Wireless lighting control systems require differing levels of security, depending on the purpose and location of the system. A home lighting system used mainly to set the correct ambiance will have less strict requirements than city lighting or a building's security lighting would. Most low-power wireless chip sets today support 128-bit AES

Fig. 1: Low-power wireless lighting control.

encryption of the packets sent over the air, which is generally sufficient to avoid sniffing or injection. Authentication and key exchange when new devices enter the network are challenging and are handled differently depending on the level of security needed and the mechanisms available.

As low-power wireless chip sets have shrunk in size, raised their integration level and dropped in cost, it has become viable to include them in a wide range of lamps to provide direct control of each. Given the long lifetimes of LED and fluorescent-based lighting, it is practical to integrate the wireless functionality with the light source itself.

Although modern and more efficacious light sources generate less heat than traditional light sources (such as incandescent and high-intensity dis-charge lamps), LED and CFL lamps contain driver and control electronics and therefore still create high-temperature environments. The heat becomes particularly challenging in compact designs, where the cooling situation surrounding the lamp is generally not controlled. LEDs must also conduct their
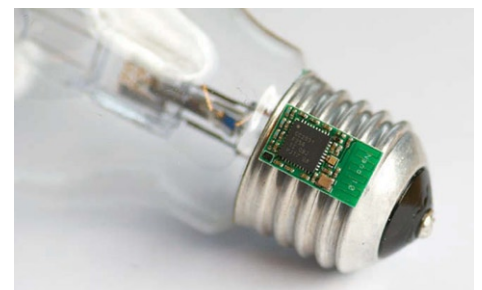

Fig. 2: The CC25312.4-GHz USB nanodongle for IEEE 802.15.4 (1.65 x0.95 cm).

heat away (as opposed to radiating heat, as is the case with incandescent and gas discharge technologies). That compounds the problem of keeping the heat away from the driver and control electronics. The low-power wireless and driver control ICs will sustain high temperatures during operation of the lamp.

It is thus important that the ICs support operation at high temperature to ensure correct operation, good RF and high-power-quality performance. Chip sets qualified at 85°C are typically not an option; a 125°C rating is sufficient for most applications, unless a very compact fluorescent design exposes the electronics to even higher temperatures.

The devices and related external components should also be qualified for a high-temperature-operation lifetime that is as long as the expected general lifetime of the bulb.

Energy efficiency

Standby current consumption has been a focus of conservation efforts in recent years, and the continued tightening of regional requirements extends to the standby cur-

rent specs for wirelessly controlled lamps. When the lamps are in standby with the light turned off, the radio is in receive mode all or a dutycycled portion of the time. Although low-power wireless radios, regardless of technology, typically consume less than 10 mW in receive mode, there can be substantial loss in the power supply. Care should be taken to design a power supply for the wireless device that meets the desired targets for standby current consumption. The lamp or luminaire must also meet a minimum lumens/watt requirement, so the efficiency of the lighting driver is critical.

Low-power wireless chip sets are continually shrinking in footprint. TI's CC2530 system-on-chip, with integrated radio, microcontroller, flash, RAM and peripherals for lighting systems, fits in a tight, 6x6-mm package. Apart from a high-frequency crystal and decoupling capacitors, all that is required for a complete solution is the addition of a balun and antenna. The antenna represents the widest range of design
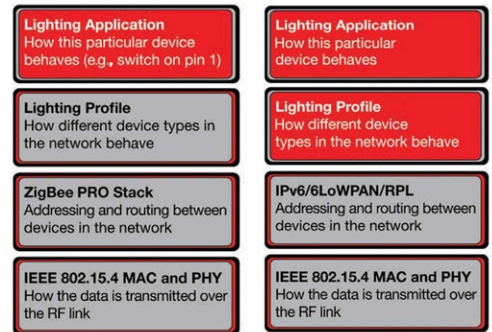
Figure 3. ZigBee architecture, with standards-based layers in gray and proprietary layers in red.
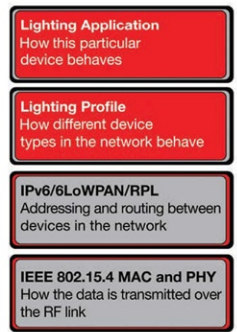
Figure 4. 6LoWPAN architecture, with standards-based layers in gray and proprietary layers in red.

choices, and the size of the solution can vary greatly. Antennas can take the form of pc board traces, whips, wires or integrated chips with associated solution size, cost, efficiency and directionality.

The lower the RF frequency, the longer the antenna; for applications with restrictions on solution size, that ratio can be an important factor in choosing between sub-1-GHz and 2.4-GHz bands. The small solution size makes it important to ensure
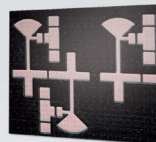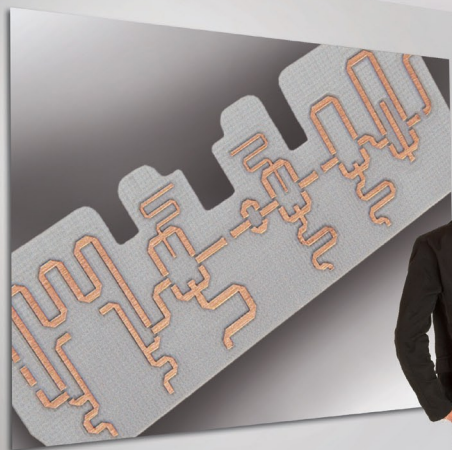
that both the MCU system and the radio are robust with respect to noise so that they can operate well even in proximity to switching power supplies. The power converter switching frequency will also affect the size of the power magnetics. Higher switching frequency will result in a smaller lighting driver (power converter), but at a trade-off of lower efficiency and potentially higher electromagnetic emissions.

To maximize battery life or enable devices to run off energy-harvesting sources, the radio should be used as little as possible, remaining in sleep mode most of the time. Remote controls and switches typically only wake up on key presses and perform the required transaction before going back to sleep. Sensors typically wake up periodically, using a low-power timer, in order to perform sensor measurement via an internal A/D converter, or they use an internal low-power

comparator to be awakened only when a certain threshold value is reached. The system should be designed so that the values are reported over the radio as seldom as possible. Current consumption in sleep mode will generally dominate the energy consumption of these devices and will be the determining factor for battery lifetime.

ZigBee and 6LoWPAN (IPv6 over low-power wireless personal area networks) are publicly available low-power radio standards supporting 2.4-GHz IEEE 802.15.4 radios.

ZigBee is a mesh network software stack, based on IEEE 802.15.4 radios, with a set of application-layer profiles on top. The profiles ensure that there are standard devices defined with standard telegrams to send commands, such as "on" or "off" in the case of a light.

6LoWPAN is a header compression scheme for IPv6 packets. In combination

with the RPL mesh network routing protocol, it provides an efficient IP-based stack for low-power wireless networks.

6LoWPAN also forms the basis for the ZigBee IP stack on which the Smart Energy 2.0 profile specification is built.

Thanks to native IP addressing, gateways from a 6LoWPAN network to the Internet can be made simple and transparent. The result can be a reasonably seamless interface to tablet, phone or existing IP-based solutions for lighting and building control.

The challenge with 6LoWPAN lighting control today is that application layers have yet to be defined, and standardsbased solutions for such aspects as commissioning and security have yet to be developed.

Since there are no application layer specifications or standards body certifying solutions, there is no clear path to interoperability. ∎

Simpler M2M remote control via GSM
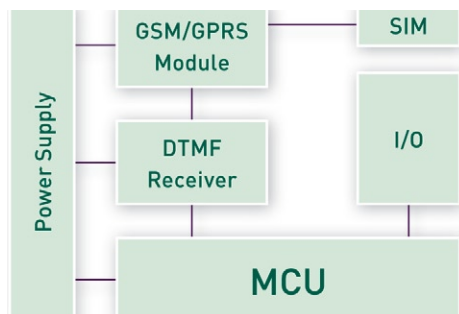
By Cristian Vacciano and Carlo Antonini

IN THE LAST FEW YEARS   one of the most successful applications in the m2m market has been the remote control of devices over GSM and this kind of application will likely continue its strong growth in the years ahead. Remote control is usually accomplished by sending commands to a remote module through DTMF tones or SMS. These commands allow remote driving of actuators and the reading of sensors status.

