european business press

www.electronics-eetimes.com

February 2014

EETimes europe

For the creators of technology

A Comparison of Open Source Hardware:

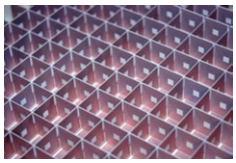
INTEL GALILEO VS. RASBERRY PI

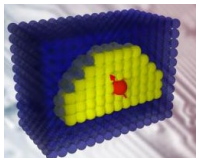
by Mouser Electronics

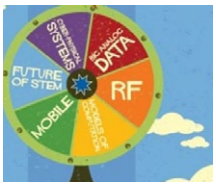

MOST PREFERRED DISTRIBUTOR
RATED #1
Source: 2013 Most Preferred Distributor, Distributor Customer Evaluation Study, North America, May 2013, UBM Electronics
THE TOP BRANDS from THE TOP DISTRIBUTOR
FREE SHIPPING
ON ORDERS OVER €65!*
DIGIKEY.COM
Digi-Key CORPORATION
FIND CONTACT AND ORDERING INFORMATION FOR YOUR REGION AT
DIGIKEY.COM/EUROPE
860,000+ PRODUCTS IN STOCK | 650+ INDUSTRY-LEADING SUPPLIERS | 3 MILLION PARTS ONLINE
*A shipping charge of €18.00 (£12.00) will be billed on all orders of less than €65.00 (£50.00). All orders are shipped via UPS for delivery within 1-3 days (dependent on final destination). No handling fees. All prices are in euro and British pound sterling. If excessive weight or unique circumstances require deviation from this charge, customers will be contacted prior to shipping order. Digi-Key is an authorized distributor for all supplier partners. New product added daily. © 2014 Digi-Key Corporation, 701 Brooks Ave. South, Thief River Falls, MN 56701, USA

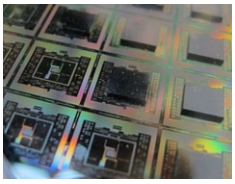
OPINION

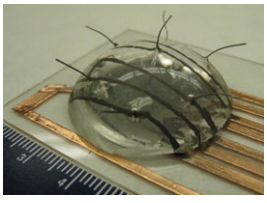
NEWS & TECHNOLOGY





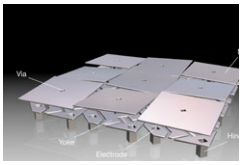


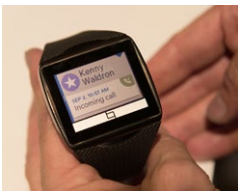




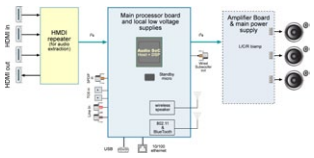
DESIGN & PRODUCTS

SPECIAL FOCUSES:
- MOEMS & MEMS

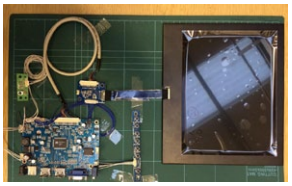




- AUDIO & VIDEO PROCESSING



- PROGRAMMING & DEVELOPMENT KITS



Precisely not there: fake GPS positioning

By Julien Happich

NOW THAT LEADING smartphones integrate a GPS to offer all sorts of geolocation-based services, some users do consider the option to opt-out the GPS tracking feature. For privacy issues, some will not want to have GPS tags associated to every Facebook-post or Tweet they make, every snapshot taken and uploaded to the cloud, or simply they don't want to be hassled with geolocalized adverts and SMS vouchers as they wander past hotels, restaurants or retail stores.

Now, how about remaining vaguely traceable, there, but not precisely, with a level of uncertainty that you could set yourself? Well, guess who would develop such an interesting option?

SinglesAroundMe is what founder and CEO Christopher Klotz calls a "Social Discovery" mobile dating app, which allows users to plot other identified singles on a geographical map around them, within a perimeter defined by users individually. One could want to look for singles within a 100km area (say if you live in the outback), while others could accept to be spotted only when within close proximity.

Now that extra geolocation feature comes with a twist, since Klotz has filed for several US patents in 2013, including one last November for "Methods and Systems Related To privacy In Location Based Mobile Applications" (Serial No. 14/089,162).

More simply put, the patent covers what Klotz markets as a "Position Shift" technology that allows users to control their location, share it or not, or should they decide, to shift the GPS data they share from their real location, a few kilometres away. Of course, all this goes hand-in-hand with the dating social network that Klotz has put into place, but this feature could be extended to many more applications for any smartphone user concerned with his/her privacy, especially when posting on social networks like Facebook, Google+, and LinkedIn.

"The initial idea came from the fact that SinglesAroundMe users didn't want to be located within a room, yet they wanted to remain visible on the radar to stay in the game, so to speak" said Klotz when interviewed. "To our knowledge, nobody has come up with such a precise idea, shifting the real location data while remaining within a predefined perimeter".

Used along social network tags, that "Position Shift" technology allows users to control their location in relation to others either as a global setting on a digital device or specifically within distinct applications (for example to leave an emergency application unaffected). And the position-shift could be set differently for whole classes of relatives, friends, or work colleagues, all the metadata posted by the user being automatically managed accordingly.

Since this GPS-location shift could appeal to many social networks, Klotz who already boasts over 2 million users in 100 countries for his application could licence the technology to larger groups.

"I think that our Position Shift algorithm is so valuable that large companies would want to add that to their portfolio. This could be through licensing, or through acquisition, but a Google or Apple of this world would certainly find innovative ways to integrate this technology" Klotz added. "They could provide elaborate interfaces to manage the position shift across multiple apps, yet retain accurate real-time positioning for some mapping services or advertising that could benefit the user without sharing the GPS data with others on the network" he concluded.

Anritsu | Since 1895

Over 100 years of Advancing the World's Communications History

If you believe the past is instrumental in shaping the future, then you'll understand why Anritsu is synonymous with innovation. Over 100 years of experience and innovation in our equipment, including our spectrum/signal analyzer.

Innovator in Signal Capture & Recreate

In 1939, Anritsu developed the AC-bias magnetic sound recorder – a key part of the tape recorder. In 2007, Anritsu marked another first with its launch of a one-box spectrum analyzer and signal generator which also provided a unique capture and recreate function. Today, Anritsu's MS2690A and MS2830A spectrum/signal analyzer series provides an all-in-one solution that captures data and signals in the field and recreates them seamlessly in the lab, maximizing product quality and efficiency.

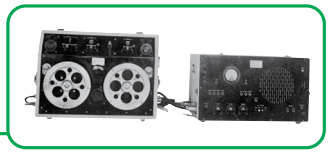
Learn more and download the FREE White Paper
- Fundamentals of RF Capture/Replay in design verification

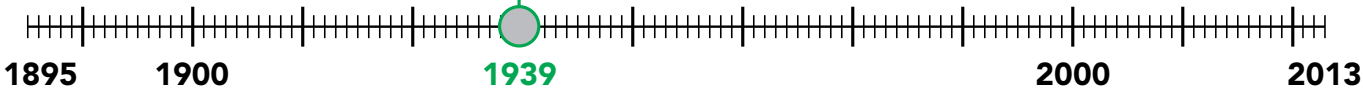
Capture & Recreate

From "record and play" to "capture and recreate" Anritsu Innovations have an impact.

Download the white paper and learn more...

AC-bias magnetic sound recorder - The prototype of modern tape recorders





Sales Offices: Europe 44 (0) 1582-433433, USA and Canada 1-800-ANRITSU, Japan 81 (46) 296-1208, Asia-Pacific (852) 2301-4980, **www.anritsu.com**

Anritsu

A Comparison of Open Source Hardware: Intel Galileo vs. Raspberry Pi

By Lynnette Reese, Mouser Electronics

The Intel Galileo and the Raspberry Pi (RPi) are both open source, do-it-yourself (DIY) electronics hardware development boards featuring embedded processors. It's not really fair to compare RPi to Galileo, since the choice should be based upon the goal of the project. Here we detail similarities and differences so that decisions can be made indirectly prior to purchase. Galileo has a new, memory-rich and powerful processor (Quark) and is compatible with existing Arduino open source hardware (OSHW). Electronics aficionados have been working DIY projects like Heath Kits since the late 1940s. Characterized by ads in the back of magazines, these kits really picked up in the 1970s. People met physically at swapmeets (flea markets for enthusiasts) to trade, sell things, and exchange ideas. This community has expanded to include a very diverse fan base, and meets in online forums and at events like SXSW or Maker's Faire. Major electronics catalogs are now online (mouser.com). OSHW was developed as a hopeful effort to provide a simple means for education in embedded hardware, where none (at least not low cost, nor as well-documented) had existed before, post-Heath Kit. OSHW has become better known and is rapidly growing since it became more modular (much like chunks of code in Open Source Software). Not only are sources openly accessible, but hardware is ready-made and simply bolted together. Detailed expertise in technology is not required.

Different Applications

The Galileo board sports a 400MHz Pentium-class System-on-a-Chip (SoC) called "Quark," that was made by Intel cooperatively with Arduino. RPi is normally clocked at 700MHz, but is easily overclocked (with the consequence of excess heat.) Both are single core processors, but RPi is apparently less efficient in how many instructions it executes per clock cycle. According to the Raspberry Pi Foundation, "The overall real world performance is something like a 300MHz Pentium 2, only with much, much swankier graphics."

Raspberry Pi is best for handling media such as photos or video, and a Galileo is an excellent choice if you have a project requiring sensors (and decent memory and processing power), monitoring, or have productivity-related applications (Galileo has a real time clock.) RPi could be used as a networked security camera or a media server, but without an analog-to-digital converter, analog sensors would not be easy to implement. Galileo could be used to develop smart everyday "things" with lots of sensors, such as watches, health monitoring or fitness devices, or simply be an inexpensive personal computer running Linux. Don't count on running Windows on Galileo, however, since Windows is a proprietary, closed source operating system. The Galileo datasheet mentions Windows as a compatible operating system. This refers to the host PC that is used to program Galileo. Intel has provided development tools for the host PC to run on Windows, Linux, or a MAC. Compilers for each of these host environments (called "cross compilers") are free. The Galileo itself comes with an Arduino Linux distribution.

The Quark, as an x86, has an existing well of software, and historically the vast majority of x86's are implemented in desktops. (Hint: Set compilers to .586 for Quark x1000.) Intel is eyeing the next wave of technology advances, known as "The Internet of Things" (IoT) or "Industry 4.0". IoT is a concept in which things have unique embedded identifiers that automatically communicate (over the internet) with other things without direct human intervention, in order to automatically transfer data for the purpose of self-regulation. The result would be great energy, cost, and time savings with efficiencies gained from every aspect of the interaction of "smart" things. Quark demonstrates Intel's interest in evolving IoT. Spill-over from the desktop domain to the embedded domain (and IoT) is feasible. The only flaw is that no one has the Internet of Useful Things[1] worked out yet.

Galileo is genuinely Arduino, and source code is available for download with no software license agreement other

[1] Ross Atkin, http://www.youtube.com/watch?v=XT5lA8BZq8Y

	Galileo	Raspberry Pi (Model B)
Board Dimensions	10cm x 7cm (slight overlap for power jack)	85.60mm x 56mm x 21mm (with a little overlap for SD card)
Processor	Intel® Quark X1000 – single core	Broadcom BCM2835 – single core
Description of Processor	Quark, described by Intel at IDF2013, is very low power consumption, small form factor, and low cost; ideal for "wearables," and the Internet of Things†.	Per ARM datasheet: For devices such as smart phones, digital TVs, & eReaders, delivering media & browser performance, a secure computing environment.
Architecture	Intel ® Pentium® Class	ARM® ARM1176™
Speed	400MHz	700MHz[0]
Width, Instruction Set	32-bit	32-bit
Real Time Clock	Yes, needs a 3.3v coin cell	No
Cache	16 KB L1 cache	32KB L1 cache & 128KB L2 cache; shared with CPU & GPU
RAM	512KB on-chip SRAM, dedicated for sketch storage & 256MB DRAM, dedicated for sketch storage	512MB SDRAM (shared with GPU)
FLASH memory	8MB NOR Flash (Legacy SPI), for FW bootloader & sketch storage	No permanent on-board Flash memory
EEPROM	11KB	No
GPU	No	Broadcom Dual-core VideoCore IV® Multimedia co-processor
External Storage	Micro-SD Card (up to 32GB), & support for an external USB2.0 drive	SD-card, & support for an external USB2.0 drive
Video Support	No	HDMI – 1080p RCA (analog), without audio DSI* – for touchscreens
Audio Support	No	HDMI & 3.5mm stereo audio-out jack
Status Indication	LED – Board Power	LEDs for – board power, SD card access, LAN connected, LAN activity, 100Mbps connected
JTAG	10-pin, Mini-JTAG header, to be used with an in-circuit debugger such as 909-ARM-USB-OCD with the 909-ARM-JTAG-20-10 converter (available at www.mouser.com), & with OpenOCD/GDB**for Quark, & GUI.	Yes, headers P2 & P3. (However, there is no current support to debug the Broadcom & SMSC USB/LAN chip.)**
Compatibility	Arduino Shields that fit the Arduino Uno R3 3.3V / 5V shields	Arduino board connects via USB. 3rd party boards enable support for Arduino shields with Pi.

*DSI – Display Serial Interface
** OpenOCD support for Quark X1000 may be available, or not be full featured as of this writing.
https://communities.intel.com/message/211778 & https://www.mail-archive.com/openocd-devel@lists.sourceforge.net/msg04709.html

Table 1: Comparison of Processors & on-Board Features

	Galileo	Raspberry Pi (Model B)
Analog I/O	Up to 6 Analog Inputs (Muxed via an I²C-controlled expansion header), with 12-bit resolution.	17 general purpose I/O (GPIO) pins (access to I²C, UART, and SPI.) 26-pin header
Digital I/O	14 Digital I/O that can be used as input or output	8 GPIO pins that can be programmed as Digital Input or Output
PWM	Up to 6 of the DI/O can be configured as Pulse Width modulation (PWM)	One of the digital I/O pins can be designated as PWM.

Table 2: General Purpose I/O

than open source licenses. Hardware and software source files, including schematics, are provided for download. Galileo has good documentation and Intel seeded the community by giving away thousands of boards.

The Galileo has some differentiating attributes such as PCI Express (PCIe) and a Real Time Clock (RTC), whereas the RPi has peripherals well-suited for graphics-intensive applications for HD 1080p streaming video. Galileo is a memory-rich, fairly high-performance 32-bit x86 with traits well-suited to embedded portables or wearable devices: small in size (highly integrated), low power, and fairly low cost with respect to the value that is packed in this SoC. Some major differences: RPi has a Graphics Processing Unit (GPU.) Galileo does not. Galileo has an I²C-controlled I/O expander that runs at 200Hz. I/O that runs through the any of the three "GPIO PWM" blocks on the Galileo schematic is going to be limited to only 200 updates per second. IO13 avoids the limitations of the expander, as well as the UARTs, SPI, I²C, and the ADC. Galileo boots from on-board memory. RPi can only boot from the SD card. Galileo has the first PCIe slot supported by Arduino.

	Galileo	Raspberry Pi (Model B)
USB 2.0	2 ports (AB and B). USB 2.0 Full Host and Client. Arduino library support (does not convert USB input to ASCII for you.) 3rd USB Host available over PCIe.	2 external ports. Two USB ports and share one upstream port to the LAN9512 chip that handles Ethernet as well. Max current draw is 100mA from USB ports, not the expected 500mA.
Ethernet (RJ45)	10/100 Mbps with a dedicated PHY for Ethernet control. One RJ45 port.	10/100 Mbps via a built-in USB-to-Ethernet adapter. One RJ45 port.
WiFi	No. Can use the PCIe slot or a USB port with a USB adapter to obtain WiFi. Intel® Centrino N135 min-PCIe wireless module is recommended by Intel.	No. Can support WiFi with a USB adapter, using one USB port.
SD Card Slot	Yes, a micro SD slot. Includes an on-board dedicated SD controller.	Standard SD slot, min 4GB, class 4 or higher. RPi must boot from a portion of the SD card.
PCIe	Yes, PCI Express mini. This enables WiFi, SD card, USB Host, Bluetooth, or GSM (cellular phone technology.)	No
TWI/I²C TWI means "Two Wire Interface"	Yes	Yes
SPI	Yes. Native controller, Master SPI programmable to 25MHz. Additional Slave SPI available only through via a USB Client connector.	Yes
Serial Data (UART)	Yes. Two, one is Tx/Rx only ported as a 3-pin RS-232 3.5mm audio-type jack. Programmable. The other has dedicated pins.	Yes, but no dedicated pins; uses up GPIO.
GPIO	Up to 6 Analog, Muxed. Up to 14 Digital, of which up to 6 can be used as PWM.	17 GPIO pins (access to I²C, UART, and SPI.) Input voltage limited to 3.3v only. 26 pin header GPIO interface
Reset button	Yes	No
DSI (Digital Serial Interface)	No	Yes (Used for char-driven LCD displays)
CAN Bus	No	Yes
GPU	No	Yes
EEPROM	Yes. 11KB.	
HDMI	No	Full HD 1920 X 1080.
DVI	No	No
VGA	No	No
On-board ADC	Yes. One AD7898. MUXed.	No
Clock	Internal. Pins for an external clock, too. On-board RTC.	
Camera	No	Header only. Expansion accessory required. A separate RPi Camera board exists.

Table 3: Comparison of Peripherals/Utilities

Cost: Galileo vs. RPi

The Galileo board costs almost twice as much as the RPi model B, but there are some hidden costs with RPi, because all that comes in the box is the board. To get RPi running, you need: a USB power supply (at least 700mA at 5V) and an SD card with boot code installed. You may also want a Keyboard, Mouse, HDMI-to-DVI cable (for a monitor), and the informed RPi user will want a powered USB Hub (for parking power-hungry USB devices.) The RPi is not fussy; an old analog TV can be a monitor via the RCA port, but it needs a standard RCA cable. On the other hand, Galileo can be booted and programmed immediately out of the box, since it ships with a USB cable, power supply, and some stand-offs. Galileo boots without the need for external memory like the RPi.

	Galileo	Raspberry Pi (Model B)
DC Power Supply (V_{IN})	Included. AC/DC adapter with a 2.1mm center-positive plug. Output rating of the power adapter is 5V at up to 3A. Galileo must only be used with 5V power supplies.	Not included. Micro USB-plug charger providing $5V_{DC}$ and 0.7A (min) or up to 2A (max) if you plan to use accessories.
Power Rating	15W	3.5W (Model B)
Ethernet cable	Cat5e/Cat6; not included.	Cat5e/Cat6; not included.
USB 2.0 type A/B-micro cable	Included.	Not included.
Mini SD Card	Not required.	At least a 4MB, Class 4 or better.
Powered USB Hub	If you require >2A for peripherals powered via Galileo.	Recommended to power any USB peripherals that would take RPi current draw above 1A.

Table 4: Board Requirements

Booting the Boards

Galileo can boot from on-board memory. The RPi boots only from an SD card (4MB or more), which needs an image that can be found on the Foundation website. Thus, RPi requires formatting a card and copying the image before booting for the first time.

Performance

Arguably, "performance" is subjective, and depends on what you want to do with the board. Recall that Galileo runs the 400MHz Pentium-class Quark. RPi is normally clocked at 700MHz, but since RPi performs fewer calculations per cycle, they are roughly equivalent in this aspect. The big difference is that RPi includes a GPU as a co-processor and is well suited to work with high definition graphics. The RPi can provide Blue Ray-quality play back. RPi allows itself to be over-clocked, but heat dissipation increases and it might need a fan to prevent erratic operation when overclocked. Galileo sports a 32-bit Pentium ISA-compatible SoC that uses 1/10th the power of the Intel Atom and a price point within reach of open source projects. Galileo could be applied in remote monitoring, but without a CAN bus, Galileo cannot interface easily with some industrial networks. However, WiFi is available with an adapter on the PCIe slot.

Over the last decade or so, embedded processors have begun to interact more with the end user over the internet. Embedded devices have begun to look more like desktops in terms of interaction with people and networking, and the demarcation is getting fuzzy. The line gets more fuzzy with the x86-based Quark in the OSHW community; so much software has already been developed to run on x86 from a desktop point of view. (If you have to program a processor via a host, it's embedded. Once you install the Linux operating system for use on Galileo, Galileo is a technically a desktop.) Although there is an Open Core movement afoot, OSHW is not always 100% open if the processor chip is not open source. (ARM cores are licensed, but not "open" to reuse without cost.) Some manufacturers make their devices more accessible by allowing users some control over a closed-source chip (e.g., software drivers that allow some manipulation without exposing contents lower in the stack.)

Both Galileo and RPi are excellent boards, and they both have the most important feature of all: an established ecosystem with open sources. Mouser Electronics (www.mouser.com) offers the Galileo and many of the products mentioned in this article.

Lynnette Reese is a member of the technical staff at Mouser and holds a B.S. in Electrical Engineering from Louisiana State University.

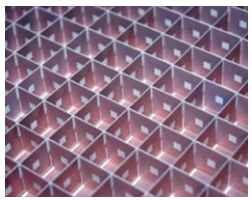
http://www.raspberrypi.org/faqs

"Overall real world performance is something like a 300MHz Pentium 2, only with much, much swankier graphics." - http://www.raspberrypi.org/faqs

Magnetic 'lens' aids wireless power transfer

By Peter Clarke

RESEARCHERS FROM PRATT SCHOOL of Engineering at Duke University (Durham, North Carolina) have demonstrated a "magnetic lens" that supports the transfer of wireless power over distances much larger than the traditional limit, which was roughly equivalent to the size of the transmitter and receiver.



A team of researchers in Duke's Pratt School of Engineering worked with Toyota Research Institute of North America to create an array of hollow cubes to act as a lens for the transfer of energy using low-frequency magnetic fields. The walls of these cells are etched with copper spirals and the geometry of these coils and their repeating nature form a metamaterial that interacts with magnetic fields in such a way that the fields are transmitted and confined into a narrow cone in which the power intensity is much higher than the conventional pattern.

The resulting lens, in some ways analogous to an optical Fresnel lens, focuses a magnetic field emanating from one power coil onto its twin nearly a foot away, inducing an electric current in the receiving coil.

"For the first time we have demonstrated that the efficiency of magneto-inductive wireless power transfer can be enhanced over distances many times larger than the size of the receiver and transmitter," said Yaroslav Urzhumov, assistant research professor of electrical and computer engineering at Duke University, in a statement.

"If your electromagnet is one inch in diameter, you get almost no power just three inches away," said Urzhumov. "You only get about 0.1 percent of what's inside the coil." But with the superlens in place, he explained, the magnetic field is focused nearly a foot away with enough strength to induce noticeable electric current in an identically sized receiver coil.

Urzhumov said that in future experiments researchers would investigate a dynamically tunable lens that could perform beam-steering. This would allow mobile devices to be charged as they move around a room.

"The true functionality that consumers want and expect from a useful wireless power system is the ability to charge a device wherever it is – not simply to charge it without a cable," said Urzhumov.

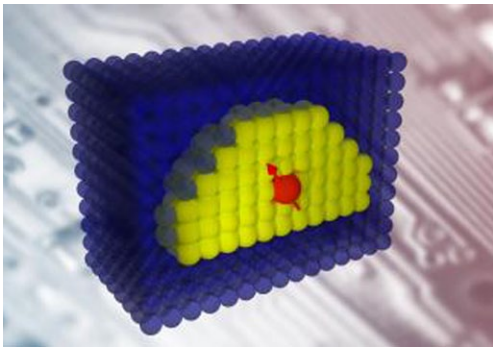
Quantum dots from Warsaw

By Nick Flaherty

RESEARCHERS AT the Faculty of Physics at the University of Warsaw have used cobalt for the first time surrounded by cadmium telluride (CdTe) and say they may be able to improve the performance by a factor of 10.

In quantum dots where tellurium is replaced by the lighter selenium, researchers observed that the duration for which information was remembered increased by an order of magnitude. This finding suggests that using lighter elements should prolong the time quantum dots containing single magnetic ions store information, perhaps even by several orders of magnitude.

"We have demonstrated that two quantum systems that were believed not to be viable in fact worked very effectively. This opens up a broad field in our search for other, previously rejected combinations of materials for quantum dots and magnetic ions," said Dr Wojciech Pacuski at the Institute of Experimental Physics at the University of Warsaw (FUW).



Researchers are able to control the behaviour of individual atoms by situating them within special semiconductor structures – this is the method used to form quantum dots that contain single magnetic ions. Until recently, only two variants of such structures were known. However, physicists from the have successfully created and studied two completely new types of the structures.

"Quantum dots are semiconductor crystals on a nanometre scale. They are so tiny that the electrons within them exist only in states with specific energies. As such, quantum dots exhibit similar characteristics to atoms, and – just like atoms – they can be stimulated with light to reach higher energy levels. Conversely, this means they emit light as they return to states with lower energy levels," says Prof. Piotr Kossacki at FUW.

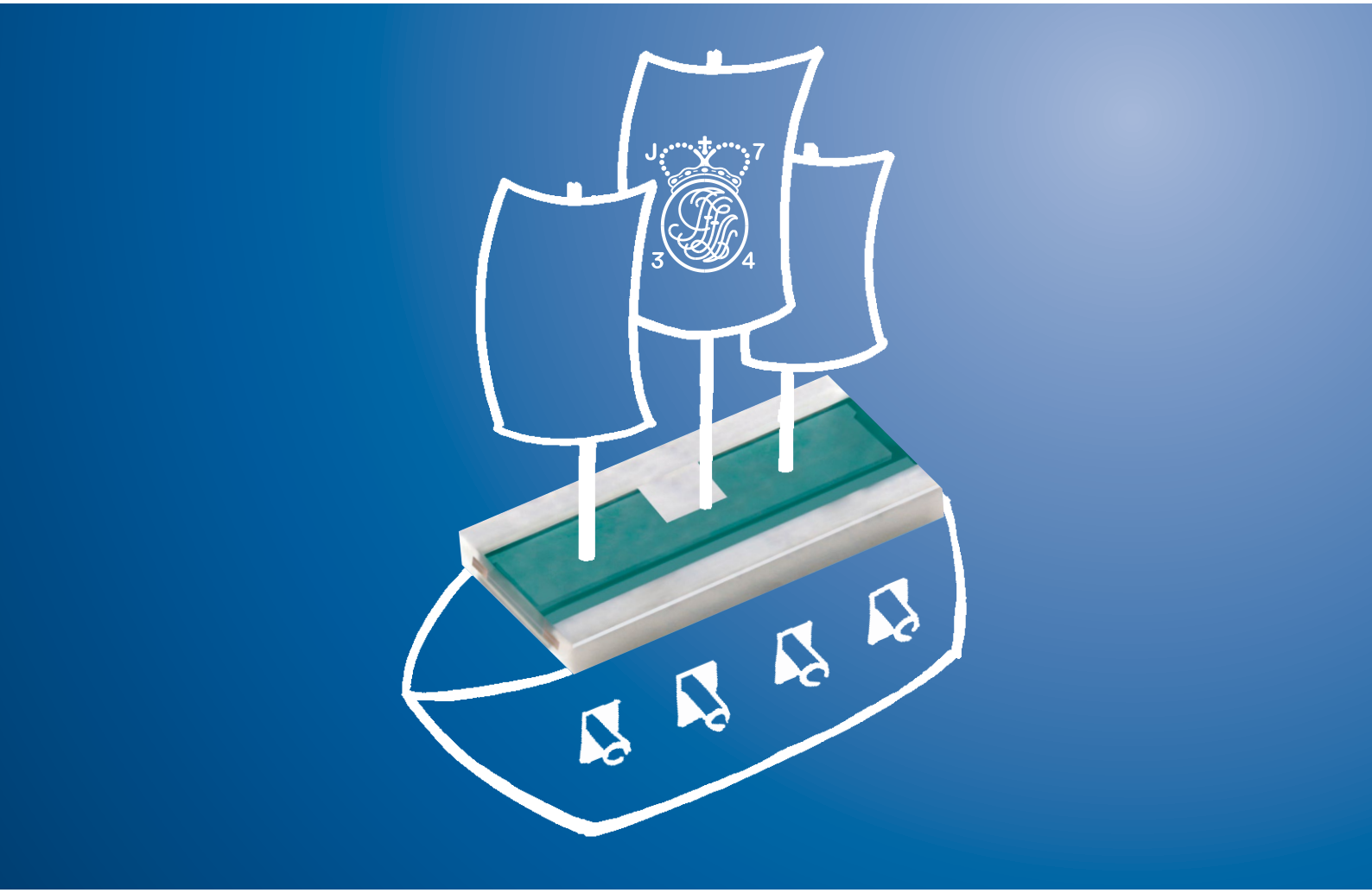
The University laboratory creates quantum dots using molecular beam epitaxy and by carefully selecting materials and experimental conditions, the atoms assemble into quantum dots.

"Atoms with magnetic properties disrupt the energy levels of electrons in a quantum dot, which affects how they interact with light. As a result, the quantum dot becomes a detector of such an atom's state. The relationship also works the other way: by changing energy states of electrons in quantum dots, we can affect the respective magnetic atoms," said Michał Papaj, a student at the UW Faculty of Physics.

The most powerful magnetic properties are observed in manganese atoms stripped of two electrons (Mn^{2+}). In experiments conducted thus far, the ions have been mounted in quantum dots made of cadmium telluride (CdTe) or indium arsenide (InAs).

"It was commonly believed that other magnetic ions, such as cobalt (Co^{2+}), cannot be used in quantum dots. We decided to verify this, and nature gave us a pleasant surprise: the presence of a new magnetic ion turned out not to destroy the properties of the quantum dot," says Jakub Kobak, doctoral student at the University of Warsaw.

A REAL BROADSIDE!



LOW OHMIC PRECISION AND POWER RESISTORS

TOP PERFORMANCE ON SMALL SURFACE AREAS WITH LOW-OHMIC PRECISION RESISTORS

By reversal of the length to width ratio, our VLx series resistors have larger soldering and contact pads, giving them:

_ better heat dissipation, Rthi < 20 K/W
_ higher power rating: 2 W for size 1020, 1 W for size 0612
_ significant increase in mechanical stability

ISABELLENHÜTTE
Innovation by Tradition

Isabellenhütte Heusler GmbH & Co. KG
Eibacher Weg 3–5 · 35683 Dillenburg · Phone +49 (0) 2771 934-0 · Fax +49 (0) 2771 23030
sales.components@isabellenhuette.de · www.isabellenhuette.de

Is Nokia's 2007 decline a lesson for Samsung today?

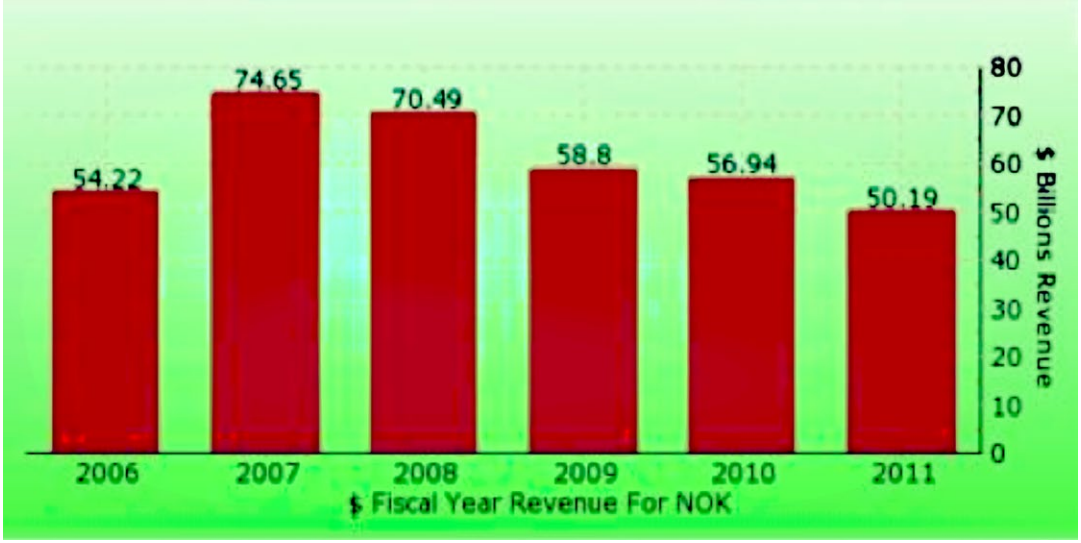
By Junko Yoshida

IN THE RESULTS POSTED FOR THE FOURTH quarter of 2013, Samsung Electronics reported an operating profit of 8.31 trillion won ($7.7 billion), which missed analyst expectations by a whopping 20%.

Samsung also reported its first quarterly operating profit decline in two years - an 18% drop from the $9.4 billion it reported for the third quarter. Though it posted a record $54.95 billion of revenue, the industry is focused now on its potential growth limits in the coming quarters.

The Korean company also issued a warning about anemic earnings in the current quarter. It's blaming "weak seasonality" in the IT industry early in a calendar year. It expects performance to pick up in the second half, but admitting a disappointment in advance is hardly good news.

Nobody is predicting the beginning of the end for Samsung, but this might be an opportune moment to compare its situation today with Nokia's back in 2007. Today the mobile division is responsible for more than half of Samsung Electronics' revenue and profit. Further, Samsung's share of the global smartphone market is more than 35%, and Nokia's share peaked at 39% in the third quarter of 2007.



Today, the prevailing analysis of Nokia's downfall says the Finnish mobile company didn't see the emerging smartphone trend, causing it to hang on to feature phones too long. It's interesting to look back on the history, though. Back then, analysts were less concerned about Nokia's lack of presence in the North and South American markets. They were betting on its feature phones to capture the rising demand from non-US markets.

Analysts even talked about Nokia's ability to manufacture inexpensive cellphones in China and India profitably. They told The New York Times in 2007 that it would "help the company build on its already sizable lead over its challengers -- Motorola, Samsung and Sony Ericsson -- whose combined market share barely equals that of Nokia."

Obviously, it wasn't just Nokia that didn't see the smartphone tsunami coming -- at least in 2007. Analysts missed it, too. Moreover, they underestimated the power of China's OEMs and whitebox vendors. Their ability to churn out a host of mobile phones at a much lower cost and (more importantly) much faster turned Nokia into the biggest loser in the global feature battle.

