

# EDN

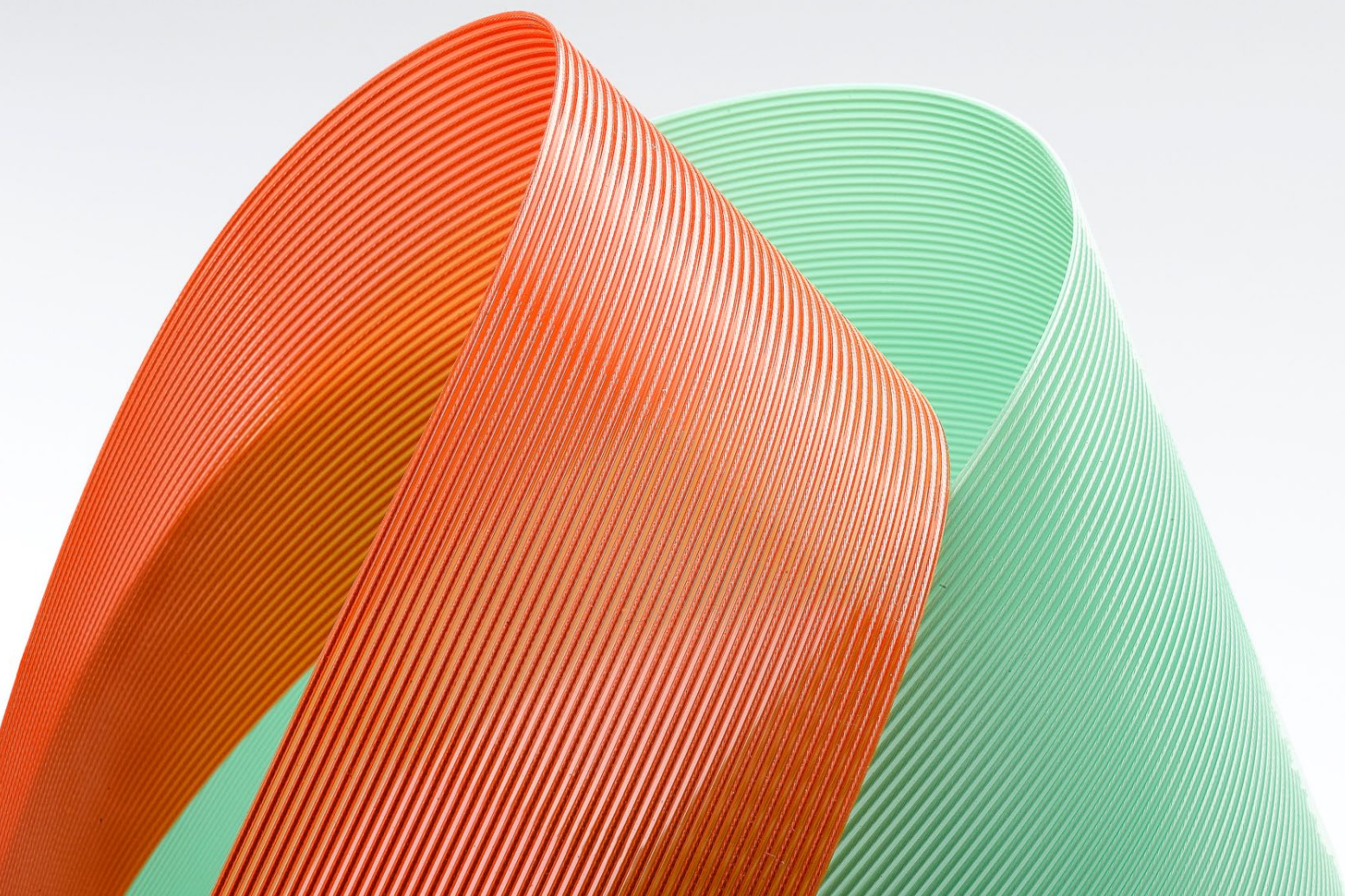
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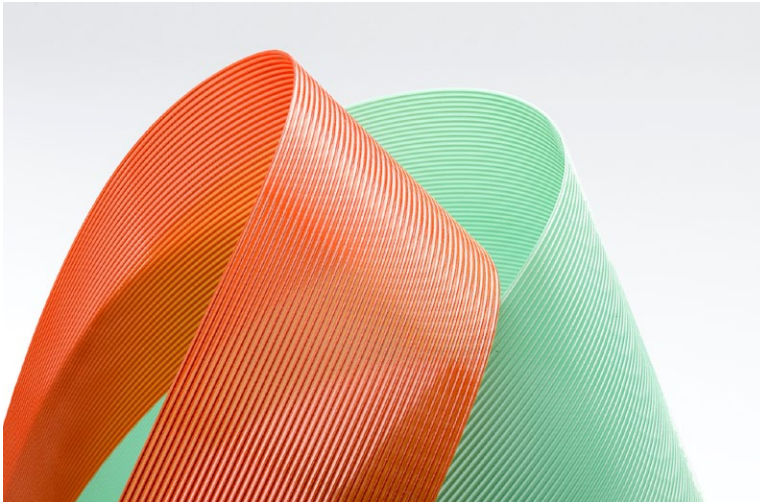
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Issue 10

# europa

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### Cover image; FEP MIL-Spec-approved flat-ribbon cable

Molex says it is the only source of rugged and flexible, FEP flat-ribbon cable that can withstand high-temperatures, high flexure, abrasion and chemical exposure; Temp-Flex FEP flat-ribbon cable is, Molex claims, the only solution on the market that meets the MIL-Spec requirement for M49055/11 & M49055/12 for harsh environment applications such as those found in aircraft avionics and industrial equipment. Unlike PVC (Polyvinyl Chloride) and TPE (Thermoplastic Elastomers) products, this uses extruded FEP (Fluorinated Ethylene Propylene) dielectric insulation material for a high-performance ribbon cable, that can withstand exposure to chemicals, extreme temperatures, abrasions and flexure. Its makers say it is applicable to rugged applications including flight data recorder boxes, missile systems and robotics found in manufacturing plants across multiple industries. Read the full product news item [here](#).

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# "OF MICE AND MEN; OR, OF MAMMALS AND BUGS"

In a recent presentation and interview, Cadence Design Systems' CTO of the company's IP Group, Dr. Chris Rowen, outlined how the advent of the Internet of Things is changing not only the application space, but the entire model of how we process data gathered from the world around us. In turn, Dr. Rowen concludes, it will change the way that SoC design itself is carried out. Chris Rowen arrived at Cadence with its acquisition of Tensilica, in 2013. Unsurprisingly, one thread of his presentation has to do with the appropriateness of the Tensilica – now Cadence – configurable processor IP, for the IoT era; how it scales from the “mote” level to the cloud. But, that message being delivered, Dr. Rowen also has a series of predictions for the era of, and the coming “explosion” in, data-efficient design. It's all about – at one level – energy. The need to operate, at every level of the “connected-everything” world, with the minimum energy expenditure. Rowen calls this a “layered cognition” model: at every level from the cloud to the sensor node, systems must use the minimum power to process data at their own level, and only pass upwards abstracted data that is of interest to the higher level. Low-level processing may be intensive, but the data it is handling is not interesting to the upper layers, and that intensive processing must abstract whatever is relevant, for the least possible energy input. The mantra will be; compute-locally/share globally. This leads to some apparent paradoxes, that we are already familiar with, for example in the sensors and raw-data capture systems at the lowest level of the model. These must give the appearance of being “always-on”: but we know that this is not sustainable in energy terms, if implemented literally. So “always-on” must be delivered by devices that are in reality, “almost always off”.

The term IoT does not adequately describe the diversity of tasks in the connected environment; Rowen draws an analogy – that some might find a little fanciful – with evolution and the tree of life. He predicts a splitting of SoC designs for the IoT into “mammals” and “insects”. Mammals are relatively few in number (by species), adaptable, all-in-one system entities that are capable of a wide range of high-level tasks; these are the chips that are characterised by scale, with multiple processor cores. Insects (in this analogy) are very numerous by species count, and each is optimally fitted for a specialised niche. These are the wearables, the smart-home sensors, the medical and the industrial data gathering nodes. But – and this is a significant point – both are SoC designs, essentially custom ICs, albeit of very different styles.

An IoT SoC is a mix of rich analogue – radio/MAC/baseband, LNA, power management, power amplifier – with optimised digital. Logic focusses on low-energy processors, on-chip memory (energy to shift data on- and off-chip is not affordable), dedicated digital baseband functions, and sensor I/O. All effort is concentrated on energy-reduction strategies, such as – Dr. Rowen cites – cognitive layering (processing data at the

most appropriate level and context); power/clock/data gating; architectural optimisations; and selection of algorithms and data-types.

As the ICs split into “mammals” and “insects”, so too will the design tool flows, Dr. Rowen suggests. SoC design starts, he says, will accelerate: an assertion that may generate some scepticism.

The main thrust of EDA tool flows, for as long as most of us can remember, has been to pursue the every-shrinking process geometries embodied in “Moore's Law”. In Chris Rowen's latest analogy, it has sought to serve the evolution of the “mammals”; design flows have escalated in complexity to handle the famous Law and its consequences, the number of design teams – and large SoC designs – has been stable if not declining.

We can recall that at one point, this was not how things were predicted to develop. That point can be approximated to the time of the realisation that pre-built IP blocks would form a large part of the future of IC design. Chip design would be democratised, there would be many startup companies, each buying-in IP and rapidly assembling their diverse product concepts into dedicated ICs. As we know, it did not entirely work out like that. However, Chris Rowen holds out the prospect that something of the sort may be about to emerge. Not that the leading edge, “mammal design” aspect of EDA progress will in any way slow; but that a separate strand may emerge to serve the creation of the “insects”. Such a flow would draw on what has been learned from the most ambitious tool development, but be structured to architecting systems and chips for specific niche applications. One of Dr. Rowen's predictions surrounding the IoT is that we will, “stop worrying about the ‘death of Moore's Law’” – not least because the lower-level, niche application ICs will have little to gain from the most aggressive process scaling, and will be best implemented in a (relatively) mature geometry. Can that sector not be served by one or other of the very many microcontroller-based ASSPs that continue to be introduced? The implicit answer appears to be that the absolute need to optimise local-processing to the very minimum of energy expenditure indicates a custom solution.

A custom solution, that is, to be served by [a class of] easy to use, affordable tools that will be capable of working with next-to-leading-edge – or rather more mature than that – technologies. Chris Rowen concludes that there is potentially a very attractive “trickle-down” of technology that can be transformed to apply it to this broader market, and that will be fitted precisely to the applications.

Might this be – at last – the democratisation of ASIC design? Time will tell; but if the predicted growth path of IoT applications is to be met, time that can only be measured in months rather than years.



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# pulse

## Tek's compact, USB spectrum analyser spans 6GHz for under €3k

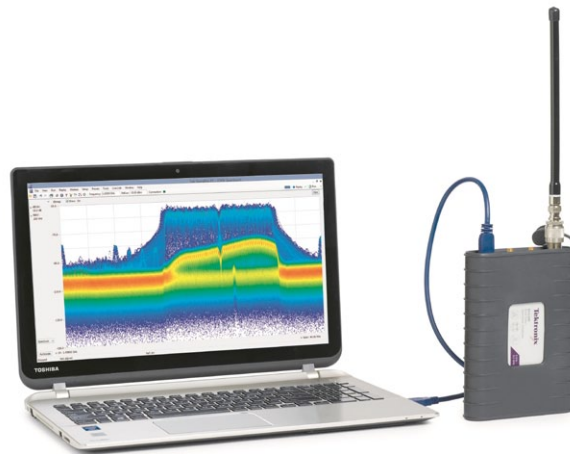
**T**he RSA306 spectrum analyser from Tektronix marks a departure for the company; it has packaged a 6.2-GHz spectrum analyser in a “screenless” handheld module that is PC hosted, connected and powered by a USB 3.0 port. The company has taken its real-time spectrum analysis technology from its bench instruments, and applied it to the new format. Priced at €2,810, the unit spans 9 kHz to 6.2 GHz, has a capture bandwidth of 40 MHz (that is, in one capture it can “see” any 40-MHz segment in its range) and a corresponding real-time bandwidth of 40 MHz. The instrument relies on Tek’s SignalVu software running on the host PC: in the same release, the basic SignalVu software package becomes free-of-charge (it has been around \$2000), and software modules that implement more advanced measurement and analysis functions are significantly reduced in cost. The signal processing architecture of the real-time spectrum analysis technique places a limit on the minimum duration signal that can be captured; for the RSA306, 100% assurance

of capture extends down to 100  $\mu$ sec. With a swept-spectrum analyser, this figure can be much higher. The real-time technique, Tek also asserts, also allows capture and characterisation of pulse waveforms, and the software can present information

in multiple formats, all derived from the real-time capture. For example, the PC screen can simultaneously display signal parameters; a constellation diagram; a spectrogram of power vs. time; as well as the basic amplitude/frequency representation.

The company says the unit will not replace any of its bench-top instruments, but will open up the option of having “one per engineer” of the compact units and retaining the conventional instrument for the most demanding measurements. Other application targets include mobile radio network installation,

interference hunting – an option allows real-world mapping and triangulation to aid interference detection – and university level lab classes.



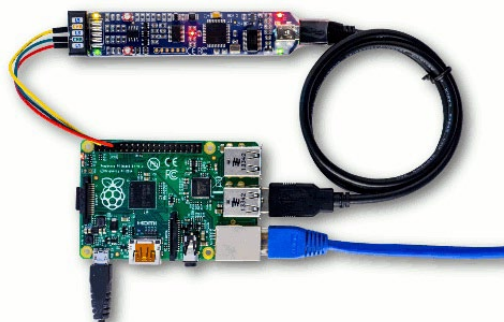
Complete article, here 

## 20-MHz bandwidth multifunction scope for the Raspberry Pi

**D**istributor Farnell element14 has partnered with Australian company BitScope Designs to manufacture BitScope Micro, a full-feature dual channel digital oscilloscope for the Raspberry Pi: this low-cost add-on for the Raspberry Pi is also an eight channel logic analyser, waveform generator, clock generator and spectrum analyser. The involvement of element14 will make the BitScope Micro available much more widely than it has been until now.

The oscilloscope function has a 20 MHz analogue bandwidth and the ability to capture signals of up to 40 Msamples/sec, BitScope Micro also supports frame rates

beyond 20 Hz and includes a digital phosphor display. The plug and play BitScope Micro is an entry level oscilloscope that has all the functionality needed to support the maker community, according to element14.



BitScope Micro comes packaged in a single low cost lightweight water resistant test probe. It is fully user programmable and downloads are freely available for Raspberry Pi, Linux, Windows and Macintosh. Priced at £89.00 or equivalent, BitScope

Micro is available from Farnell element14 in Europe.

Complete article, here 



# Arduino Uno shield-compatible kit for Bluetooth Smart, ANT, 2.4 GHz designs

**N**ordic Semiconductors' low-cost nRF51 DK development kit comes in Arduino Uno shield-compatible single-board form factor - supporting a broad range of third-party Arduino shield expansion boards - and provides flexibility for product development with all key ULP wireless technologies.

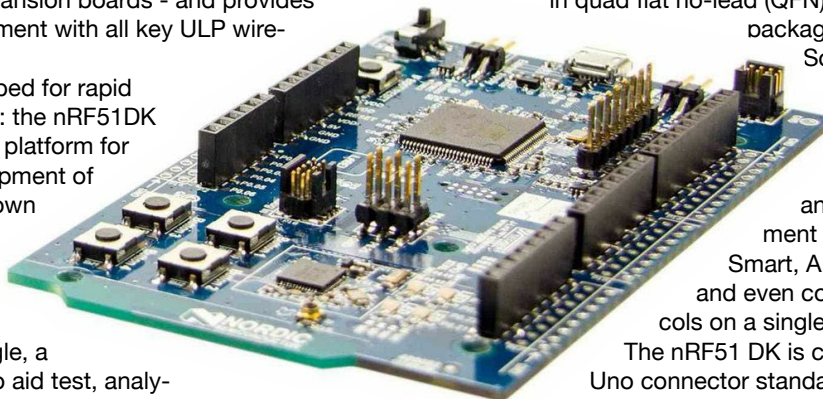
The kit also supports ARM mbed for rapid prototyping and development: the nRF51DK is a low-cost development kit platform for fast, easy, and flexible development of Bluetooth Smart (formerly known as Bluetooth low energy), ANT/ANT+, and 2.4 GHz proprietary applications.