The newly released DTMF decoder in Telit modules allows developers to change their traditional approach when working

with GSM remote control systems. Although a TCP connection mode is also available this article will focus on the DTMF solution.
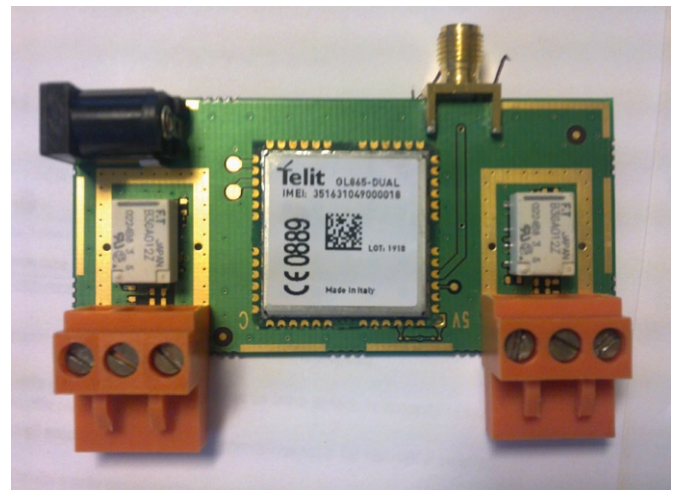
Traditional approach

The traditional way to implement remote control via GSM using DTMF tones typically involves the use of a microcontroller (MCU), a GSM module and a hardware DTMF decoder. When DTMF tones are employed to send remote commands, the audio output from the GSM module is connected to the DTMF receiver which provides decoded tones to the MCU – see figure 1. The MCU receiving this information recognizes

the command and takes the appropriate action or sequence of actions. The Achilles heel of this approach is the need for several components to execute even the simplest command.

Relying on the GSM capabilities

A new approach is to simplify the system by more fully utilizing the embedded features of the GSM module while at the same time giving new degrees of freedom to the developer. With this smart use of the Telit module the DTMF receiver and the external microprocessor can be removed leading to a

Fig. 1: A traditional remote control implementation via GSM using DTMF tones.

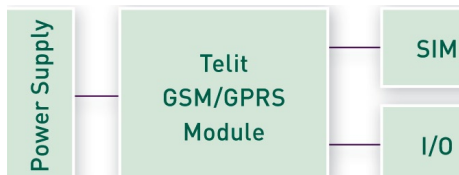Cristian Vacciano is Senior Software Engineer at Telit - www.telit.com - Carlo Antonini is Senior RF-HW-engineer for the same company.

Fig. 2: Using the Telit module, the DTMF receiver and the external microprocessor can be removed.

```
AT#EVMONI="DTMF0",0,1,0
AT#EVMONI="DTMF0",0,0,"AT#GPIO=3,1,1"
AT#EVMONI="DTMF0",1
AT#ENAEVMONI=1
```

Fig. 3: Upon detection of a DTMF tone 0, an event will be generated and AT#GPIO command will be executed automatically.

```
AT#EVMONI="GPIO1",0,1,1
AT#EVMONI="GPIO1",0,2,1
AT#EVMONI="GPIO1",0,3,5
AT#EVMONI="GPIO1",0,0,"AT+CMGF=1;#C
    MGS=+393468686XYZ,\22GPIO1 ON\22"
AT#EVMONI="GPIO1",1
AT#ENAEVMONI=1
```

Fig. 4: Contextually the module can be triggered by a high level on GPIO1 and send an SMS to alert the remote application.

smaller and cheaper implementation – see figure 2. In fact DTMF tones are recognized by the internal decoder embedded in the module without the need of any external device.

Embedded DTMF decoder

To access this feature, developers can select between python script or event monitor for the software implementation. Access to the embedded "Python Easy Script" gives the developer the ability to program complex control sequences. Using the virtual internal AT serial port, a Python script can be written to receive the asynchronous messages generated by the embedded DTMF decoder, interpret them, make decisions or execute commands. If the designer prefers to avoide software programming, he/she can take advantage of the event monitor. This feature allows a DTMF tone detection to be automatically associated with a specific action at the module by simply sending it an AT configuration command.

SMS at run

Another solution available with Telit modules is to use the Embedded SMS AT Run. This feature allows users to run AT commands remotely just by sending an SMS to the module. Responses and errors are sent back by the module via SMS. Two types of messages are available: simple and protected. Protected messages are encrypted with an MD5 hash algorithm. It is important to note that the SMS AT Run feature is also available via TCP where AT commands are sent to the module via TCP/IP. Responses and IP protocol related traffic are redirected via TCP/IP to the device acting as the TCP terminal.

Event monitor example

Based on a Telit GL865 module a simple 2 IN/2 OUT remote control can be implemented using event monitor for action control. In this sample application the objective is to read the status of the 2 opto-isolated inputs or set the status of the 2 relays. If the user wants to link the activation of Relay 1

(connected to GPIO3) to the receiving of a DTMF tone equal to 0, the following custom command must be sent to configure the module: AT#EVMONI. Upon detection of a DTMF tone 0, an event will be generated and AT#GPIO command will be executed automatically activating Relay 1 – see figure 3. Contextually the module can be triggered by a HIGH level on GPIO1 and send an SMS to alert the remote application – see figure 4. ∎

How femtocells will solve data capacity

By Steven Brightfield

DATA TRAFFIC IS OVERWHELMING mobile operator's networks. Projections from major operators confirm this trend, with recent reports ranging from data capacity doubling every 3 months (KT/Korea) to 12 months (Vodafone).

If we project these sustained rates of data growth to future mobile network capacity, the current network capacity will represent less than 10 per cent of what is needed by 2016. Future network deployments will, in fact, be handling the vast majority of data capacity requirements for mobile network operators. If we were to scale today's mobile network architectures to handle this tsunami of data, the cost to deploy would be too high. Future mobile network architecture therefore needs to change, by not only scaling to handle the much higher data loads, but also by scaling cost effectively so that mobile operators can afford to deploy it.

Why Femtocells?

They deliver on the promise of providing the next leap in performance for wireless networks by bringing cell sites closer together, providing coverage, capacity and service delivery platform to subscribers. To realize this vision the industry has had to address the challenges of interference mitigation and mobility requirements from operators and subscribers. But to make this transition, what are the issues that this technology faces? What innovations need to take place? How will they alter the topology of mobile networks and, what will this landscape look like when the roll out of femtocells reaches its apogee?

It is the rapidly rising rate of mobile data which has propelled the development and deployment of femtocells. By 2014, monthly worldwide mobile data traffic will exceed the total for 2008. The pattern of usage has equally inspired this technology with 70 per cent of all mobile use in 2008 done whilst at home or in the office. But the most important factor today impacting mobile

Steven Brightfield is Director of Product Management at Qualcomm CDMA Technologies - www.qualcomm.com

broadband performance and use is coverage, particularly in rural areas, and the differences between the performances of operators' 3G networks. The mass deployment of femtocells should solve this problem resulting in ubiquitous coverage, indoors and out, with faster connection and download speeds.

For operators, the key advantage of femtocells is that they are able to offload resource-intensive over-the-air data traffic onto an IP backbone, reducing both capital (less macro sites) and operational (less backhaul costs) expenditures while creating a branded operator point of presence in either the home or the work environment. As femtocells increase signal strength and provide excellent coverage indoors, they also contribute to a better user experience, with improved coverage/peak data rates and quality of service. As mobile users are offloaded to femtocells, data traffic load and signaling load on the macrocell reduces.