Every investor, every analyst, and every reporter is in the business of hunting for the next big thing. Knowing what will come after the current smartphone boom should help predict Samsung's future. Though the Internet of Things and wearable devices are the buzz of the moment, the jury is still out on both categories.

Drawing a parallel between Samsung today and Nokia in 2007, the key to the analysis is software. Can any company launched as a hardware manufacturer adjust to today's more software-driven hardware business?

Nokia's Waterloo wasn't just smartphones or China. It was an inability to transform its mobile hardware-oriented handset business and develop a real understanding of the software-intensive future. Remember that Nokia was fully aware of the software trend.

It invested in a host of software companies and technologies, including Symbian, Meego, and Navteq. But in the end, the more software assets Nokia amassed, the less focused it became. Last year, it announced that it would drop support for Symbian and Meego applications, despite having pledged its troth until 2016.

Samsung also pays lip service today to the importance of becoming a leading player in software. It says that 35,000 of its 65,000 R&D staff members are working on software. But name one stellar software investment Samsung has made in the last five years. Name one Samsung product whose performance is significantly differentiated by its software.

But don't ask me. I'm stumped.

— Junko Yoshida, Chief International Correspondent, EE Times

Receive more Oscilloscope bandwidth for free

www.agilent.com/find/bandwidthpromo

OFFER ENDS MARCH 31ST 2014

No other oscilloscope can touch it. But you can.

The oscilloscope experience redefined.

Agilent 4000 X-Series Oscilloscopes	Agilent 3000 X-Series Oscilloscopes
200 MHz to 1.5 GHz	100 MHz to 1 GHz
Starting around €4500	Starting around €2600
12.1" capacitive touch display	8.5" display
InfiniiScan Zone touch triggering	—
1M waveforms/sec update rate	1M waveforms/sec update rate
Fully upgradable: bandwidth, MSO, dual-channel WaveGen, DVM, serial analysis including USB	Fully upgradable: bandwidth, MSO, WaveGen, DVM, and serial analysis

* Prices are in euro and subject to change

3 WARRANTY

Get greater reliability - Standard

Now with Agilent's new three-year worldwide warranty on all instruments

Scan or visit http://qrs.ly/hz3lhmd to see a video demo

Buy from an Authorized Distributor

www.agilent.com/find/distributors

Experience the difference.
Get time-saving app notes.
www.agilent.com/find/newexperience

Anticipate — Accelerate — Achieve

Agilent Technologies

Five technology trends for 2014

By Nick Flaherty

NATIONAL INSTRUMENTS IS highlighting five key trends for engineers in 2014, from control systems to RF and user interfaces.

The cyber-physical design challenge

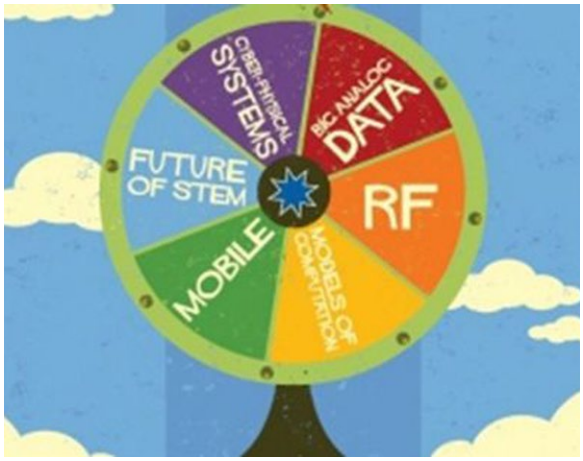
Cyber-physical systems (CPSs) are engineered to continuously and dynamically interact with their environment through the coupling of distributed computational and physical components. CPS applications are all around us and include smart grid, vehicle traffic networks, smart buildings, cooperative robots, telecommunications, automotive systems, and avionics.

A CPS is characterized by three fundamental and deeply interwoven behaviours - computation, communication, and control - the three Cs of CPSs. Better CPS designs are achievable with disciplined design methodology, holistic development tools, and commercial off-the-shelf hardware.

Big analogue data - the biggest big data

In test, measurement, and control applications, engineers and scientists can collect vast amounts of data in short periods of time. When the National Science Foundation's Large Synoptic Survey Telescope comes online in the US in 2016, it should acquire more than 140 terabytes of information per week.

In general, big data is characterized by a combination of three or four "Vs" - volume, variety, velocity, and value. An additional "V," visibility, is emerging as a key defining characteristic. Drawing accurate and meaningful conclusions from such high-speed and high-volume analogue data is a growing problem. This data adds new challenges to data analysis, search, data integration, reporting, and system maintenance that must be met to keep pace with the exponential growth of data. Solutions for capturing, analysing, and sharing Big Analogue Data work to address the combination of conventional big data issues and the difficulties of managing analogue data.



The SDRification of RF Instrumentation

The modern RF instrument has evolved from merely a measurement device into a premier tool for system design. This evolution was fueled by a broad range of technologies from the software defined radio (SDR). The flexibility of the SDR is revolutionizing not only the wireless industry but also RF test equipment.

The ability to fully define and customize the behavior of RF instrumentation with software is a key element to solving the next generation of test challenges. As a result, the architecture of tomorrow's RF instruments will look more and more indistinguishable from that of the SDR.

The evolution of system-level design

Today's complex design spans multiple knowledge domains. The development of a cyber-physical system like a smart appliance requires domain knowledge in a handful of RF standards, power management, physical design, heat dissipation, image capture and analysis and potentially video quality.

In a market where requirements and technology are constantly changing, the tools used to solve increasingly complex problems aren't keeping pace. As a result, today's engineer is slow to adjust, even if it makes getting the job done harder than it should be. The engineering mindset must not only recognize that multiple models of computation are required for complex system development but also demand that the integration of these disparate languages evolve.

This evolution in the approach to system-level design allows each domain expert to choose the best tool for the job and then integrate the tools into a single representation of the overall system. Even better, this lets the single developer choose the most appropriate approach, regardless of expertise level.

Using mobile devices as remote interfaces

Understanding how mobile technology can impact measurement and control systems, and especially the expectations of the users of those systems, becomes a challenge for system designers.

A modern UI architecture with multiple points of access, including remote access via mobile devices, can add significant value for users of measurement and control systems. Technicians can carry a single mobile device to check and debug issues with multiple systems, simplifying their workflow and reducing equipment costs. When managers or engineers need to monitor a system at a critical time, they no longer need to be present at the system itself. They can use a mobile device from a location in the field, at home on the weekend, or while travelling across the world. By enabling access to systems from any place at any time, mobile devices serve to make the lives of the system's users easier and more productive.

Whether to create cross-platform web pages using tools such as HTML5 and JavaScript, or native applications using the platform-specific tools for iOS, Android, or Windows RT depends on the mobile device ecosystem in which the system lives. If a wide variety of devices connects to the system, a cross-platform solution like HTML5/JavaScript may be best. If a narrower range of devices needs to be supported, or if the absolutely best possible experience and performance for the specific device are needed, a platform-specific approach like Objective-C for iOS and Java for Android is warranted.

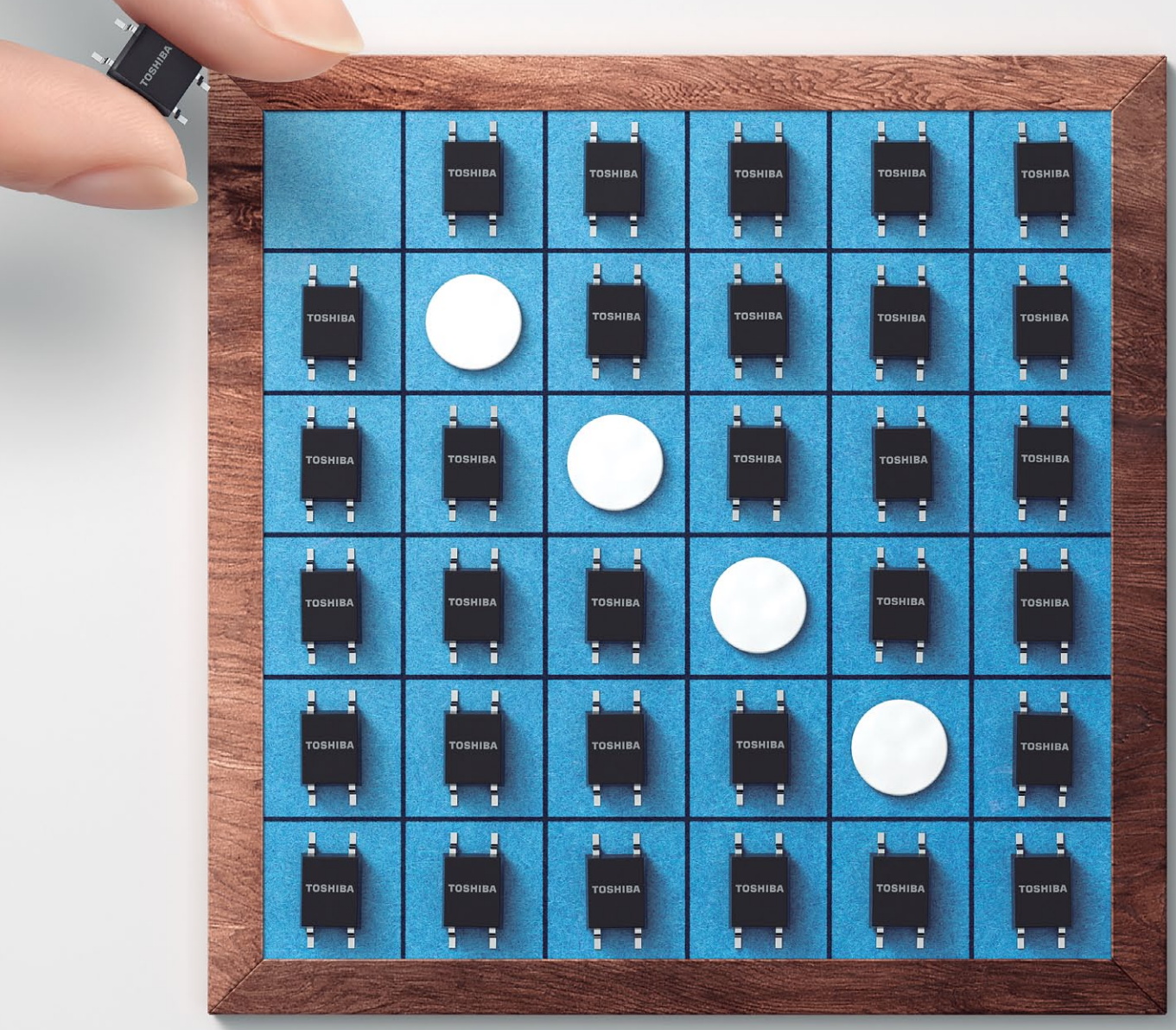
"Because engineers use NI tools in so many different industries and applications, we are in a position to examine trends in measurement, sensors, networks, test and more - as they happen," said Eric Starkloff, NI Senior Vice President of Marketing. "NI compiled what we learned in this report to help engineers take advantage of the latest technological breakthroughs and stay ahead of the competition."

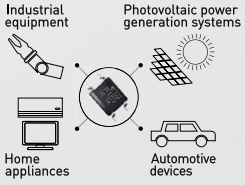
TOSHIBA
Leading Innovation

WW Share No.1* in photocouplers

We will continue boosting production to bring these devices to the world.

* Revenue in 2011 and 2012, Source: Gartner, "Market Share: Semiconductor Devices, 2012" 1 April 2013





Toshiba's photocouplers

Thanks to the low power consumption, small and thin package size, and variety of line-ups, Toshiba's photocouplers have earned the world's highest sales revenues*. From 2013, we began operating a new factory in Thailand to reinforce the stable supply of these high quality devices at a lower cost.

New factory in Thailand, in operation since April 2013

Toshiba Semiconductor & Storage Products

http://www.semicon.toshiba.co.jp/eng/product/opto/coupler/index.html

Toshiba Group contributes to the sustainable future of planet Earth.
TOSHIBA eco style

Fully encrypted? Watch your back!

By Julien Happich

SURE ENOUGH, the revelations of whistle-blower Edward Snowden on NSA's large-scale surveillance practices have not just created political embarrassment among US allies, they have raised the level of "Big Brother" suspicion among even the most naïve citizens who would have assumed until then that any sort of state-surveillance is for their good only.

Then European governments somehow faked their surprise and horror. "Why would you so comprehensively spy on your closest allies?" they asked candidly, industrial espionage being just a bonus. Early November last year, I remember receiving some press releases from companies exhibiting at Paris-based event Milipol, about stealth fibre communications interception equipment and server-based snooping software, to be installed on telco's racks (the press release didn't say if they had to agree or not). This global event gathers all the who's who in the tech world of law enforcement, crowd control, surveillance, and military equipment. At the time, I just thought, "if it's for sale, surely there is a well-documented market for it and undoubtedly it will be used by any state or company acquiring it". Nearly every day, there was a new revelation in the newspapers about how comprehensive, how "unfair" the NSA's surveillance strategy had become.

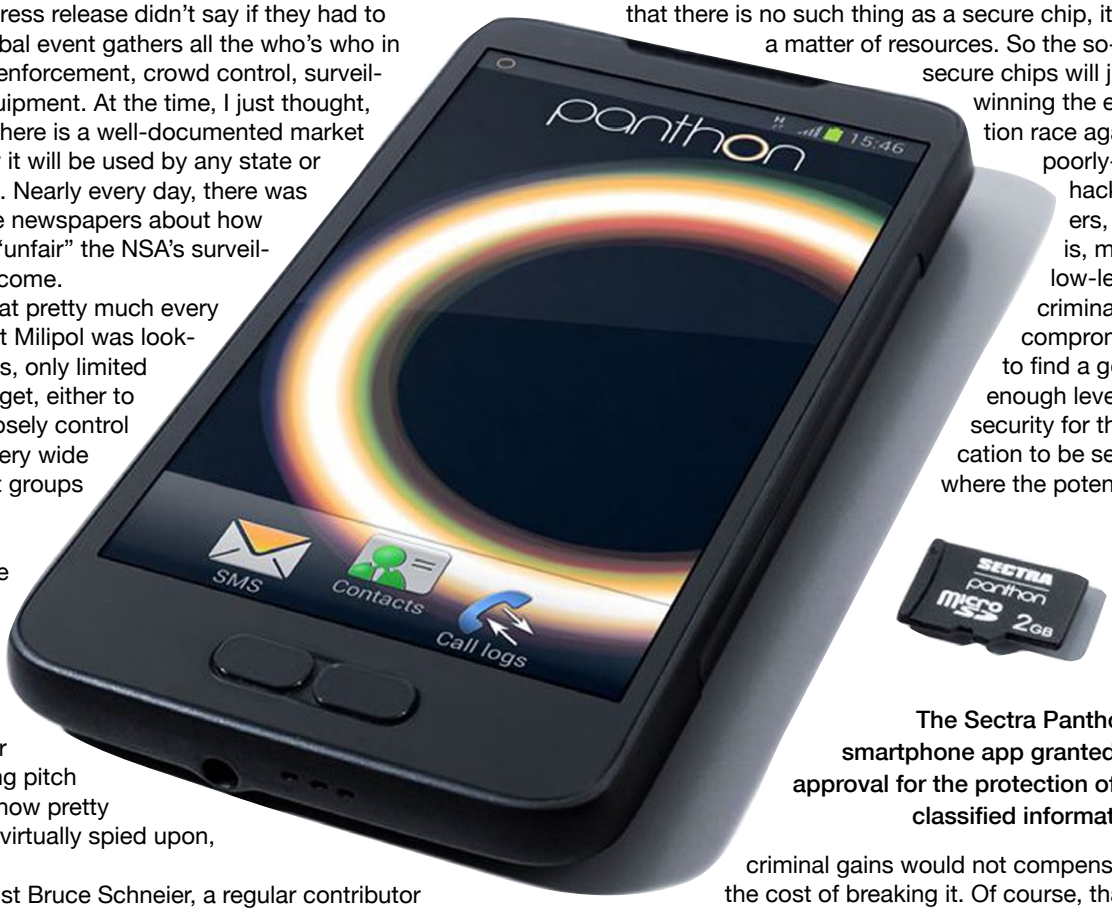
And you can bet that pretty much every country represented at Milipol was looking for similar solutions, only limited by their spending budget, either to spy on others or to closely control their own citizens or very wide encompassing "select groups of activists".

This surveillance scandal definitely gave a boost to providers of data encryption solutions, since you could argue that well encrypted data is rendered useless for analysis. The marketing pitch is easy now that we know pretty much anyone of us is virtually spied upon, indiscriminately.

Security technologist Bruce Schneier, a regular contributor to *The Guardian* on secure communications, got early access to leaked NSA documents to help journalists clarify the technical implementations of data collection and sifting. His main conclusions regarding encrypted data, is that the NSA will circumvent state-of-the-art encryption by finding the weakest point in the communication chain, accessing the data at weakly protected spots before the hard encryption takes place. Often these include the end-points, your mobile device or computer, running an easy to tamper operating system, possibly compromised software, and poorly chosen passwords. What's more, the huge amounts of meta-data collected across social networks and any internet page you visit will give up as much about you as low-level social engineered phishing.

In his analysis, Schneier warns that large commercial encryption software can be assumed to have installed backdoors, and that being open, public-domain encryption solutions will less likely be perverted. You could use hidden services, such as Tor to anonymize yourself, but then the NSA will more specifically target any group of users trying to hide or encrypt their communications. The "air gap" as Schneier likes to call it - moving data from a non-connected computer to a connected one using an encrypted USB key - is pretty efficient, but then I suppose the next level of secrecy would simply be not to share your secrets or at least stop communicating them electronically.

A friend of mine who's daily job in a state-funded lab is to crack secure chips and evaluate their protection level, told me that there is no such thing as a secure chip, it is just a matter of resources. So the so-called secure chips will just be winning the encryption race against poorly-funded hackers, that is, most low-level criminals. The compromise is to find a good-enough level of security for the application to be secured, where the potential criminal gains would not compensate the cost of breaking it. Of course, that just won't hold back state-funded hackers.



The Sectra Panthon 3 smartphone app granted EU approval for the protection of EU classified information.

So the announcement of the Sectra Panthon 3 smartphone app for secure voice communication and text messaging, granted EU approval for the protection of EU classified information, somehow makes me smile. Yes, the end-to-end smartcard-based encryption (via a plug-in microSD-card) is probably very secure at least against most common interceptors, and since it is available as a service, the users can rely on all major public wireless networks. They don't have to manage encryption keys either. Now a PIN code is all that is needed to activate the added protection, boasts the press release. Hopefully you won't choose 123456, ranking at the top of SplashData's "Worst Passwords of 2013".

When you have to know you sound your best.

Rohde&Schwarz offers the right mix for the development of top-class, professional audio equipment and systems:

- The high-end R&S®UPV audio analyzer delivers highest accuracy, resolution and dynamic range when measuring frequency response, distortion, FFT and other characteristics
- A wide variety of digital interfaces ensures maximum flexibility, even for mixed analog/digital applications
- The integrated PC makes for an extremely compact solution

Our local audio experts in over 70 countries are standing by to provide you with in-depth advice. Find out more about our products at www.rohde-schwarz.com/ad/pro-audio.

From professional audio to automotive: **25 years of audio analysis with Rohde&Schwarz.**

ROHDE&SCHWARZ

Micron preps Italian job cuts

By Peter Clarke

MICRON TECHNOLOGY INC. (Boise, Idaho) is set to cut about 420 jobs out of more than 1,000 in its Italian operation, according to local reports.

Italian unions started to protests about possible job cuts in September 2013. The protests came shortly after the sale of Micron's Avezzano wafer fab to LFoundry GmbH in the middle of 2013 and after Micron's acquisition of Japan's Elpida Memory Inc. in July 2013. It is reported that the cuts are part of a 5 percent job reduction plan announced in August 2013.

Micron's level of staffing in Italy is largely a result of its acquisition of memory company Numonyx NV in May 2010. Numonyx had been a joint venture between Intel and STMicroelectronics and therefore brought a lot of former ST employees into Micron at sites in at Agrate Brianza (Milan), Arzano (Naples), Catania and Avezzano.

According to an Evertiq report, which referenced Italian Ansa as its source the job cuts are set to be 223 in Agrate Brianza; 128 in Catania, 53 in Naples and 17 in Avezzano.

Micron benefited from strengthening memory chip prices in 2013 and swung back into profit. The company made a net income of $358 million on sales revenues of $4.04 billion in its first fiscal quarter of 2014, which ended on Nov. 28, 2013.

The Micron cuts appear to be part of a trend across the semiconductor industry as chip companies return to profit after the global economic collapse post-2008. Several companies including, Intel, Texas Instruments and Renesas Electronics are continuing to cut their workforce as they seek to re-align themselves to changing markets.

Micron Technology said it is in discussions with the Italian government and trade unions over job cuts, however, those discussion also appear to focus on whether Micron will pay sacked workers severance payments or not.

The company says it wants to move support closer to manufacturing sites and R&D centers that are now in United States and Asia, and that this is the purpose of a reorganization plan announced internally by Micron in August 2013. The action is expected to reduce Micron's global work force by less than 5 percent through the end of fiscal 2014.

In 2013 Micron sold its wafer fab in Avezzano, Italy to LFoundry GmbH although much of its employment at multiple sites around Italy results from its acquisition of memory company Numonyx NV in 2010. The reducing significance of NOR memory and Micron's dropping of phase-change memory products could also have had a bearing on its Italian job cuts.

The workforce is being reduced through a combination of natural attrition, voluntary redundancy and job cuts, the company said in a statement. It added that it is being done so that Micron has resources in the right places to best address customer needs and maintain competitiveness.

A spokesperson for Micron said the company isn't discussing specifics per site but did not deny previous estimates of about 420 jobs going in Italy.

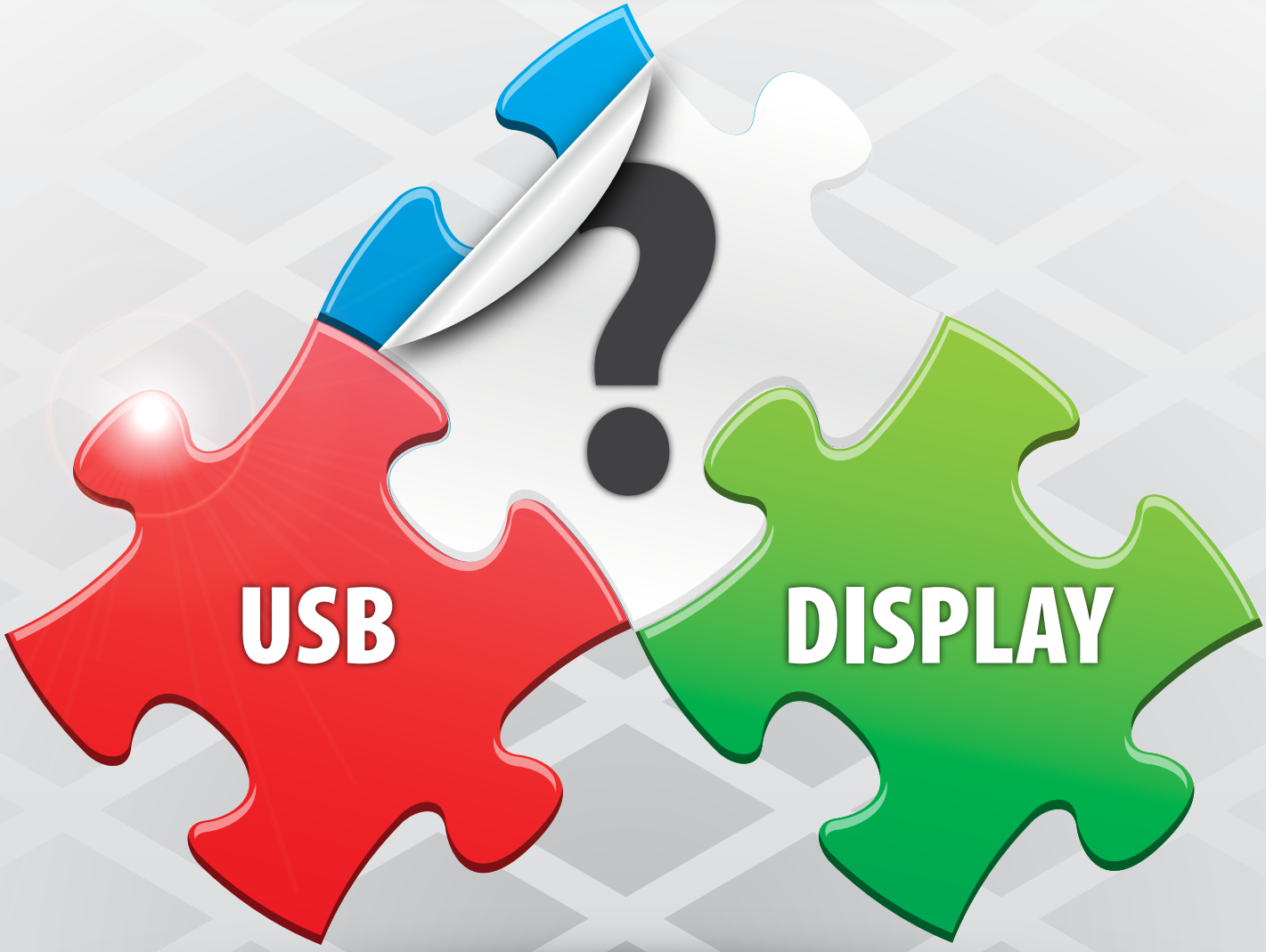
"Micron's restructuring plan in Italy is aimed at aligning Micron's workforce to its business needs while continuing to leverage the contribution of key Italy-based teams working on current product and technology that do not require proximity with manufacturing sites and customer headquarters." the spokesperson said in email correspondence with EE Times Europe.

The spokesperson added that Micron will work through formal collective layoffs procedures but that it could not give information on the support measures for employees being forced to leave the company as they are the subject of the discussions with trades unions and the Italian Ministry of Economic Development. Support measures would conventionally include severance payments and outplacement services to help workers find alternative jobs.

FTDI Chip

DESIGN MADE EASY

PUZZLED?



Visit us at **Embedded World 2014, Stand 328** in **Hall 4A** to discover FTDI's latest solutions to your design puzzles, featuring our leadership USB solutions, multi-award winning EVE display solutions plus…?

WINNER beea 2013 british engineering excellence awards

Elektra 2013 WINNER

@FTDIChip

www.ftdichip.com

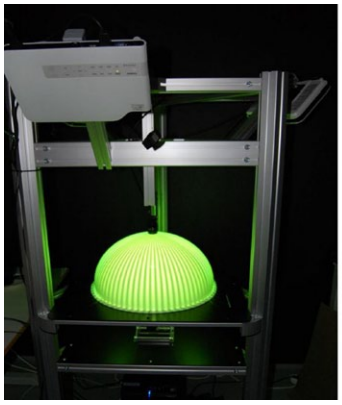
Finnish start-up automates optical inspection for highly reflective objects

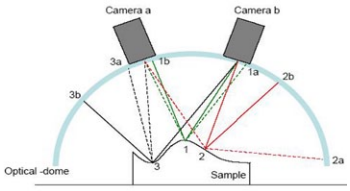
By Julien Happich

A SPIN-OFF FROM the VTT Technical Research Centre of Finland, Helmee Imaging Ltd has developed a 3D machine vision system designed to accelerate the quality control of glossy and highly reflective objects.

While camera systems with projected patterns and 3D image reconstruction are often used in the manufacturing industry for the inspection of mat objects, so far highly reflective objects could only be inspected manually, and sometimes quite approximately. This is an issue for many metal or ceramic products with coated or polished surfaces, such as tableware, faucets, artificial joints, optical components or bearings to name a few.

Based on a combination of structured lighting and stereo imaging, the system measures how the surface distorts predetermined illumination patterns, in place of traditional surface imaging. What's more, it is capable of simultaneous measurement of the object's surface quality and 3D shape, with a typical spatial resolution of 0.1mm (in X-Y) and down to 1µm in the Z-direction according to Helmee Imaging's CEO, Matti Saarinen who shared more technical specifications with EE Times Europe. This gives plenty of resolution to identify even the smallest bumps or cracks. The announced scan rate is around one second per part.





Left, a prototype showing the three illumination sources, the translucent dome with projected patterns, and one camera mounted on top of it. On the right, reconstructing the object's surface tthrough the pattern's light rays reflected by the object.

The patent-pending system is based on structural lighting and stereo calculation, with RGB lasers driven through micro-projectors to generate the illumination patterns and two to three cameras that record how these patterns behave on the object's surface. Because the objects being inspected are highly reflective, the patterns are not directly projected onto the objects surface, but instead onto a semi-transparent optical dome covering the object. The dome bends the light rays and also diffuses them a bit.

"Basically we create 80 million triangles on the object's surface. Two points of a triangle are known, the camera and the projector-dome point. Using these points we are able to calculate the surface point of the object and integrate the whole surface and 3D-shape of the object" explained Saarinen.

"The algorithm that calculates the object's properties from tens of images is compute-intensive. But then we can obtain reference images that can be used for actual inspection algorithms (contours, blobs, thresholds, texture analysis, etc.)" he added.

So when asked if there was any reflection artefacts to be removed digitally through computation, Saarinen answered logically "In fact, we don't try to remove any artefacts because the system works best on mirror-like surfaces, and the more the object reflects light, the better".

There are two major parameters that need to be controlled with this optical inspection system, the dome's transparency and transmittance which we can vary from 30 to 50% depending on the dome used (material and size), and the pattern's resolution. These are parameters that would be set with a reference sample, to optimize the inspection in the production flow.

Helmee Imaging is already working with a German tableware manufacturer whose products come with a highly reflective glazing, but in principle, the system could find many other industrial applications.

Cree beats LED efficiency benchmark

By Paul Buckley

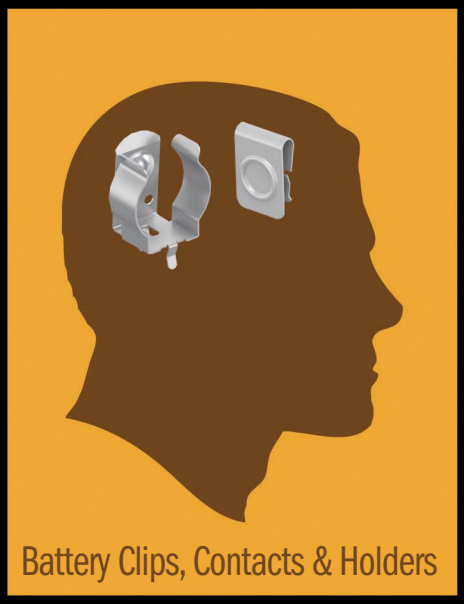
CREE, INC. IS CLAIMING to have raised the performance bar with the demonstration of the first 200-lumen-per-watt (LPW) LED concept luminaire, which is more than twice the efficiency of the best linear fluorescent luminaires. The latest Department of Energy (DoE) projections had estimated that this level of luminaire efficiency would not occur until after 2020.

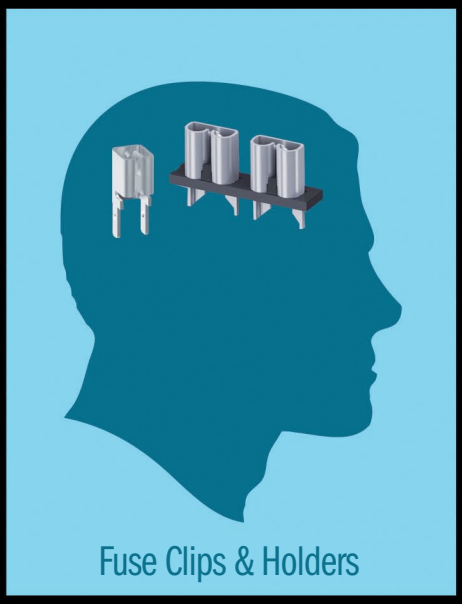
The 3,200-lumen concept luminaire delivered greater than 200 LPW at 80 CRI at thermal equilibrium while remaining within the ANSI color specification for 3000 K. The innovations behind the concept luminaire will enable Cree to deliver increased performance in LED luminaire applications at a lower cost to accelerate LED adoption.

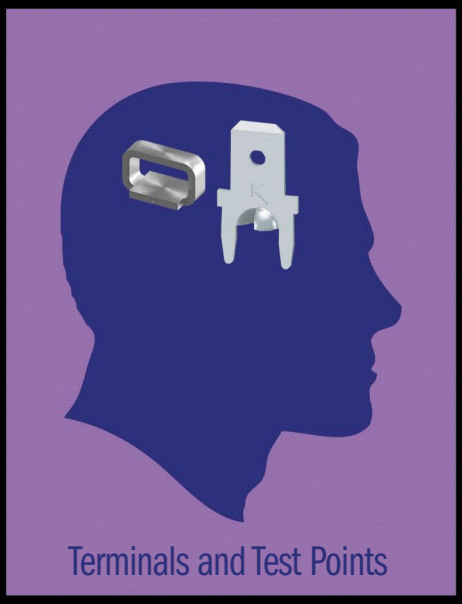
"Demonstrating the industry's first 200-lumen-per-watt luminaire once again illustrates Cree's leadership in LED lighting," said Norbert Hiller, Cree executive vice president, lighting. "The innovation required to achieve this record performance will usher in a new era of increased performance, quality and affordability for our LED lighting customers."