Nordic has also announced the launch of the nRF51 Dongle, a highly versatile USB dongle to aid test, analysis, and development of Bluetooth Smart, ANT, and 2.4 GHz applications. The nRF51 DK is based on Nordic's nRF51 Series System-on-Chip (SoC), a highly-integrated transceiver that combines a

2.4 GHz multiprotocol radio, 32-bit ARM Cortex M0 processor, 128 kB or 256 kB flash memory, and 16 kB or 32 kB RAM. The SoCs can support a wide range of peripherals and are available in quad flat no-lead (QFN) and wafer level chip scale package (WLCS) options. The

SoCs can support a range of SoftDevices (Nordic's SoftDevices are self-contained stacks that incorporate RF protocols and associated management frameworks) for Bluetooth Smart, ANT, 2.4 GHz proprietary, and even combinations of these protocols on a single device.

The nRF51 DK is compatible with the Arduino Uno connector standard enabling use with a broad range of third-party Arduino shield expansion boards. The nRF51 DK allows access to all device peripherals, interfaces, and I/Os.



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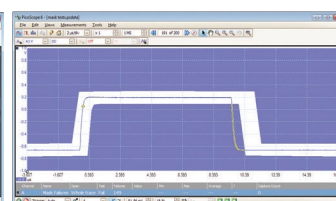
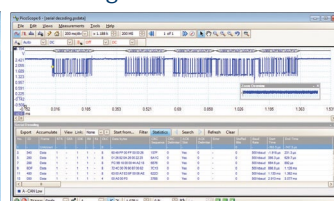
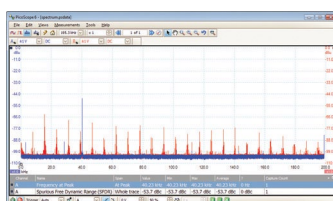
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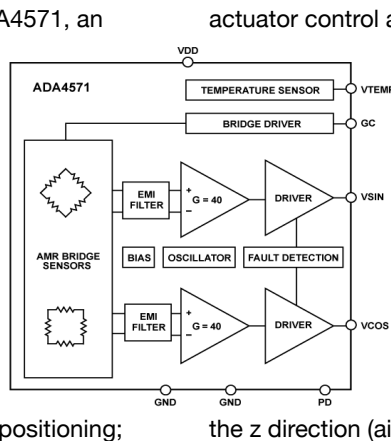
All models include full software and 5 year warranty. Software includes Measurements, Spectrum analyzer, SDK, Advanced triggers, Color persistence, Serial decoding (CAN, LIN, RS232, I<sup>2</sup>C, I<sup>2</sup>S, FLEXRAY, SPI), Masks, Math channels, all as standard, WITH Free updates.

The supplied drivers and software development kit allow you to both write your own software and interface to popular third-party software packages such as LabVIEW and MATLAB. You can now use most PicoScopes on Linux and Mac OSX.

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## Integrated magnetoresistive (AMR) angle sensor and signal conditioner

Analog Devices has posted details of the ADA4571, an anisotropic magnetoresistive (AMR) sensor with integrated signal conditioning amplifiers and ADC drivers. The device produces two analogue outputs that indicate the angular position of the surrounding magnetic field. The ADA4571 consists of two dice within one package, an AMR sensor, and a fixed gain ( $G = 40$  nominally) instrumentation amplifier. The ADA4571 delivers clean and amplified cosine and sine output signals related to the angle of a rotating magnetic field. The output voltage range is ratiometric to the supply voltage. Use the part, ADI suggests, for absolute position measurement (linear and angle); brushless dc motor control and positioning;



actuator control and positioning; contactless angular measurement and detection; and magnetic angular position sensing.

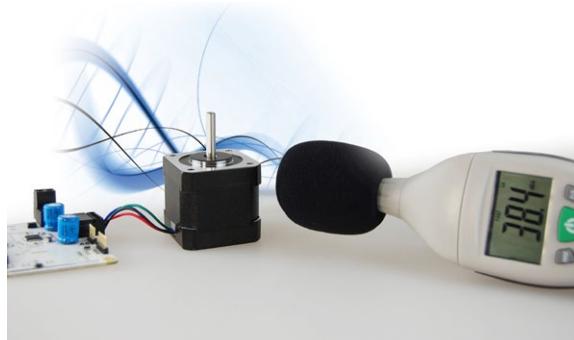
The sensor contains two Wheatstone bridges, at a relative angle of  $45^\circ$  to one another. A rotating magnetic field in the x-y sensor plane delivers two sinusoidal output signals with the double frequency of the angle ( $\alpha$ ) between sensor and magnetic field direction. Within a homogeneous field in the x-y plane, the output signals are independent of the physical placement in the z direction (air gap).

[Complete article, here](#)

## Driver design cuts acoustic noise from stepper motors

Trinamic Motion Control has disclosed a technology for stepper motors that it calls stealthChop; the new technology significantly reduces the noise of conventional stepper motor operation.

Motors operating at low speed exhibit a phenomenon known as magnetostriction, which causes an audible low frequency 'hum.' Trinamic's stealthChop minimises magnetostriction by implementing a PWM algorithm that relies predominantly on voltage modulation for motor control at lower speeds. This technology minimises PWM current fluctuation, which is the primary cause of low-speed hum.



Noise limitations are especially desirable in applications that normally occur in close proximity to human operators, in applications where multiple stepper motors are in use, in video

surveillance applications where installations near walls and ceilings amplify noise, and in consumer applications, such as home automation and air conditioning, where users expect minimal noise. Trinamic devices that implement this new stealthChop technology have achieved measured noise levels 10 dB below traditional stepper motor drive ICs.

[Complete article, here](#)

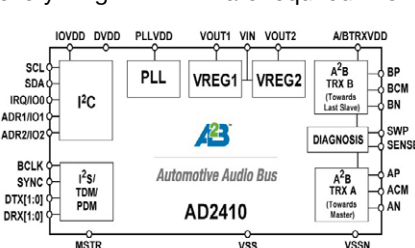
## Automotive audio bus boosts digital audio quality, uses UTP wiring

In what will be regarded as a challenge to incumbent technologies such as MOST, and to the trend for "everything-Ethernet" - in this case, Ethernet AVB - Analog

Devices' AD2410 transceiver uses the new Automotive Audio Bus (A<sup>2</sup>B) to deliver 50 Mbps bandwidth while reducing audio system cost, weight, and design complexity.

This device embodies a digital audio bus technology capable of distributing audio and control data together with clock and power over a single, unshielded twisted-pair (UTP) wire. The AD2410 transceiver is the first in a family of devices that enables ADI's new Automotive Audio Bus (A<sup>2</sup>B), which significantly reduces the weight of existing cable harnesses, while delivering high-fidelity audio. The AD2410 transceiver also eliminates the

need for expensive microcontrollers with large memories that are required in existing digital bus architectures.



The AD2410 is a low-cost audio transceiver that provides 50 Mbps of data bandwidth and support for up to 32 discrete upstream and downstream audio channels. All standard audio sampling rates are supported as is daisy-chaining of multiple AD2410 slave devices to a single master. Unlike existing digital bus architectures, system delay is fully deterministic at all slave nodes, making the AD2410 particularly well suited

for applications including active noise cancellation, in-car communications, and microphone beam forming.

[Complete article, here](#)



## Freescal claims smallest integrated tyre pressure monitoring system

**T**his highly integrated tyre pressure monitoring device combines the smallest package and lowest power consumption for precise tyre pressure sensing. The FXTH87 tyre pressure monitoring system (TPMS) family is positioned



as the smallest integrated package TPMS solution available at 0.3 grams. The FXTH87 family is 50% smaller than competing products. Freescale's TPMS system-in-package solution provides low power consumption combined with the highest level of functional integration in one package, featuring a dual-axis accelerometer architecture, pressure and temperature sensor, integrated MCU, RF transmitter and low frequency receiver.

In a 7 x 7 x 2.2 mm package, the FXTH87 family provides the smallest footprint available, enabling form factors ideal for tyre pressure sensor module developers to reduce the weight and overall bill of materials costs. Lowest RF power consumption at 7 mA I<sub>dd</sub> extends battery life. Both the single- and dual-axis accelerometer options improve accuracy and facilitate more precise tyre localisation implementation and universal interoperability for original equipment manufacturers and aftermarket applications. The integrated MCU and dedicated firmware offer the largest customer flash memory at 8 kB, increasing application flexibility and reducing time to market. The device costs \$3.45 to \$3.62 (10,000).

Complete article, here



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## Digital power consortium formed by CUI, Ericsson Power Modules and Murata

**A**rchitects of Modern Power (AMP) promises to advance power system technology and boost supply chain reliability for distributed power systems. Three power supply manufacturers have collaborated to form a new power industry consortium, Architects of Modern Power (AMP). The founding members are CUI, Ericsson Power Modules and Murata – each with an interest in advanced power conversion technology for distributed power architectures.

The aim of the alliance is, “to create the most technically advanced, end-to-end distributed power solutions – a complete ecosystem of hardware, software and support”. The AMP



Group’s work will extend well beyond defining mechanical dimensions and product footprints for intelligent DC-DC power modules and AC-DC power supplies. The consortium’s long-term strategic alliance will foster close collaboration between members to develop shared technology roadmaps.

The participating companies will establish common mechanical and electrical specifications for their products, standardisation of monitoring, control and communications functions, and create common configuration files for plug-and-play interoperability between products from each firm.



## Altium Designer steps to v.15, adds high speed PCB design aids

**D**esign and fabrication of high performance printed circuit boards will be faster and seamless in handoff to fabrication, says Altium, in previewing the upcoming release of its professional printed circuit board (PCB) and electronic system level design software, Altium Designer 15. The release incorporates feedback and technical advice about high speed PCB design offered by beta users over the last 12 months, says Altium, adding that, “The PCB industry has also made it clear that fabricators need to move beyond 30+ year old file formats for design to fab hand-off. With IPC-2581 and Gerber X2 support, Altium Designer is ready for users who work with leading-edge fabricators who build complex PCB structures.”



To handle signal propagation rates up to 100 Gbps, a new Pin Pairs feature has been added to enable accurate length and phase tuning across termination components, and to enable length, phase and delay tuning traversing an entire signal path. Designers will no longer require external software or have to

maintain complex lists of signals and nets, but instead will be able to plan and route groups of high speed nets with much greater efficiency and accuracy.

Altium Designer 15 introduces support for both IPC-2581 and Gerber X2, keeping designers up to date while giving them a choice that broadens their selection of PCB fabrication partners.



## Protect Internet-of-Things systems with security profile for VxWorks

**A** security profile for Wind River’s real-time operating system delivers capabilities to protect connected devices at every stage. It features integration with hardware- and software- based security capabilities from Wibu-Systems. Wind River’s security profile for the next generation version of its VxWorks real-time operating system (RTOS) adds advanced security capabilities to VxWorks 7 to protect Internet of Things (IoT) devices, data, and intellectual property. Security Profile for VxWorks delivers capabilities to protect connected devices at every stage, including, boot-up, operation, data transmission, and powering down. It also effectively protects intellectual property from piracy and code from reverse engineering. Security Profile provides the following comprehensive set of software-based security features:

- Secure boot: Verifies binaries at every stage of the boot-up process

- Secure run-time loader: prevents unauthorised execution and other forms of tampering with code
- Advanced user management: protects devices from unauthorised access and enables the definition and enforcement of user-based policies and permissions
- Network security: incorporates the latest Wind River security protocols, such as Wind River SSL, SSH, IPsec, and IKE to effectively secure network communications.
- Encrypted containers: supports TrueCrypt-compatible AES-encrypted file containers

For security-critical applications, the profile can be enhanced and seamlessly integrated with Wibu-Systems’ CodeMeter hardware- and software-based solution that has been tested and validated for interoperability.





## Reference design for accurate water/heat flow monitoring

**M**axim Integrated's complete flow meter system achieves 10x better accuracy and ultra-low-power performance, lasting up to 20 years on a single battery. Utilities can now improve water- and heat-metering accuracy by an order of magnitude, while operating for up to 20 years on a single A-size battery with the MAXREFDES70# ultrasonic flow meter reference design. This solid-state meter is 10x more accurate than mechanical meters, and 4x more accurate than competitive ultrasonic solutions. This accurate measurement is done without the use of heavy batteries, and the flow meter uses a single "A"-size battery that can last up to 20 years. Measuring as little as 0.5 litres of water per minute with better than 1% accuracy, its fast ultrasonic pulses can be customised to the pulse frequencies required by flow condi-

Ultrasonic Flow Meter Reference Design  
MAXREFDES70#



tions. It can detect even minor leaks that the mechanical meters will never find. It maximises uptime and provides the most accurate data possible. At the heart of the MAXREFDES70# reference design is the MAX35101, a complete time-to-digital converter with analogue front-end (AFE) that measures the difference of upstream and downstream ultrasonic pulses. Supporting flow measurement at low rates (< 30 l/hr), the MAX35101 offers the highest time-to-digital conversion accuracy. Easy to implement, the design includes free schematics, layout files, and firmware that are available for immediate use and customisation; an evaluation (EV) kit with the MAXREFDES70# board, transducers, and USB interface is available with evaluation software.

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## Microsemi adds security features to create "most secure" FPGAs

Microsemi's ultra secure SmartFusion2 SoC FPGAs and IGLOO2 FPGAs are claimed to have more advanced security features at the device, design and system levels than any other leading FPGA. The new data security features are now part of Microsemi's mainstream SmartFusion2 SoC FPGAs and IGLOO2 FPGA. In the emerging era of connected devices, Microsemi says, machines need not only to be secure, but they need to be secure at the device, design and system levels. For example, even a machine or system that meets Advanced Encryption Standard (AES) could be vulnerable to side channel attacks. Microsemi's differential power analysis (DPA) countermeasure solution increases overall system security by protecting the keys that are stored in the system, protecting it against such attacks.

Microsemi's newest generation of SmartFusion2 SoC FPGA and IGLOO2 FPGA programmable devices are positioned as the industry's most secure, with three key elements covering secure hardware, design security and data security. Built through a secure supply chain management system, Microsemi data security devices feature:

- Licensed, patent-protected DPA resistance from Cryptographic Research Inc.
- Active tamper detectors including an active mesh
- Secure flash key storage
- Unique key generation through Intrinsic ID's Physically Unclonable Function (PUF) Quiddikey-Flex
- Full NIST-certified crypto accelerators

The company asserts that with this family of devices, it has the only FPGAs with a PUF; with DPA countermeasure techniques based on Cryptographic Research Inc. licensed technology; with full data security processing capability with hardware accelerators for AES, SHA, HMAC, elliptic curve cryptography (ECC) and nondeterministic random bit generator (NRBG); and with NIST certified state-of-the-art security in a programmable device, covering DRBG, AES256, SHA256, HMAC, ECC-CDH; plus active tamper detectors, and zeroisation. Zeroisation is an in-built 'panic button' that unrecoverably deletes on-chip data in the event of unauthorised access.

Complete  
article, here



## Bluetooth Smart dongle is OS-independent and Raspberry Pi compatible

Now in distribution, the Bluegiga BLED112 comes fully loaded to kick-start Bluetooth Smart development, and further extends RS Components' portfolio of Raspberry Pi wireless solutions. RS Components is stocking the Bluegiga BLED112 Bluetooth Smart USB dongle, which comes with everything needed for developing low-cost, low-energy wireless applications to run on a wide variety of platforms including Raspberry Pi. The BLED112 is Bluetooth v4.0 single-mode compliant, supports master and slave modes, and allows up to eight connections, and implements a USB CDC interface for host OS communications. The BLED112 includes Bluegiga's Bluetooth Smart software stack which al-



lows developers to create their own onboard applications using Bluegiga's BGScript scripting language, eliminating the need for an external host. Alternatively, a host application can interface with the BLED112 via the OS-independent BGAPI software also incorporated in Bluegiga's Bluetooth Smart software stack.