Interference management

Since femtocells are being deployed in configurations and topologies that were not originally anticipated by 3G standards, one of the challenges that has required additional research and development to overcome is how to minimize downlink and uplink interference to macrocells and neighbouring femtocells when femtocell RF frequency channel overlaps with that of macro cellular transmissions. Femtocells are therefore now being designed to self-configure so that they seamlessly integrate and operate satisfactorily with the existing femtocell-macro network and provide excellent performance irrespective of their location in the residence, enterprise or the macro network. Femto solution providers, Qualcomm included, have developed algorithms for 3G femtocells to enable co-existence with macro network. These advanced interference mitigation technologies minimize the impact of the femtocells on the macro network. They use RF measurements by the femtocell and associated handsets to adapt
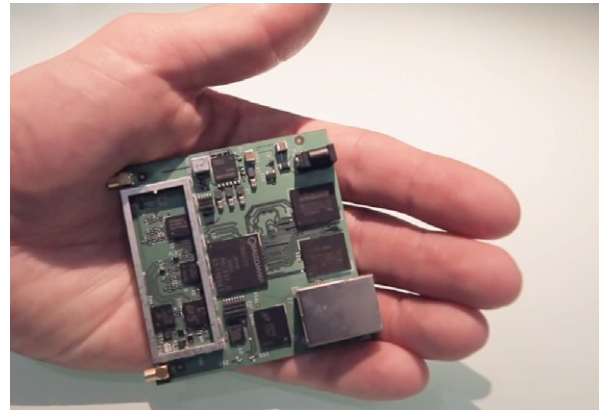
A femtocell board designed around one of Qualcomm's chips.

their operations (e.g. channel of operation, femto transmit power, associated handset transmit power cap) to minimize impact on the macro network.

Qualcomm has had an active R&D program in this area for four years, resulting in the UltraSON suite of algorithms that provide for interference as well as mobility management of femtocells. The UltraSON algorithms provide effective downlink power calibration and uplink interference management as well as reliable mobility between macrocells and femtocells. In addition to using mobile handset measurements, femtocells that use UltraSON algorithms require a key additional hardware function, network listen. Network listen is an RF receiver module which resides in the femtocell and "sniffs" the surrounding RF environment, to provide inputs to the UltraSON algorithms which then compute the initial downlink transmit power, frequency channel and scrambling code prior to the femtocell transmitting its RF signal. Subsequent to initialization, the network listen can continuously monitor the RF environment to make dynamic changes as needed to avoid transient interference scenarios.

3G small cell interference management has had to be performed in an isolated cell environment without explicit co-ordination with the macro network, since these small cells were not anticipated as part of the original macro network deployments. LTE, the next-generation mobile air interface network technology, however has incorpo-

rated support for interference management of small cells in the Release 10 and Release 11 versions of the LTE standard. As operators upgrade their LTE networks from the initial Release 8 macro deployments, they can support femtocell deployments in a coordinated fashion utilizing the X2 and other signalling messages defined in the subsequent releases of the LTE specification.

A cellular access point in every home
The femtocell landscape is changing as operators develop new business cases for femtocell deployment. One trend that we anticipate is the integration of femtocell technology into existing consumer networking products, such as Wi-Fi access points, set-top boxes and integrated access devices. Every operator will have their own business model for deploying femtocells and these will evolve over time, depending on the operator's technical and business needs. Some may choose to subsidise the full cost as they are off-loading capacity.

Others will seek to share the cost with the consumer and provide them with additional service benefits such as free talk time or data downloads in the home/enterprise in exchange. Some will use femtocells to enable replacing the wire line phone service in the home. What's clear is that femtocells are being established as part of a very sophisticated network topology, whether it is indoors in combination with afore mentioned wireline and Wi-Fi solutions, or outdoors, incorporating metro-femtocells and carrier grade Wi-Fi solutions into the macro network and picocells, to become a natural extension of the operators' network.

Femtocell discovery

Another challenge requiring some attention is a reliable method for legacy mobiles to discover and camp on femtocells in idle mode and to perform handover from a macrocell to a femtocell in active mode. Operators however, have been reluctant to modify the configuration and planning of their macro networks to accommodate femtocells. Even if the macrocell has good channel quality or the handset is operating on a different carrier on macrocell, it is still desirable to move the device from macrocell to femtocell in order to continue the network service as seamlessly as possible. The reason being that heavy traffic users can be connected on the macro network for a very long time, continuing to consume significant amount of macro

network resources before transitioning to idle mode. This kind of adaptability and efficiency is important to ensure the migration of as many users as possible to the femtocell and reduce the traffic pressure off the macro network. This is why Qualcomm recommends that a beacon signal is transmitted on the macro carrier that redirects the mobile user to the femtocell carrier frequency. Beacons work reliably with legacy handsets and

do not require any macro changes.

Femtocell power-saving advancements

The power-efficiency of femtocells has also been recognised as a challenge which will impact both residential and enterprise uptake and needs to be considered as part of refining the user experience. Qualcomm has developed its femtocell chipset to be small

and consume less than 5 watts for a residential deployment, which meets EU green guidelines and enables Power–over–Ethernet (PoE) so you don't have to route power from a wall socket.

One device to rule them all

With M2M and the Internet of Everything just around the corner, the next step in this already game-changing technology is merging Wi-Fi and femtocells to create one single intelligent gateway and coordinate the services delivery via either access technology. Recently, we announced the availability of a Femto-Wi-Fi hardware incorporating our FSM9216 enterprise chipsets, fully-integrated system-on-chip (SoC) solution for femtocell development, with the Qualcomm Atheros 802.11n Wi-Fi AR9350 and AR9344 access point solutions.

This will allow operators to design access points that let their enterprise customers connect to both Wi-Fi and cellular networks. Currently designed to support 32 active users, it can be scaled down to support residential and home applications or scaled up to suit outdoor urban metro-femto-Wi-Fi

combinations or cover larger areas. With over 90 per cent of smart phones equipped with Wi-Fi accessibility, the fusion of Wi-Fi and femtocells onto one platform will help with a variety of service issues: improve connection management and solve mobility issues that plague Wi-Fi handsets; aid network side management, resulting in a combined interactive secure gateway into the home.

This advance will see the ability to manage Wi-Fi as well as cellular traffic. Based on RF channel quality and QoS requirements of different applications, the system can select the most suitable technology (Wi-Fi or femtocell) for each traffic flow. As an example, files transfer may be offloaded to Wi-Fi while a voice call is still made through the femtocell.

Within the home environment, if the femtocell is equipped with location based services, it can recognise individual users and offer them personalised content and apps. The femtocell home zone could know what your favourite TV program is, and automatically download it onto your mobile when you enter the zone, or allow users to

use their phone to control appliances around the home from lights, air conditioning to the TV - all through the femtocell which could also be accessed remotely. The femtocell location-based services can also be used in retail environments where the users can trigger a personalized offer based on their proximity with the store. The major benefit for using femtocells in this use case is that virtually all handsets could be supported without requiring certain applications to be installed or run on the handsets.

Disruptive models for deployment are enabled by the fact that existing wireless networks need new topologies to handle the anticipated demand. The solution of using smaller cells closer to the subscriber results in the incorporation of a large number of smaller cells, with each small cell requiring a backhaul. Since wire line backhaul is a crucial ingredient in this network topology shift, one could argue that we are closing the circle from a wire-line telecom era to a wireless telecom era and now back to a mainly wire-line with last link being a short wireless hop. ∎

Overcoming the challenges of wireless audio distribution

By Tim Whittaker

IT MAY SEEM LIKE A CONTRADICTION, but there is a huge demand to provide personal feeds of sound in public spaces. This is especially important for people whose hearing is impaired for venues like theatres, cinemas, public meetings, places of worship and so on. It's even mandatory in many countries for public venues to provide these facilities. International conferences – and countries with multiple languages – need simultaneous translation.

More unexpectedly (to those who don't fall into this category) there is a demand for sight-impaired cinema-goers to hear a narrative track to help them follow some details of the plot, and this content is being

included in new films today. The cost and inconvenience of providing wiring to every possible user position is such that wireless technologies are being almost universally adopted for these sound feeds.

Several popular technologies around

Induction loops around auditoria are fed from a current amplifier, which is fed from the audio amplification system, or from special microphones. All hearing aids include a pick-up coil that can be selected as alternative to the internal microphone. Loops are relatively cheap because the user provides half the system, but they are prone to interference – the 50 or 60Hz mains power and its harmonics fall well within the pass band – and they are limited to a single sound channel.