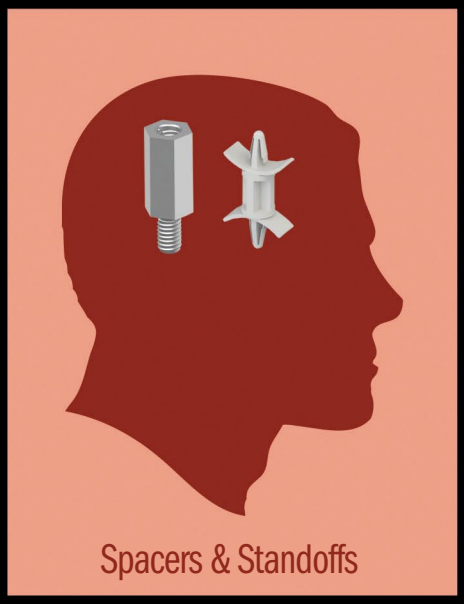
THINK™

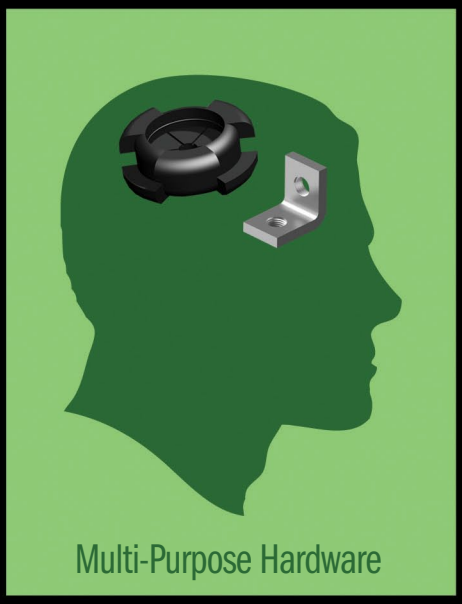
INTERCONNECT COMPONENTS & HARDWARE











IT'S WHAT'S ON THE INSIDE THAT COUNTS

KEYSTONE®
ELECTRONICS CORP.

www.keyelco.com • (718) 956-8900 • (800) 221-5510

Manufacturers' top tips to cost-effective 3D IC production

By Julien Happich

UNDER THE MOTTO "Application Ready", this year's 3D TSV Summit was very much focused on how to make 3D IC design an attractive proposition not only for very demanding niche applications, but a cost-efficient one for chips in everyday consumer electronics. Hence the debates on Grenoble's Minatec campus were all about figuring out ways to slash manufacturing costs in what turns out to be quite a process-intensive approach to miniaturization.

Stacking multiple dies together or connecting them via an interposer, the so-called more-than-moore approach to higher performance devices, relies heavily on Through Silicon Vias (TSV) interconnects. These involves extra material deposition steps for the vias to be etched and filled (the hot topic of last year's 3D TSV Summit), wafer handling and thinning and then revealing the TSVs through selective etching. A final Chemical Mechanical Planarization (CMP) step will open up the isolated vias and prepare the wafer to receive micro-bumps on top of the TSVs, so that another prepared wafer can be stacked on top of it (full wafer-to-wafer stacking) or alternatively, only know-good dies.

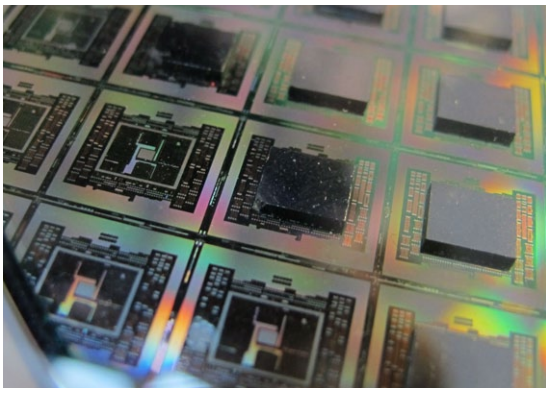
"The choice between the reconstituted wafer approach (assembled of know-good dies only) and the full wafer-to-wafer approach will very much depend on the final die size and the associated costs of managing yield" told me one of the exhibitors. Usually the smaller the die and the higher the yield, the more cost-efficient it becomes to perform full wafer-to-wafer stacking, effectively skipping a few process steps.

All these processes and assembly steps come on top of the normal IC manufacture, hence the cost-benefits are not always clear, especially in the consumer market where you want a thinner tablet year-on-year but you're not really fussed about having "3D IC inside". You just want it cheaper, or get more performance out of the same price.

Among the keynote speakers, there were many IC manufacturers and process equipment vendors, all here to demonstrate their readiness for the next killer app, or rather, trying to convince device makers that all the industry would benefit from pushing 3D TSV technology straight into the mass market. Yet, the killer app that would really pull 3D TSVs globally was not clearly identified, maybe integrated MEMS sensors in wearable electronics or those taking part in tantalizing IoT market projections, hinted Mark Stromberg, principal analyst at Gartner.

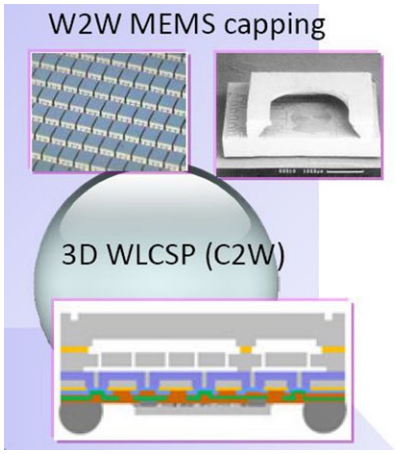
What can we learn from MEMS?

The debates started with MEMS, with fairly relaxed design rules and where TSVs are comparatively easy to integrate. Because often MEMS sensors need to physically interact with their environment, the packaging has a direct impact on performance, it must be specific to each MEMS application (hermetically vacuum sealed at die level, or with a damping gas, sometimes with a diaphragm or an opening, sometimes requiring an optical window). In this context, TSVs are an enabler explained Dr. Eric Mounier, Co-founder of market research company Yole Développement. Currently, the packaging is often large even if the MEMS die is small, Mounier noted, and the MEMS packaging assembly, test and calibration accounts for nearly 35% to 60% of a MEMS module's total cost. In that case, TSVs can not only drive package standardization to decrease overall costs, they enable compact arrays, for example by removing wire-bonds or taking connections to the back of the die. "If you need a well-controlled atmosphere with a round gasket between the MEMS active part and the cap, then TSVs provide back-side access and eliminate leakage issues", said Stephane Renard, CTO and co-founder of Tronics. "TSVs can simplify the MEMS' reliability and architecture for better protection" he added.



Cea-Leti's stacked known-good-dies on a wafer.

"TSVs are not for everyone", commented Ian Rutherford, MEMS Product Marketing & Business Line Manager at X-Fab. "We need to have a toolbox ready, but it will not make or break for all businesses. Not all TSV processes are cheap, so you need to have the right trade-off between TSV use and device-shrink", Rutherford added. Rutherford also noted that biomedical applications could drive more TSVs in 3D IC packaging, with hermetically sealed CMOS devices used in implantable electronics, package biocompatibility is key.



On ASE's roadmap: thin film MEMS capping, wafer-to-wafer metal bonding and sealing, C2W and 3D WLP ToolBox "standardization".

"Often, people focus on the mechanical sensor structure, with a lot of processes inside the cap for the insulation, the hermeticity. But using TSVs, you can replace some of the processes, sometimes, overall manufacture is simplified and there will be some economy made", Renard clarified.

As for testing the 3D IC MEMS devices, technology manager at STMicroelectronics, Marco Ferrera said that right now, TSVs are not adding complexity. "You just add series resistance to capacitors" he said.

Christophe Zinck, Application Engineering Manager at ASE Group, an Outsourced Semiconductor Assembly and Test (OSAT) service provider, observed that packaging alone accounts for 20 to 60% of the MEMS/Sensor device BOM, but it is also a key part of the MEMS function and design as it can create additional value. "To reduce packaging costs, we need to manage the applica-

tion specificity of MEMS collectively, at a wafer-level process instead of packaging individual dies", Zinck explained, mentioning ASE's new 3D WLP tool box for standardized operations in complex MEMS architecture.

"What's more, the standardization allows for volume production, enabling second sourcing and cost efficiency through technology sharing" concluded Zinck. Since 2013, the company is in volume production for full wafer-level packaged MEMSs using TSVs for chip-to-wafer assembly. The tool box presented by ASE includes wafer-level capping, wafer-to-wafer or chip-to-wafer assembly, wafer moulding, TSVs, and wafer-level redistribution and balling. On its 2015 roadmap, the OSAT plans thin film MEMS capping, wafer-to-wafer metal bonding and sealing, WLCSP of any MEMS connected on top of any ASIC using TSVs, or on top of active interposers embedding on or several ASICs.

Who should manufacture TSVs?

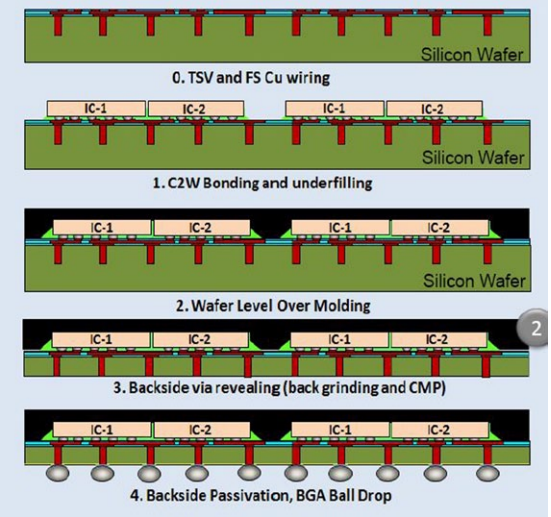
In non-MEMS ICs, TSVs must shrink too, because going to the next generation node does not necessarily make sense if your TSV keep-out zone takes too much premium silicon. The processes require equipment sets typically seen in wafer fabs, hence TSV integration could be done by the foundries, but also to some extent by OSAT service providers (Outsourced Semiconductor Assembly and Test). Some printed circuit board (PCB) makers are also looking at embedded dies into PCB substrates, in the form of active interposers for 2.5D integration.

Putting aside the current economic climate which could limit TSV ramp up in the near term, Gartner's Mark Stromberg expects the TSV market to faces capital cost issues that will limit the number of companies able to implement this technology. This is due mainly to the additional capital and material costs, together with more process steps. "As we move to the 10nm node, TSV technology will be require for system design", Stromberg said, noting that the cap-ex requirements will reduce competition with only the top Integrated Device Manufacturers (IDMs), foundries and top tier Semiconductor Assembly and Test Services (SATS) able to compete.

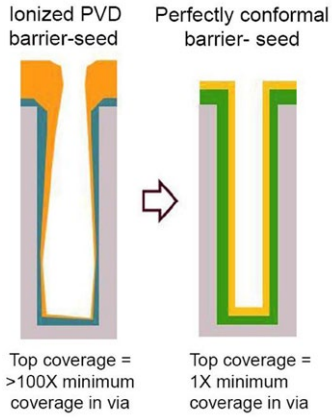
Dr. Miekei Ieong, Vice President of TSMC EMEA, presented his company's CoWoS (Chip-on-Wafer-on-Substrate) services relying on through silicon via technology to integrate multiple chips into one single package using a submicron scale silicon interposer. The company offers homogeneous CoWoS in production but says it has already demonstrated heterogeneous CoWoS. A 512-bit Wide I/O DRAM test chip was operated at 200MHz and even overdriven up to 285MHz with full operations. "Our 1024-bit TSMC CoWoS DRAM was driven to 1GHz, supporting a bandwidth up to 128GB/s", said Ieong, with plans to tape-out daisy-chained 6 top dices high bandwidth memory by the last quarter of this year. For the purpose of larger CoWoS, TSMC has also demonstrated silicon interposers up to 26x48mm on a substrate size of 60x60mm. The company says it is ready for stacking memory chips on 28nm logic, and it has characterized TSV design rules for customer's test vehicle design and functional verification.

Global Foundries' Michael Thiele, Responsible for Packaging R&D, exposed his company's readiness with TSV-capable lines installed in Malta, New York, with TSV integration characterized for 20nm devices and 14nm under way. The company has a 300mm TSV line installed in Singapore for Si interposer fabrication and is characterizing TSV integration into 28nm devices in Dresden, Germany.

"Before considering a 2.5D product tape-out, customers expect the foundry to come up with system level qualification data from a representative test vehicle", stated Thiele who then unveiled Global Foundries' dual approach, using external test vehicles with shared R&D but also creating its own internal test vehicle. Hence, the company develops interposers and micro-pillar interconnects both at OSAT partners and in-house. But Thiele stressed that yield loss, late in the supply chain, could stop the adoption of the technology, especially if there is not a clear yield ownership in the supply chain. Cost reduction at key process steps such as TSV drill and fill, temporary wafer bonding and de-bonding, TSV reveal, is another must for 3D ICs to make it to the mass market.



IME carrier-less process flow using wafer-level over moulding.



Electroless Cu conformal barrier-seed deposition technique could slash 50% of the process costs associated to TSVs, compared to using I-PVD.

Cutting on materials and process costs

Director for Industry Development at the A-star Institute of Microelectronics (IME), Surya Bhattacharya sees back-end of line (BEOL) and thin wafer handling (including temporary wafer bonding and de-bonding - TBDB) as a real cost-issue for 3D IC components. These added processes alone amount to around 50% of the total final component cost, he estimates.

Bhattacharya's drastic cost-cutting approach is to rely on low-cost multi-level copper redistribution layers (Cu RDL) in thick photo-dielectrics (polymers), requiring fewer processing steps, no CMP steps and no dielectric etch. The lab has developed photoresist materials and has demonstrated Cu RDL fabrication for different line widths and spacing, at 5/5µm and 3/3µm, with three levels of metal. The copper redistribution layer with a line width of 3µm and a polymer pitch of 6µm was demonstrated to support 20Gbit/s signals across a 10mm interconnect, versus 7.5Gbit/s for the costlier 1µm wide copper line in a damascene structure, at a 4µm pitch. The lab is also experimenting with 2µm thin copper lines in polymer, and targets 0.5µm line width by 2016 to stay competitive with very fine TSVs.

On top of this approach, Bhattacharya exposed a carrier-less technique to avoid or reduce the TBDB steps, whereby after chip-to-wafer bonding and underfilling, the full wafer is over moulded and flipped for back-side via reveal, directly maintained by the epoxy mould compound.

Altogether, removing the back end of line (BEOL) Cu RDL deposition processes and the TBDB steps, Bhattacharya roughly estimates that wafer-level processing costs could be slashed by 40% to 50%.

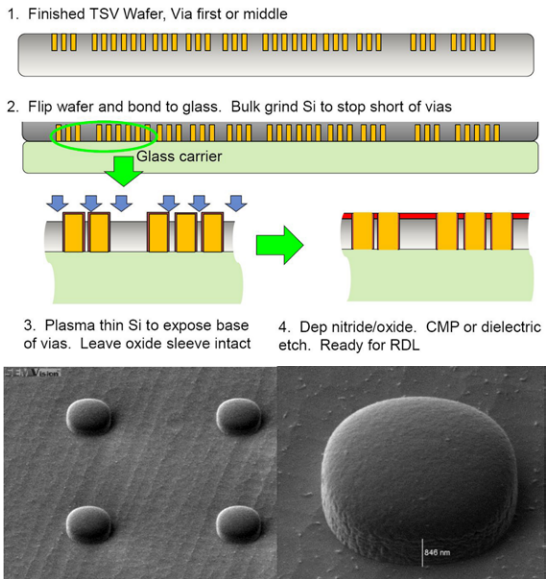
"Moving from a copper and damascene structure to a copper redistribution layer into an organic layer can cut 15 to 20% of your processing costs" concurred Sesh Ramaswami, Managing Director for Packaging Technologies and Advanced Product Technology Development for the Silicon Systems Group at Applied Materials.

One way to reduce the lengthy and costly CMP process is to fine tune the growth of the via and the subsequent via reveal step so as to stop the etch right when the vias are revealed, with only little material to remove during the Chemical Mechanical Planarization to open the vias and trim them down to the wafer surface.

Director of Process Technology at Tel Nexx, Steve Golovato exposed a cost of ownership analysis for high aspect ratio TSVs built up using conformal barrier-seed deposition. Using this particular TSV filling, Golovato says the industry could contain CMP costs compared to using Ionized PVD barrier-seed deposition which can create a material overburden atop the via (and requires more CMP to be removed). More interestingly, Golovato expects his company's electroless Cu conformal barrier-seed deposition technique to be up to 50% lower cost than I-PVD for TSVs with an aspect ratio of 20, at wafer-level.

Precise via reveal

Vice President of Marketing at SPTS, David Butler aims to minimize the CMP step by optimizing the via reveal step. SPTS has developed Deep Reactive-Ion Etching (DRIE) equipment capable of etching at rates up to 4.7µm/mn (with a uniformity of ±3.0%). That is twice as fast as competitors, according to Butler, and up to four times faster than wet-etch approaches. Another important advance is SPTS's ReVia in-situ end-point detection. Based on IR interferometry, this automated optical analysis feature looks at groups of vias across the surface being etched and is able stop the via-reveal process when via tips emerge, only 1µm above the surface. This avoids costly rework operations, typically more etch if not all the vias are revealed, or yield issues if the wafer is etched beyond usability. The company also implements dual source tuning for etching, which allows its equipment to tightly control etching across the wafer, radially. This can be used to compensate for wafer thickness variations after the wafer thinning step. Last, the company introduced its Rapier XE, its next generation equipment capable of etch rates up to 9µm/mn entirely tuneable radially and promising four fold productivity gains.



SPTS's via-reveal process implementing ReVia in-situ end-point detection.

Critical Recording in Any Arena

When You Can't Afford to Miss a Beat!

Introducing Pentek's expanded line of Talon® COTS, rugged, portable and lab-based recorders. Built to capture wideband SIGINT, radar and communication signals right out-of-the-box:

- Analog RF/IF, 10 GbE, LVDS, sFPDP solutions
- Real-time sustained recording to 4 GB/sec
- Recording and playback operation
- Analog signal bandwidths to 1.6 GHz
- Shock and vibration resistant Solid State Drives
- GPS time and position stamping
- Hot-swappable storage to Windows® NTFS RAIDs
- Remote operation & multi-system synchronization
- SystemFlow® API & GUI with Signal Analyzer
- Complete documentation & lifetime support

Pentek's rugged turn-key recorders are built and tested for fast, reliable and secure operation in your environment.

Call 201-818-5900 or go to www.pentek.com/go/eettalon for your FREE *High-Speed Recording Systems Handbook* and *Talon Recording Systems Catalog*.

TALON

PENTEK
Setting the Standard for Digital Signal Processing

Pentek, Inc., One Park Way, Upper Saddle River, NJ 07458 • Phone: 201.818.5900 • Fax: 201.818.5904 • e-mail:info@pentek.com • www.pentek.com

E-whiskers could turn robots hairy

By Julien happich

BIO-INSPIRED ROBOTICS often yields interesting new approaches to locomotion, sensing and obstacle avoidance. Even the faintest optical and tactile feedback sources gathered by the most humble insects will efficiently coordinate their moves at striking speed, without relying on a lot of processing, at least much less than what engineers tend to pack into your typical autonomous robot. That is because their locomotive action is often directly coupled to sensory feedback, with no such thing as central processing or environment data analytics from multiple data sources.

A lot of insects and certain mammals have whiskers, in effect hair-like tactile sensors that help them monitor wind and navigate around obstacles in tight spaces. This was a new source of inspiration for researchers at Berkeley Lab who have recently demonstrated electronic whiskers (e-whiskers) based on a mixture of carbon nanotubes (CNT) and silver nanoparticles coated on flexible and high aspect-ratio polymer fibres.

"In our tests, these whiskers were 10 times more sensitive to pressure than all previously reported capacitive or resistive pressure sensors" stated lead researcher Ali Javey of Berkeley Lab's Materials Sciences Division in a press release.

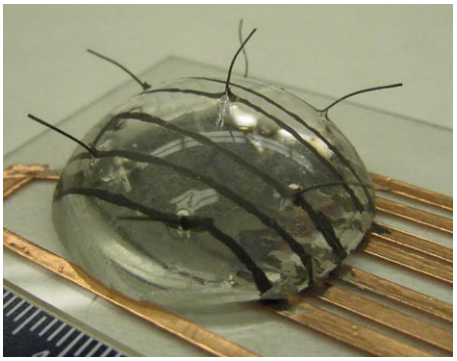
The results were published in the Proceedings of the National Academy of Sciences, in a paper titled "Highly sensitive electronic whiskers based on patterned carbon nanotube and silver nanoparticle composite films".

The feat doesn't stop here, by changing the composition ratio of the nanoparticles and the nanotubes, the researchers could observe a minimal resistance change from around 10 % up to a maximum resistance change of around 260% when a 2.4 % strained was applied.

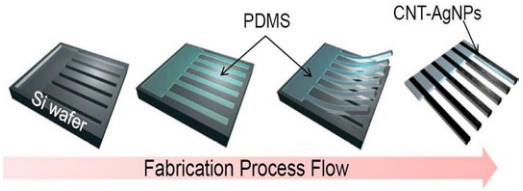
"To monitor the resistivity change, the e-whisker arrays were connected to a computer as a proof-of-concept. The tuneable range we checked was resistivity, in the order of 100x, and the sensitivity in the order of 26x" clarified Kuniharu Takei, Assistant professor in the Department of Physics and Electronics of the Osaka Prefecture University and lead author of the paper.

Whilst the nanotubes form a conductive network matrix with excellent bendability, the silver nanoparticles enhance the conductivity of the coated fibres and give them high mechanical strain sensitivity, responding to pressures as low as 1Pa with high sensitivity (around 8%).

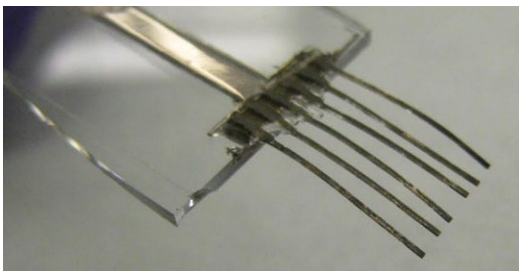
The strain sensitivity is enhanced by increasing the weight content of the silver nanoparticles (AgNPs), explains the paper, as the distance change between the AgNPs in the CNT–AgNP composite film directly affects the electron tunnelling probability through neighbouring conductive nanoparticles. What's more, compressive and tensile stresses induce smaller and larger gaps between AgNPs, respectively, compared with the relaxed state, which makes the e-whisker able to detect the direction of bending.



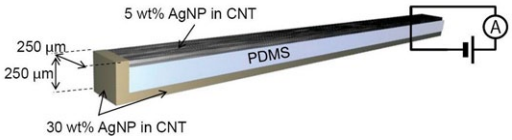
An array of seven vertically placed e-whiskers for wind mapping in 3D.



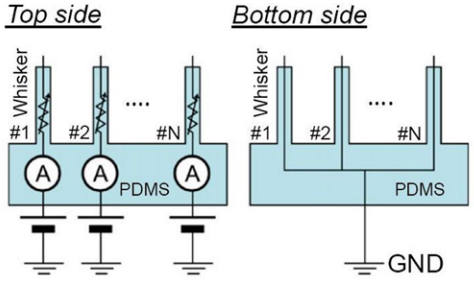
Creating thin flexible whiskers to be coated



The fully fabricated e-whisker array.



An e-whisker with 5 and 30 weight% of AgNP composite lines patterned on the top and bottom surfaces of the PDMS fibre.



Circuit diagrams of the e-whiskers for resistivity sensing under strain.

The e-whiskers are built by first imprinting a polymer substrate (polydimethylsiloxane) into a high aspect ratio fibre (this could be done by printing or painting, but in the lab it was patterned using a micro-etched silicon mould with trenches 15mm long, 250xµm wide and 250µm deep), then coating the fibre with the CNT–AgNP composite and curing it.

Although the researchers used a polymer substrate for the whisker structure, they could shrink them down using MEMS processes if necessary.

When asked if this research would lead to a form of hairy skin implementation for robotic applications, Takei told us

"We are planning to demonstrate more application in near future. In this paper, we demonstrated a weak wind flow three-dimensional mapping as the first proof-of-concept".

"The results exhibited that the e-whisker array can detect a very weak wind flow (around 1m/s) that is like the wind you can generate by shaking your hand. We are not sure the human skin sensitivity, but we believe that the e-whisker has similar sensitivity to the human skin (hair)".

Such e-whiskers could be used to offer immediate tactile sensing for the spatial mapping of nearby objects, they could also lead to wearable sensors for measuring heartbeat and pulse rate. This research was supported by the Defense Advanced Research Projects Agency.

How to design an efficient MEMS-based pico-projector

By Carlos Lopez

OVER THE LAST FEW YEARS, millions of products incorporating pico projection have shipped, and developers are innovating new applications for this rapidly growing display category. Applications for pico projection include near eye display, interactive digital signage, head mounted display, ultra short throw TV, standalone portable projectors and embedded projection in smartphones, tablets and laptops as illustrated in figure 1. New uses continue to emerge; for example, imagine a thermostat using an on-demand display with interactive touch.

After a developer formulates a great idea on how to use pico technology in their application, they are faced with several factors to be considered. As noted in the block diagram of figure 2, these include selection of the display technology, light source, optics and software. A well-chosen selection of these variables can result in an end product with optimal power and light efficiency capable of delivering bright, high quality images.

So what are the considerations for designing a pico projector that will maximize power efficiency and yet deliver large, bright and crisp images? We will next address each one of these variables.

Imaging technology

Designers are faced with imaging technology options. Selecting the imaging device that most efficiently utilizes light is most important. There are two different optical path architectures in the market place: transmissive and reflective. Most pico

Fig. 1: A smartphone embedding a DLP Pico MEMS projector.

projectors use Texas Instruments' DLP Pico technology, which is reflective. It utilizes an array of microscopic mirrors to create the image which utilizes reflection to maximize light efficiency – see figure 3.

In contrast, other technologies employ transmissive or a hybrid of transmissive and reflective systems, requiring polarization of light to control the intensity of each pixel – both of which incur significance light loss thus reducing optical efficiency.

Another consideration for the selection of the display tech-

Carlos Lopez is the Strategic Marketing Manager for Pico Products at Texas Instruments – www.ti.com - www.dlp.com

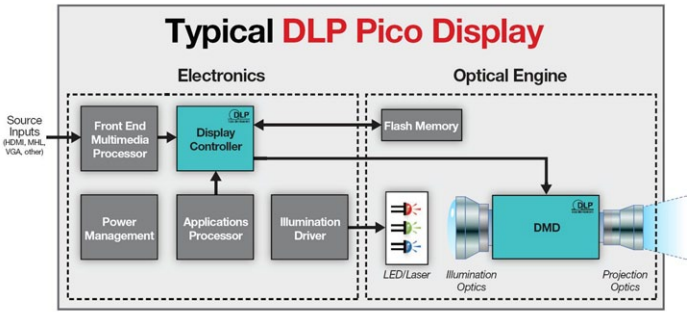


Fig. 2: A typical DLP display.

nology is the ability to tilt the micromirrors. DLP technology uses a microelectromechanical system (MEMS) superstructure to tilt the micromirrors toward or away from the optical path to create each display pixel see figure 4. Tilting mirrors allows the device to more efficiently capture light without worrying about polarization, resulting in higher brightness at lower system power.

Switching speed is another consideration for the selection of the display technology. For this case, the developer should consider a technology that can switch as fast as possible as this will allow the design to quickly control the light path and colour sources for the system. The faster switching speed not only provides better colours but also better image quality as there is less motion blur, resulting in a better viewing experience. As a reference, DLP Pico devices can switch each pixel / micromirror at up to 3000 times per second – making it the fastest solution available.

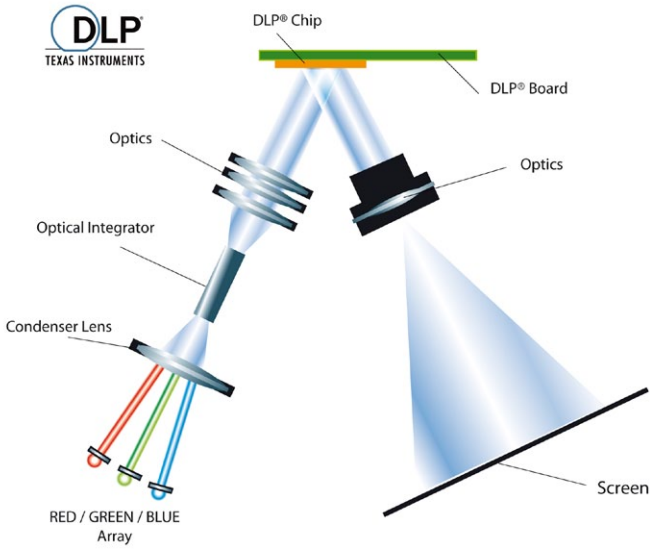


Fig. 3: Typical DLP pico display system.

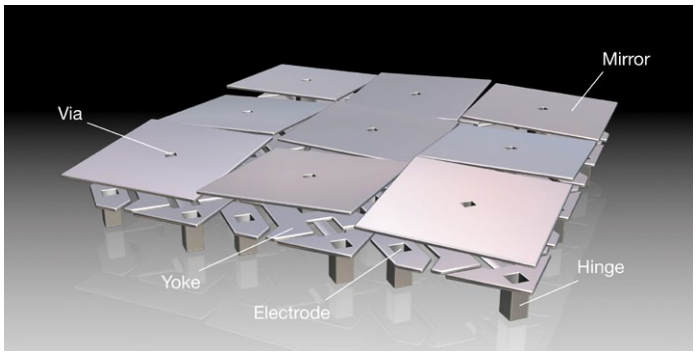


Fig. 4: DLP MEMs mirror array.

Light sources

When considering light sources, there are three primary options: lamps, LEDs and lasers. Lamps are commonly used in conference room and home theater projectors, where high lumens levels (1000L to 2000L) are required.

For pico projectors, the most common light sources used are LEDs, specifically individual red, green and blue LEDs. The benefit of LEDs is that they provide the best tradeoff between cost, size, brightness (lumens per watt) and reliability.

Laser illumination has the benefit of high flux density (lumens) from a small volume, and highly saturated colors. Laser illumination is an attractive option for pico projector applications requiring 100s of lumens and where the cost of lasers can be accommodated.

Optical engines

Creating an Optical Engine design involves making numerous trade-offs, each of which has an effect on size, cost, and optical efficiency. DLP has developed a mature network of Original Equipment Manufacturers (OEMs) that can supply fully tested, off-the-shelf (OTS) designs.

Using an OTS design is the fastest way to get to market. If there isn't an OTS design that meets a developer's needs, DLPs OEMs are fully capable of creating semi-custom or custom designs such as shown in figure 5.

Typical DLP optical engine

For most pico projectors, achieving efficiencies for battery operation is critical. An important part of managing power is by utilizing algorithms to analyze the image on a frame-by-frame basis. By doing so, the intensity of each LED can be optimized for each frame. For example, a blue sky will not need much red

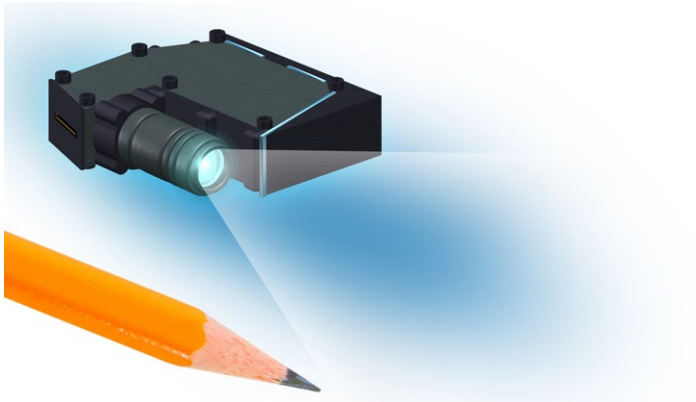


Fig. 5: A compact off-the-shelf DLP optical engine.

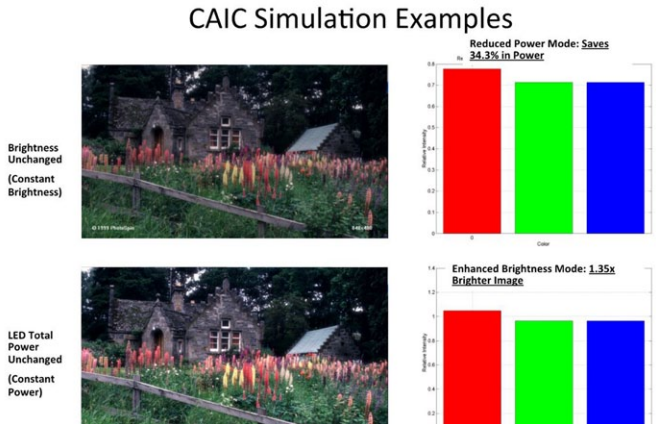


Fig. 6: Effects of the content-adaptive illumination control algorithm.

and green, while a red sunset won't need much blue and green. This can provide a savings in power consumption of up to 50% without compromising image quality or brightness - and in many cases actually improving both. TI's DLP IntelliBright suite of algorithms can be tuned by the device manufacturer to intelligently provide the optimal brightness, power consumption and contrast according to the specific usage of the device.

The first algorithm in the suite is called Content-Adaptive Illumination Control (CAIC). This algorithm operates by adjusting red, green and blue illumination strength on a frame-by-frame basis. The algorithm can be configured to maintain "constant image brightness" (which results in lower power consumption) or to maintain "constant illumination power" (which results in higher image brightness). This enables developers to select their desired amount of brightness boost versus power savings.

The second algorithm is Local Area Brightness Boost (LABB) which identifies 'dark areas' and 'light areas' within a frame. The gain is then adjusted for the darker parts of the image to give a more balanced realistic picture.