BLED112 can be used with Raspberry Pi computers and is ready to use with the latest Raspberry Pi Model B+. RS has introduced several wireless modules for Raspberry Pi, including the SparqEE 3G Cellular board, Edimax Wi-Fi Dongle and Low-Power Radio Solutions 868 MHz / 434 MHz dongle.

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# GPU COMPUTE AND OPENCL: AN INTRODUCTION.

**T**his article provides, to the reader unfamiliar with the subject, an introduction to the GPU evolution, current architecture, and suitability for compute intensive applications.

OpenCL is introduced in this context (in this first part of the article), and a sample application is presented (in the second instalment of the article), together with indications on setting up the development environment, building and running the application on a Freescale i.MX6-based platform.

## Basics of today's GPU hardware architecture

...and the forces that created it (e.g. graphic pipeline).

We cannot discuss OpenCL/GPU Compute, even in context of a highly integrated System on Chip (SoC), without at least a basic level of understanding of the GPU architecture and factors that shaped it. So let's first take an overview of this subject.

While pervasive today, and a big selling point for many everyday objects, the complex and elaborate GUIs (graphical user interfaces) we use today rely on GPUs (graphics processing units) that are the culmination of more than 30 years of evolution, driven first by a nascent graphics industry, then mostly by PC and console gaming, and being strongly influenced by the needs of low-power/high performance SoCs today.

Starting with the first monochrome video display controllers, at incredibly low resolutions ("up to" 62 x 128 for CDP1861 in mid '70s) moving to EGA adapters with 16 colours and 640 x 350 in mid '80s (VGA/SVGA, with up to 800 x 600 would come soon after), we had to wait until the early '90s for the first products that start to shape the GPU architectures in use today.

By 1996, the major players that would dominate the 3D graphics world for almost two decades are there (most of them defunct by now) and will make furious progress primarily driven by the gaming world, but with a direct impact on all devices that surround us. Also, the APIs that will enable the industry to move forward are established (OpenGL and Direct 3D), replacing proprietary ones that we see so often in nascent industries (one exception, Glide from 3dfx, still endured, and was open-sourced too late, contributing to the death of this much loved 3D pioneer). All this rapid development contributed to establishing a graphics processing pipeline that, at a high enough level, remains largely the same today, and is depicted in Figure 1.

The first GPUs were used to accelerate the processing that happened after the Transformation and Lighting (T&L) stage (handled by the CPU) - stages that were better suited for a static, non-programmable implementation (yet configurable through the inputs representing vertex sets, light position and characteristics, transformation matrices). As the evolution of CMOS process nodes allowed cramming more and more transistors on the GPU die, a few noteworthy steps were taken:

- T&L processing accelerated by the GPU offloaded the CPU and provided significant performance gains. This was achieved first at the end of the '90s, and was very quickly adopted by all 3D GPU providers.
- Programmability of the vertex processing (vertex shading) and pixel processing (pixel shading). This opened up new possibilities, and control for the GFX designers, in terms of scene design and effects. Moving from a fixed-function implementation towards a programmable pipeline was done through programmable engines called "shaders":
  - The programming model is defined by a "Shader model" that specifies instructions, registers and operations.
  - Shader models and shader definitions were initially different for vertex processing and pixel processing, but were unified starting with Shader Model 4.0 (in Direct3D)/Unified Shader Model (OpenGL). The first generation of GPUs implementing a unified shader model was available in the market in mid-2000.
  - Data format has evolved from integer only, to Floating Point with half, full and even double precision.

While the shader engines have evolved from a very limited instruction set, these are still to a significant extent purpose built, and the balance between flexibility and performance/efficiency is heavily tilted towards the latter. In terms of data format support, one relevant aspect is IEEE 754 compliance – this sometimes is traded off for some additional performance.

The shader engines in many implementations can be assimilated with Digital Signal Processors (DSP), highly optimised for the mathematical operations that the GPU pipeline needs to support. Similar techniques, and architecture approaches used in the DSP domain are in use today (or have been in the past) in premier GPU cores: VLIW, SIMD, vector processing.

A unified shader model used by the GPU processing means that the processing pipeline for today's designs can be represented

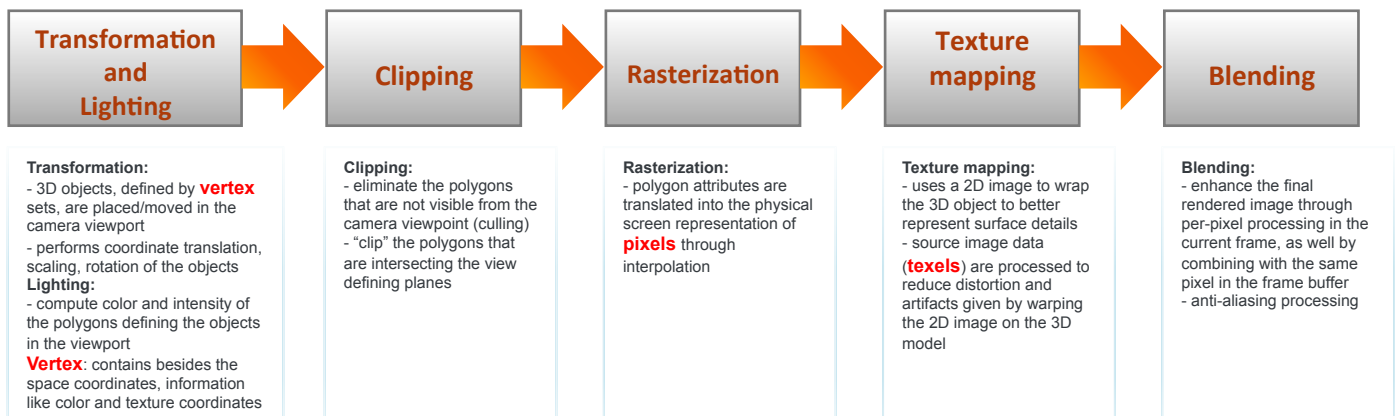
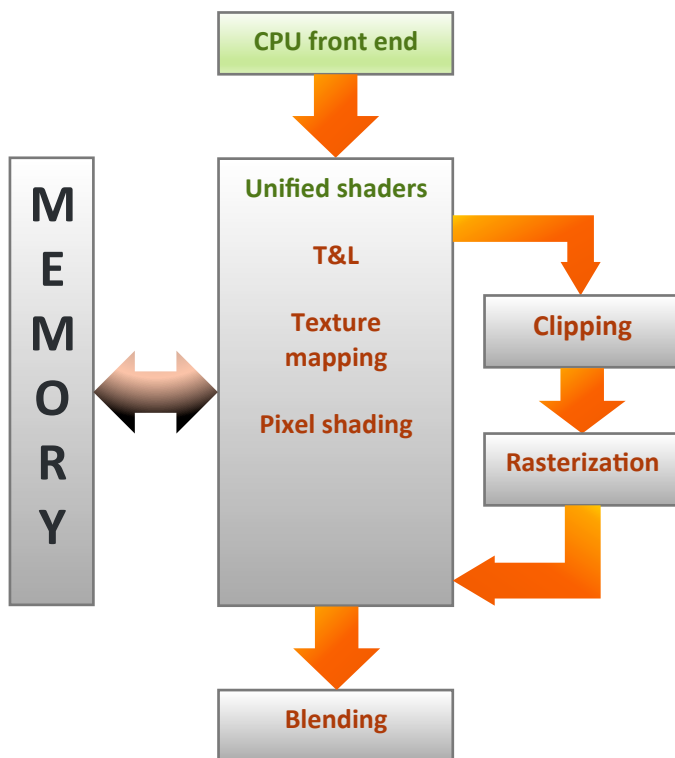


Figure 1. The basic elements of what has become the "standard" graphics processing pipeline





**Figure 2.** The main elements of a typical processing pipeline for a current graphics design

as seen in Figure 2. Note that this time we show the memory, and the fact that the shaders have RW access to the memory (dedicated video memory typically for video cards, or system memory for GPUs integrated in SoCs).

The advent of unified shader cores resulted in a new measure of the relative performance of the GPU: the number, and frequency, of these cores. These two parameters combined are typically used to give a measure of the maximum compute capacity of the GPU, expressed in Floating point Operations Per Second (FLOPS).

As an example for the GFX support in a mainstream SoC, Figure 3 shows the three GPUs present on Freescale's i.MX6Q/D. In its most powerful instantiation on the i.MX6 product family, the 3D GPU has 4 shader cores, with a compute performance rated at 24GFLOPS. Note the presence of two additional GPU cores, performing specialised functions, for increased efficiency of the typical embedded application: accelerating layer composition, and vector graphics.



**Figure 3.** Freescale's i.MX6Q/D hosts three distinct GPUs

This article continues with a further description of the shader units of a GPU, and the work that is most appropriate to be carried out by a GPU pipeline – click right.

Complete article, here



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BY BONNIE BAKER

BAKER'S BEST



# Painless reduction of analogue filter noise

**T**hey say a low-pass filter will rid you of noise in the higher frequencies. Well, this is not entirely true. It will succeed to a certain degree, but let's take a closer look.

The classical approach to arranging an odd-order, low-pass active filter is to place the single pole of the odd-ordered filter at the front-end of the circuit. Following this first stage there are the remaining second-order stages. Figure 1 illustrates this fifth-order low-pass filter example.

As shown in Figure 1, the first stage is in an active first-order configuration. This first-order stage uses an RC pair at the input followed by a buffered amplifier. Following this simple first-order stage are two second-order stages.

It is curious to look at the cumulative noise above the corner frequency of this fifth-order filter. With an operational amplifier (op amp) like the OPA350, the cumulative output noise from these three amplifiers and five resistors becomes approximately 3.9  $\mu\text{Vrms}$  at 10 kHz. If you use this circuit as an anti-aliasing filter, it reduces higher frequency signals above 1 kHz. However, some of the noise continues to sing through.

The 10 kHz noise density of this op amp is 7 nV /  $\sqrt{\text{Hz}}$ . The resistor's noise density at 10 kHz is equal to  $\sqrt{(4 * k * T * R)}$  (where  $k = 1.38 \text{ e-}23$ ,  $T$  = temperature in Kelvin, and  $R$  = resistance in Ohms).

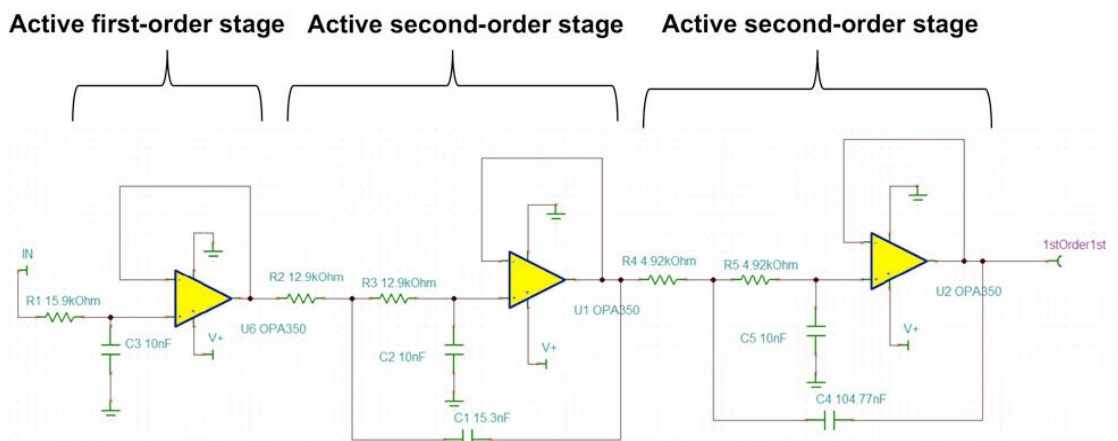
Let's break away from the classics and place the first-order stage at the end of the circuit. This is shown in Figure 2, in the [on-line version of this article](#); the low-pass filter in Figure 1 is reconfigured with the first-order stage placed at the end of the circuit.

The components and amplifiers between Figure 1 and Figure 2 are identical, but the order of each stage is changed. One would expect identical performance between these two circuits, which is true with the AC and transient step response – but that is where the similarity stops. The cumulative noise at 10 kHz of the circuit in Figure 2 is approximately 3.0  $\mu\text{Vrms}$ . This is approximately a 23% improvement ( $1 - 3.0 \mu\text{Vrms} / 3.9 \mu\text{Vrms}$ ).

This configuration can avoid peaking due to high Q sections. Peaking can occur because of possible overloaded internal nodes.

This is good news but let's take it a little further. In Figure 3 (also in the [on-line version of this article](#)), the first-order filter is again at the end of the signal path, but it has been changed to an RC pair (minus the amplifier). The values of the resistor and capacitor in this stage are the same as in Figure 2.

Once again, the components and amplifiers have not changed between the three figures. The difference in Figure 3 is that the implementation of the first-order low-pass filter now uses a resistor to the output of the filter and capacitor to



**Figure 1** Fifth-order, Sallen-Key, 1 kHz low-pass filter with a Butterworth approximation.

ground.

There is another reduction in noise with this circuit because one of the noise generators (OPA350) has been removed. The cumulative noise at 10 kHz for the circuit in Figure 3 is 2.8  $\mu\text{Vrms}$ . This improvement is not as dramatic as the difference between Figure 1 and 2. However, there is a distinct benefit to this configuration from Figure 1 to Figure 3 with approximately 28% improvement. Figure 4 shows (see the [on-line version of this article](#)) the noise performance of these three Sallen-Key low-pass circuits.

So, will a low-pass filter reduce noise in your system? It will to a certain extent in the frequencies beyond the filter's cut-off frequency. But, as always in the case of noise, there are techniques that you can use to further reduce noise after your filter. The beauty of this idea is that it is easy to make a few minor changes to your circuit architecture, and voila! A 28% improvement is as easy as one, two, three.

## References

1. "Analog filters and specifications swimming: What ... I thought I was getting rid of the noise?" On Board with Bonnie, TI, 1-22-14
2. "Noise from Active Filters: An Unwelcome Surprise," Caldwell, John, Precision Hub, TI, 3-24-14
3. Download the [OPA350 datasheet](#)





# DEMYSTIFYING ULTRA-LOW-POWER BENCHMARKS FOR MICROCONTROLLERS

**W**hat defines an ultra-low-power (ULP) microcontroller (MCU)? Is power a sub-section of system design or the most important consideration? How can applications fit more functions into reduced energy budgets?

These are some common questions embedded developers encounter when trying to define and drive requirements for their low-energy applications. Being “energy aware” encompasses all aspects of the microcontroller ecosystem starting with MCU architecture and extending across the spectrum of peripheral interconnects and system standby capabilities. This begs the question: What quick, effective and impartial tools can developers use to compare devices, architectures and solutions based on their specific application profile?

With the goal of answering this question in mind, the Embedded Microprocessor Benchmark Consortium (EEMBC) consortium has formed a working group to define and establish a new benchmark that is focused on ultra-low-power applications. Understandably, the first question to solve was “how to define the term ‘ultra-low-power’”? While this term has broad-reaching implications based on the type of application, the consortium saw fit to limit the scope to MCUs that focus on applications running from batteries or similar power sources for an extended period of time.

A new ultra-low-power benchmark called ULPBench covers a wide variety of applications with the use of a set of commonly used ‘profiles’ that are generated and bundled into the benchmark suite. The first phase of this benchmark suite, called CoreProfile, is now available and can be used to benchmark MCUs targeted for ULP application segments that use a typical peripheral set comprising, at a minimum; real-time clock (RTC), RAM and non-volatile memory in combination with the CPU.