Infra-red systems comprise a number of LED emitter units which are fed either

The DECT Salix reference design.

directly with audio (again with interference concerns) or with a modulated carrier, which can deliver multiple audio channels for stereo or for user selection, or both. Both analogue – pulse frequency modulated – and digital QPSK systems are used, generally with carriers in the range 2-6MHz. Multiple

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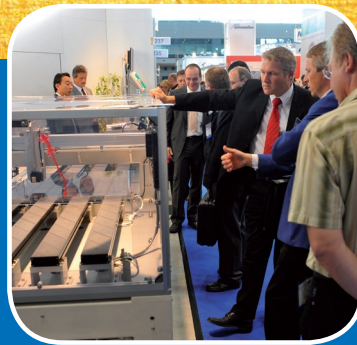
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channels are possible for conference and public systems. Infra-red equipment is fairly low-cost, with the disadvantage of needing a direct line of sight, or at least a good reflection, between the emitter and each receiver. Reflective surfaces are unfortunately undesirable in auditoria for many reasons. This means that multiple emitters have to be installed, making the total cost of a system quite high. Retro-fitting infra-red systems can be an especially tricky and expensive operation.

Radio systems classically rely on licence-free pieces of spectrum (bits around 30MHz, bits around 174MHz, 863-865MHz, 1795-1800MHz are allocated in most of Europe) or on licensed spectrum, commonly in unused television channels. Radio has the advantage of not needing a line of sight, but many of these VHF and UHF systems are under pressure either from governments who want to sell the spectrum, or by potential interference from other systems – like radio microphones – which share the same allocations.

Wireless audio distribution often takes place in dynamic, noisy environments, often close to many other competing wireless signals. How can these issues be overcome to deliver a better wireless audio experience in public venues? What is needed is a radio system with a reasonably generous licence-free allocation of spectrum, very low component cost and digital modulation to avoid interference.

Digital enhanced cordless telecommunication - DECT

Those parameters almost exactly describe a very mature radio system - DECT, or Digital Enhanced Cordless Telecommunication. Standardised in the mid-1990s, DECT now has a frequency allocation of 20MHz around 1.9GHz in almost every country (10MHz in the USA). This allows up to 10 RF carriers, each bearing 1152 kbit/s using a simple GFSK modem. DECT then allocates 24 time-slots, each carrying 32kbit/s of user data, plus various signalling and overhead data. In its original, cordless telephony application, one time-slot is used in each direction, delivering 3.4kHz audio bandwidth with a simple ADPCM codec.

DECT telephony has proven highly successful, and DECT chips come pretty cheap at $2.50 or so in 10,000s. In addition, they are now very capable, integrating powerful processors with all the radio parts on a single device. Included on-chip is a capable DSP, which has allowed manufacturers to incorporate many additional functions such as telephone answering machines, modems for calling-line identification, echo cancellation for loudspeaker phones, better quality speech for VoIP and so on.

This confluence of advantages – dedicated spectrum, spectrum etiquette, robust interference mitigation, availability and low cost – makes DECT very attractive for wireless audio distribution. Indeed, the potential to develop a system that was far superior to existing solutions led Cambridge Consultants to look at developing a commercial solution. The result is a reference design, Salix.

The design process

Although DECT lends itself well to audio distribution, there were several factors that needed to be tailored in order to deliver the best possible performance. For example, for entertainment and all-day conferencing, the audio bandwidth must be better than 12kHz. To provide this the open-source codec CELT was ported on to DECT chips from Dialog Semiconductor.

CELT, 'Constrained Energy Lapped Transform,' delivers very low latency whilst supporting stereo at 32kHz sampling rate, with a fixed bit-rate of 64kbit/s. To keep the bill of materials low, the CELT decoder is ported on to the on-chip DSP core in the receiver unit. A great deal of optimisation of the open-source code was needed to achieve this, but the cost saving per unit makes this worthwhile. The CELT encoder is more complex, and therefore runs on an external DSP in the transmitter board.

To deliver the required data rate the design uses a double time-slot in DECT, which allows for a 16-bit CRC word to protect each 64 bits of data. A packet loss concealment algorithm is triggered by the CRC pass/fail bits. Digital audio is then sent to an external DAC/headphone amplifier, which delivers stereo audio to a standard jack socket.

One of the 'standard' problems with a UHF radio is that of drop-outs in reception, as the receiver passes into a null resulting from multipath effects that occur in almost any environment. To overcome this issue the Salix receivers are designed with two antennas, and take advantage of DECT's extended synchronisation sequence, which is long enough to allow each antenna to be tried in turn, and the one with the better signal selected. This space diversity improves link margins by about 10dB, and is unusually cheaply implemented at a cost of one CMOS switch and less than 5 square centimetres of board.

One of the main advantages of DECT is of course that multiple systems can co-exist in one place due to a DECT's robust spectrum etiquette scheme. In order to translate this capability to a wireless audio distribution application the new system uses the DECT functionality of first scanning all time-slots in all channels, building a map of received signal strengths, then choosing the quietest for use. This map is maintained in the background.

The receivers each send an occasional message upstream to report received signal quality. The system knows how many receivers are present (the transmitter broadcasts this number), and the receivers adjust their period between messages accordingly. A quality assessment algorithm in the transmitter uses the upstream messages to decide whether to move to another channel to improve performance. A seamless channel move is done by establishing the new channel first, then switching over, prior to clearing the old channel.

It was also important to ensure that the system is easy to manage, with straightforward connection. Connection of a receiver to a transmitter is done (for most conference and cinema use) by plugging the receiver into a configuration unit, and keying in the auditorium number, or other channel number, on this unit. A simple text-based serial interface into the receiver sets the identity of the transmitter to be used; the transmitter broadcasts this identity in a beacon. Alternative selection schemes, perhaps using the push buttons on the receiver, can easily be implemented.

Lastly, in addition to DECT allowing multiple co-located transmitters, the very simple GFSK radio modem means that a signal to interference ratio of only 9-10dB is needed for an acceptable bit error rate. Hence DECT radio resource can be re-used after only a few tens of metres (or less in some types of building), allowing an essentially unlimited total number of systems in a large facility. ■

Femtocell base station-on-chip
supports up to 16 simultaneous users

Freescale Semiconductor is sampling its first "base station-on-chip" products built on its innovative QorIQ Qonverge multimode platform. The QorIQ Qonverge PSC9132 system-on-chip (SoC) for picocell and PSC9130/31 SoCs for femtocell base stations share a single, scalable architecture that simultaneously supports multiple air interfaces, providing operators and OEMs "future-proof", highly integrated heterogeneous solutions that help minimize power consumption, cost and design time. The QorIQ Qonverge portfolio offers a scalable line of processors built on the same architecture that spans from small- to large-cell base stations. The platform allows OEMs to reuse software regardless of cell size. Customers can leverage common hardware, software architecture and tools to minimize capital expenditure and benefit from a comprehensive solution that helps speed time to market. Freescale's first available QorIQ Qonverge processors are the PSC9130/31 femtocell SoCs (for eight to 16 simultaneous users) and PSC9132 picocell/enterprise SoC devices (for up to 100 simultaneous users).