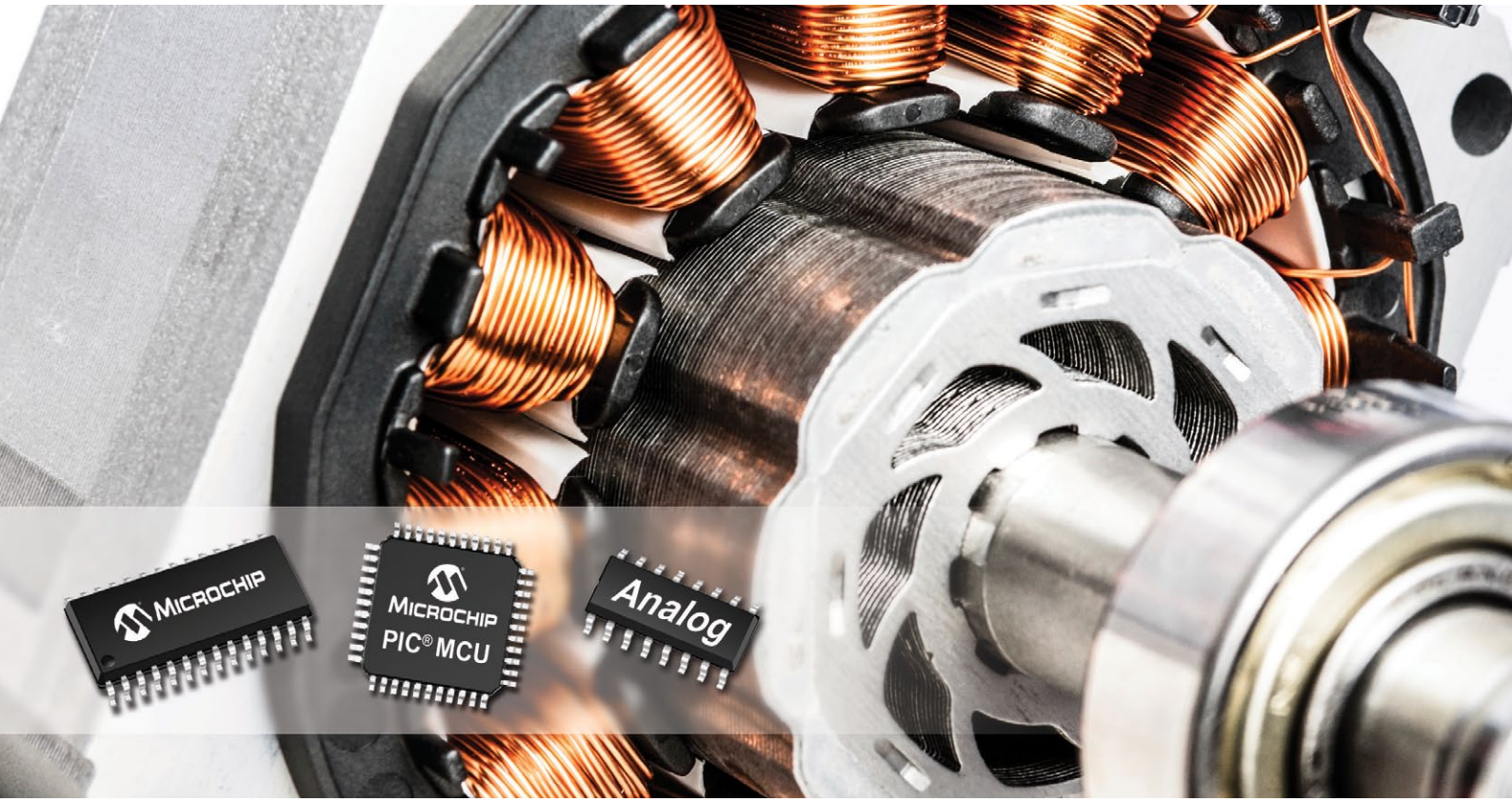
Furthermore, adding an ambient light sensor to a pico-projector enables the algorithms to adjust the image brightness to suit varying ambient light conditions. This further maximizes the battery life and optimizes the viewing experience.

Through careful selection of image technology, light source, optics and software implementation, developers can create innovative world-class applications incorporating pico projection.

Fig. 7: Effects of the local area brightness boost algorithm.

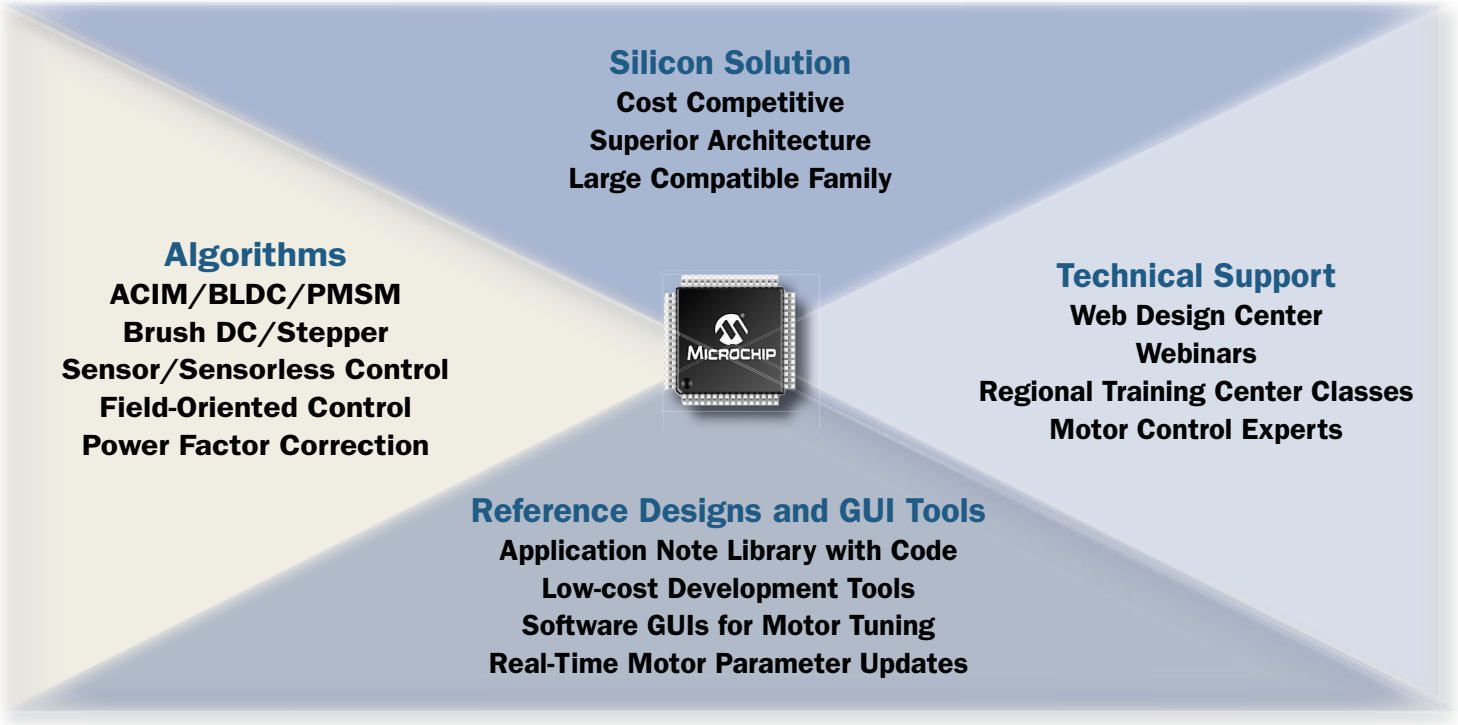
MICROCHIP

Motor Control and Drive Design Solutions



www.microchip.com/motor

Microchip Motor Control and Drive Solutions



Need Design Assistance?

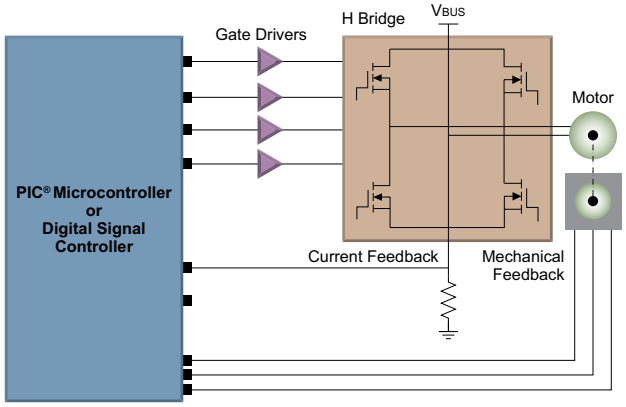
Visit www.microchip.com/partners for a directory of third party consultants and designers that can help with your motor control application.

Table of Contents

Brushed DC Motors

Brushed DC Motor Control

Brushed DC motors are easy to control because speed and torque are proportional to the applied voltage/current. The rotor is heavy due to windings on the armature, more inertia makes it more difficult to start/stop. Heat is generated in windings on the rotor and is more difficult to remove.



Brushed DC Motor Application Notes

Algorithm	App Note
PIC18CXX/PIC16CXXX DC Servomotor Applications	AN8696
Low-Cost Bi-directional Brushed DC Motor Control Using the PIC16F684	AN893
Brushed DC Motor Fundamentals	AN905

Brushed DC Motor Training

Class Title	Language	Recording Date	Duration
Brushed DC Motor Basics	English	09/18/2008	14 min.

Brushed DC Motor Development Tools

F1 BDC Motor Add-On (DM164130-6)

The BDC Motor Add-On is a simple development accessory that plugs directly into the F1 LV Evaluation Platform and incorporates all the components necessary to implement Brushed DC motor control. Key features include two MOSFET half bridge circuits, motor current limit adjustment, debug header, and pin header connector for the motor and power supply.

MTS2916 Dual Full-Bridge Stepper Motor Driver Evaluation Board (ADM00308)

The MTS2916A Dual Full-Bridge Stepper Motor Driver Evaluation Board demonstrates the capabilities of the MTS2916A to control both windings of a bipolar stepper motor. The board also demonstrates the capabilities of controlling two brushed DC motors.

Recommended Products for Brushed DC Motor Control

Device	Pins	Flash KB	SRAM Bytes	EE Bytes	Timer 8/16-bit	Comp	CCP/ ECCP	Motor Control PWM	A/D 10-bit	Quad Enc	UART	SPI/ I²C™
PIC10F322	6	0.896	64	–	2/0	–	–	2	3 ch 8-bit	–	–	–
PIC12F615/PIC16HV615[a]	8	2	64	–	2/1	1	1	–	4 ch	No	–	–
PIC12F752F	8	1.75	64	–	2/1	2	1	–	4 ch 10-bit	–	–	–
PIC16F616/PIC16HV616[a]	14	3.5	128	–	2/1	2	0/1	–	8 ch	No	–	–
PIC16F684	14	3.5	128	256	2/1	2	0/1	–	8 ch	No	–	–
PIC16F1509	20	14	512	–	2/1	2	–	4	12 ch 10-bit	–	1	1
PIC16F1783	28	7	512	256	4/1	3	2	–	11 ch 12-bit	–	1	1
PIC16F1823	14	3.5	128	256	2/1	2	0/1	–	8	–	1	1
PIC16F1933	28	7	256	256	4/1	2	2/3	–	11	–	1	1
PIC16F1936	28	14	512	256	4/1	2	2/3	–	11	–	1	1
PIC16F1937	40/44	14	512	256	4/1	2	2/3	–	14	–	1	1
PIC16F1939	40/44	28	1024	256	4/1	2	2/3	–	14	–	1	1
PIC18F45K20	40/44	32	1536	256	1/3	2	1/1	–	14	–	1	1
PIC18F46K20	40/44	64	3936	1024	1/3	2	1/1	–	14	–	1	1
PIC18F1330	18/20	8	256	128	0/2	3	–	6	4 ch	No	1	–
PIC18F2431	28	16	768	256	1/3	–	2	6	5 ch	Yes	1	1
PIC18F4431	40/44	16	768	256	1/3	–	2	8	9 ch	Yes	1	1

Note 1: HV device has on-chip shunt regulator.

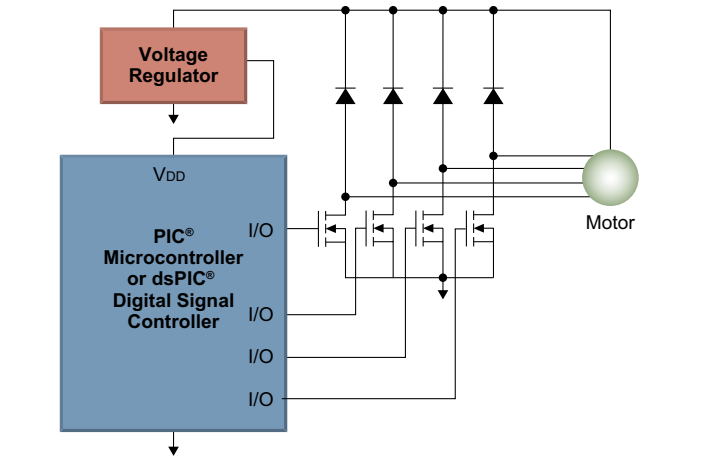
Device	Motor Type	Input Voltage Range (V)	Output Current (mA)	Control Scheme	Temp. Operating Range (°C)	Features	Packages
MTS62C19A	One Bipolar Stepper Motor or Two DC Motors	10.0 to 40.0	750	Direct PWM Input, Current Limit Control, Microstepping	–40 to +105	Overt emperature Protection, Under Voltage Protection, Dual Full Bridge Motor Driver, Microstepping, Pin-compatible with ST L6219	24-pin SOIC
MTS2916A	One Bipolar Stepper Motor or Two DC Motors	10.0 to 40.0	750	Direct PWM Input, Current Limit Control, Microstepping	–40 to +105	Over temperature Protection, Under Voltage Protection, Dual Full Bridge Motor Driver, Microstepping, Pin-compatible with Allegro UDX2916 and A4970	24-pin SOIC

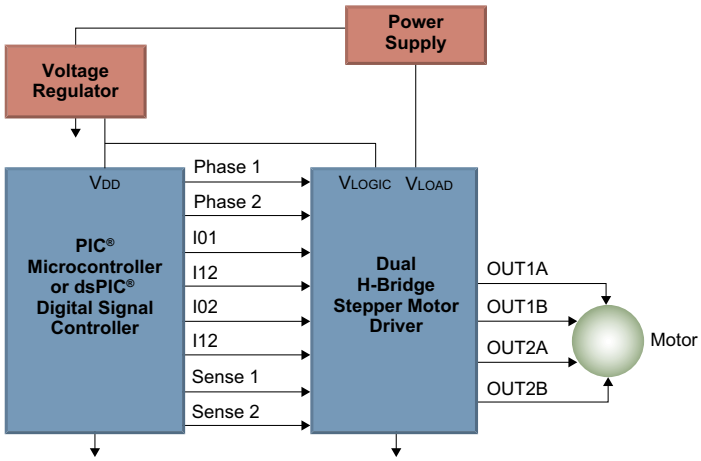
Device	Configuration	Temp. Operating Range (°C)	Peak Output Current (A)	Output Resistance (R_H/R_L) (Max. W @ 25 °C)	Maximum Supply Voltage (V)	Input/Output Delay (t_{D1}, t_{D2}) (ns)	Packages
MCP14700	Dual, Non-inverting	–40 to +125	2	2.5/2.5	5 (V_{DD}), 36 (Boot Pin)	25/25	8-pin SOIC, 8-pin 3 × 3 DFN

Stepper Motors

Stepper Motor Control

Do you need exact position control with great holding torque? If so, then a stepper motor is the best solution. While nearly every MCU or DSC from Microchip can drive a stepper motor, some are better suited for this than others.





Stepper Motor Application Notes

Algorithm	PIC16 Family	PIC18 Family	dsPIC® DSC Family
Full and Half-Stepping	AN906 AN907	–	AN1307
Micro-Stepping	–	AN822	AN1307

Stepper Motor Training

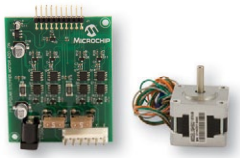
Class Title	Language	Recording Date	Duration
Stepper Motors Part 1: Types of Stepper Motors	English	09/14/2007	19 min.
Stepper Motors Part 2: Stepper Motor Control	English	09/14/2007	17 min.

Stepper Motor Development Tools

F1 Unipolar Motor Add-On for the F1 LV Evaluation Platform (DM164130-8)

The Unipolar Stepper Motor Add-On is a simple development accessory that plugs directly into the F1 LV Evaluation Platform and incorporates all the components necessary to implement Unipolar Stepper Motor control. Key features include four MOSFET drivers motor current limit, debug header, and pin header connector for the motor and power supply.

F1 Bipolar Motor Add-On for the F1LV Evaluation Platform (DM164130-7)



The Bipolar Stepper Motor Add-On is a simple development accessory that plugs directly into the F1 LV Evaluation Platform and incorporates all the components necessary to implement Bipolar Stepper Motor control. Key features include four MOSFET half bridge circuits, motor current limit sense, debug header, and pin header connector for the motor and power supply.

dsPICDEM™ MCSM Development Board (DM330022)
dsPICDEM MCSM Stepper Motor Development Board Kit (DV330021)

This development board is intended for low-voltage (up to 80 volts at 3 amps) 2-phase uni-polar or bi-polar stepper motor (4, 6 or 8 wire) applications. It provides a low-cost system for users to evaluate and develop applications using dsPIC33F motor control DSCs via a Plug-In Module (PIM) or 28-pin SOIC socket. A USB serial interface for RTDM is provided. Feedback support includes current and voltage. Demo software to run motors in open-loop or closed-loop with full or variable micro-stepping is provided. A DMCI/RTDM GUI for controlling step commands, motor parameter input and operation modes is included. The kit includes a stepper motor and a 24-volt power supply. PICkit™ 3 Debug Express, MPLAB® ICD 3 In-Circuit Debugger or REAL ICE™ In-Circuit Emulator is required for programming or debugging operations.

MTS2916A Stepper Driver Evaluation Board (ADM00308)

This evaluation board incorporates features through the implementation of push button switches and a variable speed input potentiometer to exercise a stepper motor in Full-Step, Half-Step, Modified Half-Step and Micro-stepping modes.

Stepper Motors

Recommended Products for Stepper Motor Control

Device	Motor Type	Input Voltage Range (V)	Output Current (mA)	Control Scheme	Temp. Operating Range (°C)	Features	Packages
MTS62C19A	One Bipolar Stepper Motor or Two DC Motors	10.0 to 40.0	750	Direct PWM Input, Current Limit Control, Microstepping	–40 to +105	Over temperature Protection, Under Voltage Protection, Dual Full Bridge Motor Driver, Microstepping, Pin-compatible with ST L6219	24-pin SOIC
MTS2916A	One Bipolar Stepper Motor or Two DC Motors	10.0 to 40.0	750	Direct PWM Input, Current Limit Control, Microstepping	–40 to +105	Over temperature Protection, Under Voltage Protection, Dual Full Bridge Motor Driver, Microstepping, Pin-compatible with Allegro UDX2916 and A4970	24-pin SOIC

Device	Max. Input Voltage (V)	Output Voltage (V)	Output Current (mA)	Junction Temp. Range (°C)	Typical Active Current (µA)	Typical Dropout Voltage @ Max. Iout (mV)	Typical Output Voltage Accuracy (%)	Features	Packages
MCP1754	16	1.8, 2.5, 2.7, 2.8, 2.85, 3.0, 3.3, 3.6, 4.0, 5.0	150	–40 to +125	50	300	±2	70 dB PSRR	5-pin SOT-23, 3-pin SOT-89, 3-pin SOT-223, 8-pin 2 × 3 TDFN

Device	Pins	Flash KB	SRAM Bytes	EE Bytes	Timer 8/16-bit	Comp	CCP/ ECCP	Motor Control PWM	A/D 10-bit	Quad Enc	UART	SPI/ I²C™
PIC16F616/ PIC16HV616(1)	14	3.5	128	–	2/1	2	0/1	–	8 ch	No	–	–
PIC16F684	14	3.5	128	256	2/1	2	0/1	–	8 ch	No	–	–
PIC16F1509	20	14	512	–	2/1	2	–	4	12 ch 10-bit	–	1	1
PIC16F1783	28	7	512	256	4/1	3	2	–	11 ch 12-bit	–	1	1
PIC16F1823	14	3.5	128	256	2/1	2	0/1	–	8	–	1	1
PIC16F1933	28	7	256	256	4/1	2	2/3	–	11	–	1	1
PIC16F1936	28	14	512	256	4/1	2	2/3	–	11	–	1	1
PIC16F1937	40/44	14	512	256	4/1	2	2/3	–	14	–	1	1
PIC16F1939	40/44	28	1024	256	4/1	2	2/3	–	14	–	1	1

Note 1: HV device has on-chip shunt regulator.

Device	Pins	Flash KB	RAM KB	DMA # Ch	Timer 16-bit	Input Capture	Output/Compare/ Standard PWM	Motor Control PWM Ch	QEI	ADC 10-/12-bit* 1.1/0.5 Msps	16-bit DAC	Analog Comparators	CodeGuard™ Security Segments	UART	SPI	I²C™	PMP	RTCC	CAN	Package	Temperature Range***
dsPIC33FJ12MC202	28	12	1	–	3	4	2	6+2 ch	1	1 ADC, 6 ch	–	–	2	1	1	1	–	–	0	SO, SP, ML	I,E
dsPIC33FJ32MC202	28	32	2	–	3	4	2	6+2 ch	1	1 ADC, 6 ch	–	–	2	1	1	1	–	–	0	SO, SP, MM	I,E
dsPIC33FJ32MC302	28	32	4	8	5	4	4	6+2 ch	2	1 ADC, 6 ch	–	2	–	2	2	1	1	1	–	SO, SP, MM	I,E,H
dsPIC33FJ64MC202	28	64	8	8	5	4	4	6+2 ch	2	1 ADC, 6 ch	–	2	–	2	2	1	1	1	–	SO, SP, MM	I,E,H
dsPIC33FJ64MC802	28	64	16	8	5	4	4	6+2 ch	2	1 ADC, 9 ch	–	2	–	2	2	1	1	1	1	SO, SP, MM	I,E,H

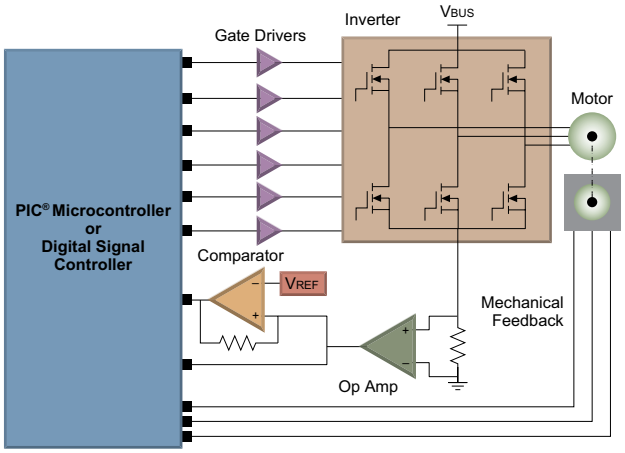
*dsPIC33 devices feature one or two user-selectable 1.1 Msps 10-bit ADC (4 S & H) or 500 ksps 12-bit ADC (1 S & H).
**A DAC is associated with each analog comparator to set a programmable voltage reference. One DAC output may be selected by software and driven on an external pin.
***I = Industrial Temperature Range (–40°C to +85°C), E = Extended Temperature Range (–40°C to +125°C), H = High Temperature Range (–40°C to +140°C).

Brushless DC Motor Control

BLDC Motor Control

Looking for high reliability, high efficiency, and high power-to-size ratio motor? The obvious solution is a Brushless DC (BLDC) motor. It shares many of the same torque and speed characteristics with the brushed DC motor, but without the brushes. Technically it is a Permanent Magnet Synchronous Motor (PMSM), but its name comes from the simple method of commutation and in some cases the stator windings are constructed to match the non-sinusoidal commutation.

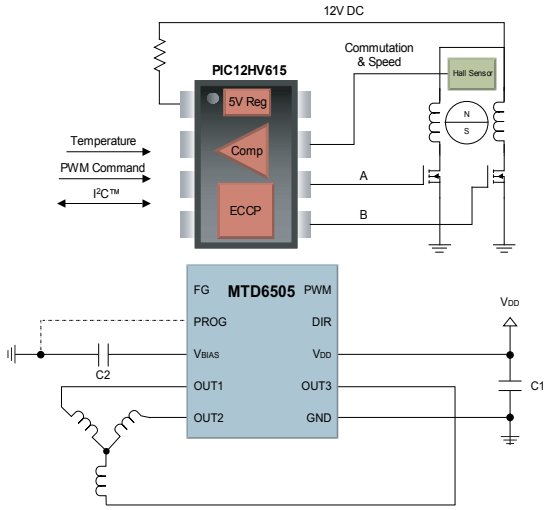
The simpler commutation methods allows the use of a wide range of Microchip products, from 8-bit PIC16 MCUs to MTD650X dedicated BLDC driver chips to dsPIC® digital signal controllers. The device best suited to your application depends on what you are trying to achieve: performance, cost, efficiency, time to market, etc. Microchip has a wide range of application notes and development tools that allow you to get started with your application quickly.



BLDC Fan Motor Control

Need a highly integrated fan controller with a customizable speed/temperature profile? Take a look at Microchip's PIC12HV and PIC16HV devices. These devices have a built-in 5V regulator and on-chip comparator to save system cost. The rotor position is determined by a hall-effect sensor connected to the on-chip comparator. The Enhanced Capture Compare PWM (ECCP) Module uses this feedback information to drive the motor by steering the PWM signal to the appropriate motor phase. Temperature sensor inputs can be used to create a unique fan speed profile and the application can provide digital status information to a host device.

If space or time-to-market is a concern for your next project, Microchip's 3-phase full-wave sensorless drivers for brushless DC (BLDC) motors are the answer. The devices feature 180° sinusoidal drive, high torque output and silent drive. With the adaptive features, parameters and wide range of power supplies, they work standalone or with Microchip's broad range of microcontrollers.



BLDC Application Notes and Tuning Guides

Algorithm	PIC16 Family	PIC18 Family	dsPIC® DSC Family
Sensored	AN857 AN885	AN899	AN957
Sensored Sinusoidal	–	–	AN1017
Sensorless BEMF	AN1175 AN1305	AN970	AN901 AN992

Algorithm	App Note
Sensorless Filtered BEMF with Majority Detect	AN1160
Sensorless Dual-Shunt FOC with SMO Estimator and Field Weakening	AN1078
Sensorless Dual-Shunt FOC with SMO and PFC	AN1208
Sensorless Dual-Shunt FOC with PLL Estimator and Field Weakening	AN1292
Sensorless Sing-Shunt FOC with SMO Estimator and Field Weakening	AN1299
Tuning Guide: Sensorless BLDC Control with Back-EMF Filetering Using a Majority Function	AN1160

BLDC Training

Class Title	Language	Recording Date	Duration
Sensorless BLDC Motor Control Using a Majority Function	English	04/29/2008	19 min.

Brushless DC Motor Control

BLDC Development Tools

F1 BLDC Motor Add-On (DM164130-2)

The BLDC Motor Add-On is a simple development accessory that plugs directly into the F1 Evaluation Platform or F1 +LV Evaluation Platform and incorporates all the components necessary to implement Brushless DC motor control. Key features include three MOSFET half bridge circuits, adjustments for zero crossing and current limit of the motor, debug header, and screw terminals for the motor and power supply.

Motor Control Starter Kit with mTouch™ Sensing (DM330015)

The Motor Control Starter Kit with mTouch Sensing is a complete, integrated development platform based on the dsPIC33FJ16MC102. It includes a USB interfaced debugger programmer, a complete drive circuit featuring Microchip's TC4428 dual 1.5A gate drivers, an onboard BLDC Motor, a user configurable switch and an mTouch slider with LED indicators for speed control. Simply power the board using a 9V supply and the pre-loaded code begins to execute.

dsPICDEM MCLV-2 Development Board (DM330021-2)

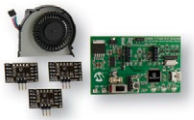
This development board is intended for low-voltage (up to 48V at 10A) BLDC sensored or sensorless applications. It provides a low-cost system for users to evaluate and develop applications using dsPIC33F/E motor control DSCs via a Plug-In Module (PIM) or 28-pin SOIC socket. With the MCLV-2 either the internal, on-chip op amps or the external op amps on the MCLV-2 board can be used. Microchip provides PIMs for using either the internal or external op amps. The MCLV-2 is fully backwards compatible with the original MCLV and all MC PIMs. Serial interfaces include: RS-232C, CAN, LIN and USB (for RTDM). Feedback support includes Hall- Effect Sensors, Shaft Encoder, Back EMF voltages and single or dual shunt resistors for current. PICkit 3 Debug Express, MPLAB ICD 3 In-Circuit Debugger or MPLAB REAL ICE In-Circuit Emulator is required for programming or debugging operations.

dsPICDEM MCHV-2 Development System (DM330023-2)

This development system is intended for high-voltage (up to 400V at 6.5A) BLDC, PMSM and ACIM sensored or sensorless applications. It provides a low-cost Integrated Power Module (IPM) based system for users to evaluate and develop applications using dsPIC33F/E motor control DSCs via a Plug-In Module (PIM) or a 28-pin SOIC socket. With the MCHV-2 either the internal, on-chip op amps or the external op amps on the MCHV-2 board can be used. Microchip provides PIMs for using either the internal or external op amps. The MCHV-2 is fully backwards compatible with the original MCHV and all MC PIMs. Isolated serial interfaces include RS-232C and USB (for RTDM). Feedback support includes Hall-Effect Sensors, Shaft Encoder, Back EMF voltages and single or dual current shunt resistors. A PFC circuit is provided to meet regulatory requirements. An isolated built-in debugger (similar to a starter kit programmer/debugger) permits a direct connection with a PC.

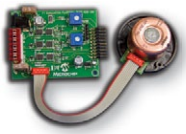
BLDC Fan Control Development Tools

MTD6505 3-Phase BLDC Sensorless Fan Controller Demonstration Board (ADM00345)



The MTD6505 3-Phase BLDC Sensorless Fan Controller Demonstration Board allows the control and monitoring of the MTD6505 device using PC software connected to the board via a USB connection.

F1 BLDC Motor Add-On (DM164130-2)



The BLDC Motor Add-On is a simple development accessory that plugs directly into the F1 Evaluation Platform or F1 +LV Evaluation Platform and incorporates all the components necessary to implement Brushless DC motor control. Key features include three MOSFET half bridge circuits, adjustments for zero crossing and current limit of the motor, debug header, and screw terminals for the motor and power supply.

Recommended Products for Brushless Fan Control

Device	Pins	Flash KB	SRAM Bytes	EE Bytes	Timer 8/16-bit	Comp	CCP/ ECCP	Motor Control PWM	A/D 10-bit	Quad Enc	UART	SPI/ I²C™
PIC16F616/PIC16HV616(1)	14	3.5	128	–	2/1	2	0/1	–	8 ch	No	–	–
PIC16F684	14	3.5	128	256	2/1	2	0/1	–	8 ch	No	–	–
PIC16F1509	20	14	512	–	2/1	2	–	4	12 ch 10-bit	–	1	1
PIC16F1783	28	7	512	256	4/1	3	2	–	11 ch 12-bit	–	1	1
PIC16F1823	14	3.5	128	256	2/1	2	0/1	–	8	–	1	1
PIC16F1933	28	7	256	256	4/1	2	2/3	–	11	–	1	1
PIC16F1936	28	14	512	256	4/1	2	2/3	–	11	–	1	1
PIC16F1937	40/44	14	512	256	4/1	2	2/3	–	14	–	1	1
PIC16F1939	40/44	28	1024	256	4/1	2	2/3	–	14	–	1	1

Note 1: HV device has on-chip shunt regulator.

Brushless DC Motor Control

Recommended Products for Brushless Fan Control (Continued)

Device	Motor Type	Input Voltage Range (V)	Output Current (mA)	Control Scheme	Temp. Operating Range (°C)	Features	Packages
MTD6505	3-Phase Brushless DC Motor	2.0 to 5.5	750	Sensorless Sinusoidal	–40 to +125	180° Sinusoidal Drive, Direction Control, Programmable BEMF Coefficient Range, Current Limitation, Lock-up Recover, Over temperature Protection, Output Switching Frequency at 30 kHz	10-pin 3 × 3 UDFN
MTD6501C	3-Phase Brushless DC Motor	2.0 to 14.0	800	Sensorless Sinusoidal	–30 to +95	180° Sinusoidal Drive, Current Limitation, Lock-up Recover, Over temperature Protection, Output Switching Frequency at 20 kHz	Thermally Enhanced 8-pin SOP
MTD6501D	3-Phase Brushless DC Motor	2.0 to 14.0	500	Sensorless Sinusoidal	–30 to +95	180° Sinusoidal Drive, Current Limitation, Lock-up Recover, Over temperature Protection, Output Switching Frequency at 20 kHz	10-pin MSOP
MTD6501G	3-Phase Brushless DC Motor	2.0 to 14.0	800	Sensorless Sinusoidal	–30 to +95	180° Sinusoidal Drive, Current Limitation, Lock-up Recover, Over temperature Protection, Output Switching Frequency at 23 kHz	Thermally Enhanced 8-pin SOP

Recommended Products for Brushless DC Motors

Device	Pins	Flash KB	SRAM Bytes	EE Bytes	Timer 8/16-bit	Comp	CCP/ ECCP	Motor Control PWM	A/D 10-bit	Quad Enc	UART	SPI/ I²C™
PIC16F616/PIC16HV616(1)	14	3.5	128	–	2/1	2	0/1	–	8 ch	No	–	–
PIC16F684	14	3.5	128	256	2/1	2	0/1	–	8 ch	No	–	–
PIC16F1509	20	14	512	–	2/1	2	–	4	12 ch 10-bit	–	1	1
PIC16F1783	28	7	512	256	4/1	3	2	–	11 ch 12-bit	–	1	1
PIC16F1823	14	3.5	128	256	2/1	2	0/1	–	8	–	1	1
PIC16F1933	28	7	256	256	4/1	2	2/3	–	11	–	1	1
PIC16F1936	28	14	512	256	4/1	2	2/3	–	11	–	1	1
PIC16F1937	40/44	14	512	256	4/1	2	2/3	–	14	–	1	1
PIC16F1939	40/44	28	1024	256	4/1	2	2/3	–	14	–	1	1

Device	Pins	Flash KB	RAM KB	DMA # Ch	Timer 16-bit	Input Capture	Output Compare/ Standard PWM	Motor Control PWM Ch	QEI	ADC	Analog Comparators	Op Amps	CodeGuard™ Security Segments	UART	SPI	I²C™	PMP	RTCC	CAN	USB 2.0	Package	Temperature Range***
dsPIC33EP32MC202	28	32	4	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP32MC502	28	32	4	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP32MC203◊	36	32	4	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	–	–	TL	I,E, H
dsPIC33EP32MC503◊	36	32	4	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	1	–	TL	I,E, H
dsPIC33EP32MC204	44	32	4	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL, ML, PT	I,E, H
dsPIC33EP32MC504	44	32	4	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL, ML, PT	I,E, H
dsPIC33EP64MC202	28	64	8	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP64MC502	28	64	8	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP64MC203◊	36	64	8	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	–	–	TL	I,E, H
dsPIC33EP64MC503◊	36	64	8	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	1	–	TL	I,E, H
dsPIC33EP64MC204	44	64	8	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL◊, ML, PT	I,E, H
dsPIC33EP64MC504	44	64	8	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL◊, ML, PT	I,E, H
dsPIC33EP64MC206	64	64	8	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP64MC506	64	64	8	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP128MC202	28	128	16	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP128MC502	28	128	16	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP128MC204	44	128	16	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL◊, ML, PT	I,E, H
dsPIC33EP128MC504	44	128	16	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL◊, ML, PT	I,E, H
dsPIC33EP128MC206	64	128	16	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP128MC506	64	128	16	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP256MC202	28	256	32	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP256MC502	28	256	32	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP256MC204	44	256	32	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL◊, ML, PT	I,E, H
dsPIC33EP256MC504	44	256	32	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL◊, ML, PT	I,E, H
dsPIC33EP256MC206	64	256	32	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP256MC506	64	256	32	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP512MC202	28	512	48	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SO, SS, MM	I,E, H
dsPIC33EP512MC502	28	512	48	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SO, SS, MM	I,E, H
dsPIC33EP512MC204	44	512	48	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP512MC504	44	512	48	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP512MC206	64	512	48	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP512MC506	64	512	48	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H

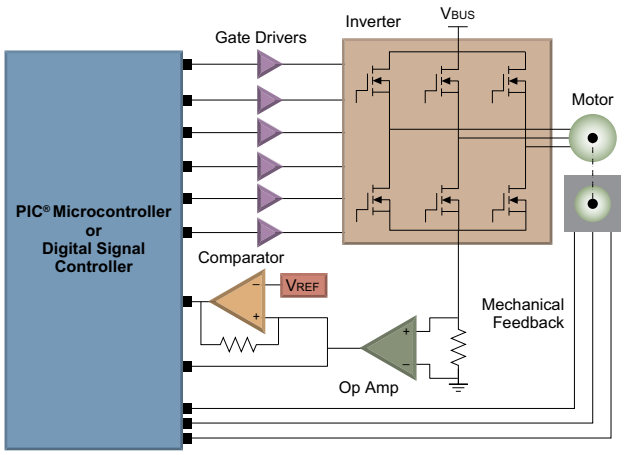
*dsPIC33 devices feature one or two user-selectable 1.1 Msps 10-bit ADC (4 S & H) or 500 ksps 12-bit ADC (1 S & H).
**Op amps can be configured as comparators.
***I = Industrial Temperature Range (–40°C to +85°C), E = Extended Temperature Range (–40°C to +125°C), H = High Temperature Range (–40°C to +140°C).
◊Check www.microchip.com for availability.