## Requirements for profiling ultra-low-power applications

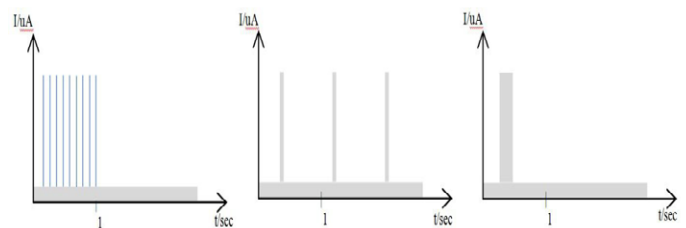
When defining ULP benchmarks one of the first hurdles to cross is the wide variances in microcontroller implementations. The CPU, in most cases, is not the most critical component as it is typically abstracted by C-compilers capable of generating highly optimised code. It is fairly simple to port benchmark code between architectures if users take care of some basic rules, such as only using ANSI C and using the data-type definitions in the C99 standard for variables. This standard defines the bit-width with a fixed value and not based on the architecture as per Table 1.

Variable size in bits					
CPU type (Data Bus width)	char	word	short	int	uint16_t
8 Bit MCU	8	-	8	16	16
16 Bit MCU (e.g. MSP430)	8	16	16	16	16
32 Bit MCU	8	32	16	32	16

**Table1.** Variable size depending on CPU architecture

However, in many applications, the CPU is not the only significant energy user. The peripherals and the system architecture can contribute significantly to the total energy consumption. This makes it harder to create a processor-agnostic benchmark since peripherals vary widely between microcontroller vendors and also between multiple platforms from the same vendor. Benchmark code must therefore be developed in a manner that allows for flexibility and easy adoption or integration into any microcontroller system. The benchmark code must also work to establish a higher-level function set for a ULP application without favouring a specific functionality provided by ‘niche’ MCUs.

Following the CPU and peripherals, the next important power contributor is the frequency at which the MCU wakes up from standby modes. It is a logical assumption that MCUs that focus on lowering their energy profile ensure that the ON duty cycle is kept as low as possible while spending a large portion of time in standby. However this needs to be balanced with the real-time needs of the system. For example, the systems may have a calendar function that needs to update every second. Another example to consider is industrial sensors requiring a collection of ADC samples at a rate of 1 ksps, following which the data is evaluated and processed. Some applications, on the other hand, may wake up every 10+ seconds or may only be on for a minute a day. Since it is not efficient to cover all duty cycles and corner cases, the ULPBench benchmark used a 1 second wake up interval. This interval serves the purpose of providing a reasonable power-down time while also incorporating the energy budget required in moving the system in and out of power-saving modes. The energy budget during wakeup is not always specified directly in MCU datasheets and is therefore a useful part of the benchmark evaluation.



**Figure 1.** Application wakeup frequency over time

## EEMBC ULPBench Phase 1: CoreProfile

As explained in the introduction, due to the wide variance in complexity of ULP applications, the benchmark suite is being built in several developmental phases. The first phase, CoreProfile, covers the CPU, memory access, real-time clock and power-saving features. CoreProfile is applicable to a large number of applications and provides a valuable means to compare various MCUs.

*In the continuation of this article, the author adds more detail on the CoreProfile benchmark and how it is applied, and goes on to give examples of the benchmark in action, using TI MCUs – click right.*



# HOW A WIDE CHOICE OF PERIPHERAL CELLS INFLUENCES THE PERFORMANCE AND COST OF ANALOGUE/MIXED-SIGNAL ICS

**S**killed designers of advanced analogue or mixed-signal ICs are constantly on the look-out for new ways to squeeze higher performance, lower power or lower cost out of the silicon fabrication processes available to them. The common assumption is that real breakthroughs can only be made in big, once-in-a-generation shifts, such as a move from a larger process node to a smaller one.

In fact, a comparable big effect can be achieved over time, through the accumulation of many small or incremental improvements. But the potential for such gradual improvement can easily escape notice, because it does not produce a sudden and dramatic change. All too often its importance is not recognised.

This article highlights one example of this. Complex analogue and mixed-signal ICs contain many IO (peripheral) cells which implement the device's signal and power interfaces to other components. Optimising peripheral cells can provide many small improvements which in aggregate have a big impact on the whole IC's performance and cost.

So how can designers take advantage of the opportunity for peripheral cell optimisation?

## Improvements in peripheral cell libraries

The ongoing improvements in peripheral cell design are the result of continual research and development efforts undertaken by a range of organisations: analogue IC manufacturers, specialist analogue foundry service providers, and third-party providers of analogue and mixed-signal libraries and process development kits (PDKs).

The improvements stem in large part from the interactions that these specialist providers have with customers. In the field of high-performance analogue semiconductors, the most successful chip designs are the result of close collaboration between the IC's developers, suppliers of analogue and mixed-signal IP, and a specialist analogue foundry.

Every IC developer benefits from the resulting accumulation by IP suppliers and foundries both of knowledge and of IP. In relation to the selection of optimised peripheral cells, this should be available to the chip design team in the form of:

- a comprehensive benchmark PDK, providing access to the peripheral cell IP supported by the designer's chosen fabrication process (see Figure 1 in the online version of this article - click the link, right)
- engineering consulting services

A specialist analogue foundry or IP provider will have a much more extensive library of peripheral cell IP for analogue and mixed-signal ICs than a general-purpose foundry can offer. The development efforts in this direction by foundries and IP suppliers have been aimed in part at giving chip designers more

choice, so that they can more closely match the specifications of the peripheral cell to the requirements of their design than they can if using a general-purpose foundry's more restricted library.

But with choice comes complexity. This in turn means that an important function of the consulting service is to support the chip designers in their selection of the optimal IO cells.

## Parameters specified in peripheral cell libraries

The choice of peripheral cells in an extensive library can be specified in terms of various parameters. An example of the benefits of choice and optimisation is the specification of dedicated electrostatic discharge (ESD) protection structures. Greater choice of ESD specifications can result in:

- cost advantages – if the designer needs 1 kV of protection but the library only supports a minimum 2 kV, the cell will be larger and more expensive than the application requires
- performance advantages – dedicated protection structures offering the required protection value can provide for optimised internal routing and improved reliability

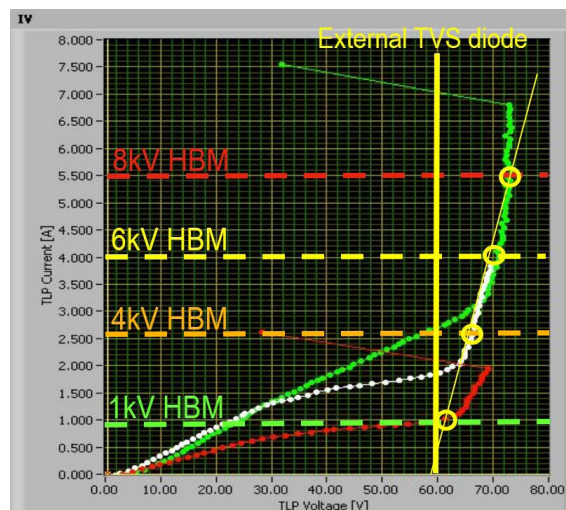
The so-called SEED method (System Efficient ESD Design) is an effective way to find the best trade-off between analogue performance and protection for system-level ESD-exposed pins. While most IO library cells include ESD protection up to 2 kV, special IO cells featuring ESD protection levels up to 4 kV and 8 kV may be offered to protect specific pins, and to allow the designer to optimise the system-level ESD performance in light of the choice of external discrete components.

Specialist analogue foundries must therefore be able to offer library cells which can be used to achieve a wide range of ESD protection levels (e.g. 500V, 1 kV, 2 kV, 4 kV, 8 kV – see Figure 2). In addition to library cells conforming to the Human Body Model (HBM), as well as to various standards such as MIL-883H method 3015.8, JEDEC JESD22-A114F, JS-001-2012 and the automotive AEC-Q100 standard, speciality analogue foundries should also offer library cells that conform to the Charged Device Model (CDM).

This combination of protection values and standards compliance alone provides a huge number of possibilities for proper ESD protection. It is also to the

advantage of the IC design team if the PDK and library supplier is ISO/TS16949 certified: this means that the ESD protection structures provided may be safely used in the development of automotive ICs and other ICs with high reliability requirements.

*In the continuation of this article (click right) the author continues with a discussion of power rail options, and the impact of choices of numbers of metal layers in mixed-signal processes.*



**Figure 2** various levels of ESD protection should be available to analogue IC designers





# Analog Tips

## SELECTING AN ADC DRIVER TO ACHIEVE OPTIMISED SIGNAL CHAIN PERFORMANCE

BY MAITHIL PACHCHIGAR, ANALOG DEVICES

**P**recision high-speed data-acquisition systems used in multichannel applications require state-of-the-art performance. This analogue tip covers the specifications that are critical to consider when selecting an ADC driver to optimise signal chain performance.

The figure shows a high-precision, low-noise, 18-bit data-acquisition signal chain that features  $\pm 0.8$ -LSB integral nonlinearity (INL),  $\pm 0.5$ -LSB differential nonlinearity (DNL), and 99-dB signal-to-noise ratio (SNR). The AD7960 18-bit, 5-MSPS PulSAR differential ADC uses a capacitive digital-to-analogue converter (CAPDAC) to provide unprecedented [low levels of] noise and linearity without latency or pipeline delay. It provides the wide bandwidth, high accuracy (100 dB dynamic range), and fast sampling (200 nsec) required for multiplexed applications, while significantly reducing power dissipation and cost in multichannel applications.

### ADC driver

The acquisition time of the ADC determines the settling time requirements for the ADC driver. The table shows some specifications that must be considered when selecting an ADC driver. As always, the signal chain performance should be verified on the bench to ensure that the desired performance is achievable.

ADC Driver Specifications	General Formula	Minimum Requirements
Bandwidth ( $f_{-3dB\_amp}$ )	$\frac{N \ln 2}{\pi t_{acq}}$	40 MHz
Slew Rate	$\frac{\text{Single-ended input voltage}}{0.5 t_{acq}}$	100 V/ $\mu$ sec
Settling Time	From data sheet	100 nsec
SNR	$10 \log \left( \frac{V_{rms\_in}^2}{\sqrt{(2(e_{n\_amp})^2 \times f_{-3dB\_ADC} \times \frac{\pi}{2})^2}} \right)$	105.5 dB

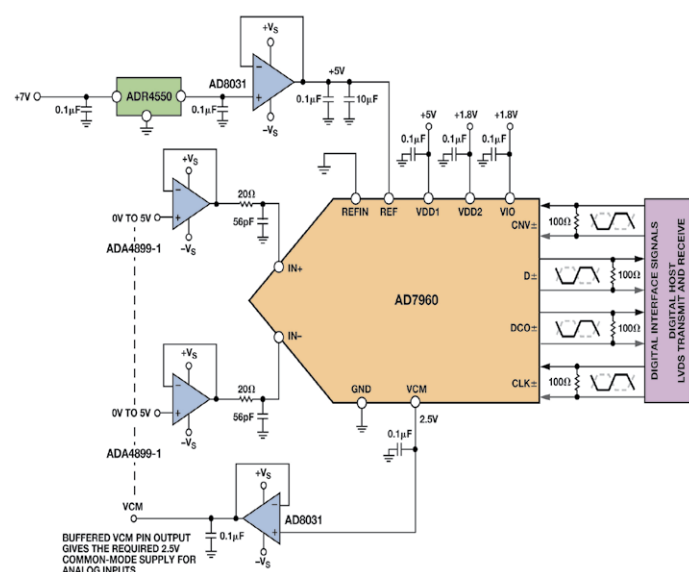
**Table 1.** AD7960 ADC driver selection benchmark.

Notes:  $N = 18$ ;  $t_{acq} = 100$  nsec;  $(V_{rms\_in})^2 = 5^2/2 = 12.5$  V<sup>2</sup>;  
 $e_{n\_amp} = 2$  nV/ $\sqrt{\text{Hz}}$ ;  $f_{-3dB\_ADC} = 28$  MHz.

The op amp data sheet usually specifies the settling time as the combined time for linear settling and slewing; the formulae give are first-order approximations assuming 50% for linear settling and 50% for slewing (multiplexed application) using a 5-V single-ended input.

The ADA4899-1 rail-to-rail amplifier features 600-MHz bandwidth, -117-dBc distortion @ 1 MHz, and 1-nV/ $\sqrt{\text{Hz}}$  noise. It settles to 0.1% within 50 nsec when configured as a unity-gain buffer driving the inputs of the AD7960 with a 5-V differential signal.

Maithil Pachchigar [maithil.pachchigar@analog.com] is an applications engineer within the Precision Converters business unit at Analog Devices, Inc. He joined ADI in 2010 and supports the precision ADC product portfolio and customers in the industrial, instrumentation, medical, and energy segments. Having worked in the semiconductor industry since 2005, Maithil has published several technical articles and application notes. He received an MSEE from San Jose State University in 2006 and an MBA from Silicon Valley University in 2010.



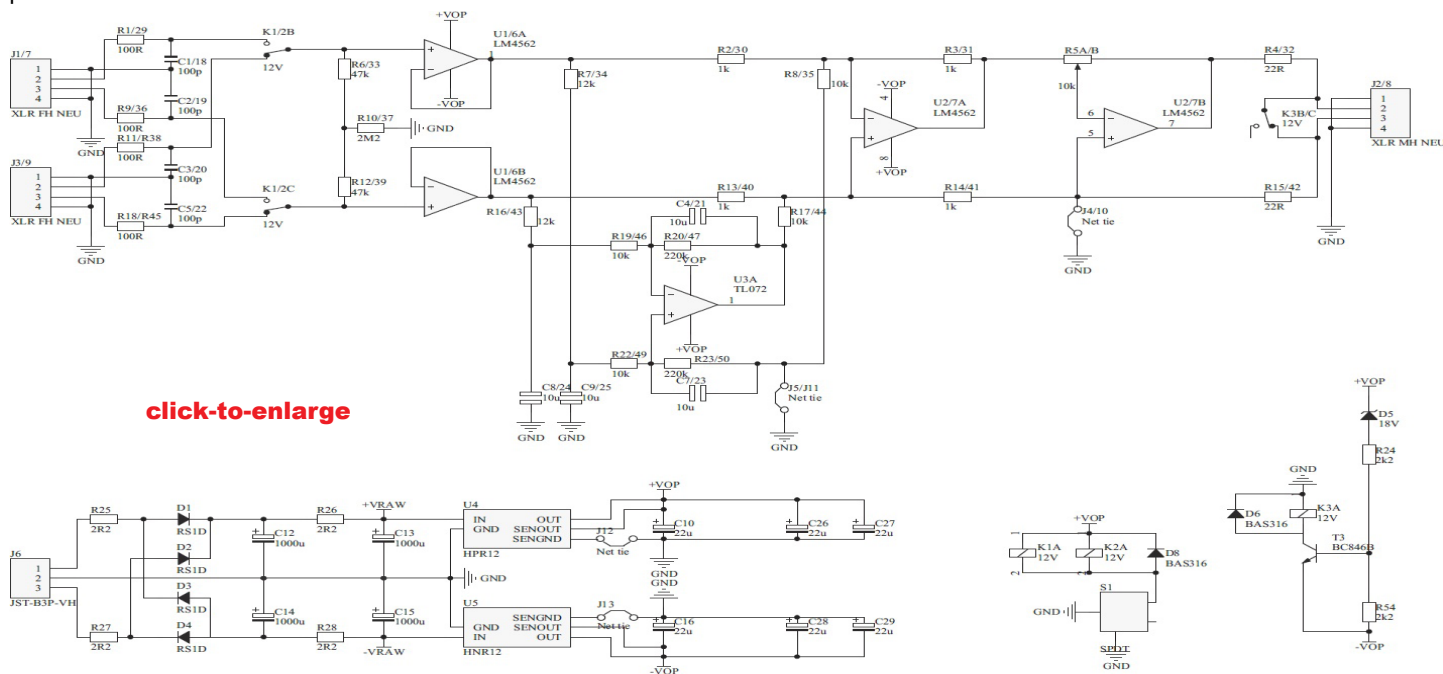
**Figure 1.** Precision, fast-settling signal chain using AD7960, ADA4899, AD8031, and ADR4550

# THE G WORD: HOW TO GET YOUR AUDIO OFF THE GROUND (PART 4): DEMO PROJECT - A BALANCED VOLUME CONTROLLER

[Part 1 introduces the topic of grounding and "GND-think." Part 2 considers the ideal differential input. Part 3 looks at impedance balance vs. current balance, instrumentation amps and cable shielding.]