The processors support a range of air interfaces, including LTE (FDD/TDD), WCDMA (HSPA+), WiMAX, UMTS and CDMA. The devices also incorporate glueless RFIC communication and antennae interfaces, eliminating the need for additional chips (such as FPGAs) and ultimately reducing board space and cost. The ultra-integrated PSC913x family also provides support for GPS synchronization and 2G/3G sniffing in a single device.
Freescale Semiconductor

High power broadband pallet amplifiers
100W output over the 20 to 500MHz range

Bristol-based RF design specialist, Amplifier Technology Ltd has developed a new range of compact broadband pallet amplifiers which will be shown for the first time at the DSEi exhibition in London in September 2011. The pallet amplifiers use GaN technology, and there are three models covering different frequency bands. The 9001 model is a power pallet amplifier that delivers a minimum saturated output power of 100 W over the frequency range 20 to 500 MHz. The 9004 amplifier is similar, also delivering 100 W, operating in the 0.8 to 1.0 GHz frequency bands. The third model, the 9005, gives 100 watts saturated output power and operates at frequencies from 1.7 to 2.2 GHz. All three amplifiers feature a shut-down pin to allow the RF output to be disabled. The pallet amplifiers are made to a compact design for OEM use, and measure 160x100mm.
Amplifier Technology

360 degrees absolute encoder
supports 17-bit resolution over full rotation

Avago Technologies announced a high-resolution absolute optical encoder for high-performance servo and motor feedback applications. The AEAT-9000 single-turn encoder offers up to 17-bit resolution for precise angle measurement over a full rotation of 360 degrees. The device's modular design consists of a read head module and a high-precision code disc. The modular package of the AEAT-9000 encoder enables it to be directly integrated on the motor, providing system cost savings and better overall performance. Leveraging differential internal and external signal paths, the absolute encoder delivers superior noise cancellation for robust system noise-immunity in industrial environments. The encoder delivers high-accuracy positioning with 2-channel true differential Sine/Cosine outputs and A/B incremental analog outputs all with 2048 counts per rotation. The multiple output formats offer flexibility to support both absolute and incremental position information. In addition, the encoder incorporates photo detectors for electrical alignment on the radial and tilt. Other features include on-chip interpolation and code correction to compensate for mounting tolerance, selectable direction for Up/Down position counters, a built-in monitor track for monitoring LED light level, and an error output for LED degradation. The device is rated for operation in the -40 to 115°C temperature range.

Avago Technologies

www.avagotech.com

Multi-core communications processors
with unparalleled scalability to 640 NXCPUs

NetLogic Microsystems announced its XLP II family of multi-core processors designed with a 28nm process technology. The new processor family delivers a dramatic 5-7x performance enhancement over the company's existing generation of XLP processors. It is designed to deliver over 100 Gbit/s of network processing performance per device, and over 800Gbit/s in a clustered, fully-coherent system. The XLP II multi-core processors integrate up to 80 NXCPUs per chip, featuring an enhanced quad-issue, quad-threaded, superscalar out-of-order processor architecture capable of operating at up to 2.5 GHz to provide unmatched control and data plane processing and low-power profile. These processor cores include advancements that considerably improve pre-fetch performance, branch mis-predict penalties and cache access latencies. The XLP II multi-core processor family also significantly expands the tri-level cache architecture to over 32MB of fully coherent on-chip cache which represents over 260MB of on-chip cache in the maximum clustered configuration of 8 fully-coherent XLP II processors. To further extend the performance and capabilities of the XLP II processors, customers will be able to design systems using eight sockets of XLP II processors to achieve an unprecedented scalability of up to 640 NXCPUs. A second-generation high-speed Inter-chip Coherency Interface (ICI) enables full processor and memory coherency across all 640 NXCPUs, making it seamless for software applications to run in Symmetric Multi Processing (SMP) or Asymmetric Multi Processing (AMP) modes.

NetLogic Microsystems

www.netlogicmicro.com

Two current probes to win
to track signals directly on your PCB

Reader Offer

This month, AimTTi gives away two of its I-prober 520 positional current probes worth 599 Euros each, complete with a control box and calibrator, power supply, and a clip-on toroid assembly which can convert it into a conventional closed magnetic loop current probe. The I-prober 520 hand-held probe is designed to be used with an oscilloscope. By placing the insulated tip of the probe onto a PCB track, engineers can observe the current flowing in the track in a bandwidth of DC to 5MHz without the need to break or surround the conductor.

The probe's dynamic range is from 10 mA to 20 A peak to peak. It is safety rated to 300 V Cat II (600 V Cat I) and is suitable for connection to any oscilloscope. The Aim I-prober 520 operates by sensing the field in very close proximity to the track. It relies on a patented miniaturised version of a fluxgate magnetometer that enables the probe to measure the field at a precise point in space. In addition, the miniature sensor has much lower noise and much wider bandwidth than a conventional fluxgate magnetometer. As well as measuring currents in PCB tracks, the probe can be used on component leads or any other current-carrying conductor.

AimTTi

Complete smart meter solutions
single-chip and two-chip networked options

Accent announced its second generation ASMgrid standard product family targeted at smart meters. The chips incorporates optimized flexibility to support and track next-generation home-area-network (HAN) and near-area-network (NAN) communication standards including IEEE 802.15.4g, G1 and G3, PRIME, IEEE 1901.2, home area networking with IEEE 802.15.4.

To provide complete advanced smart meter solutions, the ASMgrid2 system-on-chip architecture encompasses a broad range of technologies including high-precision analog-front-ends, RF transceivers, non-volatile memories, and processing capabilities needed to run required protocol stacks and vendor application software. Each one of the three devices in the ASMgrid2 product family contains an ARM processor for unmatched performance, code density, and development capability.

In addition to other processing, the ARM processors are also used in combination with hardware acceleration for Accent's SUNFXTM modems, providing adaptable solutions for still evolving utility communication standards.

The ASM201, ASM211 and ASM221 feature an ARM ARM926EJ-S, an ARM Cortex-M0 and an ARM Cortex-M3 processor, respectively, running at 192, 88 and 88MHz. They integrate from 32 to 512MB of flash and 32 to 64KB of SRAM.

Accent

www.accent-soc.com

Video splitter
connects up to four cameras

Up to four cameras may be connected to Jetter AG's new JXM-MUX video splitter. The unit bundles the signals and offers the option of displaying one, two, three or four camera images on a monitor at the same time. Thanks to its robust construction, the unit meets the relevant requirements in respect of ambient temperature, shock, vibration, electromagnetic compatibility and leak tightness. This makes the JXM-MUX especially suitable for mobile use, for picking up the signals from reversing cameras, for instance. Any current camera with a CVBS output running on 12 VDC can be connected. The unit is conveniently controlled via the CAN interface using the CANopen protocol. This saves up to eight outputs on the control unit.

Jetter AG's

www.jetter.de

8-channel monitoring IC
temperature, voltage and current

Linear Technology Corporation has introduced an 8-channel I^{2}C temperature, voltage and current monitor for 3 V and 5 V systems. The LTC2991 is a highly integrated monitoring solution that incorporates a 14-bit ADC, 10ppm/°C voltage reference and I^{2}C digital interface to provide submillivolt voltage resolution and 1% current measurement, as well as ±0.7°C remote accuracy and ±1°C internal accuracy, when making temperature measurements. Eight single-ended voltage inputs can be configured to measure any combination of internal temperature, remote temperature, remote voltage and internal V$_{CC}$ for single or repeated measurements. When making differential measurements of diode or transistor voltages to calculate temperature, the LTC2991 allows for cancellation of error due to sensor series resistance.
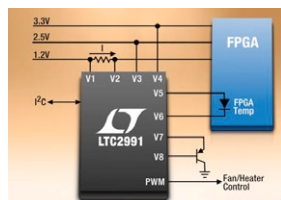
Linear Technology Corporation

www.linear.com

Mezzanine connectors
64 position, 1mm pitch

Mill-Max introduces 64 position, 1 mm pitch mezzanine connectors for parallel board stacking interconnections. The connectors meet EIA-700 AAAB specifications for IEEE 1386 applications. The 891-10-064-30-120000 male and 893-43-064-30-420000 female are surface mount connectors that have a mated height of 10 mm. The 1 mm pitch provides high density packaging crucial for saving board real estate. Locating posts are incorporated into the housing to promote accurate placement on the PCB. RoHS compliant, both the 891 & 893 connectors feature 30 micron gold plated contacts, providing optimum conductivity and effective wear resistance, and tin plated solder terminals for ease of soldering. The insulator housings are made of high temperature glass filled LCP, rated UL 94 V-0.
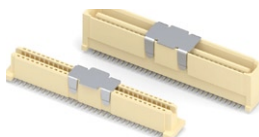
Mill-Max