Permanent Magnet Synchronous Motors

PMSM Motor Control

Permanent Magnet Synchronous Motors (PMSM) are brushless and have very high reliability and high efficiency. Due to permanent magnet rotor, they also have higher torque with smaller frame size and no rotor current, of all which are advantages over AC induction motors. With a high power-to-size ratio, PMSMs can help you make your design smaller without the loss of torque.

PMSMs need to be commutated like BLDC motors, but due to the construction of the windings, the waveforms need to be sinusoidal for good performance. This requires more complicated control algorithms and, therefore, a higher performing controller like Microchip's dsPIC digital signal controllers. Microchip offers development tools and applications notes to develop advanced PMSM control solutions like sensorless Field Oriented Control (FOC).



PMSM Application Notes and Tuning Guides

Algorithm	dsPIC® DSC Family
Sensored	AN957
Sensored Sinusoidal	AN1017
Sensorless BEMF	AN901, AN992

Algorithm	App Note
Sensorless Filtered BEMF with Majority Detect	AN1160
Sensorless Dual-Shunt FOC with SMO Estimator and Field Weakening	AN1078
Sensorless Dual-Shunt FOC with SMO and PCF	AN1208
Sensorless Dual-Shunt FOC with PLL Estimator and Field Weakening	AN1292
Sensorless Single-Shunt FOC with SMO Estimator and Field Weakening	AN1299
Sensorless Dual-Shunt FOC with SMO Estimator BLDC/PMSM	AN1078
Sensorless Dual-Shunt FOC with PLL Estimator BLDC/PMSM	AN1292
Tuning Guide: Sensorless Single-Shunt FOC with SMO Estimator BLDC/PMSM	AN1299

PMSM Motor Training

Class Title	Language	Recording Date	Duration
Sensorless Field Oriented Control for Permanent Magnet Synchronous Motors	English	03/30/2007	30 min.

PMSM Development Tools

dsPICDEM MCLV-2 Development Board (DM330021-2)

This development board is intended for low-voltage (up to 48V at 10A) BLDC sensored or sensorless applications. It provides a low-cost system for users to evaluate and develop applications using dsPIC33F/E motor control DSCs via a Plug-In Module (PIM) or 28-pin SOIC socket. With the MCLV-2 either the internal, on-chip op amps or the external op amps on the MCLV-2 board can be used. Microchip provides PIMs for using either the internal or external op amps. The MCLV-2 is fully backwards compatible with the original MCLV and all MC PIMs. Serial interfaces include RS-232C, CAN, LIN and USB (for RTDM). Feedback support includes Hall- Effect Sensors, Shaft Encoder, Back EMF voltages and single or dual shunt resistors for current. PICkit 3 Debug Express, MPLAB ICD 3 In-Circuit Debugger or MPLAB REAL ICE In-Circuit Emulator is required for programming or debugging operations.

dsPICDEM MCHV-2 Development System (DM330023-2)

This development system is intended for high-voltage (up to 400V at 6.5A) BLDC, PMSM and ACIM sensored or sensorless applications. It provides a low-cost Integrated Power Module (IPM) based system for users to evaluate and develop applications using dsPIC33F/E motor control DSCs via PIM or a 28-pin SOIC socket. With the MCHV-2 either the internal, on-chip op amps or the external op amps on the MCHV-2 board can be used. Microchip provides PIMs for using either the internal or external op amps. The MCHV-2 is fully backwards compatible with the original MCHV and all MC PIMs. Isolated serial interfaces include RS-232C and USB (for RTDM). Feedback support includes Hall-Effect Sensors, Shaft Encoder, Back EMF voltages and single or dual current shunt resistors. A PFC circuit is provided to meet regulatory requirements. An isolated built-in debugger (similar to a starter kit programmer/debugger) permits a direct connection with a PC.

24V 3-Phase Brushless DC Motor (AC300020)

The 24V 3-phase Brushless DC (BLDC) motor with Hall-Effect sensors can be used with the dsPICDEM MCLV-2 development board (DM330021-2).

24V 3-Phase Brushless DC Motor with Encoder (AC300022)

This Brushless DC (BLDC) motor has a 250-line encoder, and can be used with the dsPICDEM MCLV-2 Development Board (DM330021-2).

Permanent Magnet Synchronous Motors

Recommended Products for PMSM Motors

Device	Pins	Flash KB	RAM KB	DMA # Ch	Timer 16-bit	Input Capture	Output Compare/ Standard PWM	Motor Control PWM Ch	QEI	ADC	Analog Comparators	Op Amps	CodeGuard™ Security Segments	UART	SPI	I²C™	PMP	RTCC	CAN	USB 2.0	Package	Temperature Range***
dsPIC33EP32MC202	28	32	4	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP32MC502	28	32	4	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP32MC203◊	36	32	4	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	–	–	TL	I,E, H
dsPIC33EP32MC503◊	36	32	4	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	1	–	TL	I,E, H
dsPIC33EP32MC204	44	32	4	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL, ML, PT	I,E, H
dsPIC33EP32MC504	44	32	4	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL, ML, PT	I,E, H
dsPIC33EP64MC202	28	64	8	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP64MC502	28	64	8	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP64MC203◊	36	64	8	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	–	–	TL	I,E, H
dsPIC33EP64MC503◊	36	64	8	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	1	–	TL	I,E, H
dsPIC33EP64MC204	44	64	8	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL◊, ML, PT	I,E, H
dsPIC33EP64MC504	44	64	8	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL◊, ML, PT	I,E, H
dsPIC33EP64MC206	64	64	8	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP64MC506	64	64	8	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP128MC202	28	128	16	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP128MC502	28	128	16	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP128MC204	44	128	16	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL◊, ML, PT	I,E, H
dsPIC33EP128MC504	44	128	16	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL◊, ML, PT	I,E, H
dsPIC33EP128MC206	64	128	16	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP128MC506	64	128	16	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP256MC202	28	256	32	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP256MC502	28	256	32	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP256MC204	44	256	32	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL◊, ML, PT	I,E, H
dsPIC33EP256MC504	44	256	32	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL◊, ML, PT	I,E, H
dsPIC33EP256MC206	64	256	32	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP256MC506	64	256	32	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP512MC202	28	512	48	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SO, SS, MM	I,E, H
dsPIC33EP512MC502	28	512	48	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SO, SS, MM	I,E, H
dsPIC33EP512MC204	44	512	48	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP512MC504	44	512	48	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP512MC206	64	512	48	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP512MC506	64	512	48	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H

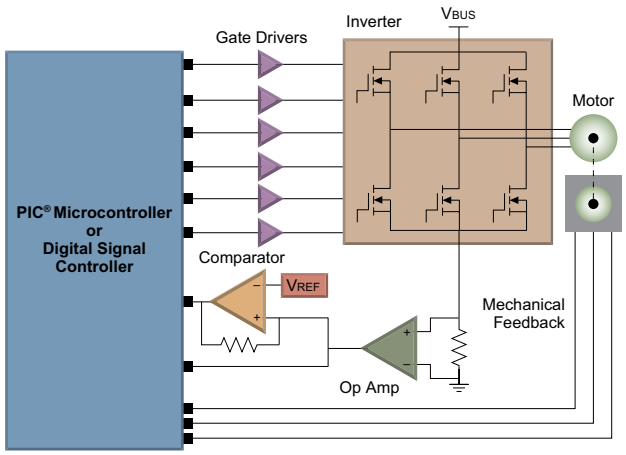
*dsPIC33 devices feature one or two user-selectable 1.1 Msps 10-bit ADC (4 S & H) or 500 ksps 12-bit ADC (1 S & H).
**Op amps can be configured as comparators.
***I = Industrial Temperature Range (–40°C to +85°C), E = Extended Temperature Range (–40°C to +125°C), H = High Temperature Range (–40°C to +140°C).
◊Check www.microchip.com for availability.

AC Induction Motors

AC Induction Motor Control

The AC Induction Motor (ACIM) is the workhorse of the world. It is the most common motor type, used in everything from consumer products to heavy industry. Its simple design with no brushes makes it highly reliable and also allows it to be manufactured at a low cost. But, it is less efficient than other motors like PMSM, which is partially related to the heat generation in the rotor windings.

The Open Loop Voltage/frequency (V/f) drive technique is tradionally used to control ACIMs. It can be implemented on an 8-bit PIC® MCU. This drive technique is not very efficient, so for applications that need higher efficiency, an advanced control solution like Field Oriented Control can be applied. This requires a high performance controller, like a dsPIC digital signal controller. Hardware and software development solutions are available from Microchip.



AC Induction Motor Training

Class Title	Language	Recording Date	Duration
Sensorless Field Oriented (FOC) Control for AC Induction Motors	English	01/21/2008	23 min.

AC Induction Application Notes

Algorithm	PIC16 Family	PIC18 Family	dsPIC® DSC Family
Open Loop V/F	AN887 AN889 AN955 AN967	AN900 AN843	AN984
Closed Loop Vector Control	–	–	AN980
Sensorless Dual-Shunt FOC with PLL Estimator	–	–	AN1162
Sensorless Dual-Shunt FOC with PLL Estimator and Field Weakening	–	–	AN1206

AC Induction Development Tools

dsPICDEM MCHV-2 Development System (DM330023-2)

This development system is intended for high-voltage (up to 400V at 6.5A) BLDC, PMSM and ACIM sensored or sensorless applications. It provides a low-cost Integrated Power Module (IPM) based system for users to evaluate and develop applications using dsPIC33F/E motor control DSCs via a Plug-In Module (PIM) or a 28-pin SOIC socket. With the MCHV-2 either the internal, on-chip op amps or the external op amps on the MCHV-2 board can be used. Microchip provides PIMs for using either the internal or external op amps. The MCHV-2 is fully backwards compatible with the original MCHV and all MC PIMs. Isolated serial interfaces include RS-232C and USB (for RTDM). Feedback support includes Hall-Effect Sensors, Shaft Encoder, Back EMF voltages and single or dual current shunt resistors. A PFC circuit is provided to meet regulatory requirements. An isolated built-in debugger (similar to a starter kit programmer/debugger) permits a direct connection with a PC.

AC Induction Motor (AC300023)

This compact 3-phase AC Induction Motor has been certified for use with dsPIC33 ACIM motor control application notes in conjunction with the dsPICDEM MCHV-2 Development System (DM330023-2).

Recommended Products for AC Induction Motors

Device	Pins	Flash KB	SRAM Bytes	EE Bytes	Timer 8/16-bit	Comp	CCP/ ECCP	Motor Control PWM	A/D 10-bit	Quad Enc	UART	SPI/ I²C™
PIC16F616/PIC16HV616(1)	14	3.5	128	–	2/1	2	0/1	–	8 ch	No	–	–
PIC16F684	14	3.5	128	256	2/1	2	0/1	–	8 ch	No	–	–
PIC16F1509	20	14	512	–	2/1	2	–	4	12 ch 10-bit	–	1	1
PIC16F1783	28	7	512	256	4/1	3	2	–	11 ch 12-bit	–	1	1
PIC16F1823	14	3.5	128	256	2/1	2	0/1	–	8	–	1	1
PIC16F1933	28	7	256	256	4/1	2	2/3	–	11	–	1	1
PIC16F1936	28	14	512	256	4/1	2	2/3	–	11	–	1	1
PIC16F1937	40/44	14	512	256	4/1	2	2/3	–	14	–	1	1
PIC16F1939	40/44	28	1024	256	4/1	2	2/3	–	14	–	1	1

Note 1: HV device has on-chip shunt regulator.

AC Induction Motors

Recommended Products for AC Induction Motors (Continued)

Device	Pins	Flash KB	RAM KB	DMA # Ch	Timer 16-bit	Input Capture	Output Compare/ Standard PWM	Motor Control PWM Ch	QEI	ADC	Analog Comparators	Op Amps	CodeGuard™ Security Segments	UART	SPI	I²C™	PMP	RTCC	CAN	USB 2.0	Package	Temperature Range***
dsPIC33EP32MC202	28	32	4	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP32MC502	28	32	4	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP32MC203◊	36	32	4	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	–	–	TL	I,E, H
dsPIC33EP32MC503◊	36	32	4	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	1	–	TL	I,E, H
dsPIC33EP32MC204	44	32	4	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL, ML, PT	I,E, H
dsPIC33EP32MC504	44	32	4	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL, ML, PT	I,E, H
dsPIC33EP64MC202	28	64	8	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP64MC502	28	64	8	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP64MC203◊	36	64	8	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	–	–	TL	I,E, H
dsPIC33EP64MC503◊	36	64	8	4	5	4	4	6	1	1 ADC, 8 ch	1 + 2**	2	1	2	2	2	–	–	1	–	TL	I,E, H
dsPIC33EP64MC204	44	64	8	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL◊, ML, PT	I,E, H
dsPIC33EP64MC504	44	64	8	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL◊, ML, PT	I,E, H
dsPIC33EP64MC206	64	64	8	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP64MC506	64	64	8	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP128MC202	28	128	16	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP128MC502	28	128	16	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP128MC204	44	128	16	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL◊, ML, PT	I,E, H
dsPIC33EP128MC504	44	128	16	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL◊, ML, PT	I,E, H
dsPIC33EP128MC206	64	128	16	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP128MC506	64	128	16	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP256MC202	28	256	32	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SP, SO, SS, MM	I,E, H
dsPIC33EP256MC502	28	256	32	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SP, SO, SS, MM	I,E, H
dsPIC33EP256MC204	44	256	32	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	TL◊, ML, PT	I,E, H
dsPIC33EP256MC504	44	256	32	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	TL◊, ML, PT	I,E, H
dsPIC33EP256MC206	64	256	32	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP256MC506	64	256	32	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP512MC202	28	512	48	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	–	–	SO, SS, MM	I,E, H
dsPIC33EP512MC502	28	512	48	4	5	4	4	6	1	1 ADC, 6 ch	1 + 2**	2	1	2	2	2	–	–	1	–	SO, SS, MM	I,E, H
dsPIC33EP512MC204	44	512	48	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP512MC504	44	512	48	4	5	4	4	6	1	1 ADC, 9 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H
dsPIC33EP512MC206	64	512	48	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	–	–	ML, PT	I,E, H
dsPIC33EP512MC506	64	512	48	4	5	4	4	6	1	1 ADC, 16 ch	1 + 3**	3	1	2	2	2	–	–	1	–	ML, PT	I,E, H

*dsPIC33 devices feature one or two user-selectable 1.1 Msps 10-bit ADC (4 S & H) or 500 ksps 12-bit ADC (1 S & H).
**Op amps can be configured as comparators.
***I = Industrial Temperature Range (–40°C to +85°C), E = Extended Temperature Range (–40°C to +125°C), H = High Temperature Range (–40°C to +140°C).
◊Check www.microchip.com for availability.

Application Notes for Motor Control

Motor Control Application Notes by Motor Type

Motor Type	App. Note	Description
Stepper Motor	AN822	Stepper Motor Micro-stepping with PIC18C452
	AN906	Stepper Motor Control Using the PIC16F684
	AN907	Stepper Motor Fundamentals
	AN1307	Stepper Motor Control Using the dsPIC® DSC
Brushed DC Motor	AN696	PIC18CXXX/PIC16CXXX DC Servomotor Applications
	AN893	Low-Cost Bi-directional Brushed DC Motor Control Using the PIC16F684
	AN905	Brushed DC Motor Fundamentals
BLDC and PMSM	AN857	Brushless DC Motor Control Made Easy
	AN885	Brushless DC (BLDC) Motor Fundamentals
	AN899	Brushless DC Motor Control Using PIC18FXX31 MCUs
	AN901	Sensorless Control of BLDC Motor Using dsPIC30F6010
	AN992	Sensorless Control of BLDC Motor Using dsPIC30F2010
	AN957	Sensored Control of BLDC Motor Using dsPIC30F2010
	AN970	Using the PIC18F2431 for Sensorless BLDC Motor Control
	AN1017	Sinusoidal Control of PMSM Motors with dsPIC30F With Four Quadrant Control
	AN1078	Dual Shunt Sensorless FOC for PMSM with SMO Estimator and Field Weakening
	AN1160	Sensorless BLDC Control with Back-EMF Filtering Using a Majority Function
	AN1175	Sensorless Brushless DC Motor Control with PIC16
	AN1208	Integrated Power Factor Correction and Sensorless Field-Oriented Control System
	AN1292	Dual Shunt Sensorless FOC for PMSM with PLL Estimator and Field Weakening
	AN1299	Single Shunt Sensorless FOC for PMSM with SMO Estimator and Field Weakening
	AN1305	Sensorless 3-Phase Brushless Motor Control with the PIC16FXXX
AC Induction Motor	AN843	Speed-Control of 3-Phase Induction Motor Using PIC18 Microcontrollers
	AN887	AC Induction Motor Fundamentals
	AN889	VF Control of 3-Phase Induction Motors Using PIC16F7X7 Microcontrollers
	AN900	Controlling 3-Phase AC Induction Motors Using the PIC18F4431
	AN908	Using the dsPIC30F for Vector Control of an ACIM
	AN955	VF Control of 3-Phase Induction Motor Using Space Vector Modulation
	AN967	Bidirectional VF Control of Single and 3-Phase Induction Motor Using Space Vector Modulation
	AN984	Introduction to ACIM Control Using the dsPIC30F
	AN1162	Sensorless Field Oriented Control (FOC) of an ACIM
	AN1206	Sensorless Field Oriented Control (FOC) of an ACIM Using Field Weakening
Other	AN894	Motor Control Sensor Feedback Circuits
	AN898	Determining MOSFET Driver Needs for Motor Drive Applications
	AN1106	Power Factor Correction on dsPIC DSC
	AN1229	Meeting IEC 60730 Class B Compliance with dsPIC DSC
	AN1332	Current Sensing Circuit Concepts and Fundamentals

Motor Type/Algorithm Versus MCU Family

Motor Type	Algorithm	PIC16 Family	PIC18 Family	dsPIC® DSC Family
Stepper Motor	Full and Half-Stepping	AN906 AN907	–	AN1307
	Micro-Stepping	–	AN822	AN1307
Brushed DC Motor	Unidirectional	AN905	–	–
	Bi-directional	AN893	–	–
	Servo Motor	AN696	AN696	–
BLDC and PMSM	Sensored	AN857 AN885	AN899	AN957
	Sensored Sinusoidal	–	–	AN1017
	Sensorless BEMF	AN1175 AN1305	AN970	AN901 AN992
	Sensorless Filtered BEMF with Majority Detect	–	–	AN1160
	Sensorless Dual-Shunt FOC with SMO Estimator and Field Weakening	–	–	AN1078
	Sensorless Dual-Shunt FOC with SMO and PFC	–	–	AN1208
	Sensorless Dual-Shunt FOC with PLL Estimator and Field Weakening	–	–	AN1292
	Sensorless Single-Shunt FOC with SMO Estimator and Field Weakening	–	–	AN1299
AC Induction Motor	Open Loop V/F	AN887 AN889 AN955 AN967	AN900 AN843	AN984
	Closed Loop Vector Control	–	–	AN980
	Sensorless Dual-Shunt FOC with PLL Estimator	–	–	AN1162
	Sensorless Dual-Shunt FOC with PLL Estimator and Field Weakening	–	–	AN1206
Other	PFC	–	–	AN1106
	Appliance Class B (IEC 60730)	–	AN1229	AN1229
	Motor Control Sensor Feedback Circuits	AN894	AN894	AN894
	MOSFET Driver Selection	AN898	AN898	AN898
	Current Sensing Circuit Concepts and Fundamentals	AN1332	AN1332	AN1332

World Class Development Tools

MPLAB X IDE

Universal and Integrated Tool Set

MPLAB X IDE is a single, universal graphical user interface for Microchip and third party software and hardware development tools. It is the industry's only IDE to support an entire portfolio of 8-bit, 16-bit and 32-bit PIC MCUs, dsPIC DSCs and memory devices.

MPLAB X supports Microchip's compilers, emulators, debuggers and starter kits, as well as many third-party tools. Moving between all of your favorite Microchip tools and upgrading from software simulators to hardware debugging and programming tools is simple with this IDE's seamless user interface.

Powerful Yet User-Friendly Interface

With complete project management, visual call graphs, a configurable watch window and a feature-rich editor that includes code-completion, context menus and a task navigator, MPLAB X is flexible and friendly enough for new users.

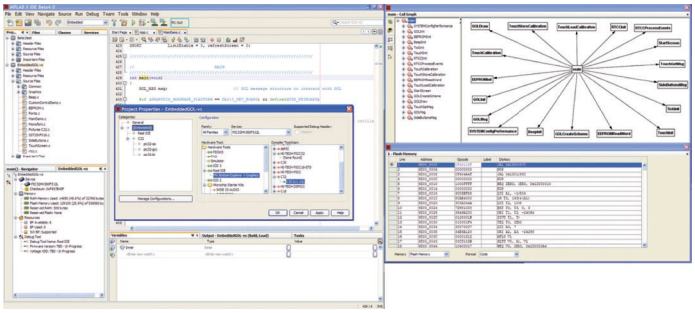
MPLAB X is also fully equipped for the needs of experienced users with the ability to support multiple tools on multiple projects with multiple configurations and simultaneous debugging.

Open-Source Platform

Based on the NetBeans™ Platform, MPLAB X supports a host of free software components and plug-ins from the NetBeans community for high-performance application development customized to your needs. In addition to local file history, MPLAB X is also compatible with revision control plug-ins and Bugzilla.

Cross-Platform

Using MPLAB X IDE, users can run their favorite toolset and develop their next embedded application on Windows®, Linux® or Mac® OS X.



MPLAB XC16 C Compiler for PIC24 MCUs and dsPIC DSCs

The MPLAB XC16 C Compiler includes a complete ANSI C standard library, including string manipulation, dynamic memory allocation, data conversion, timekeeping and math libraries. The compiler has a powerful code optimizer. Other 16-bit MCU compilers generate as much as 165% more code for the same application.

The assembler comes with the MPLAB XC C Compiler and may be used with the compiler or as an assembler. It is a full-featured macro assembler. User-defined macros, conditional assembly and a variety of assembler directives make the assembler a power code generation tool.

FREE Download a full-featured, time-restricted evaluation version of the MPLAB XC16 C Compiler for PIC24 MCUs or dsPIC DSCs from the Microchip web site.

www.microchip.com/compilers

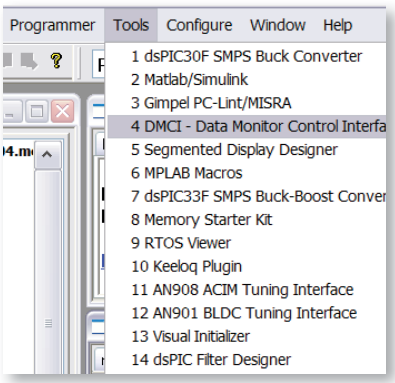
Available for MPLAB X IDE

FREE MPLAB X SIM Software Simulator

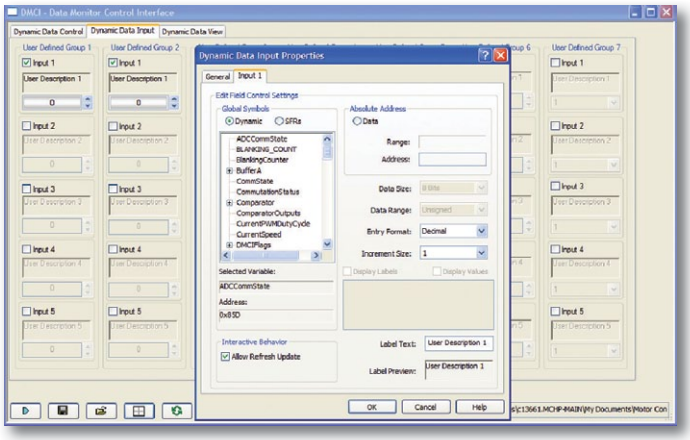
The MPLAB X SIM Software Simulator is a full-featured, cycle-accurate software simulator. In addition to simulating the CPU and the instruction set, it also supports key peripherals.

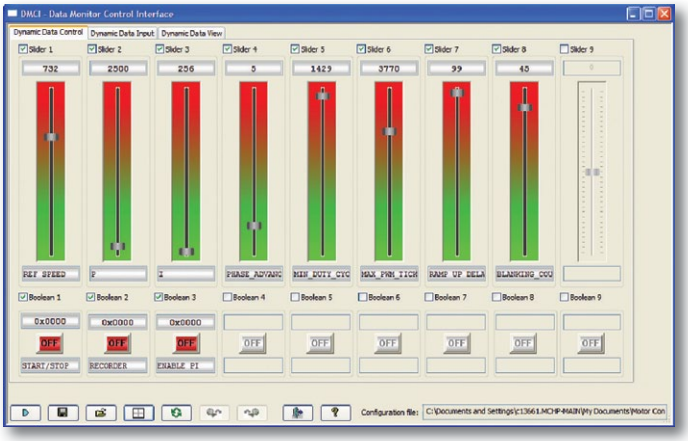
Motor Control Tuning GUIs

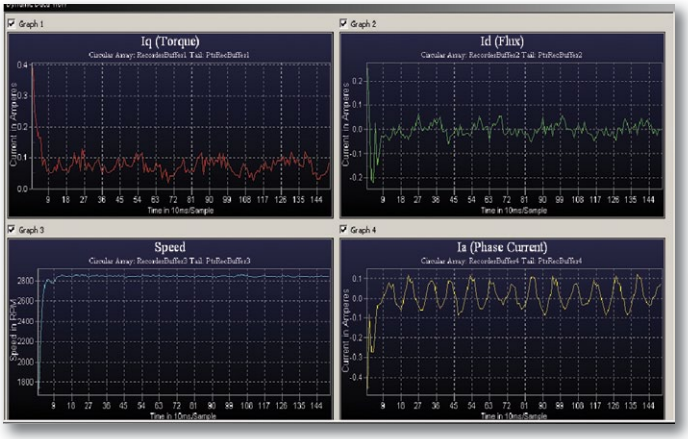
These software plug-in tools included with MPLAB X IDE assist with the development of motor control applications:

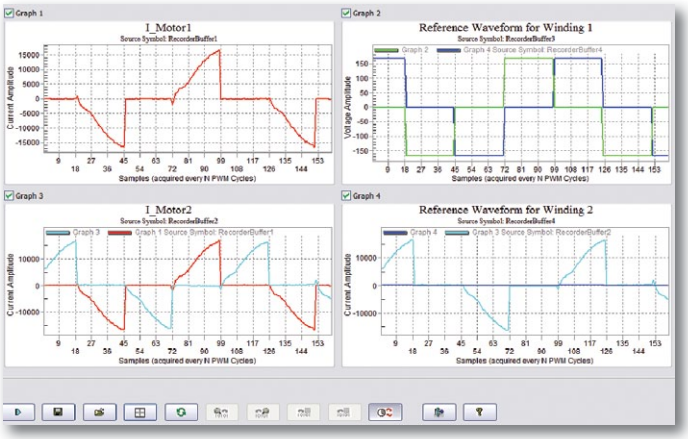


- **Data Monitor and Control Interface (DMCI):** Provides a customizable GUI to input and adjust software motor parameters using sliders and switches. Four customizable output plots can be used to show a graphical history of control variables so that the motor dynamic response can by analyzed. This tool is useful for tweaking software parameters and visualizing historical data during debug sessions. Most motor control application note software comes with a setup file to automatically configure DMCI for the application.

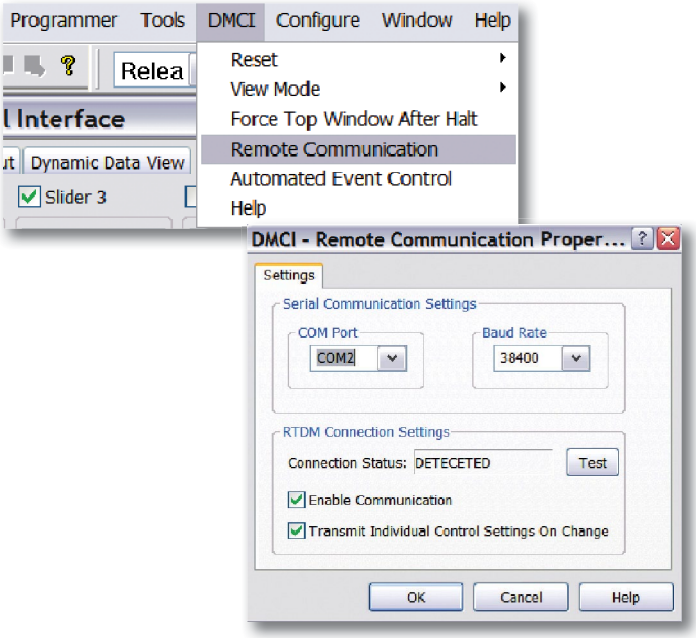








- **Real-Time Data Monitor (RTDM):** Make a change to a software parameter and see the effect immediately without stopping the motor. A serial USB or UART cable supports bi-directional data transfers between the host PC and the MCU/DSC. This is configured within DMCI and most motor control application note software comes with a setup file to automatically configure RTDM for the application.



Support

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:

- **Support** link provides a way to get questions answered fast: http://support.microchip.com
- **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
- **Buy** link provides locations of Microchip Sales Channel Partners: www.microchip.com/sales

Training

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.

- Technical Training Centers: **www.micr**ochip.com/training
- MASTERs Conferences: www.microchip.com/masters
- Worldwide Seminars: www.microchip.com/seminars
- eLearning: www.microchip.com/webseminars
- Resources from our Distribution and Third Party Partners www.microchip.com/training

Sales Office Listing

AMERICAS

Atlanta
Tel: 678-957-9614
Boston
Tel: 774-760-0087
Chicago
Tel: 630-285-0071
Cleveland
Tel: 216-447-0464
Dallas
Tel: 972-818-7423
Detroit
Tel: 248-538-2250
Indianapolis
Tel: 317-773-8323
Los Angeles
Tel: 949-462-9523
Santa Clara
Tel: 408-961-6444
Toronto
Mississauga, Ontario
Tel: 905-673-0699

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Denmark - Copenhagen
Tel: 45-4450-2828
France - Paris
Tel: 33-1-69-53-63-20
Germany - Munich
Tel: 49-89-627-144-0
Italy - Milan
Tel: 39-0331-742611
Netherlands - Drunen
Tel: 31-416-690399
Spain - Madrid
Tel: 34-91-708-08-90
UK - Wokingham
Tel: 44-118-921-5869

ASIA/PACIFIC

Australia - Sydney
Tel: 61-2-9868-6733
China - Beijing
Tel: 86-10-8569-7000
China - Chengdu
Tel: 86-28-8665-5511
China - Chongqing
Tel: 86-23-8980-9588
China - Hangzhou
Tel: 86-571-2819-3187
China - Hong Kong SAR
Tel: 852-2493-5100
China - Nanjing
Tel: 86-25-8473-2460
China - Qingdao
Tel: 86-532-8502-7355
China - Shanghai
Tel: 86-21-5407-5533
China - Shenyang
Tel: 86-24-2334-2829
China - Shenzhen
Tel: 86-755-8864-2200
China - Wuhan
Tel: 86-27-5980-5300
China - Xiamen
Tel: 86-592-2388138
China - Xian
Tel: 86-29-8833-7252
China - Zhuhai
Tel: 86-756-3210040

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-3090-4444
India - New Delhi
Tel: 91-11-4160-8631
India - Pune
Tel: 91-20-3019-1500
Japan - Osaka
Tel: 81-6-6152-7160
Japan - Tokyo
Tel: 81-3-6880-3770
Korea - Daegu
Tel: 82-53-744-4301
Korea - Seoul
Tel: 82-2-554-7200
Malaysia - Kuala Lumpur
Tel: 60-3-6201-9857
Malaysia - Penang
Tel: 60-4-227-8870
Philippines - Manila
Tel: 63-2-634-9065
Singapore
Tel: 65-6334-8870
Taiwan - Hsin Chu
Tel: 886-3-5778-366
Taiwan - Kaohsiung
Tel: 886-7-213-7828
Taiwan - Taipei
Tel: 886-2-2508-8600
Thailand - Bangkok
Tel: 66-2-694-1351

8/20/13

microchip DIRECT
www.microchipdirect.com

MICROCHIP

Microcontrollers • Digital Signal Controllers • Analog • Memory • Wireless

www.microchip.com

Microchip Technology Inc.
2355 W. Chandler Blvd.
Chandler, AZ 85224-6199

MEMS-based displays enable always-on experience in wearables

By Brian Gally

IMAGINE IF, WHEN the first smartphones were being designed, there was no limiting factor around battery life. Think how differently each design decision could have been made. Would form factor be so standardized? Would the display need to turn off every few seconds after being idle? What kind of content and usage patterns would have developed around hardware that offered a completely open channel of content flow right into the pocket (or wrist, but we'll get to that) of a consumer?