This article originally appeared in [Linear Audio](#), a book-format audio magazine published half-yearly by Jan Didden.

According to a quick scan of professional audio fora, a perennial question is how to build a purist balanced volume controller. Two recurring themes are H-pad attenuators and dual-gang pots.





# HOW TO ACHIEVE EARLIER, FASTER SUBSYSTEM PERFORMANCE ANALYSIS AND DEBUGGING

To understand system performance, engineers have traditionally relied on testbenches to model corner-case scenarios that can cause performance bottlenecks. This is a time-consuming, manual process, where it's difficult to mimic real traffic situations that lend themselves to productive hardware debugging. This article discusses technologies and techniques that make it possible to, early in the design process, model realistic traffic that taxes the interconnect in order to quickly identify and resolve performance bottlenecks.

## Introduction

Corner cases—those exceptional, unexpected scenarios or sequences of events that wreak havoc on otherwise well-behaving designs—happen. While you may not be able to prevent corner cases, you can take steps to model them in order to debug the hardware in your design to minimise their impact.

Understanding system performance calls for a considerable investment in testbenches that you can use to put your system through corner-case scenarios that can cause performance bottlenecks. Done manually, this can involve weeks or even months of testbench coding. And this doesn't include accommodating changes in the design. Who can afford this investment in time and resources? What's more, once you've detected the performance bottlenecks, how can you efficiently find and debug the causes?

Fortunately, there are technologies and techniques available that help you automate testbench creation and accurately model the kind of traffic that a given design is anticipated to experience. With these insights, you can productively accomplish cycle-accurate performance analysis of bandwidth and latency in your design.

## Cycle-accurate performance analysis

Traditionally, one way to generate the kind of realistic traffic that will burden [stress] a system-on-chip (SoC) interconnect has involved a lot of waiting. After all, it's only at the end of the register-transfer level (RTL) simulation stage that you would have in place all of the intellectual property (IP) and associated software drivers. Of course, the closer you are to the end of your design cycle, the costlier it is to make changes.

Another solution is to model all of the IP in SystemC and run early versions of the software on top. There are many limitations to this approach, not the least of which is that the models are not cycle-accurate. However, worse than this is that many components of the SoC infrastructure may be extremely complex and, in many cases, provided by third-party providers (the ARM CoreLink CCI-400 Cache Coherent Interconnect is an example of such an IP). This limits the availability of models and may force analysis to be deferred until RTL analysis has been performed.

Ideally, it would be great to run performance analysis simula-

tions with the cycle-accurate RTL of the interconnect subsystem. In this approach, we would add critical IPs such as the DDR controller, while removing dependency on the availability of other IPs by replacing them with traffic synthesisers that drive realistic traffic patterns representing the replaced IP.

Coupling this approach with a tool capable of automating the creation of the necessary testbench would greatly reduce the effort and risk associated with manual testbench creation. This is especially true as experience shows that interconnect configuration frequently changes during the design cycle.

## GUI-based tool automatically generates testbenches

Cadence's Interconnect Workbench is a tool with two major capabilities. One: it automatically generates testbenches tailored for functional verification and performance analysis of complex

interconnect subsystems. Two: the tool provides a powerful GUI for analysing the performance metrics collected while running simulations using the generated testbenches. These testbenches use Cadence Verification IP to replace selected IP blocks in your design and gain access to faster simulation and a higher level of control over simulation traffic. Verification IP monitors can assess traffic at each of your interconnect ports. Making cumbersome spreadsheets redundant, the GUI has built-in filters for choosing the masters, slaves, and paths that you want to evaluate. Rather than running multiple, lengthy simulations, the tool can quickly identify the critical paths for debugging.

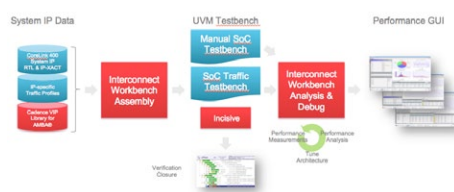
By using Interconnect Workbench on its SoC, one leading communications technology company reduced its interconnect verification effort from eight man-months down

to one man-month, gaining important insights into latency, bandwidth, and outstanding transaction depth.

Here's a summary of what Interconnect Workbench can do:

- Automatically generate Universal Verification Methodology (UVM)-compliant performance and verification testbench code from ARM CoreLink AMBA Designer output (interconnect fabric RTL and IP-XACT metadata)
- Deliver cycle-accurate performance analysis, plus a performance analysis cockpit that lets you visualise, discover, and debug system performance behaviours
- Collect all transactions and verify the correctness and completeness of data as it passes through the SoC interconnect fabric, via integration with Cadence Interconnect Validator Verification IP

Concluding this methodology description, the authors look at how this approach adopts a top-down debug approach, and how it allows examination of the SoC's response to high traffic workloads.



**Figure 1.** Data flow through Interconnect Workbench. RTL, Verification IP, and traffic pattern descriptions move into the tool, which automatically generates a testbench for simulation. As other variations of SoCs are generated, the tool can generate additional testbenches. The performance GUI provides an overview of simulation results. Performance metrics can also be collected from manually created testbenches, as long as they include an instance of the Interconnect Validator.

## WHEN YOUR MSO NEEDS HELP: UNDERSTAND WHEN A LOGIC ANALYSER CAN REALLY ADD VALUE TO YOUR MSO.

**M**ixed-Signal Oscilloscopes (MSO) have become everyone's 'Engineering Swiss Army Knife': why would you need an additional logic analyser?

Mixed-signal oscilloscopes (MSOs) with sampling rates in the GHz range and eight or more digital lines can be priced well under \$3,000. For this reason, many in the electronics industry are announcing the demise of the logic analyser as a piece of stand-alone equipment.

It is no surprise that mixed-signal oscilloscopes are to be found in most electronic engineering labs today. They are versatile, affordable and have become the basic instrument for any engineer who is testing, debugging and verifying electronic systems. In fact this could be the only instrument that most electronic engineers will ever have to (or want to?) use for 90% of their lab time. So, it is wise to spend part of an initial engineering or test lab budget on an MSO. But does this mean that you will not need a logic analyser (LA)? Read on...

### Oscilloscopes vs. logic analysers – the basics, revised

Digital oscilloscopes and logic analysers are based on sampling techniques. Electrical signal (usually voltage) measurements are transformed into digital values by a high-speed analogue-to-digital converter (ADC) and stored into memory at regular intervals defined by the instrument's sampling clock.

A logic analyser can be thought of as an oscilloscope with 1-bit vertical resolution on all channels. It displays signals as logic (binary) values, according to whether the measured voltage is above or below a conventional voltage level called 'threshold value'. That is the first fundamental difference between an oscilloscope and a logic analyser.

The other fundamental difference between an oscilloscope and a logic analyser is how the sampled values are displayed. In its most common mode of operation, an oscilloscope is essentially a device that repeatedly captures a "window" of events of a given length (defined by its total memory) and refreshes the display of a portion of that window on a screen. Many oscilloscopes simulate 'persistence' by superimposing multiple captured windows on the display and by modulating the screen pixel intensity.

A logic analyser is mostly used for single-shot captures (no superimposition of successive captures) and to analyse the sequence of events of – sometimes – over more than 100 digital signals before and after an event called trigger.

It was the appearance of microcontroller-based systems that required the creation of tools such as logic analysers. First, there was a need to observe digital busses – and hence to have more than two or four channels. Second, there was a need to see the signals the way logic circuit does, i.e. at the sampling

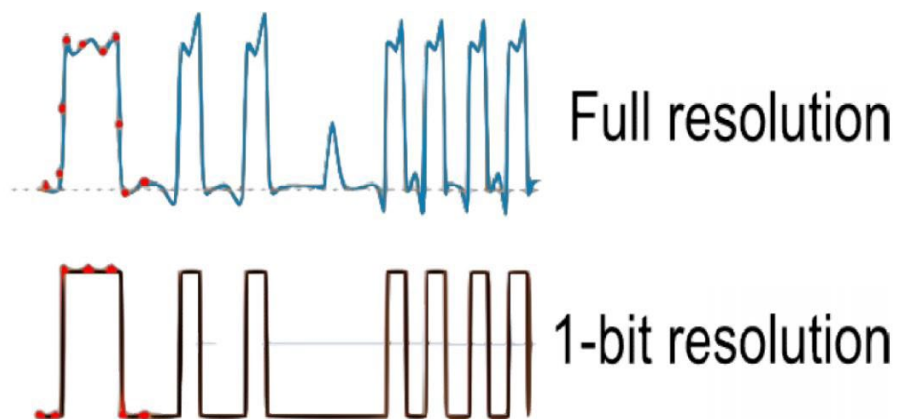
events of the circuit, in the form of binary values. Over time, logic analysers have turned into less 'pure' instruments with an ability to perform some analogue measurements – especially for checking threshold levels, detecting glitches and verifying the compliance of signals to specific I/O standards.

### MSO = Oscilloscope + Logic analyser?

Well, mostly. A mixed-signal oscilloscope (MSO) features 'analogue channels' (usually two to four) and 'digital channels' (usually eight to 16). On both types of channels, data is sampled at the MSO's maximum sampling rate (1 GHz, typically). The sampling clock is usually generated internally by the MSO. In other words, the reference time base for sampling is not correlated with the data – this is what is called 'Timing Analysis'. And of course, the signal vertical resolution is retained for the analogue channels and is reduced to 1 bit for the digital channels.

MSOs are able to perform some of the functionalities traditionally reserved to LA:

- Timing analysis on digital signals
- Ability to see more than two or four channels: on modern MSO, 16 digital inputs are available
- Digital signal integrity check. From this respect, being able to visualise both the analogue extension of a digital signal and its digital version on the same screen is certainly an improvement compared to using a scope and a logic analyser separately. With electronic systems evolving towards more complexity, debugging involves a mix of analogue and logic types of potential issues. An MSO's trigger can be defined for either type of signal. Repetitive (oscilloscope-like) or single-shot (logic analyser-like) types of display can be used as well. It must be noted that displaying analogue and digital recording on the same screen as time-correlated data is one of the biggest advantages of MSOs.



**Figure 1.** The logic analyser's samples are displayed as either above or below a threshold value..

The continuation of this article goes on to consider some of the basic attributes of the logic analyser, makes some observations about the "real-time" nature of measurements, and sets boundaries that define when a logic analyser may be an essential "extra" acquisition. Click right.



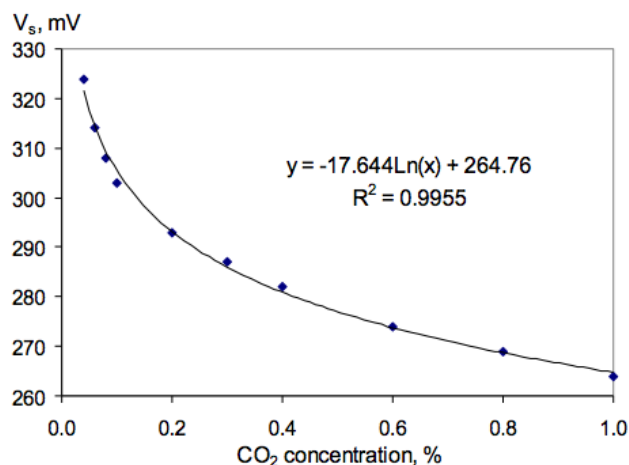
## Antilog converter linearises carbon dioxide sensor

Jordan Dimitrov

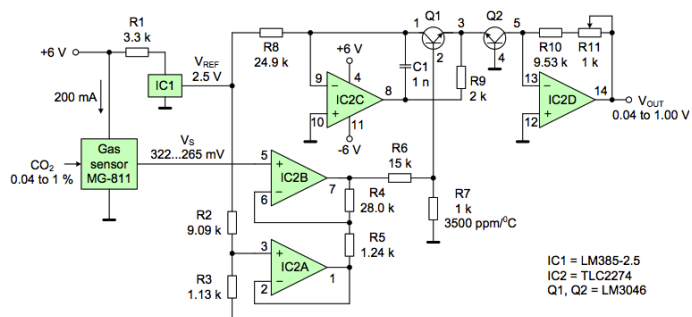


While most carbon dioxide sensors use IR technology, electrochemical sensors are a serious competitor because of their high sensitivity, wide measurement range, and low price. As a rule, electrochemical sensors connect to a microcontroller through a buffer amplifier with an extremely low bias current (<1 pA). The micro is needed to linearise the logarithmic response of the sensor. A good example of this approach is the SEN-000007 module from Sandbox Electronics, which uses an MG-811 CO<sub>2</sub> sensor from Hanwei Electronics. Reference 1 reveals the circuits and the code, but does not specify accuracy.

This Design Idea shows a pure hardware solution to the linearisation problem with a simple and cheap circuit that features easy adjustment and good accuracy. The output signal can go directly to a panel meter or a microcontroller, requiring no complex data manipulation such as log or antilog calculations.



**Figure 1.** The sensor has a logarithmic response with a 265 mV offset.



**Figure 2.** A quad op-amp and a pair of matched transistors provide simple and cheap linearisation. R7 is a standard compensating resistor, as from PRC.

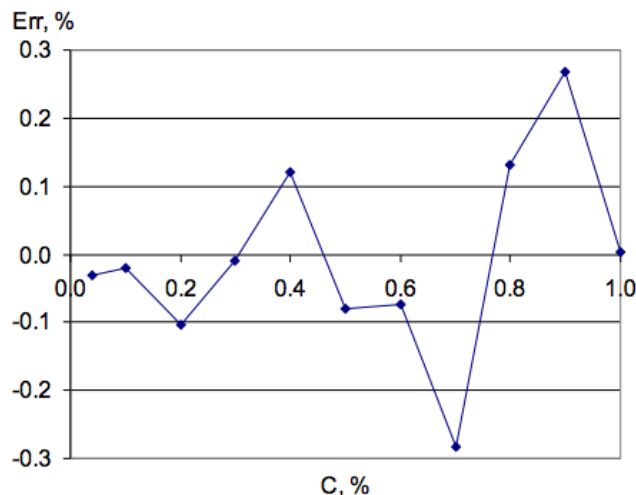
The MG-811 sensor measures CO<sub>2</sub> concentration from 400 to 10,000 ppm (0.04% to 1%). Figure 1 displays the transfer function of the sensor. The data points come from the datasheet of the MG-811. The line and equation are generated by the curve fitting tool of Microsoft Excel.

Figure 2 presents the circuit. It uses a quad op-amp and a pair of matched transistors. IC2A and IC2B, make a conditioning circuit that provides high input resistance to the sensor, removes the 265 mV offset from the sensor response, and amplifies the resulting signal. The goal is to modify the sensor response to the form  $V_s = \ln C$  (C is CO<sub>2</sub> concentration) so the antilog converter (built with IC2C, IC2D, and the matched transistors, Reference 2) can implement the  $\ln C = C$  identity, thus providing a linear relation between V<sub>OUT</sub> and CO<sub>2</sub> concentration. The 2.5V reference IC1 allows the circuit to work with other gas sensors – such as the TGS4161 from Figaro – that require not 6V, but a 5V power supply. Note that the sensor draws a lot of current.

The circuit needs only a full-scale adjustment (R11) for calibration. Accuracy is  $\pm 0.3\%$  (see Figure 3), which matches well to a 3.5-digit panel meter, and is much better than the expected accuracy of this type of sensor.