www.mill-max.com

RJ45 connector module
transmission rates up to 10Gbit/s

An RJ45 Category 6 Ethernet module that allows transmission rates of up to 10 Gbit/s has been added to the Han-Modular Series of industrial connectors from Harting. In addition to its high-speed capabilities, the RJ45 Ethernet module offers a very high level of mechanical stability, allowing it to be used in applications with high mechanical demands. The module is executed as a gender changer on the socket side so that inserting a commercially available RJ45 patch cable is all that is needed to make the connection. Two Category 6 solutions are available on the male connector: a field-installable version with an RJ Industrial interface and a module that is capable of accommodating corresponding Harting patch cables. The unit incorporates a complete 360° shielded RJ45 metal coupler, and is 100% plug compatible with the company's previous RJ45 module.
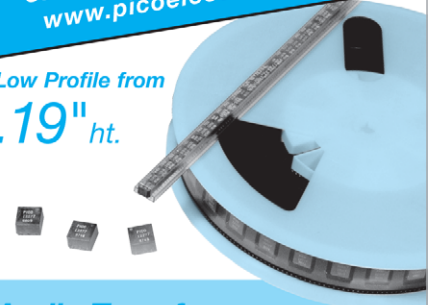
Harting

www.harting.com

Hermetically sealed TO-8 VCO
offers frequency control from 2400 to 2500MHz

Crystek has released the CV-COT8BE-2400-2500 TO-8 VCO (Voltage Controlled Oscillator) which operates from 2400 MHz to 2500 MHz and provides high-performance frequency control in harsh, demanding environments. The VCOs feature a typical phase noise of -101 dBc/Hz at 10KHz offset and excellent linearity. Tuning sensitivity is rated at 55 MHz/V. Pulling and Pushing are minimized to 11.0 MHz and 1.0 MHz/V, respectively; second harmonic suppression is -15 dBc typical.

The CVCOT8BE line features a full-functioning VCO in a rugged, hermetically sealed TO-8 package to protect the VCO from moisture, contaminants and other elements. The metal-can construction features gold plated pins with no internal wire bonds for enhanced signal integrity. Engineered and manufactured in the USA, the CVCOT8BE-2400-2500 VCO features a control voltage range of 0.5 V to 4.5 V with an input voltage of 5 V. Maximum current consumption is 25 mA and output power is +0 dBm. Crystek's TO-8 VCO line has an operating temperature range of -40 to +85°C

Crystek

www.crystek.com

3-axis MEMS gyroscope
measures only 3.5x3x1mm

Housed in a 3,5x3x1mm package, the L3G3250A is what STMicroelectronics claims to be the world's smallest high performance 3-axis analogue gyroscope. With a resonant frequency beyond the audio bandwidth, the L3G3250A is completely immune to audio noise, such as from speakers mounted close to the sensor, and mechanical vibrations coupled through the printed circuit board, therefore operating with greater accuracy and reliability. In addition, its advanced design, with a single sensing structure for motion measurement along all three orthogonal axes, further increases sensing accuracy and reliability and delivers the industry's highest level of output stability over time and temperature. The device offers two user-selectable full scales – 625 or 2500 dps (degrees per second) – with sensitivities of 2mV/dps and 0.5mV/dps, respectively. The high range allows the device to detect and measure very fast gestures and movements. Other features include an embedded self-test function, a wide supply voltage range from 2.4 to 3.6V, embedded power-down and sleep modes, an embedded low pass filter and a high pass filter reset function, and high shock survivability. The device operates over an extended temperature range of -40 to +85°C and is available in a LGA-16 ECOPACK RoHS compliant package.

STMicroelectronics

www.st.com

ECU calibration unit
has a data throughput of up to 5 MByte/s

Developers and calibration engineers can use Vector's VX1060 to measure and calibrate internal ECU system variables at a maximum sampling rate of 80 kHz. Data is accessed over microcontroller-specific data trace and debug interfaces for greater data throughput of up to 5MByte/s with little effect on ECU performance. Measurement data throughput depends on the microcontroller used. On the Renesas V850, Freescale MPC5xxx or Infineon XC2000, data throughput is 1 MByte/s, while on the Infineon TriCore-PD it is 3 MByte/s, and 5 MByte/s is possible with the TriCore-ED. Signals are acquired time-synchronously, even in very fast tasks with cycle times less than 50 microseconds, and they are provided with precise time stamps. With the TriCore-ED it is even possible to achieve cycle times less than 15 microseconds.

The device is connected to the ECU's microcontroller using a compact adapter measuring 23x24mm. The plug-on device enables simple and flexible mounting on the ECU. Together with the cable and the waterproof plug connections, the hardware is designed for the high temperatures of automotive applications. The measurement system is well suited for use in the vehicle interior and engine compartment, on test benches and in the laboratory. The VX1060 base module processes the measurement and stimulation data and interfaces to a measurement and calibration tool such as CANape via the standardized XCP on Ethernet protocol.

Vector

www.vector.com

0.5mm thin piezoelectric speaker
reduced distorsion and increased sound pressure

Murata has enhanced the audio characteristics of its ultra thin piezoelectric speaker. Measuring just 0.5 mm in thickness, the VSLBP2115E1100 series is believed to be the world's smallest piezoelectric speaker. By optimizing the product's structure and the use of new materials it has been possible to reduce distortion and increase sound pressure level without any change in the speaker's size. Distortion has been reduced by 50 % in the voice frequency region of 2 to 4 kHz. Sound pressure improvements have been made in the low frequency regions of 1 kHz and below. Having such small dimensions, the series well suited for use in narrow spaces and is often used in a wide variety of compact personal electronics devices. Using a piezoelectric device within the speaker means that no magnetic elements need to be used. This greatly aids design since no electromagnetic interference is created and it also reduces the likelihood of magnetic particles contaminating the speaker surface.

Murata

www.murata.eu

Sensing technologies
microsite for fast product access

Farnell has launched a new microsite dedicated to sensors and sensing applications. In addition to giving fast and easy access to over 4,000 products, the sensing microsite also provides extensive design resources including application notes, white papers and product training videos to help keep engineers involved in this rapidly evolving sector up-to-date with the latest technologies and methodologies.

A product range that includes PCB level and micro-electro-mechanical (MEMS) sensors addresses applications in sectors ranging from medical to automotive. A diverse array of devices provides pressure, temperature and humidity sensing capabilities as well as resistive, inductive, capacitive, optical touch, proximity and hall effect technologies.
Farnell

www.farnell.com/sensing

Free European seminars
on efficient power design

Distributor Avnet Abacus is teaming up with some of the world's leading manufacturers of power components to deliver a series of free technical seminars in five locations across Europe focused on the difficult challenges that face power system design engineers. In the one-day sessions, Avnet Abacus and its franchises Aimtec, Cymbet, Emerson, Enpiron, Excelsys, Murata Power Solutions, Power Integrations, and Schaffner will provide an overview of environmental and energy efficient directives impacting power supply design. The seminar series will address these topics and many more, for design engineers to raise their own specific areas of interest during extensive Q&A sessions with technical representatives from the participating companies.
Avnet Abacus

www.avnet-abacus.eu

SuperSpeed USB 3.0
product knowledge training site

Mouser Electronics launched a new Product Knowledge Center (PKC) technology training site devoted to the communication bus technology USB 3.0 SuperSpeed, its practical applications, and featured products. Consumer interest is rapidly gaining momentum, as an estimated 80 million USB 3.0 devices are set to ship in 2011. The smartphone industry alone is expecting sales of over 160 million units in 2013, many of which will use USB 3.0 technology.
The familiarity of the plug-and-play USB interface, continuation of backwards compatibility, and the nearly 5Gb/s speed widens the market of buyers for USB with the introduction of fast and consumer-friendly transfer of streaming data. This comprehensive new PKC technology training site starts with an analysis of the new SuperSpeed USB features, moves into the various component families and then transitions to newly-available USB components for interface design-in.
Mouser Electronics

www.mouser.com/usb30/

SpeedWay workshops
around FPGA LX9 MicroBoard

Distributor Silica will host a series of SpeedWay Design Workshops featuring the low-cost Xilinx Spartan-6 FPGA LX9 MicroBoard in Europe including Germany, UK, Denmark, Sweden, Norway, Netherlands, Belgium, Spain, Switzerland and Italy. The European workshops are part of a global technical tour launched by Avnet Electronics Marketing, an operating group of Avnet. Combining instructor-led courses with hands-on workshops, these full or half-day technical sessions feature a range of topics designed to teach engineers everything from the basics of FPGA design to best-practices for integrating Xilinx's MicroBlaze soft processor core. Taught by Avnet's technical specialists, these courses are geared towards engineers at all levels including: designers who are new to FPGAs; those looking to enhance or update their capabilities with Xilinx's suite of development tools; and those looking to implement embedded processing designs using Xilinx's SDK.
Silica

www.silica.com

Consumer apps get comfortable with MEMS

By Laurent Robin

THE MICROELECTROMECHANICAL system accelerometers in the iPhone and the Wii revolutionized the user interface by introducing natural motion as an input mechanism.