Strangely enough, that movement toward a continuous flow of content has actually begun even with display-specific constraints ensconced. As connectivity through 3G, 4G and WiFi has become seemingly ubiquitous, so, too, has the computing prowess of our mobile devices. Sensors, chipsets, memory, display and power management are creating a highly contextual environment dictating how and which content is actually served.

All the inertia described above, however, is actually still stymied by that modern mobile buzzkill – the black screen of a display turned off. Because, you see, this problem has not yet been solved. Devices are still constrained by their least efficient components: chief among them is the display.

Modern displays (LCD or OLED and their variants) all must make certain tradeoffs. For the bright and colorful experience you want, you trade battery life and the ability to have that experience in brightly lit environments. While marginal improvements certainly continue to be hashed out in efficiency, the display still consumes upward (well upward in many cases) of 50% of the energy in a mobile device.

Of particular interest is how this plays out in the new wide-open landscape of wearable computing. Looking at this category strictly from the perspective of the display technologies therein, there are seemingly two distinct camps. One says you can have your bright indoor device in exchange for charging daily (at least) and limited visibility outdoors. The other says you can have your outdoor-readable display and days of battery life, but at the expense of some mix of interactivity, color and pixel density. This is particularly interesting because the margin for error in a smartwatch is small for two reasons.

First, a device worn on the body invokes a different consumer expectation. It should be thin and fashionable, of course, but from a technical perspective, it needs to be visible at a glance – indeed, always on – no matter where the user is. If the wearable screen is off, there is no appreciable difference than reaching into one's pocket for their smartphone. And if the display is obscured by bright environmental light, like sunshine, always on is pointless.

This is not a foreign concept to consumers. We all encounter various types of passive content every day. In fact, the very real estate the smartwatch seeks to fill was previously occupied by a passive content display – the wrist watch. No buttons to push to activate the screen, just glance down and there is the information you need. The opportunity to leverage the great wave of contextually relevant data and serve it to the consumer in helpful and interesting ways is obviously the Holy Grail for the wearable and why most CE companies are clamoring to present their offering.

Fig. 1: The Qualcomm Toq smartwatch.

Second, and more simply, the device is just much smaller. Smaller screens, smaller batteries. If product managers have been pulling their hair out for years managing the delicate balance of power allocation for a 2100mAh battery on a smartphone, a 210mAh battery is going to really give them fits. A wholesale change needs to happen. There is simply nowhere to hide a bigger battery on a wrist-worn device; the componentry must get more efficient.

One solution, then, to unlocking the true potential of wearables and indeed the next generation of mobile experiences is a fundamentally different approach to the display component. A display that is reflective for great visibility even in the brightest of sunshine while being low power enough to enable days and days of usage while never going dark. This is, in a few words, the Qualcomm Mirasol display.

The fundamental technology behind the Mirasol-branded display offerings from Qualcomm is called Interferometric Modulation (IMOD). IMOD technology offers an answer to what ails the nascent wearable space.

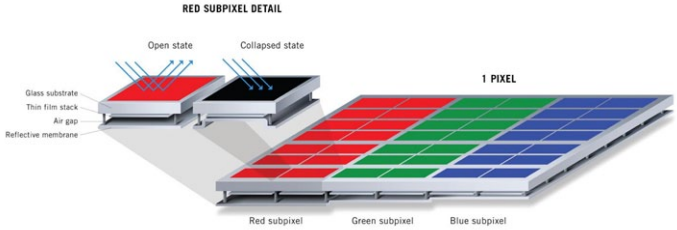


Fig. 2: Qualcomm Mirasol display sub-pixel architecture, current generation.

Brian Gally is VP Product Management and Marketing at Qualcomm MEMS Technologies - www.qualcomm.com/mirasol

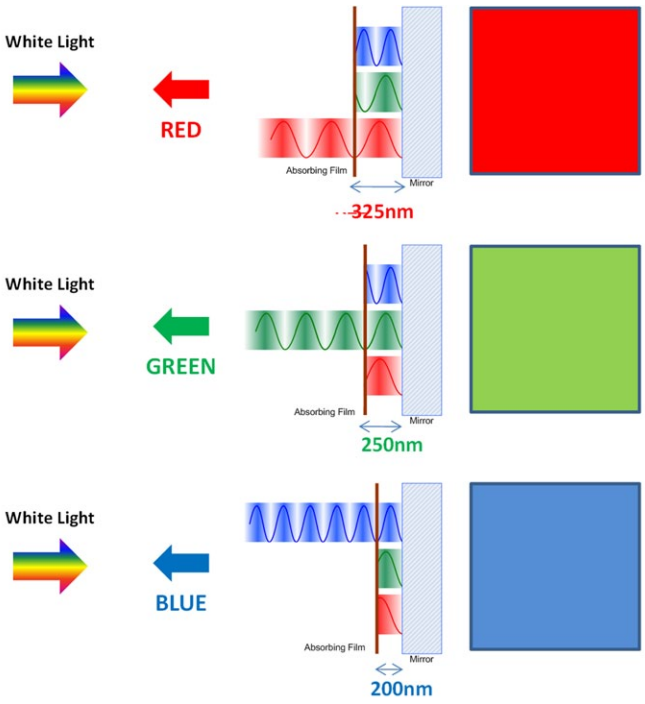


Fig. 3: Qualcomm Mirasol display sub-pixel architecture, next-generation single mirror (SMI).

The core underpinnings of the technology are based on the concept of optical interference. As one might observe in a soap bubble, when light passes through an optical resonant cavity, it reflects off both the outer and inner reflective surfaces. Whatever reflected wavelengths that are coming off both surfaces and that are in phase with each other are the color the cavity appears. Mirasol displays operate exactly the same way. An optical resonant cavity is constructed out of thin-films and through the use of MEMS (or indeed, as an example of MEMS), the cavity can be either opened or closed. When open, it is set either to red, green or blue and when closed, the cavity is black.

This unique approach to creating a color display is from where the differentiation of Mirasol displays is derived. Because only reflected light, in most instances, is required, the lion's share of power consumed by most modern displays is not expended. Secondarily, Mirasol displays are bi-stable. This means that once an image is addressed to the display, near-zero power is consumed in holding that image in view. Essentially, once the mirrors are set in place, the constant refreshing of the content seen in LCD/OLED is not necessary, another significant savings in power.

Fig. 4: Image of the single mirror IMOD demo from SID 2013.

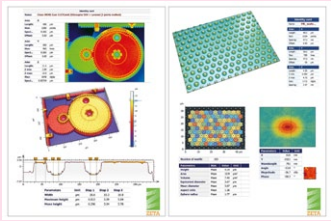
The above description describes the current version of IMOD, commercially available in the Qualcomm Toq and soon in additional smart wearables – see figures 1 and 2. In development, however, is the next generation of the technology. Bucking the trend in all color displays to date - where a color matrix of RGB is required to address a wide gamut of colors - the next generation of Mirasol displays will use a single element to address each individual state of color. This single mirror IMOD (SMI) iteration of the technology is in early development now, but offers a revolutionary glimpse into the mobile display and consumer experiences of the future – see figure 3.

Qualcomm has publicly demonstrated early prototype versions of this new SMI architecture Mirasol display. Demonstrated at SID 2013, the SMI architecture delivers 557ppi of resolution on a 4.7" demonstrator – see figure 4.

While a vision of an always-on device may be borne out of the upcoming proliferation of smart wearable devices, the trend towards continuous consumption is well afoot. New and innovative UI and UX design centered on a vision of what will become individuals' digital sixth sense is already being fueled by hardware and software development. This confluence of experience and consumer demand is bringing a new opportunity for the industry and will be best accelerated by innovative technology development in hardware like the Qualcomm Mirasol display.

Surface imaging and metrology software support 3D imaging and analysis

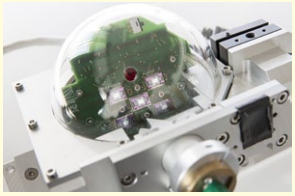
Zeta Instruments is now offering ZMorf Surface Imaging and Metrology software with its Zeta optical profilers. ZMorf is based on Digital Surf's industry-standard Mountains Technology software platform, providing 3D surface imaging and analysis coupled with automated metrology reports and full data export for specific applications. ZMorf supports real time 3D imaging of surface topography at any angle and zoom level, combined with colour image overlays to speed up the identification of surface features and anomalies. Image enhancement tools reveal fine surface details and intelligent pre-processing filters correct and normalize surface data prior to analysis. ZMorf integrates the latest standards and methods for analyzing surface texture and geometry. Surface roughness and waviness components are separated by applying advanced ISO 16610 filtering techniques and IS0 25178 3D parameters are generated. Distances, areas, volumes, step heights and coplanarity are calculated. Regions of interest can be extracted from a measured surface for independent analysis. Numerous advanced features are available including the analysis of tribological surfaces, grains and particles analysis, and 3D Fourier and wavelets analysis. The tool allows users to develop applications and generate multi-page analysis reports quickly and easily. Templates automate the analysis of similar measurement data sets and common sequences of analysis steps can be saved for reuse at any time. All numerical results are accessible in a single results manager panel and can be exported for post-processing by complementary application-specific software or 3rd party software. Images and documents can be exported in standard formats for easy publication.



Digital Surf
www.digitalsurf.com

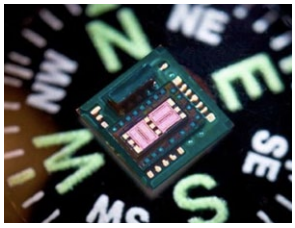
MEMS-based robotic eyes for 3D scanning with adaptive resolution

For three-and-a-half years, five research institutions and two industrial companies have been working within the scope of the European joint research project "TACO" (Three dimensional Adaptive Camera with Object Detection and Foveation) on the development of a new kind of 3D-camera system that should allow robots to perform more demanding tasks. For this project The Fraunhofer Institute for Photonic Microsystems IPMS in Dresden contributed a novel MEMS scan technology as a key hardware component, enabling "relevant" objects in the surroundings to be detected with a higher resolution, similar to human vision, without having to increase the volume of data. Robots typically lack either spatial information that is resolved in real-time by humans or the necessary focus for artificial, three-dimensional seeing. Another issue is that often too much image information is recorded and can't be processed quickly enough to be translated into action. Researchers at Fraunhofer IPMS have developed an extremely compact scanning technology, dubbed LinScan, for ToF (time of flight) telemeter systems that allows a three-dimensional image acquisition with a flexible scanning rate and thus scanning with an adapted resolution. 3D camera systems equipped with LinScan could enable future generations of robots to roughly search their surroundings for objects that appear in their visual field and to only resolve the objects they are looking for at a higher accuracy. The robot would work with a relatively small volume of data and would still be able to gain a better understanding of its surroundings so as to better interact with everyday objects and our environment. A precondition for the realization of this so-called principle of foveation is, however, that the robot knows what it is looking for and that it is also able to identify and interpret the objects being sought in a matter of seconds. The novel adaptive camera system developed within the scope of European joint research project TACO relies on an optical scanner with five synchronously operated LinScan mirrors from the Fraunhofer IPMS. The MEMS scanner array guarantees the necessary receiving aperture for the Time of Flight (TOF) telemeter system of effectively 5mm and was designed for an adaptive 3D-camera system with an optical scanning range of at least 40°x60°, 1 MVoxel/s measuring rate of the TOF telemeter system with a 3mm measuring uncertainty at a measuring distance of 7.5m. The quasi-static drive of the microscanner allows a line-by-line image formation with a variable refresh rate ranging from under 1Hz to 100Hz, whereby the vertical measuring point density in the relevant image section can be locally increased by reducing the scanning rate. The horizontal image acquisition by means of the gimbal-mounted 1.6 kHz resonant micro-mirror guarantees a larger receiving aperture compared to a 2D-quasi-static drive.



Memsic announces SDK for MEMS-watch ref design

Memsic has announced it is developing a software development kit for a connected watch with an integrated electronic compass. Memsic has teamed up with Meta Watch Ltd. (Dallas, Texas) to provide advanced features for a watch development kit that can support context awareness, health and many types of motion and orientation The SDK makes use of the MMC3416xPJ magnetometer which uses less than 50-microamps of current and can be always on. Memsic is providing sensor fusion software to allow applications to understand the context of the user, such as whether the user is standing, sitting, lying, walking or running, and can also assist in indoor navigation applications. The SDK also provides a wireless connection to another mobile device, further simplifying the development and integration process. The software provides magnetic tilt compensation and the MMC3416xPJ magnetometer comes in a 1.6mm by 1.6mm by 0.6mm package.



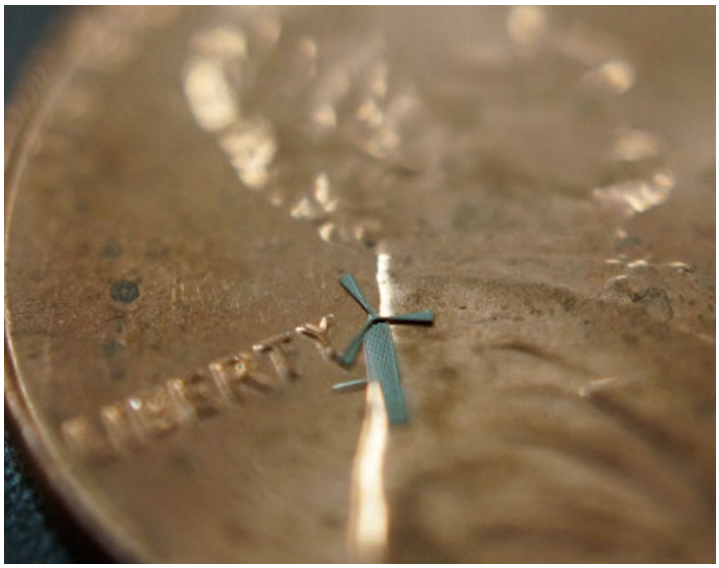
Memsic
www.memsic.com

How much power from MEMS windmills?

By Peter Clarke

A University of Texas Arlington research team has enjoyed considerable publicity for its development of a MEMS windmill that the developers have said could, when produced in array, provide energy for a mobile phone or be used for home energy generation.

But is that reasonable?



The one thing that is conspicuous by its absence from any of the photographs or the Youtube video of the prototype MEMS windmill, is any electrical wiring. Similarly conspicuous by its absence from the UT Arlington website posting, is any discussion of how much electrical power could be drawn from a millimeter-scale windmill.

In fact it is a general consideration that the efficiency of conversion from wind to electrical power increases the larger the system. Hence the desire to create wind turbines that are hundreds of feet high. So how efficient would an array of thousands of millimeter-scale windmills be? Would it be practical as a source of significant amount of electrical energy?

Nonetheless Smitha Rao and J.-C. Chiao at UT Arlington have designed and built a windmill that is about 1.8-mm at its widest point using a recently formed foundry, WinMEMS Technologies Co. Ltd. (Guishan, Taiwan). The blades are made from nickel alloy using planar multilayer electroplating techniques.

"The problem most MEMS designers have is that materials are too brittle," Rao said, in a statement on the website. MEMS are typically made from silicon. The micro windmills were tested in September 2013 and operate under "strong artificial winds" without any fracture in the material because of the durable nickel alloy and smart aerodynamic design, according to UT Arlington.

Tiny windmills and tiny amounts of power. But how much?

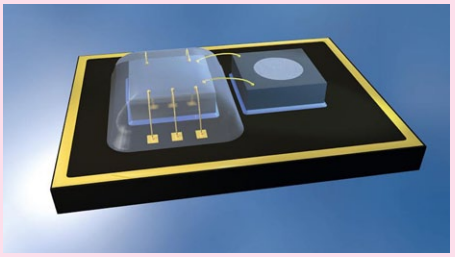
WinMEMS likes the idea and has struck an agreement with UT Arlington whereby the university gets to hold the intellectual property while WinMEMS is licensed to explore commercialization opportunities.

It is clear that MEMS windmills could be easy to make at the wafer scale and could be produced in very thin redundant structures. Researcher Chiao said that flat panels with thousand of MEMS windmills could be mounted on the walls of buildings to harvest energy for lighting, security or environmental sensing and wireless communication.

There may be some issues about the most efficient MEMS structure and its orientation within a wall-mounted panel – where the wind passes over the surface rather than through it – but such a discussion can only be had in the context of how much electrical power can be drawn from the system.

MEMS adhesives are flexible and equalize tensions from thermal stress

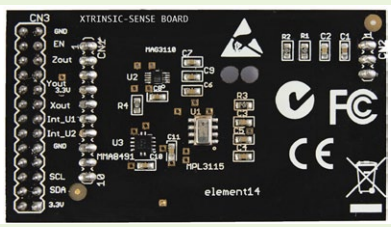
Delo Industrial Adhesives has developed new adhesives for MEMS packaging, designed to exhibit high flexibility combined with high shear strength, while providing the best processing properties. The new adhesives have a high die shear strength and are easy to process, yet they are highly flexible, do not get brittle, and reliably equalize tensions arising from thermal stress. This ensures unchanged signal characteristics of MEMS during the entire duration of use. The adhesives can be jetted and cure at low temperatures within short periods of time.



Delo
www.delo.de

Farnell launches multiple MEMS sensors evaluation board

The MEMS sensor evaluation board distributed by Farnell element14 contains multiple Freescale Xtrinsic sensors including the MPL3115 high-precision pressure sensor, the MAG3110 low-power 3D magnetometer, as well as the MMA8491Q 3-Axis, digital accelerometer. It communicates through I2C, and is equipped with headers with an Arduino shield and Freescale Freedom footprint, as well as a dedicated connector that allows connection to the Raspberry Pi. The evaluation board comes complete with device drivers and sample code to easily evaluate and demonstrate the performance of the sensors.



Farnell element14
www.element14.com

Full-duplex data streaming via the analogue audio connector

By Alex Costa and Helmut Theiler

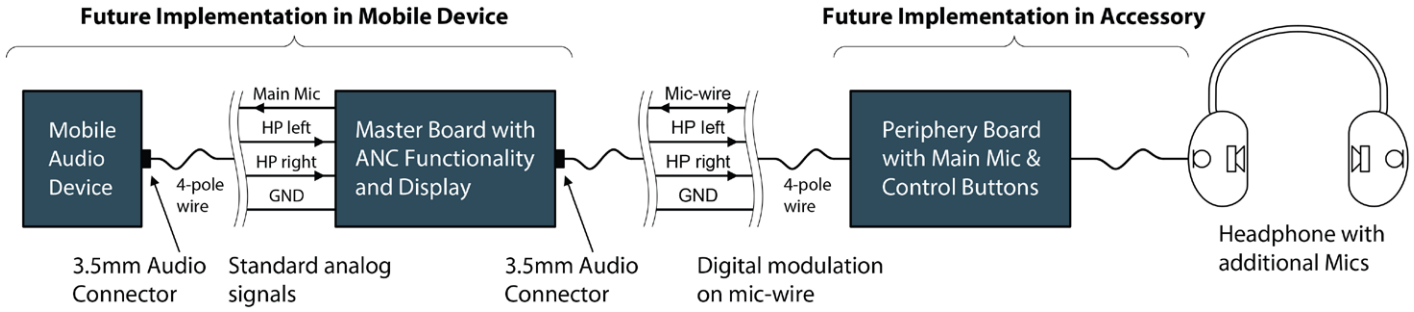


Fig. 1: Block diagram of the digital multiplexing demonstration system.

ACTIVE NOISE CANCELLATION (ANC) technology has been a hit with consumers. To date, it has been implemented mainly in stand-alone ANC headphones and earphones. Consumers have been prepared to pay a premium for headsets that enable them to listen to music undisturbed by ambient noise.

Now, mobile phone manufacturers are looking to ANC as a way to differentiate their products and provide a superior audio experience in both voice calls and media consumption. The most economical and convenient way for them to implement noise cancellation is by hosting the noise-cancellation circuitry inside the mobile phone itself. But the ambient noise must be sampled at the headset, not at the phone (which could be inside the user's pocket and insulated from the sources of noise).

This then presents a considerable difficulty: how to get two (left and right) sampled noise signals from the headset to the phone, and the inverted (noise-cancelling) signal back from the phone to the headset via the standard 3.5mm audio connector found on nearly all headsets.

This standard analogue audio connector is usually a four-pole device. The four wires are used for left and right headphone speakers, a single microphone output, and ground. The microphone wire (mic-wire) also typically carries the supply for the microphone amplifier in the headset. In today's mobile phone applications, the single microphone channel carries the user's voice signals in normal voice call mode.

When the 3.5mm audio connector is used in conventional analogue mode, then, there is no route for the two sets of noise samples to be transmitted from the headset to the mobile phone for signal processing.

Now ams has developed a new digital multiplexing technique that, in effect, creates extra channels in the mic-wire. These channels can be used in ANC applications to carry the noise samples from two or four additional left and right microphones in the headset to the mobile phone.

In other applications, the extra channels might be used for low- or mid-rate data transfers to audio accessories, for instance to enhance them with data displays, sensor data and other additional features. Of course, the conventional analogue functionality of the audio connector may be maintained, so standard headsets can still be used, although they will not support the enhanced features. This article describes the implementation of this new technique for full-duplex data streaming via the 3.5mm audio connector.

Alex Costa and Helmut Theiler are Design Engineers at ams AG - www.ams.com

Simultaneous voltage and current modulation

The digital microphones widely used today supply the audio signal as a serial Σ-Δ-modulated bit stream based on an oversampling clock. This makes a digital technique for multiplexing signals to provide full-duplex communication on the mic-wire feasible.

The challenge is to avoid interference between the up-link and down-link signals on the same wire, while providing a high enough bit-rate to meet consumers' demands for high audio quality. The successful method that ams has developed combines voltage and current modulation on the mic-wire: one provides the up-link and the other the down-link.

To prove the effectiveness of the technique, ams has produced a fully operational demonstration system. This system, which includes ANC functionality, can be linked to a mobile phone or MP3 player with a standard 3.5mm audio connector. It offers data rates of around 2Mbits/s in the up-link and

Fig. 2: The ams demonstration system, showing the master board (bottom), the peripheral circuit (top) with Volume Up, Mode and Volume Down buttons, and a headphone set.

12Mbits/s in the down-link.

The demonstration system consists of a master circuit and a peripheral circuit - see figures 1 and 2. (In an actual end product design, the master circuit would be embedded in the mobile device and the peripheral circuit in the control part of the headset.). To provide for a single power supply, the battery is connected to the master board, where various voltage levels are generated. The peripheral board is supplied via the mic-wire of the 3.5mm connector, which carries the modulated microphone signals as well. A main clock is generated on the master board, and the peripheral board is synchronised with it.

The partitioning of the functional blocks can be seen in figure 3. Both the master circuit and the peripheral circuit consist of two boards sandwiched together. Master board A provides the power supply, clock generation via a PLL, digital circuitry for data preparation, lock-out detection and – the core block – the combined data modulator/demodulator. So this board contains the main functionality of the data transfer system.

Master board B contains the application circuitry: a DAC converting digital microphone signals to audio signals, audio amplifiers, the AS3430 ANC chip, filters, a microcontroller and an LCD.

Peripheral board A contains the supply LDO, the sync- and data-extractor, data modulator, control buttons, and the main microphone (for sensing the user's voice). Peripheral board B contains the PLL and the control logic for data manipulation. Then a headphone set is connected to the peripheral board: the headphone features two additional microphones to pick up the ambient noise that should be suppressed.

The main clock frequency generated at the master board is 2MHz. This is used to modulate a saw-tooth voltage around the 3V mic-wire supply to the peripheral board. At the peripheral board, an internal supply of 2.2V is extracted; the falling edges of the saw-tooth voltage are used to reconstruct the 2MHz clock. (In order to ensure the digital components operate properly at this low 2.2V supply, TTL-gates on the peripheral boards are taken from the LV/LVC series.) The saw-tooth voltage frequency controls a PLL that generates the master clock of the peripheral circuit. Since the same PLL circuit is implemented in the master board, both devices operate synchronously - this avoids problems with sampling of the transmitted data.

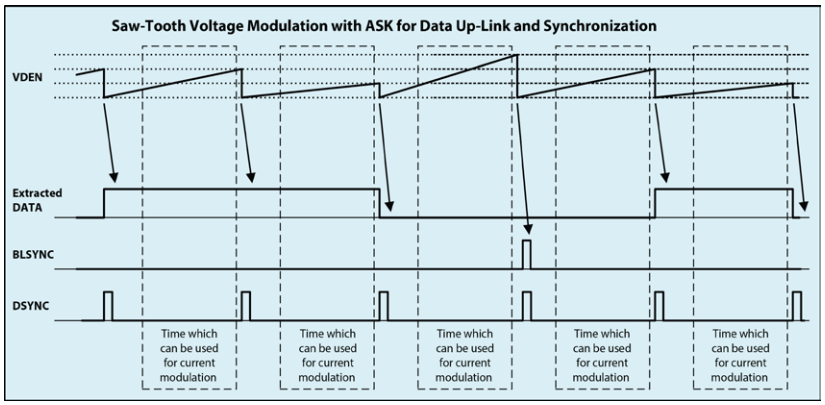


Fig. 4: Timing diagram of voltage modulation scheme.

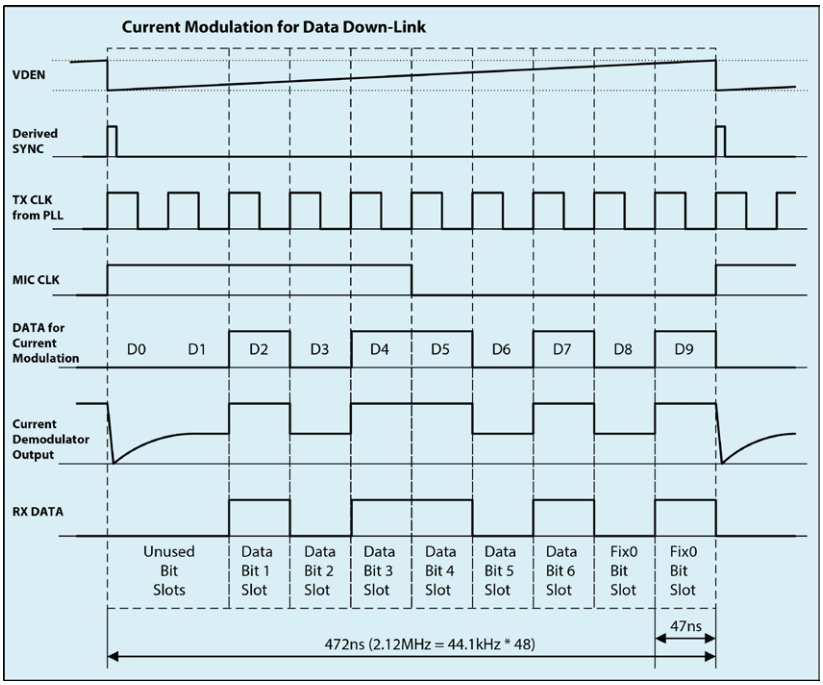


Fig. 5: Timing diagram of current modulation scheme.

When data is to be transmitted from the master board to the peripheral board, the size of the saw-tooth steps is ample for the coding required - see figure 4. Two levels are sufficient for 'High' and 'Low' signals; a third can be used for synchronisation purposes. An upstream data rate of 2Mbits/s is possible with the selected clock frequencies.

While upstream transmission is achieved through voltage modulation, downstream data transfer from the peripheral board to the master board is realised with current modulation. Although using the same mic-wire, the up- and down-link data streams do not interfere with each other if the circuit is carefully designed. First, the circuit that injects the saw-tooth ripple into the DC voltage at the master board must have low impedance, to ensure that the current modulation does not disturb the voltage signal. Second, the current demodulator on the master board must be insensitive to the voltage variations on the mic-wire. In addition, the current consumption of the peripheral board has to be more or

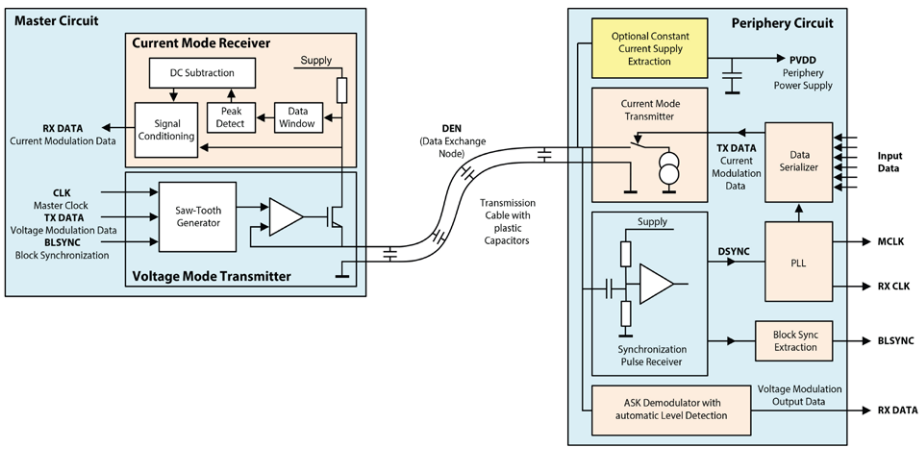


Fig. 3: Block diagram showing partition of functions between the master circuit (the mobile phone in an end product design) and peripheral device (headset controller in an end product design).

less constant (at least within one data frame), because the downstream information is coded in the current through the mic-wire that at the same time supplies the peripheral board.

During one data frame between two 2MHz pulses of the main clock, eight bits are transferred from the peripheral board to the master board (see Figure 5). This supports the ANC application implemented in this demonstration system: the first three bits denote which of the three control buttons in the peripheral circuit have been pressed the next three bits represent the three digital microphones (the main voice microphone, and two noise-sensing microphones) the last two bits are always '0' and '1'. This is necessary to automatically adjust the demodulation level in the master board. Furthermore, these two bits are used for lock-out detection, to prove that the data transfer is stable.

The data rate of the down-link is 6 x 2Mbits/s = 12Mbits/s.

For current modulation, no parasitic capacitors have to be charged and the parasitic inductance is quite low, so high-frequency data pulses can be realised without difficulty. Figure 6 shows a measurement of the analogue output of the current demodulator (in cyan) and the reconstructed digital data pulses (in magenta) on the master board, at a scale of 50ns/division. The yellow signal shows the 2MHz data frame of the down-link.

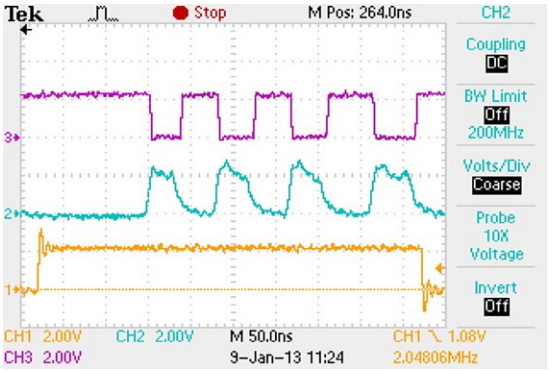


Fig. 6: Demodulated (analogue) down-link signal.

Measurements show that delay attributable to the whole transmission, from the digital microphone at the input of the peripheral board, then transmitted, received, demodulated and reconstructed, until it reaches the output of the receiver, is around 530ns. This short delay proves that the system is suitable for ANC applications, in which the latency has to be as small as possible in order to ensure that the noise-cancelling signal is closely synchronised with the ambient noise.

Digital microphone multiplexing: beyond experimentation

The demonstration system described in this article proves that a digital multiplexing system can be realised on a standard 3.5mm audio connector. In the short term, this new technique will make it easier for mobile phone manufacturers to implement ANC. Products now in development by ams will enable one part of the circuit to be integrated together with the microphones and buttons in the headset, and the other part, including the ANC circuitry, in the mobile device. Further into the future, a digital link through the 3.5mm audio connector could also be used for various accessory applications to transmit and receive data at low and medium data rates.

Technologies for high quality audio soundbars

By Brewster LaMacchia

AS TVS HAVE gotten flatter their cabinet volumes have reduced; the laws of physics dictate that their sound quality has gotten worse. At the same time audio content has gone from stereo to high resolution multichannel formats. In parallel with the growing complexity of the audio sources and content are the consumer expectations that nobody will read a manual, fiddle with multiple setup menus, or run wires around existing rooms in a home or apartment to achieve surround sound for a theater-like experience.

Active soundbars, which combine the features of a traditional A/V Receiver for multichannel sound with a dedicated set of speakers, have become popular as a way to provide a surround sound experience with TV and movie viewing. They use a digital signal processor (DSP) device to decode multichannel audio, optimize the sound for the particular transducers/drivers, and apply psycho-acoustic processing to create a wider soundstage than the bar itself – see figure 1.

A critical feature in a high quality soundbar is bass management. Due to the small cabinet volume and limited driver size, reproduction of frequencies below 150 Hz starts to become a difficult design problem. Listening to music or movies that are missing frequencies below 150 Hz would give the audio the sound quality of an old table radio and not the high impact realism of a "you are there" experience.