### References:

1. MG-811 CO<sub>2</sub> Sensor Module
2. AN-30 Log Converters, National Semiconductor (TI)




**Figure 3.** Accuracy is enough for a 3.5-digit panel meter.



## Gated oscillator holds last level

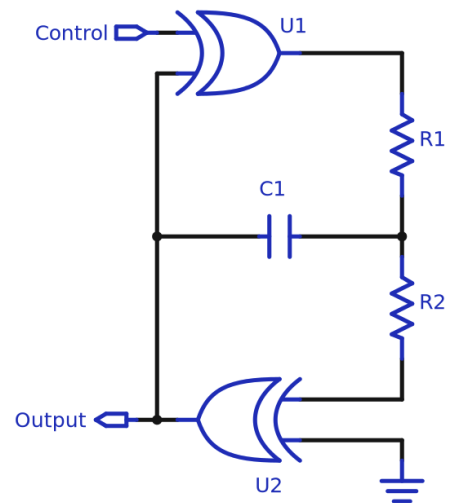
Einar Abell

 This Design Idea is a gated oscillator with the unusual (unique?) characteristic of stopping in its current state rather than being forced high or low. Unlike a conventional gated oscillator, this one both starts and stops in its existing state whether high or low. Gating a conventional oscillator may cause the output to change state with the control signal, either at the start or the end (or both). Also, it will not produce any truncated pulses.

The circuit consists of the conventional CMOS oscillator, but with the feedback split into a separate positive path (the non-inverting U2), and a controlled path (the XOR gate U1) that can be either positive or negative, depending on the state of the control input.

When the control input is high, the XOR is an inverter, and its output will be the reverse of U2's output, allowing C1 to charge or discharge through R1 until the threshold of U2 is reached ( $1/2 V_{+}$ ) and the output switches, reversing the process for the next half-cycle. When the control input goes low, the XOR gate becomes a non-inverter, and only positive feedback is present. C1 now discharges through R1, and the output remains in whatever state it was in. When the control input goes high again, the oscillation starts from whatever state this was.

Another unusual feature of this circuit is that it can act as a frequency divider. If the control input is a repetitive signal, and R1 and C1 are chosen such that the oscillator output changes state just once when the input is high, the output frequency will be one half the input.



R2 limits the current into the protection diodes of U2; it is most conveniently made equal to R1, but can range from  $1k\Omega$  to several megohms. U2 can be an EXOR gate with one input grounded, or whatever form of buffer is available.

Oscillation frequency is approximately  $1.4 \cdot R1 \cdot C1$ .

This switched feedback method will also work if U2 is a Schmitt trigger; connect C1 to ground instead of the output, and remove R2.

## Circuit discriminates and recovers noisy pulses

Vladimir Rentyuk


 This Design Idea is a solution for the following problem: I needed to provide a pulse of a specified duration from "dirty" pulse bursts that can vary over a 60 dB range. Minimal delay time between input and output was also required, so I could not use an integrator or other simple design. The circuit is used in a distance meter, which is why little and constant delay between input and output pulses is so important. Testing has demonstrated excellent operation.

Figure 1 provides a well specified output from dirty input pulses, such as relaxation, harmonic oscillations, pulse bursts, pulses

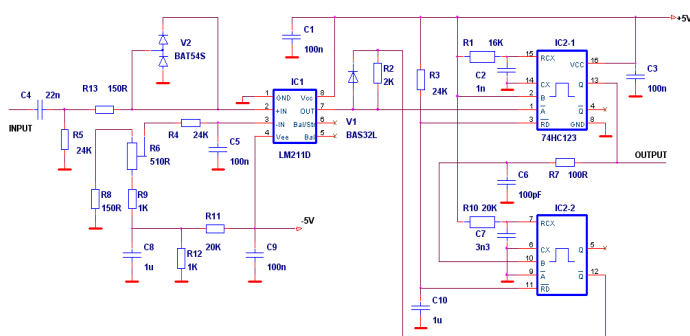


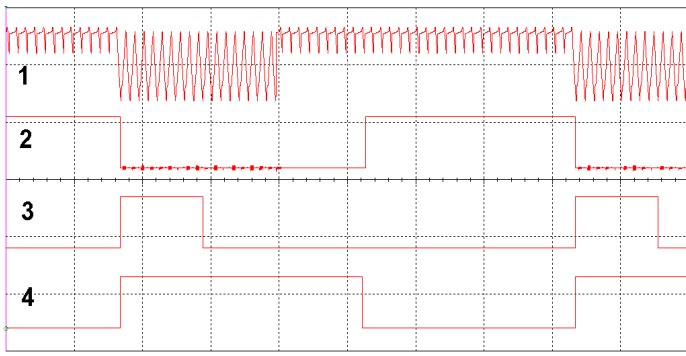
Figure 1 A pulse discriminator

with undefined durations, etc., ranging from 10 mV to 5V. The output is a positive logic-level pulse of controlled duration.

Input pulses come to a positive input of comparator IC1 through a differentiating circuit C4 and R5, which should be set to the minimum permissible for your application. Pot R6 establishes the threshold of the comparator, in this case from 13 mV to 60 mV. The threshold should be set to the minimum allowable level of the input signal.

Monostable multivibrator IC2-1 generates the output pulses. A second monostable, IC2-2, generates a protective or blanking interval. This interval (established by R10, C7) should be longer than the output pulses, and shorter than the input pulse burst period.

When the level of the input drops below the threshold of comparator IC1, its output will change from high to low. (Note: the initial condition of IC2-2 is high on pin 12.) Monostable IC2-1 generates output pulses by its negative-edge triggered input (pin 1). The positive edge of its output triggers (by its positive edge-triggered input pin 10) IC2-2, which generates the blanking interval. During this time interval, the open-collector output of the comparator will not be able to go high. A timing diagram of this process is presented in Figure 2.



**Figure 2** Timing diagram of the pulse discriminator, 5  $\mu\text{sec}/\text{div}$ .  
Traces show;

- 1 Input "dirty" signal with noise (1.5 MHz, burst 12  $\mu\text{sec}$ , burst period 34  $\mu\text{sec}$ )
- 2 Output signal of comparator (Pin 7 IC1)
- 3 Output pulse, 6  $\mu\text{sec}$  (Pin 13 IC2-1)
- 4 Blanking interval, 17  $\mu\text{sec}$  (Pin 12 IC2-2)

The delay time of this circuit is about 120 nsec, and can be reduced by choosing faster parts. The dynamic range is more than 60dB.

R3 and C10 provide a power-on reset. R7 and C6 provide stability of trigger of both monostable multivibrators. Otherwise, a starting pulse has a glitch of a few nanoseconds only. The diode V1 provides rapid discharge of all parasitic capacitances connected to the output of comparator IC1. Hence, any additional input impulses will not retrigger IC2-1. R13 and V2 are optional – they protect the comparator input against signals with amplitudes beyond  $\pm 5\text{V}$ . Naturally, this Design Idea can be used with positive polarity inputs by changing the connections of the comparator inputs.

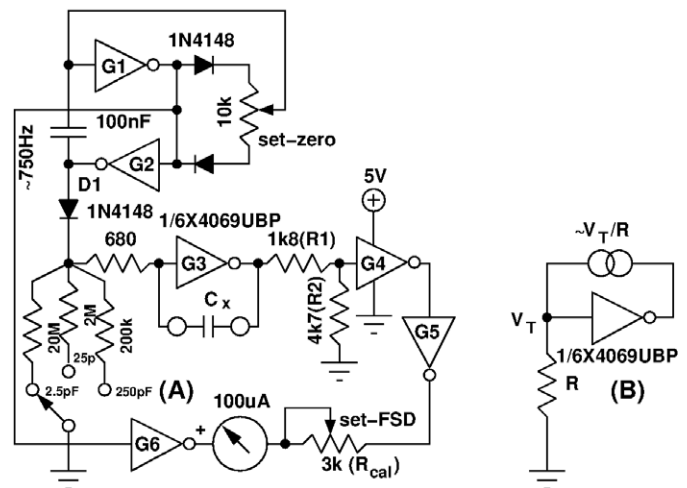
## Sub-picofarad measurement with CMOS inverters

Raju Baddi



The inverters in a CMOS CD4069 can be used for both analogue as well as digital applications. This Design Idea illustrates this by using all six inverters in a 4069 package to make a closed loop, duty-cycle-based capacitance meter with a full scale deflection below one picofarad.

The inverters exhibit stable output with a direct feedback connection: When the input of one gate is directly connected to the output, the resulting output is around  $V_T$ , the threshold voltage. If a resistor  $R$  is connected between the input and ground, a current equal to  $-V_T/R$  flows, as shown in Figure 1B. Its magnitude remains fairly constant, even when a resistor – small compared to  $R$  – is introduced in the feedback loop. The voltage window  $\Delta V_T$  around  $V_T$  that changes the gate's output from logic-0 to logic-1 is very small compared to  $V_T$  itself. This means the voltage across  $R$  would remain within  $V_T \pm \Delta V_T/2$ , yielding an approximately constant current through it (since the output voltage can have a value up to  $V_{DD}$ , up to  $V_{DD} - V_T$  can be dropped across the feedback resistor). The feedback loop is thus a source of constant current.



**Figure 1** (A) 2.5 pF-250 pF FSD capacitance meter using all six inverter gates of a CD4069.  
(B) A single-gate constant current source.

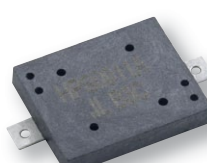
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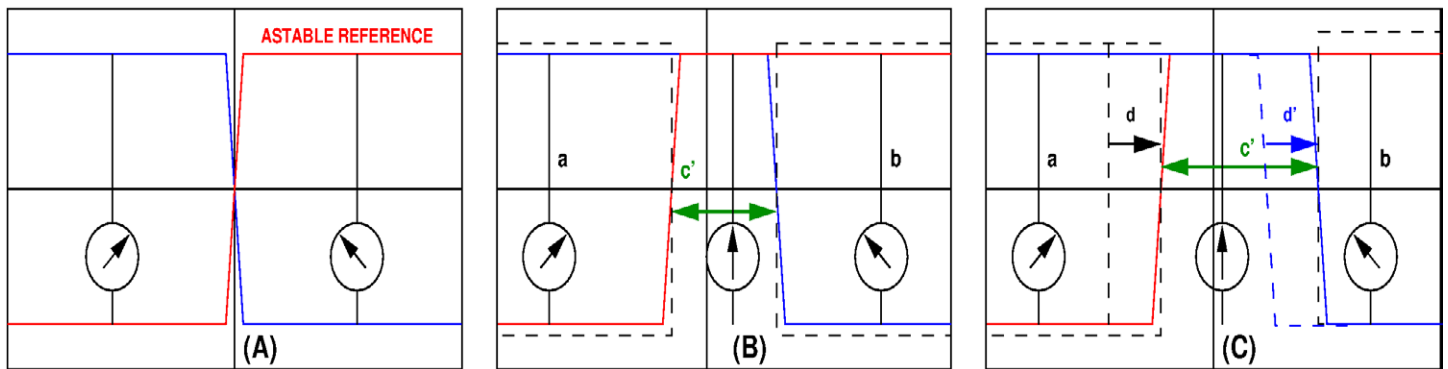
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**Figure 2** (A) 50% duty cycle signal when applied to a meter through two gates, 180° out of phase. The average difference is zero, hence the meter shows no deflection.

(B) Stray capacitance compensated waveform from the astable (G5<sub>IN</sub>, G6<sub>IN</sub>), a and b phases produce equal and opposite deflection in the meter causing a net null deflection. However the delay along the ramp line causes one of the signals to have an offset for a duration (c' - null phase). During this null phase (c') the net potential difference across the meter is zero so it contributes no deflection. Overall during the entire period, the meter has net zero algebraic deflection. It should be noted that

stray capacitance compensation is provided by adjusting the astable duty cycle which is represented by the red waveform.

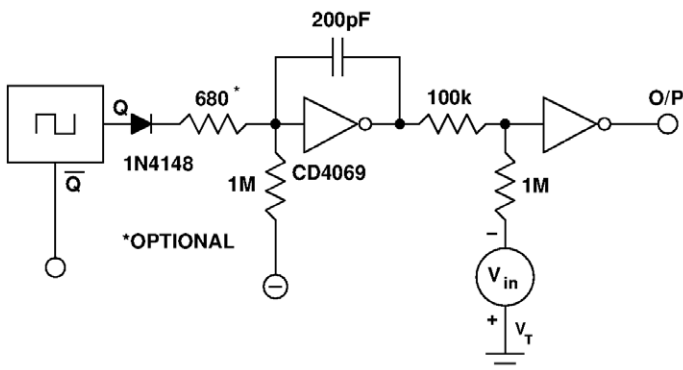
(C) Waveforms across the meter when an external capacitor to be measured CX is introduced in the ramp circuit. This causes additional delay causing asymmetric deflection moments in the meter, the phase a now lasts for a relatively longer period compared to phase b by an amount d' proportional to the value of the capacitor CX. So for one astable period (T) the residual algebraic deflection in the meter now is for duration d(=d'). The average deflection seen in the meter now depends on d/T which in turn measures test capacitor's value.

By having a capacitor within this loop, one can charge it at a constant rate, giving rise to a linearly rising voltage ramp. This technique is applied in the circuit of Figure 1A to build a picofarad full scale deflection (FSD) capacitance meter. It consists of a two-gate astable (G1, G2), a single-gate voltage ramp generator (G3) whose slope depends on the value of the test capacitor CX, a single-gate voltage level detector (G4), and two buffers (G5, G6) which drive the meter through the calibrating resistor Rcal.

The reading due to stray capacitance can be nulled by adjusting the duty cycle of the astable with the 10 kΩ set-zero pot. The astable drives the ramp generator through isolating diode D1, which serves to rapidly discharge CX, but which allows charging through the ramp resistor (20 MΩ/2 MΩ/200 kΩ) alone. A reverse-biased diode has an effective resistance on the order of 10<sub>9</sub>Ω, and hence is much larger than even the 20 MΩ resistor.

The complementary output of the astable drives G6, whose output drives one of the terminals of the meter. Gate G4 acts as a level detector for the ramp through the divider network R1/R2 (resistance values can be increased if desired). The output of G4 is buffered by G5, whose output drives another terminal of the meter. The ramp effectively introduces a delay in the falling output of the astable, directly proportional to the value of CX. This delay produces a voltage difference across the meter for part of the cycle, resulting in a display of the value of CX. An RC filter may be needed if driving a digital meter.

The high impedance of the CMOS inputs is another essential feature that makes this design work, allowing large resistors like 20 MΩ or more across its input. This simple circuit uses only a single 4069 inverter chip to make a complete, reliable capacitance meter.



**Figure 3** Another application of the constant current source integrator is to realise PWM using only two gates. Vin introduces a voltage across the 100 kΩ resistor which the ramp has to overcome in order to switch the output gate. If needed, V<sub>T</sub> bias can be obtained using another gate with output connected to input.

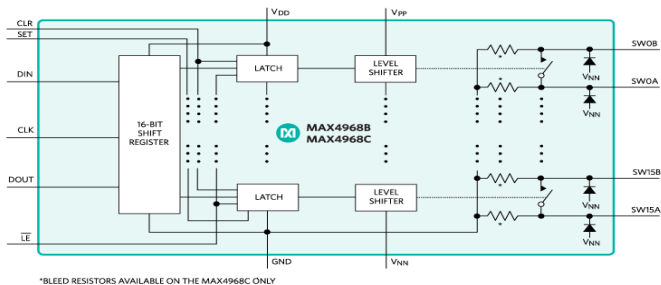




# productroundup

## High-voltage, latchup-free analogue switches

Maxim Integrated has posted details of the MAX4968B and MAX4968C, which are 16-channel, high-linearity, high-voltage (HV), bidirectional SPST analogue switches with 18 $\Omega$



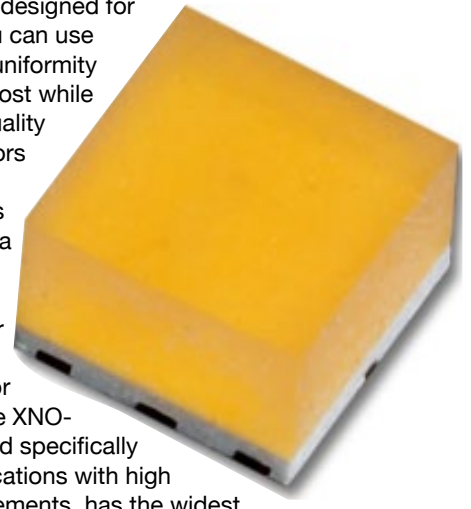
(typ) on-resistance. Use the parts, Maxim suggests, in applications requiring high-voltage switching controlled by a low-voltage control signal, such as ultrasound imaging and industrial printing. The MAX4968C differs by providing integrated 40 k $\Omega$  bleed resistors on each switch terminal to discharge capacitive loads. Using HVC MOS technology, these switches combine high-voltage bilateral MOS switches and low-power CMOS logic to provide efficient control of high-voltage analogue signals. The devices are available in the 64-bump BGA package and are specified over the -40°C to +85°C extended temperature range.