Now MEMS inertial sensors are moving into a wider range of motion control and precision location applications, helped along by lower costs and by the general maturing of the knowledge base and infrastructure.

Yole Développement projects accelerometers and magnetometers will be designed into close to 50 percent of all mobile phones within five years; gyroscopes will land design slots in some 20 percent of phones and are already used in almost all tablets. We expect that usage of inertial sensors in consumer electronics will increase by about 24 percent on average annually for the next five years, to reach some 5 billion individual sensor units by 2015.

Accelerometers have become a must-have in mobile phones for switching between portrait and landscape mode, and have seen scattered use in pedometers. Magnetometers hit mass adoption in phones last year to supply correct navigational headings. Multi-axis MEMS gyros have just reached consumer price points and volumes.

Yole sees prices for discrete inertial devices continuing their steep decline, with the ASP of a three-axis accelerometer, for example, dropping from 70 cents in 2010 to around 30 cents by 2015. The cuts will be driven in part by solutions that share the cost of one controller ASIC between two sensor devices—by packaging together the accelerometer and the magnetometer, for example, as one combo sensor with one ASIC.

Leading MEMS device makers such as STMicroelectronics and InvenSense supply

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software and libraries to make it easier for phone and tablet makers to add basic motion functions. Dedicated motion sensor software suppliers like Movea and Hillcrest Labs are supplying device-agnostic software to allow wider apps, particularly for gesture control in air mice and TV remotes. And the latest version of Android supports some

> "Navigation and location apps will drive consumer inertial sensor demand"

motion processing APIs, with more-sophisticated versions expected.

LG's Optimus Black Android phone uses a gyro to enable its convenient, one-hand interface. It is also the first phone to use a gyro from fabless MEMS startup InvenSense Inc., attesting to the maturity and volume reliability of the MEMS foundry supply chain. Gyros are expected to find use for image stabilization in cell phone cameras, and they are appearing in remote controls for Internet TV.

LG is shipping a TV with a point-and-click remote that uses motion control software from Hillcrest for precise naviga-

tion. Remote control giants SMK Corp. and Universal Electronics are customers as well.

Hillcrest has evangelized the idea of motion control, and it has moved the infrastructure along with its own ringshaped point-and-click remote and a computer Web browser specifically for computers linked to the TV.

Internet service providers and set-top makers are likewise getting into the act. France's Free ISP has introduced a set-top designed by Philippe Starck with a motion sensing remote that uses Movea software to control its extensive menu of live and streaming TV, Internet, gaming and phone services.

But the major driver for inertial sensors in mobile consumer devices will likely be the demand for more-accurate location and navigation applications. GPS chip set makers say customers are asking for reliable pedestrian navigation that combines outdoor and indoor maps to enable location-aware searches.

Achieving the necessary level of accuracy for such apps requires not just an accelerometer and a magnetometer, but also a gyroscope and a pressure sensor.

Here, too, the infrastructure is developing, with indoor maps of major U.S. destination locations, such as malls and airports, now available from suppliers like Point Inside Inc.; indoor locator technology installed by some mall and store operators; and advertiser testing of hyperlocalized information and offers.

Localized search applications such as Gas Buddy, OpenTable and Groupon's I'm Hungry, which don't need particularly high location accuracy, are finding traction. But detailed searches within stores, or augmented-reality apps that can show information about particular places, will require a full complement of accurate, low-drift sensors to improve precision. ■