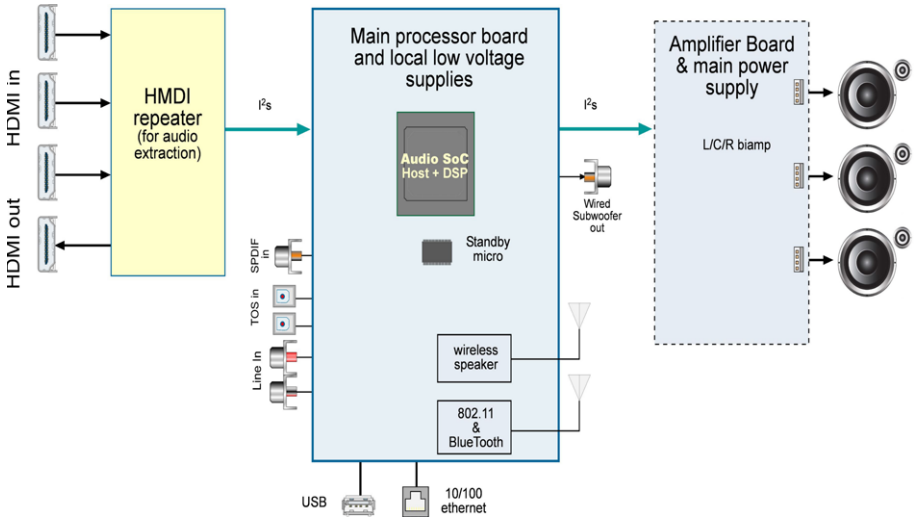


Fig. 1: The components in a typical active soundbar.

To avoid the need for all speakers to reproduce down to the typical lower audio limit of 20 Hz, surround systems (and some stereo systems) redirect bass energy from each channel to a dedicated subwoofer. This works because human hearing is non-directional at these lower frequencies. Correctly creating the crossover filter to preserve both time and frequency domain performance when attached to real world drivers is a difficult problem with many advocates for differing methods.

While soundbars can generally be wide (even a small LCD TV is over one meter in width) they are often limited in height and depth to match the visual aesthetics of a flat screen TV. The resultant limited cabinet volume of a soundbar typically results in low acoustic sensitivities, limiting the acoustic output for a given power input.

In the same way that class D amplifiers have made small volume subwoofers possible (by throwing lots of amplifier power at it with limited heat generation compared to traditional class AB amplifiers) soundbars too can benefit. However this approach to solving the output level problem does require physically small drivers that can handle high (25W – 50W) power levels. Here the DSP can be used to perform intelligent dynamic range compression to achieve the desired loudness with minimal distortion and protect the driver from long term over-heating.

For example, in a recently completed prototype made here at MDS an existing retail passive soundbar was used as stand-in for the final cabinet and drivers so that software developers would be able to listen to the results with actual audio content and not just view test tones on an oscilloscope. The passive crossovers were removed from the purchased soundbar and electronic ones created in the amplifier ICs (TAS5727 I2S input class D amplifier ICs from Texas Instruments in this case).

The SoC's DSP core performs content decoding, bass management and other post processing. Initial listening to the bar produced a sound quality that was lacking for vocals and bass that sounded out of balance with the rest of the system. Modifying bass management, and tweaking the electronic crossover settings between the mid-woofer and tweeter, as well as a small correction in the 1.2 kHz and 3kHz area produced a sound quality that was preferred in A/B testing - see figure 2.

The use of a DSP to enhance the sound quality can further be extended to accommodate listener preferences without the need to switch in different physical components like in a traditional passive speaker crossover. The DSP also offers audio companies the ability to add proprietary processing to create a unique product in the audio market. For example the trend towards more sophisticated room correction, which uses prodigious amounts of DSP computational power, will no doubt find its way into soundbars.

In parallel with the technology advances in the soundbar electronics, consumers now expect to source audio content from their portable electronic devices or stream from online cloud services. Combining an ARM based host processor with a high performance DSP allows creation of a soundbar that offers the functions consumers look for. For example, the TMS-

Brewster LaMacchia is responsible for development of DSP-based audio and video systems, including consumer audio applications at Momentum Data Systems - www.mds.com

320DA830 SoC from Texas Instruments used in the example above offers a single device with an ARM core and floating point DSP core, along with a large number of I2S digital audio interfaces to support direct connection to an HDMI transceiver for input and a digital input Class D amplifier ICs for output. The DSP decodes multichannel Dolby and DTS compressed audio formats back to multichannel surround PCM audio. In the early 2,000s five channels were standard; systems with 11 channels are now common and newer emerging formats support virtually unlimited number of audio object channels that are then mapped to as many physical speaker locations as desired.

Using a Linux based host processor in the soundbar makes adding wireless features such as Bluetooth and Wi-Fi much easier as the protocol stacks are available either in community supported versions or commercially supported software libraries. Bluetooth includes the SBC codec for stereo audio; when operated at its highest bit rate it offers quality levels near that of typical MP3/AAC downloaded content. Most Bluetooth stereo audio devices will support AAC, but oddly enough there are almost no sources from portable electronic devices for MP3 over Bluetooth, even though that is a dominant download format.

The co-existence of multiple RF sources (Bluetooth, Wi-Fi, wireless subwoofer) in a soundbar with high power Class D amplifiers and a lot of digital logic are a serious EMC design issue that must be factored into the industrial design from the beginning.

While active soundbars provide much better sound than the TV, they must still be wired to all the audio sources and the TV. Some people prefer the experience of five or seven physical speakers versus the psycho-acoustic methods used for only a soundbar positioned below the TV screen. In both cases physical wires present a problem when setting up a system in an existing space.

Many soundbars include a wireless link to the subwoofer; being physically large the subwoofer can then be placed in an unobtrusive location and/or located to produce better bass performance. There are multiple vendors offering devices for this purpose (for example TI's CC8520 PurePath CC8520 Wireless audio IC was used in the system described earlier).

The problem is extending that wireless link to multiple speakers for the full surround sound experience, including not having to run wires from all of the sources (cable TV box, game console, etc) to the front sound bar. Different proprietary schemes exist, some use compression to lower the bit rate to simplify the radio requirements but would still not support seven audio channels plus a sub woofer.

A new standard for this purpose has been developed by the Wireless Speaker and Audio association (WiSA). The WiSA Compliance Test Specification (CTS) outlines an interoperability testing and certification program aimed at products that offer multi-channel wireless, interference-free, uncompressed HD quality audio. Operating in a 5 GHz UNII band more RF channels are available to avoid the congestion consumers can experience in 2.4 GHz and 5GHz unlicensed bands. The WiSA technology provides up to 8 channels of 24 bit uncompressed audio at up to 96 kHz sample rates with less than 5 milliseconds latency. These characteristics allow for the highest possible audio quality with no artifacts from compression.

Using the WiSA standard for audio transport, an active soundbar could offer the left, center, and right (LCR) front channels, and wirelessly send out the subwoofer, surround, and rear channels for the full 7.1 surround sound experience. Bang and Olufsen, known world wide for unique and high quality systems, introduced complete WiSA-based systems at CES 2014.

The WiSA standard also offers a solution to the problem of running cables from all of the sources to an active soundbar. Instead a small audio "hub" can be used to select inputs, decode the surround sound formats, and then use WiSA standard to send the 7.1 audio wirelessly to all speakers. Or the WiSA transmitter can be built into the TV itself, and the 60's table radio-sounding flat-screen speakers avoided in the first place.

Of course wireless speakers require AC power to operate, but that is usually not a problem. Also schemes using rechargeable surround speakers, which need less total energy in most cases, can be considered.

The combination of efficient class D amplifiers, wireless audio sources such as Bluetooth, and uncompressed high quality wireless audio transport systems such as WiSA offer an opportunity for audio electronic manufacturers to create better sounding systems with less installation headaches than available just a few years ago.

Figure 1 illustrates the major components of a typical active soundbar. Due to space constraints in a soundbar the major functions are usually split across multiple circuit board assemblies. The I2S standard for audio is used to send multichannel audio data between sections. To meet the 0.5W standby energy consumption targets and be able to turn the unit on with an IR remote, a small microprocessor is typically used, allowing the main SoC to enter deep sleep mode. Electronic crossovers are implemented for the speakers, which consist of woofers and tweeters for the Left, Center, and Right channels.

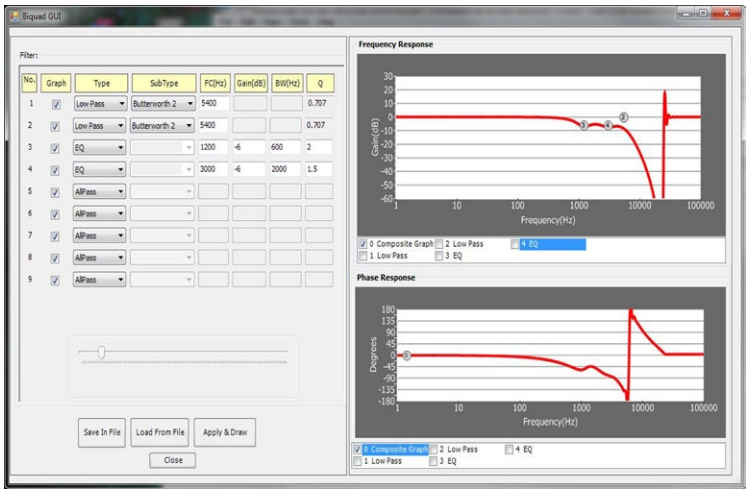


Fig. 2: Screen capture of the filter setup for the TAS5727 amplifiers.

Figure 2 shows a screen capture of the filter setup from the design tool for the TAS5727 amplifier ICs, which were also used to provide electronic crossover and driver correction in the prototype system described in the article. This easy to use interface, typical of these types of parts, makes it easy to enhance the driver sound quality much more easily than could be done with passive crossovers in a traditional speaker design.

SDR chip supports multiple digital radio standards - DRM, HD Radio and DAB

Digital technology is about to displace FM and AM reception in the infotainment system, and this trend is gaining momentum. A growing number of car OEMs and Tier 1 suppliers

are already offering in-car digital radio systems. With the introduction of a multi-standard software-defined radio co-processor capable of decoding all three major digital terrestrial radio standards including Digital Radio Mondiale (DRM), HD Radio and DAB/DAB+/T-DMB, NXP Semiconductors is set to accelerate this trend. NXP's new SAF360x series – code-named 'Saturn' – enhances digital audio quality via features such as Maximum Ratio Combining for DAB and HD Radio, and scalability for single, dual and triple tuner use designs. The SAF360x platform also offers a very high level of integration, replacing up to six chips with a single IC and reducing the footprint of the automotive digital radio application by over 75% for considerable cost savings. The SAF360x is the first automotive-quality chipset including two on-board DAB tuners and memory.

NXP
www.nxp.com

Revolutionary low cost micro thermal imaging core at heart of iPhone case

FLIR Systems has developed a thermal imaging camera core using wafer level lenses and sensors that is small enough to be integrated into the case of an iPhone. The Lepton thermal

imaging camera core uses CMOS technology, high volume manufacturing techniques, and commercial scale to deliver a price point that is an order of magnitude below current thermal camera cores. Similar in size, weight, and power consumption to a conventional CMOS cell phone camera module, Lepton is the world's smallest microbolometer-based thermal imaging camera core currently available. The first commercial use of Lepton is in the new FLIR ONE thermal imaging smartphone case introduced at CES last week. Lepton has also been designed for easy integration into third party products, such as smartphones, tablets, diagnostic tools, automobiles, toys, building controls, process equipment, security systems, machine vision systems, and advanced gaming devices. OEMs around the world can benefit from the fully-exportable Lepton core, which generates high-quality, fully-processed thermal images through common standard interfaces. The 90g case includes a 1400mAh battery where the power can be split between the thermal imager and the phone.

FLIR Systems
www.flir.com/lepton

Hardware designers take on the software challenges of verification

By Nick Flaherty

TESTING THE SOFTWARE in a complex System on Chip (SoC) design is an increasingly important challenge, and two UK tool developers have come from chip design backgrounds to tackle that problem. Development kits and integrated development environments can take the project so far, but the two companies are taking a different approach to verifying complex code on such designs.

Engineers at Cadence Design Systems working on the Verisity tool saw an opportunity to take the techniques we use for testing system on chip devices and apply them to the challenge of testing software. With millions of lines of code, many software projects are approaching the complexity of SoC devices from a few years back. So engineers took the coverage driven verification (CDV) test technology that is standard in hardware as the basis for Coveritas to apply to system code.

Argon Designs in Cambridge similarly has developed a compiler for executable specifications so that the standard can be fully tested with directed random streams of data. Their focus is on the HEVC video compression standard (also called H.265) that is emerging to reduce the bitrate of HD and UltraHD video.

The founders of Argon were previously with chip designer Alphamosaic and come to IP verification from a chip angle rather than a software one. The Argon tools take the specification and compiles the pseudocode to generates the minimum streams of test data that can validate the decoder IP against the original specification.

"What's good about the formal specification approach is that by making the streams check the specification against the code you can choose either the specification or the code as the golden reference," said Peter de Rivaz at Argon. "Once we have the formal specification we can apply code transformations for example to measure line by line branch coverage and cross coverage, checking macro blocks."

"We have a mode that can trace through the specification and understand the maximum and minimum range for any symbol at any point. This is particularly important in HEVC and motion prediction as you have 16 cases that all fit into 16bits, except one. As a result the streams are compliant and measurable."

The ability to produce an executable model of the spec to generate the test streams means the team found over 60 bugs where the reference silicon implementation differs from the specifications. This matters to the system code developers – do they change their code to pass the reference decoder and risk that changing in the future, or stick with the standard.

Fig. 1: sample output from an Argon Stream.

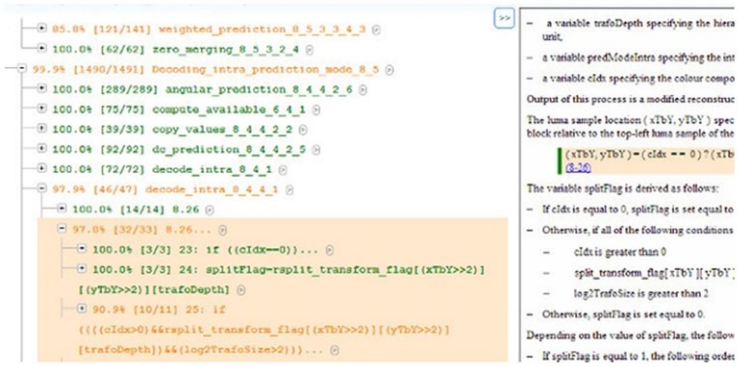


Fig. 2: Sample output from the Argon Coverage tool.

This is a key challenge, says Alan Scott, CEO at Argon. "We have come at it from an odd background because a lot of the team has been in chip design," said Scott.

Argon has a pipeline tool that gives the theoretical ranges and output from the test stream so that the streams themselves can be evaluated. This ensures that any issues that are seen are from the design of the block, rather than the test streams. This is linked to an interactive view of the specification. "It's a very human readable approach," he said. "Because you are able to measure these against the specification we can select a tiny set to streams that cover all the things you want to test. This means you can simulate RTL in minutes without having to use an FPGA and you can do all the development using the compressed set."

"There's been a little delay in people making IP blocks available for HEVC but we are seeing a surprising number of people wanting to do their own, often because they have done H.264 in the past and want the smallest chip cost," said Scott. "We are quite pleasantly surprised."

The streams are produced on the same principle used in microprocessor random instruction testing. The streams are generated randomly at the syntax level, giving high specification coverage per byte, which is good news for simulator-based testing – see figure 1. These streams form a provably rigorous decoder test, giving great confidence to silicon IP designers that any decoder which can produce correct output for this set will be able to handle anything that might be thrown at it.

The compiler produces a decoder which mirrors the structure of the specification document and has profiling hooks inserted into its code at every calculation. This allows a coverage report to be produced for either a single stream, or set of streams, showing which code paths were hit or missed, and what ranges of values were supplied to each calculation. This comes in the form of an interactive collapsed tree with each branch being dynamically linked to the relevant line in the specification.

The compiler which produces the coverage tool can also produce an encoder which generates valid streams which are random at the syntax level. Like the coverage tool, the encoder's structure mirrors the structure of the specification document, but where the coverage tool would read from its input stream, the encoder generates a random value, within the rules of the specification, and writes it to its output stream.

Argon is now looking at how to support other profiles in HEVC and now that the standard is stable is expecting more IP blocks to emerge. "We have one large IP vendor waiting for this point before kicking off their development," said Scott.

Making sure video works is one side of the code verification challenge. Making sure all the options and elements of control code can be tested is another being tackled by Coveritas. The software analyses the constraints of the software and generates random but repeatable streams of data, playing through multiple scenarios, testing for edge and corner cases. The key is that this process if both random but repeatable and automated on a vast scale.

The last four years have been focussed on a few large target customers, not the broader market, and they have now worked with key SoC users Cisco Systems, Ericsson, Renesas and NXP. With the release of 2.0 of the Vitaq tool in 2013 the company is looking further afield, and showing the importance of software testing at the top of the SoC eco-system. Software is now the critical factor in an SoC development, not the hardware, says Sean Redmond, CEO at Coveritas.

Vitaq includes C++ libraries which provide the framework to express the constraints and sequential rules that are required to build such powerful environments. The resulting test program is then run on a conventional workstation and may either test the system software directly on the same workstation or may interface to the electronic system development board under test using available serial interfaces, network connectivity or other suitable mechanisms. As the environment is run, Vitaq's constrained random scenario generator allows it to automatically create scenarios of fully formed use case tests that obey the pre-defined rule sets. Each run with a given seed will produce the same parameter values and sequence of events and so is precisely repeatable, but selecting a different random seed will produce a completely different run exercising completely different aspects of the software and system under test, all the while obeying the defined rule sets.

The latest interest is coming from a global SoC vendor that is offering software defined functionality on a programmable platform and needs to test all the different use cases on the silicon, says Redmond, as the this provides up to ten times the productivity in software testing without the developers having to learn new test methodologies.

Bringing hardware SOC chip techniques to code coverage and testing is delivering increased quality and faster time to market. Compiling a standard into an executable specification and using that to generate the test streams automates the testing of standards-based blocks. Using random yet repeatable data to test the options and branches of complex software helps improve the quality of the software and soothe performance of the system.

Key trends for development systems in 2014

By Nick Flaherty

FUNCTIONAL SAFETY, SOME parts of the Internet of Things and increasing consolidation are all going to be key trends for development systems in 2014, according to Stefan Skarin, CEO of Swedish ARM specialist IAR Systems. However the rise of Intel into the Internet of Things and more x86-based embedded devices isn't an issue.

"It's going to be a good year for the hardware side," he said. "Trace functionality is increasing and more and more companies are moving to trace. With the Cortex A and R you need a trace solution and it comes for free so people assume its automatically in there for other devices. "

This is a key part of the increasing move to designs where safety is important, from automotive to pharmaceutical equipment. "Functional safety is a very interesting segment and I think we see more real projects where companies invest in functional safety," he said.

A key example of this is Wittenstein High Integrity Systems in Bristol, which extended its SafeRTOS Real Time Operating System to support IAR Systems' safety certified development tool-chain IAR Embedded Workbench for ARM.

IAR Systems' CEO Stefan Skarin: "There are a lot of x86 and MIPS legacy designs out there but if they move, they move into the ARM market"

SafeRTOS is an IEC61508 SIL 3 safety certified Real Time Operating System that delivers high performance and dependability to safety critical applications, whilst utilising minimal resources. Used throughout the Industrial, Medical, Nuclear and Transportation sectors, SafeRTOS is supplied with a Design Assurance Pack supporting certification to a wide range of international design standards.

IAR Embedded Workbench for ARM includes pre-certified tools that simplify the certification process of the end product as they remove the need to generate a time consuming and problematic 'proof of use' claim against the tool. Instead the developer only needs to show compliance with the constraints defined within the all-important Safety Manual.

The initial SafeRTOS port supporting IAR Embedded Workbench has been developed for use with the Hercules Safety Controller from Texas Instruments. "We see an increasing number of our customers replacing components they have traditionally used in their safety critical products in preference for modular, safety certified alternatives," said Andrew Longhurst, Engineering Manager for Wittenstein. "Our customers are seeking the benefits of using pre-certified components including outstanding levels of determinism and robustness, but also a smoother and quicker route to achieving their own product certification."

"Companies developing safety-related applications can benefit greatly from the combined offerings of WHIS and IAR Systems," said Anders Holmberg, Product Manager for Functional Safety, IAR Systems. "Using pre-certified, highly integrated tools will simplify their certification process, which will enable them to save time as well as money. Thanks to IAR Systems' extensive functional safety support and update agreement, they can also be sure their development tools investment is protected throughout the product life cycle."

Wittenstein provides board support packages for use with SafeRTOS which include USB, data storage and networking components, as well as bespoke drivers.

The Renesas functional software package for its 32-bit RX631 and RX63N microcontroller is also coming to the market through IAR this month (February 2014), providing a self-test diagnostic software library and a complete safety manual.

The new solution provides diagnostic software for the RX CPU core and its internal memory, and a detailed safety manual to significantly reduce development time for designs that need to conform to stringent safety directives for industrial equipment, such as safety controllers, programmable logic controllers, industrial motor drives and safety sensors.

"Compliance with safety directives such as IEC61508 is a necessary yet complex process for developers designing industrial or safety systems," said Ritesh Tyagi, Senior Director, Marketing, Renesas Electronics America, Inc. "Renesas' new RX Functional Safety solution simplifies this process by providing pre-certified diagnostic software and a comprehensive

Safety Manual that reduces design risk and development time, allowing engineers to focus on their core competence."

To conform to functional safety, system manufacturers need to perform safety analysis not just at the system level, but also down to the device level. Safety analysis includes failure mode analysis, consideration of diagnostic methods, and assessment of its diagnostic coverage. Doing these tests and trying to get detailed test analysis from the device manufacturer is a significant burden.

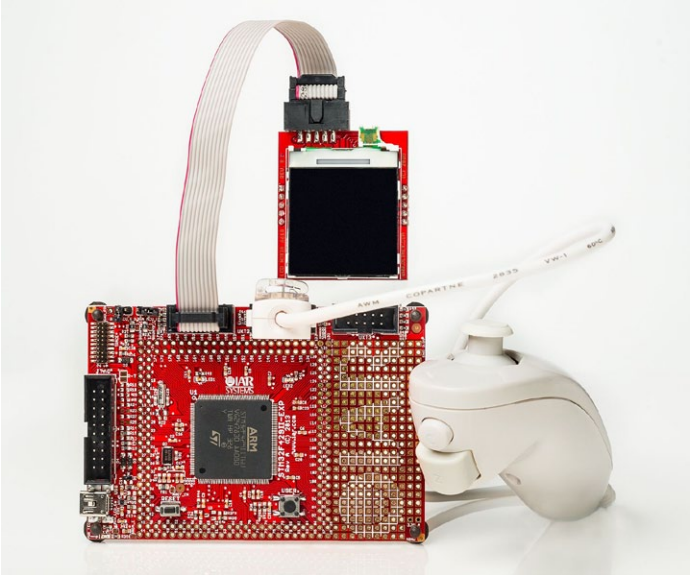
The RX631 and RX63N MCUs are high-performance, 32-bit MCUs that operate at 1.65 DMIPS/MHz, and include a floating point unit (FPU), hardware multipliers & MAC, flash operation without wait states, memory sizes up to 2MB of on-chip flash, and a rich set of peripherals such as multiple timers, high speed analogue, Ethernet connectivity, and built-in safety-related functions. By using the new functional safety solution, system manufacturers can easily apply functional safety to their systems using the RX631 and RX63N MCUs. The diagnostic coverage of the CPU core has undergone comprehensive fault simulation tests to make it easy to show the basis of the coverage estimation and enables effective system integration.

The benchmarking of low power devices is also an issue, he says. "The message it totally confusing, many of my customers assume everything is low power," said Skarin. "It's a scattered picture."

There is also more consolidation set to happen. "We've seen Silicon Labs buy Energy Micro and Ember, NXP buy Code Red, the ARM acquisitions, I think we will see more consolidation and competition."

But that's not necessarily from Intel with its Edison SD-sized PC and Galileo development board and Quark cores. "It's all about the ARM market," said Skarin. "There are a lot of x86 and MIPS legacy designs out there but if they move, they move into the ARM market," he said.

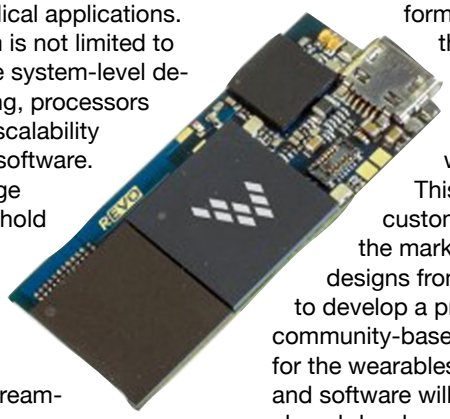
"The new competition coming you can bet will be ARM-based. The other risk is that you have a need for a global solution. I see a trend where US customers are bringing development back from China, India, the Ukraine and this means customers need a global solution, not different stacks or RTOS in different regions. There are few global players in this area," said Skarin.



IAR's ARM-based game controller development kit.

Open source wearables reference platform supports multiple applications

Freescale Semiconductor has launched an open-source, scalable reference platform for OEMs to develop a wide range of wearable product designs from a common platform. The wearables reference platform (WaRP) is based on Freescale's single core i.MX6 and Kinetis processors for multiple vertical segments such as sports monitors, smart glasses, activity trackers, smart watches and healthcare/medical applications. Unlike other wearable solutions, the platform is not limited to just one form factor or product category. The system-level design kit supports embedded wireless charging, processors and sensors within a hybrid architecture for scalability and flexibility, and comes with open-source software.



"Wearables represent one of the ultimate edge node sensors for the Internet of Things, and hold tremendous promise for equipment makers, service providers and consumers alike," said Rajeev Kumar, director of worldwide marketing and business development for Freescale's Microcontrollers business. "This new solution is engineered to dramatically streamline the design and development of exciting new wearables products. It allows designers and OEMs to go from concept to prototype as quickly as the market is changing."

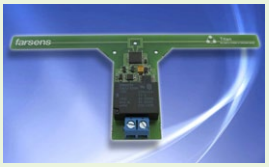
WaRP speeds and simplifies development by addressing many of the top technology challenges of the wearables market – connectivity, usability, battery life and miniaturization – thereby freeing developers to focus on creating differentiated features. The platform is built on Freescale's i.MX 6SoloLite ARM Cortex-A9 apps processor as the core processing unit, supports the Android OS, and integrates production-grade silicon, software and hardware. The BOM-optimized hybrid architecture also features Freescale's Xtrinsic MMA9553 turn-key pedometer, award-winning FXOS8700 electronic compass and ARM Cortex-M0+ Kinetis KL16 microcontroller. WaRP is a result of collaboration between Freescale, Kynetics and Revolution Robotics. Kynetics provides the expertise for the platform's software, and Revolution Robotics supplies the solution's hardware. Freescale, Kynetics and Revolution Robotics worked together to develop a platform that is both scalable and modular for various usage models in the wearables market.

This hybrid architecture-based platform enables customers to address different and new verticals as the market evolves, and to scale and customize their designs from both a hardware and software perspective to develop a product, or even an entire portfolio. A nonprofit, community-based organization will provide service and support for the wearables reference platform. The solution's hardware and software will be open sourced and community-driven. No closed development tools or licensing fees are required when used in conjunction with open source resources. In addition, WaRP will have its own .org community to drive innovation in the market. The wearables reference platform kit includes the main board, a daughter card, an LCD display battery and a micro USB cable.

Freescale Semiconductor
www.warpboard.org

Bistable RFID relay can be activated in range up to 1.5m

The TITAN from Farsens S.L. is a battery free RFID bistable relay tag compatible with commercial EPC C1G2 readers. The relay can be wirelessly activated and deactivated via its unique ID and keeps its latest status even when the RFID reader is gone. The device has a 96-bit EPC number, a 32-bit TID and a password protected Kill command. Built in a PCB format, it is available in different sizes. The device operates in the -30 to +85°C temperature range. The actuator tags are available in a variety of antenna design and sizes, depending on the specific application. They can be encapsulated in an IP67 or IP68 casing for usage in harsh environments.



TITAN tags are used in energy scarce applications where the stored energy is limited and the system's circuit can be opened and closed using a commercial RFID reader.

Farsens S.L.
www.farsens.com

Starter Kit for nanoRISC Processor modules based on the TI AM335x

The MSC NANORISC-SK-MB2 starter kit from MSC Vertriebs GmbH consists of the versatile MSC nanoRISC-MB2 baseboard with a power supply, a 7" WVGA TFT display and a 7" PCT touch panel. A Debian Linux operating system installation on a bootable SD card or downloadable or free is ensuring immediate operation of the starter kit. Even though the carrier board MSC nanoRISC-MB2 used for the starter kit provides an input for resistive 4-wire touch panels, a controller for projected capacitive touch (PCT) panels was added to the most recent board revision, enabling users to follow the general trend to user-friendly iPhone-style user interfaces which are increasingly found in industrial applications. Along with the starter kit, the user can choose the 70x50mm nanoRISC module from the MSC NANORISC-AM335x family from MSC. These boards are based on the Texas Instruments AM335x ARM Cortex-A8 processor. The AM3352-based module is clocked at 300MHz and draws 1.7W, while the entry-level module based on the AM3354 CPU board is clocked at 800MHz and provides hardware 3D graphics acceleration. This more powerful nanoRISC module consumes less than 2W of power and can also be operated without any cooling. These processor modules can hold up to 512 Mbyte of DDR3 DRAM, up to 512 Mbyte of SLC NAND Flash and optionally up to 64 Gbyte eMMC Flash. They come with Ethernet, USB, CAN, UART, SPI, I2C and I2S audio and support direct LCD drive (16/18/24 bit RGB) at a resolution of up to HD. Further options include a versatile Programmable Real-time Unit (PRU) allowing fast response to real-time events and Industrial Ethernet for industrial field bus applications.

MSC Vertriebs GmbH
www.mscembedded.com

Intel pushes into wearable designs with energy harvesting earphone reference designs

Intel has developed a reference design for smart earbuds that provide biometric and fitness information, harvesting energy from the audio stream, as well as a Bluetooth speech recognition headset. The smart earbuds (above) are aimed at fitness enthusiasts and is unique for being built into an accessory that many people already wear when they exercise. They provide full stereo audio and monitor heart rate and pulse, while the applications on the user's phone keep track of run distance and calories burned. The product also includes Intel-developed software that enables users to precision-tune workouts and acts as a coach, automatically selecting music that matches the target heart rate profile.

In addition to the convenience of having biometric and fitness tracking built into the earbuds, Intel designed the product in such a way that eliminates the need for a battery or additional power source to charge the product, as it harvests energy directly from the audio microphone jack. The smart earbuds use sensor technology developed in collaboration with Valencell and its PerformTek Precision Biometrics that continuously measure real-time biometric data with a high degree of accuracy and consistency and uses this data to give people meaningful fitness assessments.

Intel
www.intel.com

Bluetooth starter kit and software speeds up dual mode development

The BMSKTOPASM369BT starter kit from Toshiba Electronics Europe is based around a Panasonic PAN1026 module featuring an embedded TC35661SBG-501 ("Chiron-501") dual mode Bluetooth IC and includes a Toshiba TMPM369 ARM Cortex-M3 based MCU with 512KB flash memory. The embedded dual mode software has an easy to use, high level Serial Port Profile (SPP) and Bluetooth Low Energy (LE) GATT API for device set up, connection and data transfer. A high level driver layer allows access to the function set of the Bluetooth IC. Application examples are provided on the internet that can be compiled to run on the TMPM369 MCU with FreeRTOS integration (OS itself is available from Real Time Engineers Ltd). The application software includes a set of BLE standard reference profiles and a design guide on how to develop a proprietary BLE profiles. A J-Link JTAG debugger interface incorporated in the starter kit board is compatible with commonly available third party toolchains such as those from Atollic, IAR and Keil. The embedded MCU also supports standard interfaces on the board for Ethernet, CAN, USB (host and device), serial and UART connection. Compliant with the Bluetooth v4.0 communication standard, Toshiba's Chiron IC can support both Bluetooth Classic and Low Energy communications.

Toshiba Electronics Europe
www.toshiba-components.com

System-on-module optimizes power line communications

Texas Instruments has collaborated with Tailyn Technologies to offer a field-tested PLC module that can be customized in terms of form factors, communication interfaces and applications to meet any design needs. The module can be used to create products that support multiple PLC standards and enable a wide variety of customizations based on utilities' design need to address time-to-market, performance and certification requirements. Pairing TI's real-time C2000 microcontroller with its AFE031 or AFE032 PLC analog front ends provides support for multiple PLC standards, including S-FSK, G3, PRIME, and IEEE-1901.2. The field-tested PLC module is ready for many types of conditions found in real-world smart grid implementations, such as automatic meter reading (AMR) or advanced metering infrastructure (AMI) metering, solar invertor control, street lighting control, and machinery control. Developers can expect a high-quality product that will meet the individual needs of their implementation. An accompanying reference design can be customized with application-specific software.