Complete article, here



## 1W LED “Cube” package provides wide-angle illumination for lighting

Luminus’ XNOVA Cube is a 1W SMD LED with extremely wide emission angle for illumination applications, in contrast – says its maker – to many devices currently on the market which were primarily designed for backlighting use. You can use fewer LEDs, improve uniformity and reduce system cost while retaining optimum quality of light with CRI factors of 80 or 90, Luminus says. XNOVA Cube is a 1W SMD LED with a 170 degree emission angle. Unlike some traditional mid-power LEDs, which were originally designed for LCD backlighting, the XNOVA cube is engineered specifically for illumination applications with high quality of light requirements, has the widest viewing angle, emits more light than any midpower LED, and delivers it from 1.9 by 1.9mm package. Typical efficacy is 120 LPW; the LEDs offer a wide colour selection of 2700K-5000K; and are powered by a 6V input.



Complete article, here



## 75V MOSFETs have ultra-low $R_{ds(on)}$

International Rectifier has expanded its StrongIRFET MOSFET portfolio to include 75V devices for industrial applications including power tools, light electric vehicle (LEV) inverters, DC motor drives, Li-Ion battery pack protection, hot-swap and switched mode power supply (SMPS) secondary-side synchronous rectification. On resistances range from 1.8 to 10.6 m $\Omega$  for devices with current ratings of 195-42A. This family of 75V



high-current carrying capability, soft body diode, and 3V typical threshold voltage to improve noise immunity. Each device in the family is 100% avalanche tested at industry highest avalanche current levels. The devices come in through-hole packages.

Complete article, here



## GPS-disciplined OCXO maintains stability over loss of signal

QD’s IQCM-110 is a series of GPS-disciplined OCXOs (oven-controlled crystal oscillators) that incorporate an internal GPS receiver with a 1PPS output, housed in a 14-pin 60-mm square package. When coupled to an external aerial via an SMA connector, in the event of the loss of the GPS signal the highly specified 10 MHz OCXO will switch-in with a holdover capability



ity of 1.5  $\mu$ sec for a 24-hour period thereby maintaining lock until restoration of the reference signal. The standard operating temperature range of the module is -20 to 75°C but other temperature ranges and holdover specifications can be considered upon request. The design incorporates an internal adaptive algorithm which enables the module to ‘learn’ the parameters of the GPS signal after a period of 2 days of lock so that the holdover function can start in the event of signal failure.

Complete article, here



## Digitally-enhanced analogue power controllers

Claiming to combine the flexible control and telemetry aspects of digital power supply architectures with easy-to-use analogue control loops, Microchip's MCP19118/9 provide



simple analogue PWM control and a configurable MCU to yield the first PMBus compatible controller with up to 40V operation. They are positioned as the first devices to combine 40V operation and PMBus communi-

cation interfaces. These features enable quick power-conversion circuit development with an analogue control loop that is programmable in the integrated 8-bit PIC MCU core's firmware. By integrating a supervisory microcontroller, the MCP19118/9 devices can create programmable power supplies. Key system settings—such as switching frequency (100 kHz to 1.6 MHz), current limits and voltage setpoints—can be adjusted on-the-fly during operation by issuing write commands to the registers in the device.

[Complete article, here](#)

## Cooling fans fit in 3- and 2-mm thicknesses

As mobile devices are becoming slimmer, Sunon is providing a full range of 2-mm thickness cooling fans. Mobile products now host multi-core processors, and cooling is more critical than ever. Sunon, with a 32-year history in innovation in the miniature cooling field, is creating various "thin and light cooling fan" series. These measure 30 x 30 x 3 mm to 8 x 8 x 3 mm, in addition to products of 2mm thickness or below that



can be custom-made. Traditional fans are 0.6-cm minimum thickness. They have a large interior space and use washers, retaining rings, and other necessary parts. Moreover, they fix the fan in place and enable it to rotate using silicon steel and magnets which supply magnetic lines of force. Known problems with "thinned" fans include blade run-outs, blade loosening, and ineffective dust blocking. All these will impact the cooling efficiency, even endangering the product's service life, and Sunon believes it has overcome all of these issues.

[Complete article, here](#)

## Frequency-programmable narrow-band transmitter

RF module designer and manufacturer Radiometrix has a range of flexible, frequency programmable, RF power adjustable, radios. The NTX2B transmitter offers true Narrow Band FM (NBFM) performance and is available on user/factory programmable custom frequencies between 425 MHz and 470 MHz. The NTX2B provides users with the ability to dynamically re-program the module via a microcontroller UART to other



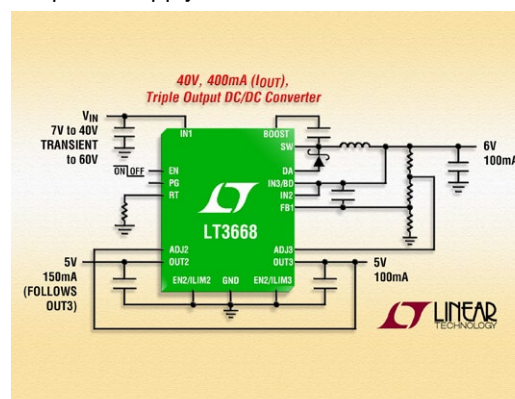
channel frequencies in the band or store new frequency/power settings on EEPROM. The standard NTX2B version is a 10 mW 25 kHz Narrow band Transmitter with data rates up to 10 kbps and is

available on 434.075 MHz, 434.650 MHz European SRD frequencies and 25 mW on 458.700 MHz for the UK. The NTX2B is also available with 12.5 kHz or 20 kHz channel spacing for licensed US FCC Part 90 or legacy European Telemetry/Telecommand bands.

[Complete article, here](#)

## 40V, 400mA output, step-down regulator has dual tracking LDOs

LT3668 is a 400mA, 40V step-down switching regulator with dual tracking LDO outputs packaged in an MSOP-16E. The LT3668 offers a complete, robust power solution for applications that require the power supply of a sensor to tightly track the power supply of a measurement ASIC. The LT3668 oper-



ates from a VIN range of 4.3V to 40V with transient protection to 60V, making it suitable for automotive and industrial applications. Its internal 600 mA switch can deliver

up to 400 mA, which is distributed to the combined loads of the primary output and both of the tracking LDOs. The primary switching channel can deliver outputs as low as 1.2V, and each LDO can deliver outputs as low as 1.1V. The LT3668 requires only 50  $\mu$ A of quiescent current when all three channels are in regulation, making it appropriate for always-on automotive applications.

[Complete article, here](#)



## “Natural Light Technology” boosts LED lighting quality

These “Natural Light” LEDs will provide a colour quality of better than 95Ra CRI for the high-end, professional lighting market. Everlight Electronics is adding to its LED Lighting



product portfolio, which currently features standard CRI factors of better than 80Ra, with higher colour-quality versions. The new Natural Light LED variants will provide a CRI over 95Ra, averaging 98Ra. Everlight is pursuing this goal a step at a time. The first LED series to implement the Natural Light Technology are Everlight’s 3-50W Ceramic COBs (JU Series) and Metal PCB COBs (XUAN Series). All other LEDs will offer Natural Light versions in Q4 of 2014.

[Complete article, here](#)

## LED matrix manager for adaptive automotive headlights

From Texas Instruments, this device is aimed at a new generation of “smart” multi-emitter LED headlamps: it is a compact, scalable solution that reduces board space by 73%, controlling up to 96 high-brightness LEDs in innovative headlamps. This fully integrated high-brightness LED matrix manager IC for adaptive automotive headlight systems, TPS92661-Q1, enables car manufacturers to create innovative LED headlamps that



vary beam patterns and intensity dynamically for optimum roadway illumination and enhanced driver safety. The TPS92661-Q1 is a compact solution for shunt FET dimming arrays of high-brightness LEDs and includes 12 individually controlled MOSFET switches to steer current through or around the connected LEDs, thereby providing individual pixel-level light adjustment. A serial communication port facilitates control and diagnostic functions from a master microcontroller.

[Complete article, here](#)

## Microthermal mass flow meter for intelligent gas meters

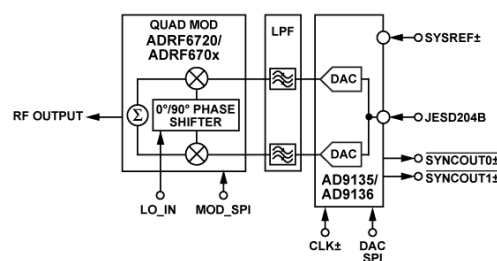
Sensirion’s SGM70xx mass flow meter is based on a microthermal measuring principle suitable for applications in the residential market. Sensirion has been working on a microthermal solution for industrial and private gas meters for the past fifteen years. The mass flow meter has proven itself in the field in Italy and Germany for over three years. The SGM70xx is the first microthermal gas flow module to be produced as standard by the company and will be available from March 2015. The SGM70xx is available for G1.6 and G2.5 gas meters. It offers reliability, long-term stability, dust and dirt resistance and a compact design that enables easy integration in gas meters. The mass flow meter is digital, temperature-compensated and pressure-corrected. It is also fully calibrated for air and natural gas and has a standard connection and I<sup>2</sup>C interface. Sensirion’s mass flow meter is based on its CMSens technology in which sensor component and evaluation circuit are integrated on a single CMOS microchip.



[Complete article, here](#)

## Dual 16-bit DAC has highest signal bandwidth

Claimed by Analog Devices as an industry first that achieves 70% wider bandwidth than competing devices, a 2.8-Gsample/sec dual 16-bit converter is intended for telecommunications system manufacturers that require microwave frequencies in point-to-point wireless backhaul equipment. The 16-bit AD9136 and 11-bit AD9135 dual D/A converters achieve higher signal bandwidth than competing devices while enabling designers to support 71-76 GHz and 81-86 GHz frequencies being adopted by wireless carriers to support steadily increasing demand for high-speed mobile voice and data transfers. The new converters’ maximum sample rate allows multi-carrier generation up to the Nyquist frequency. The AD9136/5 D/A converters support complex input data rates of up to 2.12 Gsample/sec per D/A converter using a flexible, 8-lane, 10.6 Gbps JESD204B interface. The new devices achieve better than -80 dBc spurious-free dynamic range (SFDR) and have noise performance of -163 dBm/Hz to provide high quality synthesis of wideband signals.



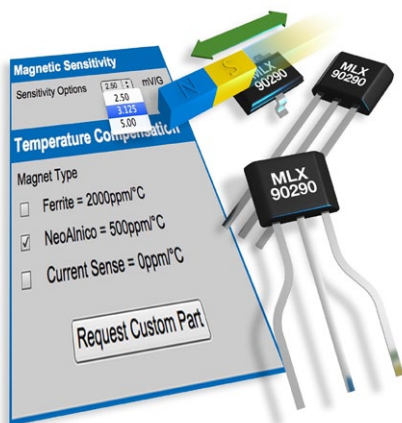
[Complete article, here](#)



## Programmable Hall sensor fits simply into industrial designs

**M**XL90290 is a monolithically integrated magnetic sensor IC, with amplifier, analogue output and internal compensation circuits all incorporated. It converts magnetic flux into an analogue output and guarantees the critical functional parameters (such as sensitivity, offset and their respective thermal drift characteristics) to absolute levels, thus simplifying integration processes by removing the need for end-of-line calibration. This means that design engineers can deliver high-performance position sensing solutions without extra end-of-line testing and validation.

They can buy off-the-shelf versions of the MLX90290 capable of satisfying their sensor requirements. Standard versions of the MLX90290 when combined with MCU units allow fast and accurate rotary, linear or motor commutation applications to be realised. It can also be applied to sense DC and AC current when combined with a ferrite toroid core.



[Complete article, here](#)

## “Secret-until-lit” illuminated switches

**J**apanese maker NKK Switches' YB2 half-mirrored push button switch family is available from distributor Foremost Electronics; the switches are suited to applications including machinery, medical devices, kitchen equipment, measurement instruments, equipment installed outdoors, and equipment installed in stores (e.g. vending machines). These aesthetically pleasing switches are a vapour deposition onto plastic design, providing the appearance and “feel” of stainless steel while being lightweight. The design eliminates any need for additional antistatic protection and offers enhanced durability protection from UV and other environmental conditions. The combination of a moulded flange and button produces a comfortable and pleasant tactile feel with no sensation to the user of metal parts chafing together. With a height above mounting panels of 1.8 mm, the YB2 push button switch is the slimmest design available with a panel seal mechanism waterproof to IP65 under IEC 60529.



[Complete article, here](#)

## 2D multi-touch and 3D gestures in one development kit

**M**icrochip's 3DTouchPad is a PC peripheral and first development platform for 2D multi-touch and 3D gestures, applications and drivers. The 3DTouchPad adds a dimension to input sensing by adding free-space gesture recognition to projected-capacitive multi-touch; as a development platform and reference design. The 3DTouchPad is the first development platform that combines 2D multi-touch and 3D air gesture input



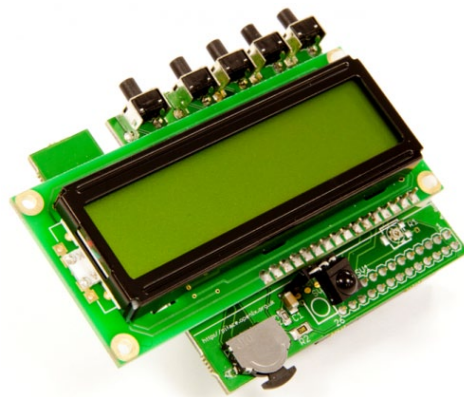
focussed on the PC/peripheral market. The 3DTouchPad provides robust and innovative 3D gesture recognition utilising Microchip's GestIC technology that offers a detection range of up to 10 cm for 3D gestures,

along with Microchip's projected-capacitive 2D multi-touch solution supporting up to 10 touch points and multi-finger surface gestures. The 2D multi-touch is enhanced by Microchip's capacitive touch-screen line driver, MTCH652, part of the same announcement.

[Complete article, here](#)

## Accessories for the Raspberry Pi; control with PiFace and SHIM

**D**istributor element14 and the team that designed the PiFace have launched a new series of exclusive Raspberry Pi accessories and updated the popular PiFace Digital and Control & Display following the launch of the Raspberry Pi model B+ in July 2014. The PiFace Digital 2 helps to sense and control real world applications and is a simple and easy way to connect switches, lights, motors and more to the Raspberry Pi allowing it to interface with the world around it. The PiFace Digital 2 includes components such as relays, switches, and digital and analogue I/O that will allow for connection to sensors, motors, lights, etc. and be controlled by the Raspberry Pi board. The SHIM RTC (Real Time Clock) means the Pi can keep a track of the current time with accuracy without using up the GPIO header, an easy plug and play integration and development for designs and/or applications requiring time stamps.



[Complete article, here](#)

## Troubleshooting in the sky

An aerospace company I worked for supplied the electric power systems for a number of turbo-prop aircraft that formed the backbone of a regional airline fleet. They can carry 50 or more passengers over 600 miles, at cruise speeds up to 250 knots, and form the spokes of the current hub-and-spokes routing system between major airports in the US.