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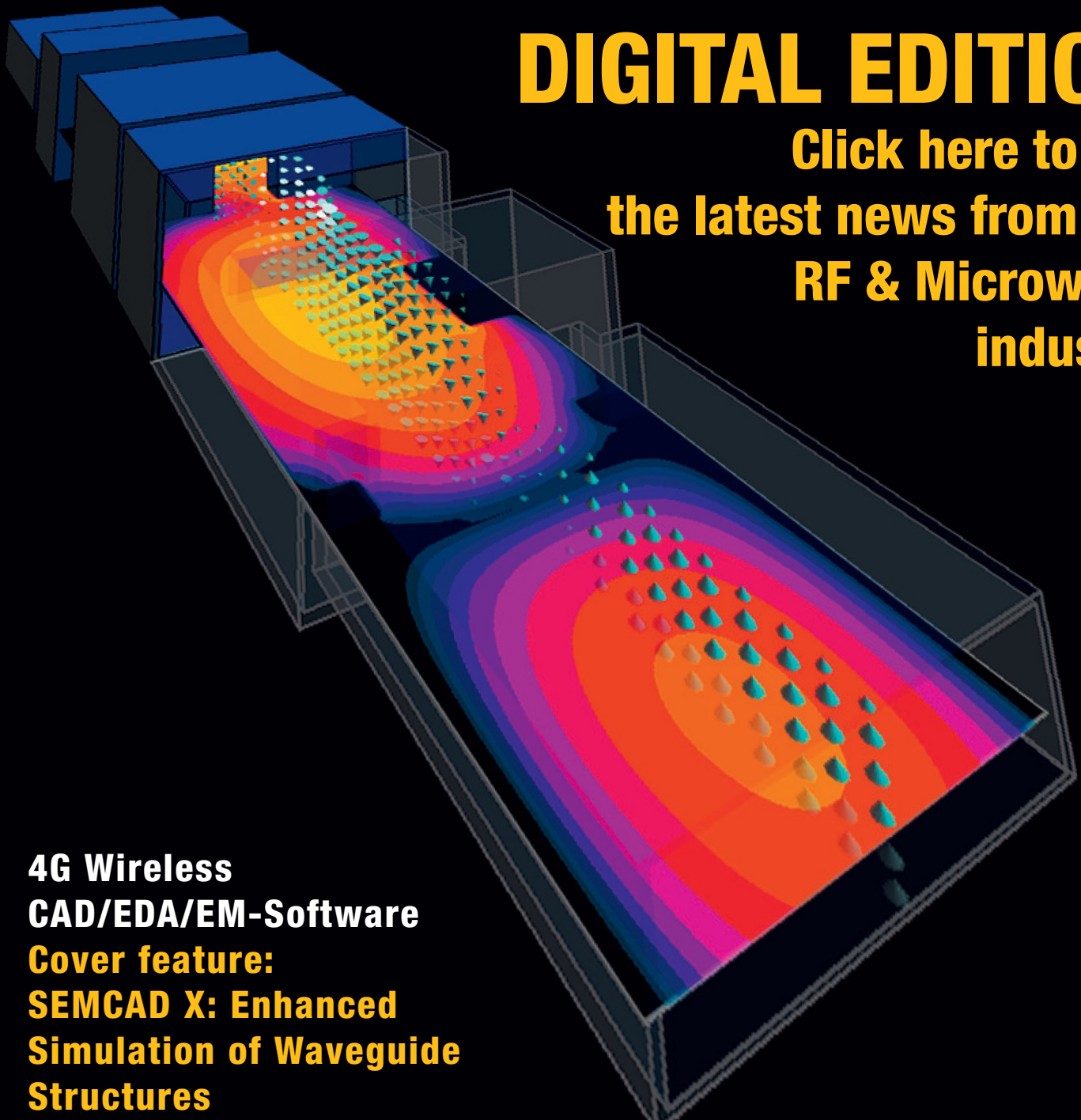
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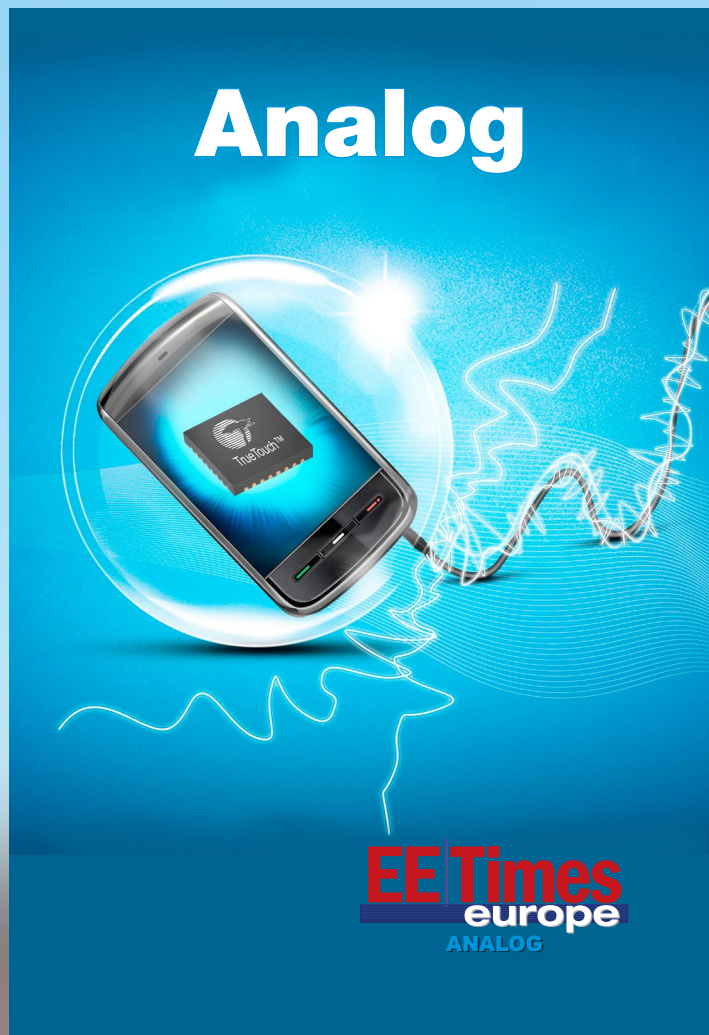
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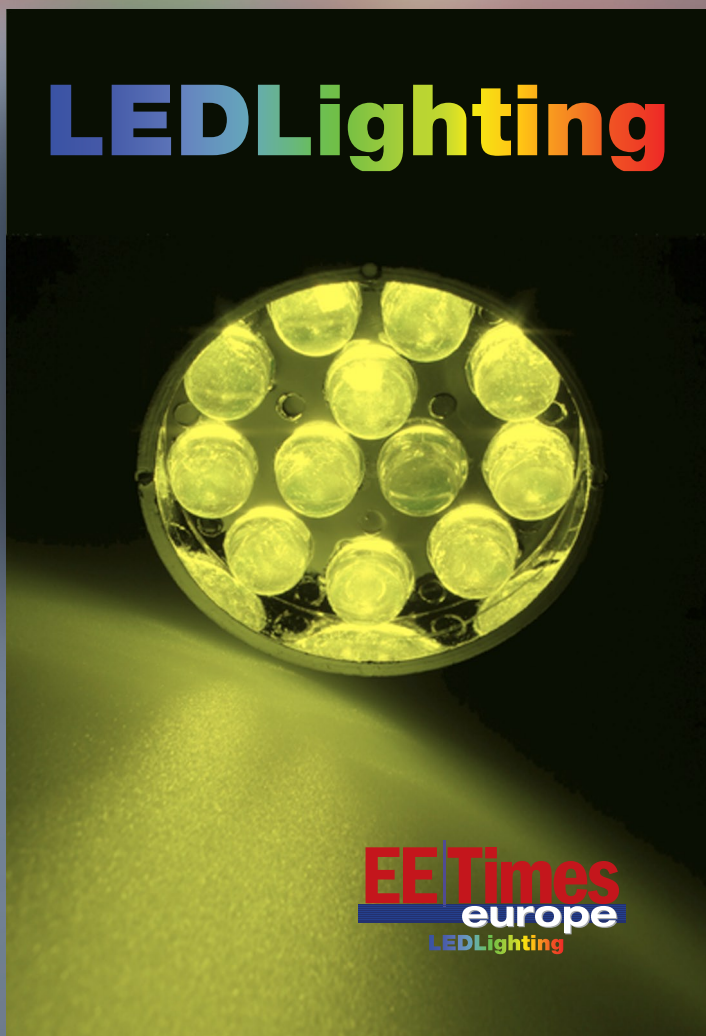
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Monday October 10				**International MEMS/MST Industry Forum**	**15th Fab Managers Forum** Networking Evening		**Smart Lighting Systems Workshop** (organized by Fraunhofer VµE) **Bio-Electronics Seminar**	**Photovoltaic PV Automation** (hosted by DAS Environmental Expert GmbH)
Tuesday October 11	**Exhibition** 10:00 – 17:00 **Show Floor Highlights:** - Science Park - Secondary Equipment and Services Pavilion - MEMS, Test and Packaging Pavilion - PE2011 Exhibition	**New Materials Session** Keynote Speeches Exhibitor Presentations	**Packaging Session** Exhibitor Presentations / **Secondary Equipment, Services and Technology Session** Exhibitor Presentations **MEMS Session** Exhibitor Presentations	**International MEMS/MST Industry Forum** / **Advanced Packaging Manufacturing Conference**	**15th Fab Managers Forum** Conference	**Opening Session SEMI / PE2011** **Press Conference** **5th Executive Summit and Reception** **SAXONY! - Get Together**	**Opening Session SEMI / PE2011** **Parallel Sessions:** - OLED's for Displays and Lighting - Flexible Photovoltaics - Organic Sensors & Actuators - Integrated Smart Systems	**PV Automation** (hosted by DAS Environmental Expert GmbH) **Photovoltaic** (hosted by DAS Environmental Expert GmbH)
Wednesday October 12	**Exhibition** 10:00 – 17:00 **Show Floor Highlights:** - Science Park - Secondary Equipment and Services Pavilion - MEMS, Test and Packaging Pavilion - PE2011 Exhibition	**Lithography Session** Keynote Speeches Exhibitor Presentations **IC Industry Awards** by EuroAsia	FITFORIT 12. Oktober 2011 . Messe Dresden **FIT FOR IT** - organized by Dualis GmbH IT Solution and AIS Automation Dresden GmbH	**Advanced Packaging Manufacturing Conference** **13th European Manufacturing Test Conference (EMTC)**	**Workshop on Equipment Assessment & Equipment Performance Improvements** (organized by Fraunhofer IISB) **450mm Session** Status and Overview (organized by Fraunhofer IISB)	**IC Industry Awards** by EuroAsia TechARENA 1	**Plenary Program** **Parallel Sessions:** - OLED's for Displays and Lighting - Flexible Photovoltaics - Organic Sensors & Actuators - Integrated Smart Systems	**Equipment Automation Silicon Wafer Gases & Liquid Chemicals** (Messe Dresden) **Silicon Wafer Gases & Liquid Chemicals** (Messe Dresden)
Thursday October 13	**Exhibition** 10:00 – 16:00 **Show Floor Highlights:** - Science Park - Secondary Equipment and Services Pavilion - MEMS, Test and Packaging Pavilion - PE2011 Exhibition	**3D IC Session** Invited Speeches **Metrology Session** Exhibitor Presentations	**Process Control, Automation and Software** Exhibitor Presentations **Test Session** Exhibitor Presentations	**13th European Manufacturing Test Conference (EMTC)** **CAST Workshop**	**450mm Session** Status and Overview (organized by Fraunhofer IISB)	**SEMI Members and Exhibitors Breakfast** 35th Anniversary SEMICON Europa	**Plenary Program** **Parallel Sessions:** - OLED's for Displays and Lighting - Flexible Photovoltaics - Organic Sensors & Actuators - Integrated Smart Systems	**Silicon Wafer Compound Semiconductor** (Messe Dresden) **Compound Semiconductor** (Messe Dresden)

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