Texas Instruments
www.ti.com

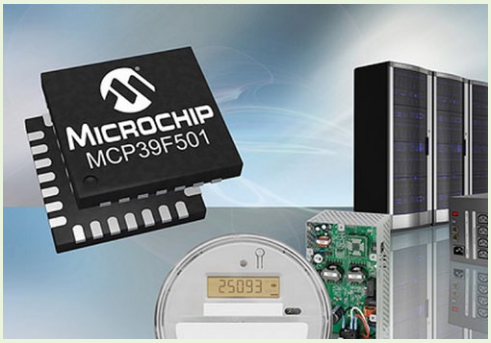
T8 LED tube family reduces energy costs by over 60 percent

Soitec Lighting has unveiled a T8 LED tube product family for the North American market. The line of solid-state replacement products for fluorescent T8 tubes complements Soitec's existing European tube series. With illuminating power above 110 lumens per watt in neutral white (4,000 degrees K), resulting in energy savings of more than 60 percent compared to fluorescent tubes, Soitec's LED tube is an efficient LED lighting solution. In addition, it has a lifespan of 50,000 hours – more than four times longer than the fluorescent tubes that it is designed to replace. The long-life solution reduces maintenance costs and, together with its high energy efficiency, offers a return on investment (ROI) of less than two years in typical applications. The new LED tube family from Soitec features a diffuser to produce glare-free, high-quality light with a beam spread of either 120 or 170 degrees, depending upon the product configuration. The system has a color rendering index (CRI) in excess of 80 and is available in color temperatures of 3,000, 4,000 and 6,000 degrees K. The solution uses a standard G13 connection and is available in the standard lengths of 600 mm (2 ft), 1,200 mm (4 ft) and 1,500 mm (5 ft), making it fully compatible with existing fluorescent tube holders. The tube's performance and physical design make it a desirable replacement solution for use in public places including underground garages, retail stores, warehouses, industrial sites, equipment rooms, offices, corridors and meeting rooms. Soitec tubes contain neither mercury nor lead, and comply with all Restriction of Hazardous Substances (RoHS) directives. They are UL/DLC certified for the U.S. market as well as CE certified and CEM compliant for Europe. DLC certification may qualify the product for an energy-saving subsidy program from utility companies in the U.S. or Canada. In Europe, Soitec tube solutions helped to win a high-volume order from Paris Métro (the RATP). Installed throughout mass-transit stations in Paris since April 2013, Soitec's LED tubes are now running 24 hours per day and, according to RATP, reducing energy consumption by 67 percent. An additional installation in the Netherlands has seen the municipality of Arnhem selecting Soitec's LED tubes for lighting a public parking garage.

Soitec Lighting
http://lighting.soitec.com

Power monitoring IC measures AC power in real-time

Microchip Technology Inc., has introduced a highly integrated, single-phase power-monitoring IC designed for real-time measurement of AC power. The MCP39F501 power monitoring IC includes two 24-bit delta-sigma ADCs, a 16-bit calculation engine, EEPROM and a flexible two-wire interface. An integrated low-drift voltage reference in addition to 94.5 dB of SINAD performance on each measurement channel allows accurate designs with 0.1 % error across a 4000:1 dynamic range. The IC allows designers to add power monitoring to their applications with minimal firmware development. The device's performance enables designs capable of 0.1% error over a wider dynamic range and superior light load measurement versus current competing solutions. In an effort to improve power management schemes in power-hungry applications, such as data centers, lighting and heating systems, industrial equipment and consumer appliances, power-system designers are driving the need for enhanced power monitoring solutions.



The built-in calculations include active, reactive and apparent power, RMS current and RMS voltage, line frequency, power factor as well as programmable event notifications. The MCP39F501 device enables high-performance, cost-effective designs in the commercial (server and networking power supplies, power distribution units, lighting systems); consumer (appliance and smart plugs); and industrial markets (e.g., power meters and industrial equipment), among others. Additionally, the wide operating temperature range from -40°C to +125°C allows the MCP39F501 to be utilized in more extreme environments, such as industrial machinery applications.

Microchip Technology Inc.
www.microchip.com

CAN to WLAN Gateway facilitates testing

During the test phase of a new car or an industrial installation it can be necessary to connect data acquisition systems and test data generators to the internal CAN bus of the vehicle or automation equipment. PEAK System's PCAN Wireless Gateways bridges the gap between these worlds by connecting of CAN busses to a WLAN. The gateway wraps CAN frames into TCP or UDP message packages and forwards them across the IP network. Configuration of the devices is provided by a web interface. It provides two High-speed CAN channels with a bit rate of up to 1 Mbit/s. The WLAN interface supports IEEE 802.11 b/g and establishes its connection via an internal chip antenna. Thanks to its extended operating temperature range of -40 to 85°C the PCAN-Wireless Gateway is suitable for use in industrial and automotive environments.

PEAK System
www.peak-system.com

Hot-switchable variable attenuators up to 6 GHz

Fairview Microwave's compact hot-switchable variable RF attenuators can be used to reduce the amplitude of an electronic signature in many common electronic scenarios including lab testing equipment, distributed antenna systems (DAS) and power and signal monitoring systems. The devices come in 3 and 6GHz frequency models and several different connector configurations including SMA and N type connectors with side or rear mount positions. Several of these attenuators are hot-switchable, meaning attenuation can be changed on the fly without powering down the system, allowing test data to be read continuously. Several models with varying attenuation adjustments are available including 0 to 12 dB attenuation in 1 dB steps and 0 to 40 dB attenuation in 10 dB steps, with other options available upon request.

Fairview Microwave
www.fairviewmicrowave.com

Peer-to-peer database simplifies IoT smart data discovery

ITTIA has introduced version 6.0 of its flagship database software, ITTIA DB SQL, which brings new intelligence to data management on embedded systems and devices with true peer-to-peer replication. As the Internet of Things (IoT) will soon comprise billions of connected devices, discovery of proximate devices is a key component of new applications. By advertising and discovering nearby database replication services, ITTIA DB SQL 6.0 greatly simplifies interoperability between home automation systems, automotive entertainment systems, mobile handsets, and more. In this new hyper-connected world, devices can relate information to each other indirectly through cloud-based services on the Internet and directly over WiFi and other wireless technologies.

This new release enables embedded systems, appliances, and personal devices to distribute locally stored data whenever a wireless connection is detected. The application software simply stores records in a replication-enabled database and authorized devices nearby will automatically receive a copy of the changes. This makes it easy for applications on diverse operating systems to interoperate and provide a seamless user experience.

Version 6.0 also brings improvement throughout ITTIA DB SQL, from utilities down to the core transactional storage kernel. The ITTIA SQL Browser, which provides a graphical interface to create and edit embedded database files, can now also provision back-end RDBMS servers such as Microsoft SQL Server and Oracle Database to synchronize with ITTIA DB SQL.

ITTIA
www.ittia.com

Power LEDs get their dedicated thermoelectric cooling unit

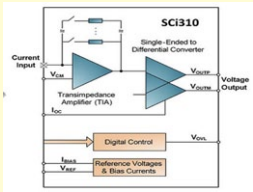
Laird's latest Tlam OptoTEC series of miniature thermoelectric modules (TEMs) are built using the company's conductive circuit boards instead of traditional ceramic-based circuit boards.

They are designed for applications where temperature stabilization of sensitive optical components is critical. The use of the circuit board improves the heat pumping capabilities of the device while providing excellent heat spreading, improved reliability and lower cost in high volume when compared to traditional heat removal systems. Tlam is used in applications where the components in the circuit produce a lot of heat, such as high powered LEDs, power supplies or motor drives. The Tlam circuit boards feature a thin layer of thermally conductive dielectric material sandwiched between a top layer of standard copper foil and a thick metal backing plate for structural strength and improved heat spreading. The combination of the Tlam circuit board with the thermoelectric offers a completely new way to design thermal rejection systems and can reduce the complexity of moving heat away from sensitive devices. The Tlam OptoTEC series includes seven new modules that can create a temperature differential (ΔT) of up to 67°C and pump from 1.5 to 9.0 watts of heat at an ambient temperature of 25°C. At 85°C, the series can create a ΔT of 77°C and pump 1.6 to 9.9 watts of heat.

Laird
www.lairdtech.com

AFE block serves as I/V converter for sensors

Fabless analog chip company JVD Inc working with partner Systemcom Ltd has developed an analog front end (AFE) intellectual property block designed to condition signals from sensors where the proportional output of the transducer is current. Apart from that restriction, the block is designed to be suitable for a variety of sensor applications based on optical, mechanical, chemical and other methods. The block is available for license for inclusion in ASICs and system chips.



It is intended for applications ranging from optically based monitoring through medical, and life-science systems up to consumer smartphones and onto industrial applications. The Si310 converts current captured from the sensor system to a differential output voltage, ready to be amplified. The current to voltage conversion is achieved using a proprietary transimpendance amplifier (TIA) architecture with 8 digitally programmable current ranges, extending from 8 microamps up to 1 milliamp in binary increments making the block suitable for connection to a wide variety of sensors with varying full-scale current outputs. One of the functionalities that the SCi310 provides is maintaining constant voltage at the input pin for all operating modes and input currents. This useful when biasing PIN diodes in the photoconductive region. The IP block can measure input current values in the range of hundreds of picoamps up to 1 milliamp.

Systemcom
www.systemcom.hr

Grab a full HD 1920x1080 transparent display kit!

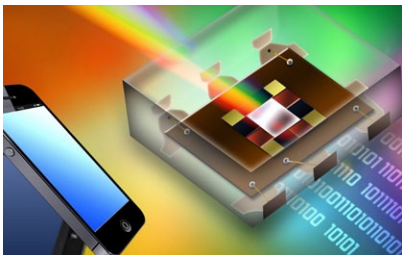
This month, Crystal Display is giving away a full HD 21.5" transparent display panel complete with its metal frame housing, an industrial interface card and a custom power supply, worth $1300, for EETimes Europe's readers to win. The display comes as an alternative to Samsung's LTI220MT02 transparent LCD panel which are no longer produced by the manufacture. This translucent display offers a really interesting concept for the point-of-sale market place as well as unique applications such as transparent showcases and kiosks and could set a new standard for POS display. The sunlight-readable display is supplied with a compatible HD media player or a compatible interface kit including USB and HDMI inputs. There is an option for a multi-touch IR touchscreen capability too.

Crystal Display
www.crystal-display.com

Check the reader offer online at www.electronics-eetimes.com

RGB digital light sensor automatically tunes displays brightness

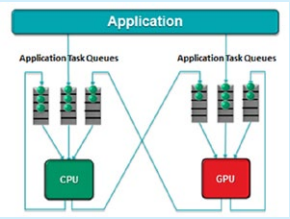
The ISL29125 RGB digital light sensor from Intersil helps engineers optimize the display resolution and colour quality of mobile devices and TVs in all lighting environments. The chip communicates directly with a device's core processor to enable the automatic adjustment of display brightness based on changing light conditions, providing consumers with a crisp and colour consistent experience while extending battery life. The chip comes as a 6-lead 1.65x1.65x0.75mm RGB sensor. With integrated, robust on-chip IR filtering technology and an angular response of a minimum of +/- 35% field of view at 50% light intensity, the ISL29125 RGB sensor eliminates display fluctuations, whether one is in an incandescent lit classroom, an LED lit store or outdoors in the sun. More specifically for organic light-emitting diode (OLED) display TV applications, the ISL29125 can be used to adjust the blue organic material ageing profile to maintain consistent contrast and brightness throughout the life of the display. The IC operates from 2.25 to 3.63V, it has a wide dynamic range of 5.7m lux to 10k lux detection capabilities. In power down mode, the RGB sensor consumes less than 0.5uA of current and on active mode it runs at approximately 85uA.



Intersil
www.intersil.com

New AMD CPUs aim for UltraHD screens

The latest A-Series Accelerated Processing Units (APUs) from AMD are adding new graphic cores to support UltraHD 4K resolution screens. The new A-Series APUs add the Radeon R7 graphics, codenamed "Kaveri" with up to 12 compute cores (4 CPU and 8 GPU in a Heterogeneous System Architecture (HSA). This is



a new intelligent computing architecture that enables the CPU and GPU to work seamlessly by streamlining right tasks to the most suitable processing element, resulting in performance and efficiency for both consumers and developers. The support for UltraHD (4K) resolutions and new video post processing enhancements that will improve 1080p videos when upscaled on UltraHD-enabled monitor or TVs, and the APUs use the current FM2+ socket compatibility for a unifying motherboard infrastructure. The AMD A-Series APU processor-in-a-box (PIBs) for the AMD A10-7850K and AMD A10-7700K, which started shipping in Q4 2013, are available starting today. The AMD A8-7600 will be shipping in Q1 2014.

AMD
www.amd.com

45W and 60W LED driver offers 3-in-1 dimming functionality

Recom Lighting has introduced new series of 45 W and 60 W LED drivers for constant current LED luminaires. The RACD45-A and RACD60-A series come with a 3-in-1 dimming function so that the modules can be controlled with analog (1-10 V), PWM, or external resistor dimming. The series operate with input voltages between 90 VAC

and 305 VAC and include 4 different models with current outputs ranging from 700 mA to 1850 mA (RACD45-A) and from 1050 mA to 4200 mA (RACD60-A). Due to their IP67-rated enclosures, these drivers are protected against dust and moisture so they can be installed in industrial or out-buildings as well as damp rooms like bathrooms or basements. These class 2 power supplies operate at temperatures ranging from -30°C up to 65°C, have efficiencies of more than 87% and feature low THD and an excellent power factor (>0.98 at 120 VAC, >0.93 at 240 VAC and >0.9 at 277 VAC). The LED drivers are UL8750 and EN61347 certified and comply with the European harmonics standard EN61000-3-2 Class C. They come with a five year warranty.

Recom Lighting
www.recom-lighting.com

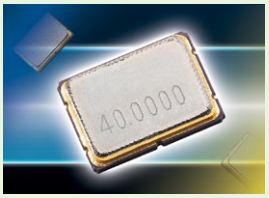
Open LED protector prevents damage from reverse polarity voltages

Littlefuse has introduced the PLEDxUx Unidirectional Series Open LED Protector, the latest addition to the company's broad portfolio of PLED Open LED protection devices. The device provides a switching electronic shunt path when one LED in a string fails as an open circuit. PLED devices are connected in parallel with each LED in a series string. If one LED fails, the PLED connected to it turns on and carries the current that would have gone through the failed LED, so the remainder of the string continues to function. PLEDxUX devices provide reverse battery/power polarity protection for greater LED reliability. Typical applications include street, subway, runway, and tunnel lighting, as well as headlights, roadside warning lights, and signage. PLEDxUx Series devices are compatible with 1-watt LEDs, nominally 350mA at 3V. Two different low-profile packages maximize heat dissipation and layout flexibility. In contrast with earlier open LED protection solutions such as silicon controlled rectifiers (SCRs) and zener diodes, the PLEDxUx Series offers higher reliability and lower maintenance requirements. Zener diodes create additional power dissipation once the LEDs they're protecting fail open. They are also not rated for large DC currents.

Littlefuse
www.littelfuse.com

2.5x2.0mm SMD crystal up to 125 MHz fundamental frequency

The SMD02502/4 MINI-SMD crystal from PETERMANN-TECHNIK comes in a ceramic casing of 2.5 x 2.0 mm (4pad) and offers a massive fundamental frequency spectrum of

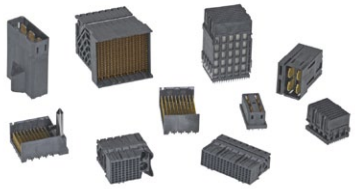


12.0 to 125.0 MHz. This MINI-SMD crystal offers a frequency tolerance of ±10 ppm and a temperature stability from ±8 ppm. The user can choose from aging rates of ±1 ppm to ±3 ppm/year, which means that the frequency tolerances, as well as narrowband and broadband wireless applications, can be realised. The crystals, which can be easily configured with a Pierce oscillator (with two external capacities to GND), can also replace high-frequency third overtone crystals and high-frequency crystal oscillators (as long as this is possible with the IC being used). In addition to wireless applications, this crystal can also be used in telecom, medical and industrial applications. Thanks to its very high fundamental range, it also opens up simple opportunities for circuit designers.

Petermann-Technik
www.petermann-technik.com

100-Ohm backplane connector will support 25 Gbps data rates

A range of modular backplane connector features low mating force and a 1.90 x 1.35 mm pitch for optimal performance in traditional backplane and midplane architectures. Molex' Impact



100-Ohm backplane connector offers speed and density in a modular package designed for high speed applications, with data rates up to 25 Gbps and signal density up to 80 differential pairs per linear inch when using a 6-pair configuration. The Impact backplane connector is suitable for high speed networking equipment and storage servers in the data and telecommunications, medical, military and aerospace industries and conforms to IEEE 10GBASE-KR and OIF Stat Eye Compliant end-to-end channel performance. With a 1.90 x 1.35 mm grid, which reduces PCB routing complexity and cost, the broad-edge coupled, differential-pair Impact backplane system supports high bandwidth needs while minimising board and system real estate usage. Compliant pin attach options (0.39 and 0.46 mm) provide the flexibility to optimise designs for superior mechanical and electrical performance in traditional backplane or midplane architectures. The Impact daughtercard mating interface uses an in-line staggered, bifurcated contact system that reduces the mating force per pin and provides ground-signal sequencing without the need for multiple backplane signal-pin heights. Available in conventional, coplanar, mezzanine, orthogonal and orthogonal direct configurations, signal module options vary by configuration and are offered in two to six 6 pairs. Power modules are available in three to six pair sizes in conventional, coplanar and mezzanine configurations with current ratings from 60.0 to 120.0 A per module.

Molex
www.molex.com

Line-scan cameras provide 2k resolution

Teledyne Dalsa (Waterloo, Ontario) has released two additional members within its Piranha-4 family of line-scan cameras, bringing the model count to more than 10. The new cameras have 2k resolution and combine CMOS image sensor improvements with improved signal-to-noise ratio for monochrome and color imaging. The monochrome Piranha-4 dual-line scan camera delivers a maximum line rate of 100kHz in TDI mode, or 200kHz in rea mode. The Piranha-4 2k trilinear model delivers a maximum line rate of 70kHz. Advanced features include sub-pixel spatial correction, lens and shading correction, and flat field correction. Both the color and monochrome models provide a GenICam-compliant interface with cable lengths of up to 30 meters. Color applications include print inspection, banknote inspection, package and label inspection, and food inspection. Monochrome applications include railway inspection, printing, wood, film, and label inspection, and general machine vision applications.

Teledyne Dalsa
www.teledynedalsa.com

High temperature DC-DC converters for down-hole tools reduce design time

International Rectifier, has introduced the HTH27022S and HTM27092S isolated hybrid hermetic DC-DC converters for high temperature and high shock environments such as oil drilling applications and mud turbine generators.

Featuring an operating case temperature of 165ºC with transient up to 175ºC and with a high nominal input voltage of 270 V, the HTH27022S and HTM27092S are commercial off-the-shelf (COTS) converters that can reduce design cycle time, size and design costs associated with high temperature applications.

The HTH27022S and HTM27092S products feature internal EMI filter, magnetically coupled current feedback, undervoltage lockout, output over-voltage limiter, external inhibit and short circuit and overload protection.

Additional features include small size, low weight and high tolerance to environmental stresses such as wide temperature extremes and severe shock and vibration. Electrical and environmental qualification reports are available for order through local sales representatives.

International Rectifier
www.irf.com

Vicor boosts Northern European sales together with Firefly

Vicor Corporation is expanding the company's sales and support network in Northern Europe by partnering with Firefly Technology which will represent Vicor in the UK, Ireland, Denmark, Sweden, Finland and Norway. With this initiative Vicor is strengthening its investment and market reach in the region, establishing and cultivating new customer relationships in close cooperation with Vicor's regional distributors. Headquartered in the UK, Firefly Technology plans to work with Vicor's distributors to identify sales opportunities and penetrate new markets. Firefly Technology brings to Vicor keen insight into the Northern European market, and provides its customers with invaluable technical guidance at every stage in the system development cycle, from concept to final design. The Hampshire-based company aims to act as an outsourced sales and support team and typically adopts a whole product eco systems.

Vicor Corporation
www.fireflytech.com

Acal BFi renews European distribution agreement with Delkin Devices

Acal BFi has signed a new European distribution agreement with Delkin Devices, a USA-based manufacturer of industrial flash storage solutions. The distributor works closely with customers to understand their requirements, to recommend the most appropriate device, increasing the chances of qualifying a product first time around and reducing the overall time to market. "As the leading supplier of rugged industrial solid state storage products, working with Acal BFi is a natural fit for Delkin Devices.

Acal BFi
www.acalbfi.com

System-on-Module in credit card format

The credit card-sized M-9G45-A board PC offered by independent German distributor acceed features an ATMEL 400 MHz processor and is equipped with 128 MB DDR2 random access memory (DRAM) as well as NAND flash memory with 128 MB. The memory can be extended via an SD interface for memory cards with up to 32 GB. Measuring only 80×50mm, the board PC is easy to fit into the smallest housings for space-critical applications in industrial and medical technology. The new Linux-based M-9G45-A comes with a variety of interfaces: 4 × UART, 1 × USB-2.0 (480 MBit/s), 1 × I²C, 1 × I²S, 1 × SPI, 1 × Ethernet and an interface for audio output. With its TTL/LCD monitor interface incorporating brightness control, the M-9G45-A supports TFT monitors up to a resolution of 1280×860 pixels.

acceed
www.acceed.de

Richardson RFPD expands video selection in its online design resource centre

Electronic components distributor Richardson RFPD, has expanded its video selection online, covering a range of topics from new product introductions to design tutorials and product family overviews. In addition to a robust technical library of application notes, tutorials, white papers and videos, Richardson RFPD's Design Resource Centre offers a full slate of design tools, including application design assistance, block diagrams, calculators and converters, cross reference support, design kits and evaluation boards, line cards, selector guides, and technology-specific Tech Hubs.

Richardson RFPD
www.richardsonrfpd.com

EBV's sensorTAG demonstrates various sensing technologies and BLE connectivity

EBV Elektronik's sensorTAG demokit features the sensorTAG, a battery-powered sensor hub, and a USB-to-BLE nanoDONGLE measuring 9x17mm. sensorTAG provides an industry-standard sensor portfolio (STM, Freescale, TI) combined with TI BLE connectivity, and includes EBV system knowledge and support for related software and hardware. A NXP humidity/light sensor is also featured as demonstration device. The Sensors chosen by EBV represent a complete offer enabled for low power operation and are either 'high-runners' in the industry or bring innovative and exciting features for the latest applications..

EBV Elektronik
www.ebv.com/sensortag

Super-flat, non-contacting rotary sensor

Made by Novotechnik, the German sensor and sensor systems specialist, and available in the UK via Variohm EuroSensor, the RFD series is a super-flat non-contacting Hall Effect rotary sensor. Amongst magnetic technologies, Hall Effect-based sensors yield absolute measurements which are reliable even under tough environmental conditions. The RFD component series of non-contacting Hall Effect-based components is mechanically and electrically compatible with its predecessor, the RFA, at a lower cost, with no technological compromises. The sensors are suitable for measurement angles of up to 360°. They offer a 12-bit resolution and an independent linearity of ±0.5%, and they are available in single, partially, or completely redundant designs. The flat sensor housing is only 7mm thick.

EuroSensor
www.variohm.com

EE Times europe

PUBLISHER
André Rousselot
+32 27400053
andre.rousselot@eetimes.be

EDITOR-IN-CHIEF
Julien Happich
+33 169819476
julien.happich@eetimes.be

EDITORS
Paul Buckley
+44 1962866460
paul@activewords.co.uk
Peter Clarke
+44 776 786 55 93
peter.clarke@eetimes.be
Nick Flaherty
+44 7710236368
nick.flaherty@eetimes.be
Christoph Hammerschmidt
+49 8944450209
chammerschmidt@gmx.net
Jean-Pierre Joosting
+44 7800548133
jean-pierre.joosting@eetimes.be

CIRCULATION & FINANCE
Luc Desimpel
luc.desimpel@eetimes.be

ADVERTISING PRODUCTION & REPRINTS
Lydia Gijsegom
lydia.gijsegom@eetimes.be

ART MANAGER
Jean-Paul Speliers

ACCOUNTING
Ricardo Pinto Ferreira

REGIONAL ADVERTISING REPRESENTATIVES
Contact information at:
http://www.electronics-eetimes.com/en/about/sales-contacts.html

EUROPEAN BUSINESS PRESS SA
7 Avenue Reine Astrid
1310 La Hulpe
Tel: +32 (0)2 740 00 50
Fax: +32 (0)2 740 00 59
www.electronics-eetimes.com
VAT Registration: BE 461.357.437
RPM: Brussels
Company Number: 0461357437

ELECTRONIC ENGINEERING TIMES EUROPE is published 11 times in 2014 by European Business Press SA, 7 Avenue Reine Astrid, 1310 La Hulpe, Belgium
Tel: +32-2-740 00 50 Fax: +32-2-740 00 59
email: info@eetimes.be. VAT Registration: BE 461.357.437.
RPM: Nivelles. Volume 16, Issue 2 EE Times P 304128
It is is free to qualified engineers and managers involved in engineering decisions – see:
http://www.electronics-eetimes.com/subscribe

Is graphene a real opportunity?

By Paul Buckley

DESPITE BEING A SUBSTANCE attracting a high level of excitement from researchers in a broad spectrum of the electronics industry, market intelligence analyst Yole Développement is only predicting that the graphene materials market will be worth $141 million in 2024.

Yole sees the market being driven mainly by transparent conductive electrodes and energy storage applications.

Novel properties including ultra-high electrical and thermal conductivities, wide-range optical transmittance and excellent mechanical strength and flexibility makes graphene a promising material for a whole host of electronics applications such as ultrafast transistors, touch screens, advanced batteries and supercapacitors, ultrafast lasers and photodetectors.

"Although today there is no graphene-based electronic application in mass production, several companies already offer commercially graphene materials. The graphene material market value in 2013 was about $11 million, represented principally by the demand for the R&D and prototyping," explained Dr Milan Rosina who is Yole Développement's analyst for photovoltaic market & technologies.

In a report entitled 'Graphene materials for opto & electronic applications' Yole estimates the global annual market value for graphene materials in opto and electronic applications will reach $141 million in 2024, featuring a 2013-2019 CAGR of 18.5%. Yole expects market growth to accelerate after 2019, with a 2019-2024 CAGR of 35.7%. In 2024, the graphene material market will be represented mainly by the demand for transparent conductive electrodes and advanced batteries and supercapacitors.

Although many leading device manufacturers are evaluating the graphene's potential; most of them have internal R&D activities or are developing R&D partnerships with graphene material suppliers. But today's graphene supply chain is widely dispersed and makes choosing the right supplier difficult. A large (and growing) number of start-up companies are looking to catch graphene market opportunities in their initial stage. Securing graphene IP appears to be crucial to a strong competitive position.

Yole anticipates strong vertical integration trends within the supply chain as the result of specific challenges in production and the handling of graphene materials such as CVD-made graphene sheets. The manufacturers of graphene nanoplatelets will also vertically integrate to gain a higher product value and better differentiation from competitors by offering application-specific materials, such as conductive inks and composite materials for graphene batteries and supercapacitors.

Yole points out that a higher level of standardization will be key to graphene technology rising to future commercial challenges. The lack of suitable graphene quality characterization tools provides opportunities for companies developing specialized tools.

The development and industrial production of new graphene applications require a reliable supply of graphene with consistently high quality.

The catalytic chemical vapor deposition (CVD) of graphene on metals, featuring the high potential for both scalability and high material quality, has the largest potential for mass production of graphene opto and electronic devices. Although the market potential of high-quality epitaxial graphene on SiC is limited by the dimensions and high costs of SiC wafers, it may be successfully applied to produce some high-end electronic applications. The nanoplatelets produced by different methods, such as liquid phase epitaxy or reduction of graphene oxide can be used to produce conductive inks for printed electronics and additive materials for energy storage devices, such as Li-ion batteries and supercapacitors.

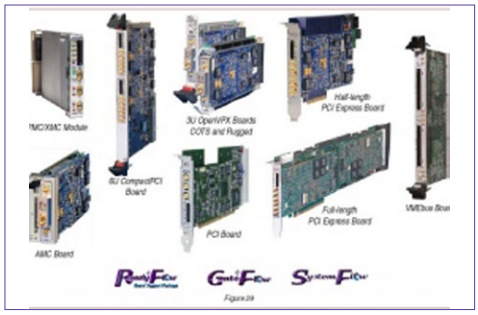
The choice of the graphene production technique is of crucial importance to a device manufacturer because it influences not only the graphene size, quality and costs, but also the design of the production line for device manufacturing.

Yole points out that large volumes of graphene materials can already be produced at relatively low costs and it is also possible to produce the high-quality graphene but the market analyst maintains that the critical challenge which needs to be overcome will be how to satisfy both conditions simultaneously.

A leading reference resource for electronics engineers, EE Times Europe's White Paper library includes over 600 white papers, application notes, technical articles, books and case studies that can be downloaded free of charge. The latest featured papers are available below.

Software-Defined Radio Handbook

The folks at Pentek, who wrote the book on software radio, are pleased to announce their expanded Software-Defined Radio Handbook. Updated recently, the handbook has proved to be a useful technical reference for engineers. Handbook highlights:



Technical methodologies for sampling and undersampling; Principles of SDR and FPGAs' role in software radio; SDR board-level products and real-time recording and playback instruments; Factory- installed FPGA IP cores for software radio; and SDR example applications.

www.electronics-eetimes.com/en/Learning-center/

Understanding WLAN offload in cellular networks

The coming challenge for Wi-FiTM offload is to provide a converged network solution for a seamless, transparent and better user experience. The user will not have to interact with its smartphone or mobile device in any way to switch from 3G/LTE to Wi-FiTM. The data stream will even be able to use both connections at the same time depending on QoS requirements. This short guide explores the technical aspects of Wi-FiTM offload architecture and its related capabilities. It concludes with an overview on testing methods.

www.electronics-eetimes.com/en/Learning-center/

High-voltage DC distribution is key to increased system efficiency

The pressure throughout the energy supply chain to deliver electrical power more efficiently is intense and growing, particularly in high load applications such as datacenters. The latest white paper from Vicor highlights how a transition to 400 VDC for power transmission and conversion offers tangible and significant benefits for both sourcing options and system performance. And provides a significant response to initiatives for reducing emissions of greenhouse gases, lowering energy consumption and increasing use of renewable energy sources.

www.electronics-eetimes.com/en/Learning-center/

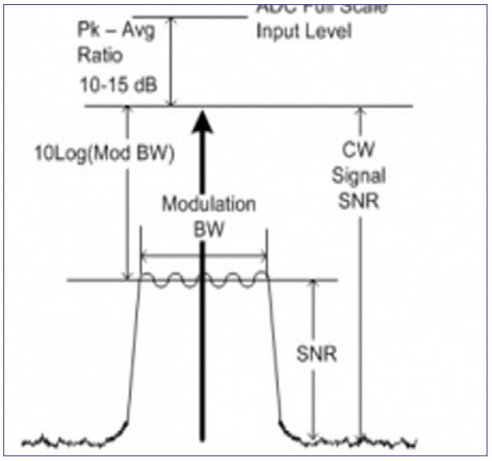
Solutions for LTE-Advanced Manufacturing Test – Understanding the Requirements for LTE

Carrier aggregation (CA), introduced in the 3GPP Release 10 standard, is an important new feature of LTE-Advanced. Carrier aggregation enables the combining of multiple LTE carriers into a larger, single-channel bandwidth to increase data rates and throughput. For operators with limited or fragmented spectrum allocations, carrier aggregation is a way to keep pace with the growing data demands on their networks.

www.electronics-eetimes.com/en/Learning-center/

Super-Heterodyne Signal Analyzers

Signal analyzers encompass test and measurement receivers known as spectrum analyzers and vector signal analyzers. The signal analyzer is to the frequency domain what the oscilloscope is to the time domain: a general purpose test instrument that can measure and display electrical signals.

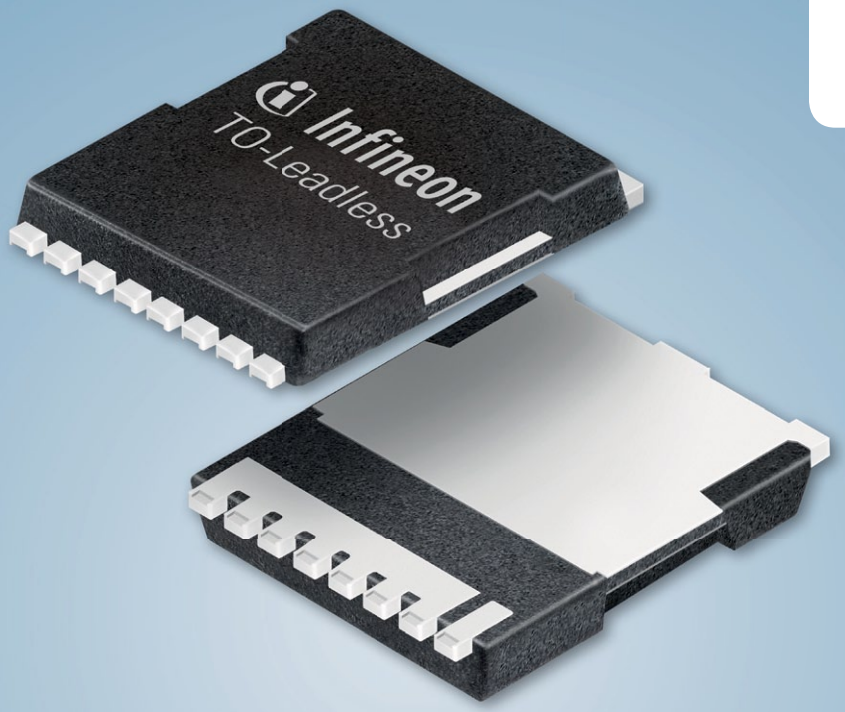


www.electronics-eetimes.com/en/Learning-center/

Using WiGig to enable PushVoD

The rise of the smartphone and tablet PC has driven an exponential growth in mobile video consumption. But the rise of ultra high-speed wireless technologies, such as WiGig, and the very large flash memory embedded in portable devices gives an opportunity to offload the bandwidth needs onto WiFi LANs; syncing video and large files to the mobile's cache – a technique called PushVoD. Here we look at PushVoD, the market, how to address the challenges, the opportunities for operators, how to exploit them and how to enable the technology on a mobile platform.

www.electronics-eetimes.com/en/Learning-center/



Join the TO-Leadless Webinar on February 27
Register at www.infineon.com/webinar

TO-Leadless

A Package Optimized for High Current Applications

Infineon's new TO-Leadless package is especially designed for high current applications such as Forklift, Light Electric Vehicles, e-fuse, PoL (Point of Load) and Telecom where highest efficiency and reliability are required. 300A continuous current can now be handled using just one single part. Furthermore, compared to D²PAK 7pin, this significantly smaller package with 60% size reduction offers a very compact design and a substantial reduction of 30% in the footprint.

Key features and benefits

- Industry's lowest $R_{DS(on)}$, reduced footprint and space
  - Enables highest efficiency and system cost reduction
- Highest current capability up to 300A
  - Requires less cooling
- Reduced package parasitics
  - Enables improved EMI-performance
  - Lower package losses

For further information please visit our Website:
www.infineon.com/toll

Go to Webinar