One aircraft type operating in Europe flew at altitudes of up to 28,000 ft. (8,540m) over the Alps. We would seasonally receive returns of the windshield de-icing AC generator voltage regulators. The entire electrical system was designed, qualified, and FAA/JAA certified for the high-altitude operation, but the voltage regulators always came back with the small diodes in the regulator voltage and overvoltage protection sensing circuits blown open. No other electronic units on the aircraft were affected, and no one particular aircraft or operator had the problem.

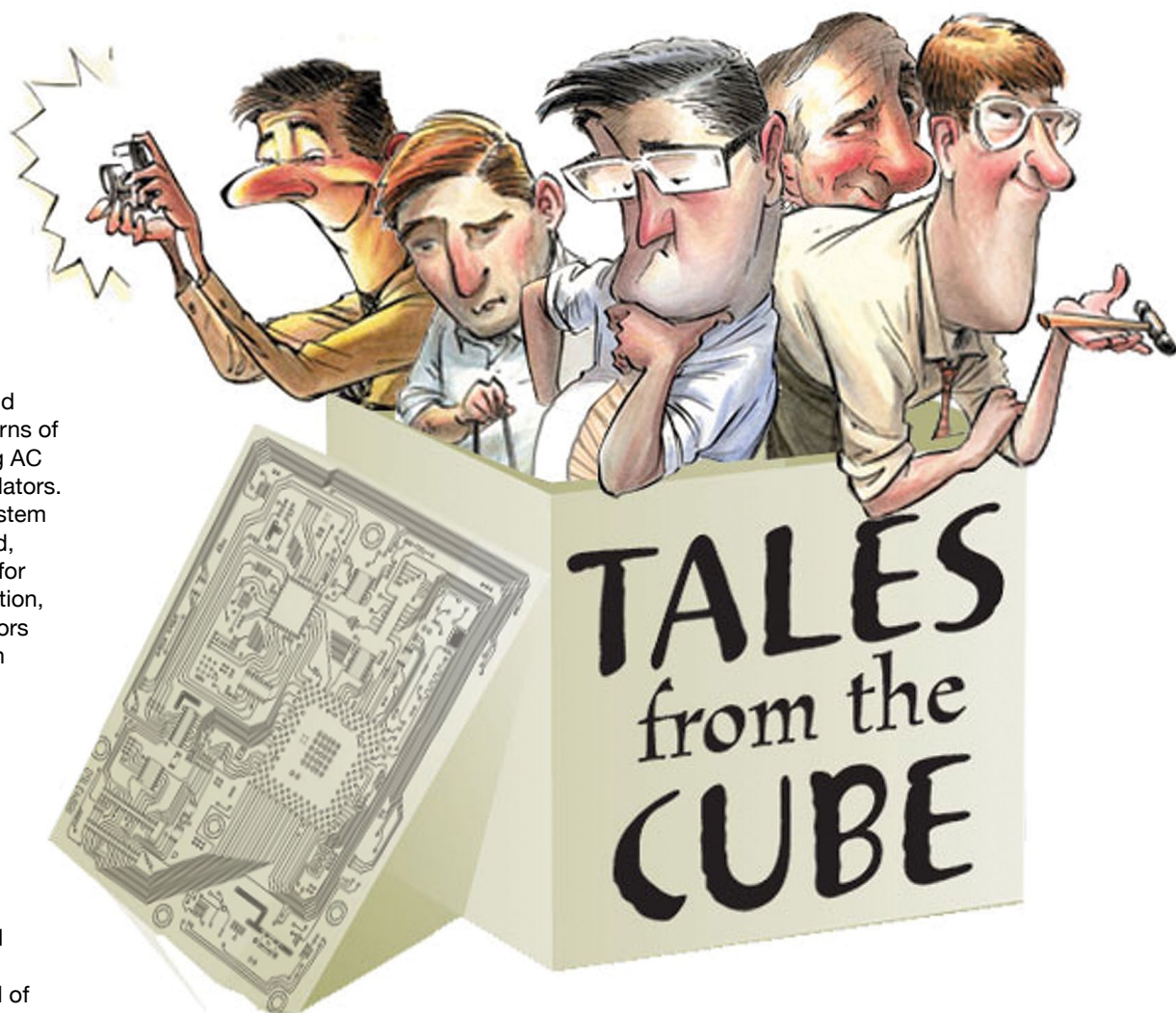
I set up one channel of the two-channel isolated de-icing system in our lab to see if we could duplicate the problem. We re-ran the lightning-withstanding qualification test again multiple times in a temperature-altitude chamber without issue. I even increased the lightning transient voltage to 25% over the specified maximum test level.

The sensing circuit diodes were rated for 1 kV, so they had plenty of margin over the 115/200 VAC three-phase generator output (163/283 Vpk). During maximum propeller and windshield de-icing operation, the generator loads remain well within their ratings, and one generator can provide the entire de-icing load if necessary. The wings and tail

surfaces are equipped with pneumatic de-icing boots. The electrical de-icing needs to use AC voltage so it doesn't delaminate the windshield, which could occur if DC voltage were used.

Since it seemed to be a bigger prob-

The de-icing system was operating perfectly on one flight and then all of a sudden there was an AC overvoltage on one channel and the generator field circuit breaker opened. The two-man flight



lem during the winter season, one of our best engineers flew over to Europe to investigate the problem in the operating environment. He brought the smallest early 1980's vintage storage oscilloscope we had, along with other test gear and flew a number of scheduled flights as they became available on the affected service routes. He had to cram himself and the test equipment into the electrical equipment area behind the cockpit. It took several weeks before the problem occurred on one of the flights he was instrumenting. I should also mention he had to buy a ticket on each flight in order to perform the tests.

crew did not report anything unusual on the trip, and the remaining de-icing generator stayed online to continue the flight to its destination.

The storage scope field current trace confirmed there was an overvoltage trip, but the AC voltage was normal until just before the trip, when it jumped to the saturation voltage of the de-icing generator, around 170 VAC (240 Vpk), still well below the 1-kV rating of the diodes. When the voltage regulator was inspected on the ground, the diodes were found to have blown open again.

The open diodes caused an AC overvoltage because the regulator lost sens-

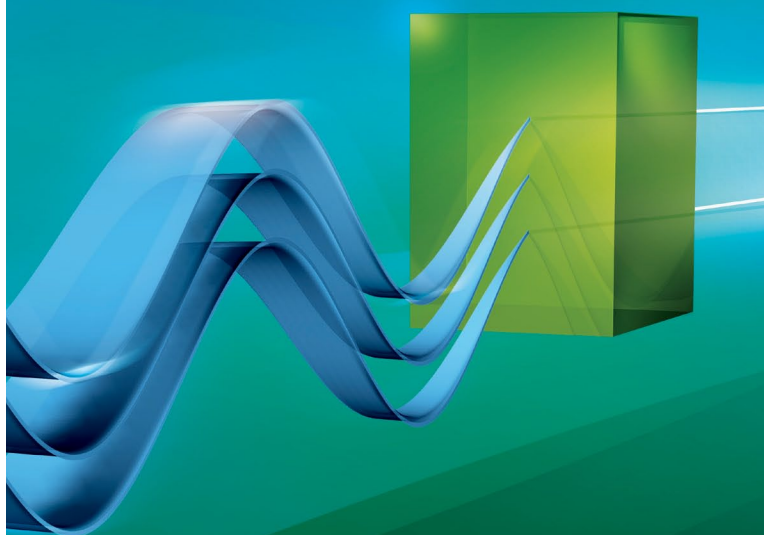


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ing and viewed it as an undervoltage. The regulator sent full current to the generator exciter field in an attempt to restore AC voltage, causing a full-field overvoltage. The open diodes in the overvoltage protection circuit meant there was no overvoltage sensing either, so the full-field current condition caused the field thermal circuit breaker to open, providing the back-up generator trip.

This continued on occasion throughout the winter flying season. Finally, during one flight over the Alps, our engineer was in the more comfortable cockpit jump seat. They were flying in cloud and there was a bit of light snow, so the de-icing system was operating. Suddenly, he noticed something odd moving down the co-pilot's windshield. When it neared the de-icing wire elements embedded in the windshield, there was a brief electric flash and the right-side de-icing generator tripped offline. The co-pilot described the event as "static discharge," and said they occurred on occasion while flying in clouds. The light bulb went on in our flight test engineer's mind.

Normally, an aircraft generator is mounted to the engine gearbox or a hydraulic constant speed drive (CSD), and the AC output is configured as a three-phase grounded wye, with 115 VAC with respect to aircraft ground (200 VAC phase to phase). But the de-icing generator on a turboprop engine is mounted to the propeller gearbox since it turns at a relatively constant speed and holds the 400 Hz AC frequency steady. The AC generator neutral stud is not grounded, so the AC voltage floats with respect to the airframe ground.

The reason for this is, if the AC neutral were connected to the propeller gearbox and one of the phase voltage feeders shorted to the gearbox case or airframe, a high current could flow through the propeller and gearbox bearings, causing damage to the bearings that might even cause them to seize. None of the propeller or windshield de-icing elements are grounded for this same reason.

When an aircraft flies through rain or snow clouds, electrons can accumulate on the wings and fuselage. This "precipitation static" charge can build up until the electric potential is high enough to discharge to a lower potential. The aircraft is equipped with "static wicks" on the wing tips that allow the static charge to dissipate into the atmosphere, but the propellers and windshield are well inboard of the wing tips, and occasionally the plastic windshield would attract the P-static charge. When it reached the de-icing element location, a very high static potential was created across the voltage regulator voltage sensing leads. This is what caused the small 1 kV diodes to blow open.

The fix was to design and install a small 400 Hz three-phase isolation transformer between the voltage regulator and its AC sensing leads. The transformer had a Faraday shield winding between the two AC windings that was grounded to the airframe. This created a "static wick" effect that prevented the static discharge voltage from being impressed on the voltage regulator AC sensing circuit diodes. The problem was fixed and has worked perfectly for over thirty years.

**Charles Hansen** is an electrical engineer and holds five patents in his field of engineering. He works as an engineer in the aerospace industry, and has written two books for *Audio Amateur* publications and over 260 magazine articles. He enjoys restoring older test equipment.





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# From analog to digital to analog: security is the binder

By Julien Happich, Editor in Chief of EE Times Europe

50 years of electronica will have been necessary to come full circle in the electronics industry, shifting its focus from analog signal, to the digital domain with chips operating at breakneck speeds, to the analog domain again as sensor nodes spread around like wildfire in the Internet-of-Things (IoT) catch-all application space.

But converting the IoT PowerPoint craze from a marketing strategy to market-ready products of dubious usefulness will take more than analog and digital chips. All under one roof at electronica, you'll find out about the passives, the connectors, the power supplies, all the peripherals and various material supplies, manufacturing and test equipment that you'll need to rely upon for your first prototypes.

For a first proof of concept, you may just consider one of the hundreds of development kits and open-source boards that more and more distributors elaborate around their partners' products as new sales channels. But more than for products whose specs you may inspect and filter out over the web, we come to electronica for the people, the real drivers behind an industry that never fail to surprise us. Sooner or later, you may want to ramp up production and talk volume manufacturing with some of the Electronic Manufacturing Services (EMS) providers, lined up side by side with pick-and-place and soldering machine vendors. Across all sectors of activity, one recurring theme and often

a key product differentiator is authentication and security, whether it is for part traceability and anti-counterfeiting or for certified software execution, data protection and secure communications. The latter closes the loop in the manufacturing industry with the former, when Information and communications technology (ICT) comes at the service of the very production

tools that make it widespread and affordable: industry 4.0 as it is known here in Germany.

Again, more than mere off-the-shelf solutions, come and pick up some noise, intercept conversations, tune-in the megatrends and get to meet with the movers and shakers of our industry at the many forums and panel discussions hosted in Munich during this busy electronica week.

In this EETimes electronica 2014 show guide, you'll find a complete exhibition agenda and floorplan to make the best of your time in Munich, together with key company profiles and product presentations.

The guide is mailed to all EE Times Europe readers in Germany and sent as a digital issue to all EE Times digital subscribers in Europe. In addition, it is available at the show entrances together with EE Times' Europe regular November issue. It is also available from EE Times' Europe stand in Hall A5, stand 543.

So come and visit us, we're here for the people too!



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Electrolube is headquartered in the UK with international offices located in the USA, China, France, Germany, Brazil, Australia and India. The continued global expansion of Electrolube and its innovative range of environmentally friendly products prove that total dedication to customer care and innovation create a winning formula.

Please visit [www.electrolube.com](http://www.electrolube.com) for more information.



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<b>Office locations:</b>	Headquartered in Norwood, USA and located in 23 countries worldwide including offices in Munich, Germany; Limerick, Ireland; Tokyo, Japan; Shanghai, China and more

Analog Devices is a world leader in the design, manufacture, and marketing of a broad portfolio of high performance analog, mixed-signal, and digital signal processing (DSP) integrated circuits (ICs) used in virtually all types of electronic equipment. Our signal processing products play a fundamental role in converting, conditioning, and processing real-world phenomena such as temperature, pressure, sound, light, speed, and motion into electrical signals to be used in a wide array of electronic devices.



HALL A4, BOOTH 159

### Analog Devices at electronica 2014:

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### A message from Mike Britchfield, Vice President, Sales, EMEA, Analog Devices, Inc.

"Transforming the physical world that surrounds us to the possibilities of the digital world is at the core of tomorrow's global business challenges. We are seeing the emergence of game-changing technologies, including the sensor and sensor node explosion and the associated trend towards solutions

that ensure lower energy consumption, as well as security and communication systems, the technologies implemented in and around the car, and software defined radio. For our customers, differentiation is an imperative. They are looking for products that make a difference for them and for their customers.

To earn their partnership and loyalty, we are focused on increasing the speed and impact of the innovation we deliver. With the stability of a high-quality, high-reliability supply chain, we are well prepared to take the bold risks that go hand-in-hand with game-changing innovation".

**Mike Britchfield**



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and increase your system productivity with our integrated diagnostics.

**ANALOG TO ADVANTAGE**  
and make the most of today by converting physical to digital to anything you imagine.



## electronica 2014: Top-class program for 50th anniversary

electronica is celebrating its fiftieth anniversary, and will once again be the industry platform for exchange of information and expertise about electronics. From November 11 to 14, 2014, visitors to Messe München can inform themselves about the whole product and service portfolios of the electronic industry: from components and systems to electronic applications and services. This year's international trade fair revolves around automotive, embedded systems and lighting, as well as the overarching themes of security and energy efficiency. The program of conferences and forums will explore these exhibition topics in greater depth.

**IN 2012**, almost half of the 73,051 visitors and 63 percent of the 2,669 exhibitors were from abroad. With its three-pillar concept of exhibition, conference and forum program, this year's electronica will again be providing the latest information about technologies, products, services and trends in the industry. A highlight of the show, the CEO roundtable, will be on the first day. Carlo Bozotti (STMicroelectronics), Rich Clemmer (NXP Semiconductors), Gregg A. Lowe (Freescale Semiconductor) and Dr. Reinhard Ploss (Infineon Technologies) will discuss about the topic: "Internet of Things: Possibilities, Challenges and the Question of Security". The focus of the trade show will be on automotive, embedded systems and lighting, as well as the cross-cutting issues of security and energy efficiency. This is reflected, among other things, in the electronica Forum, in panel discussions and lectures.



### Conference and forums program

In the exhibition halls, several forums invite you to exchange ideas and dialog. The range of topics of the forums - automotive, electronica and Exhibitor Forum as well as the PCB & Components Market Place - is application-oriented and allows visitors to learn about current and future issues. Another is the embedded Forum. Topics here range from "Internet of Things: Challenges and Opportunities", "Security for the Internet of Things: Challenges and Solutions", "ARM-based Microcontrollers, FPGAs & SoCs", "Small Form Factor Boards" or "Internet of Things: Chips, Tools & Software for Device Development". Further, these topics will be explored in greater depth within the conference program of electronica.

### Expert knowledge at the electronica automotive conference

The electronica automotive conference is held on November 10, which is the day before electronica 2014. The conference is where leading executives and experts from the automotive sector meet to exchange ideas and information about topics that

play a key role in the transition that is affecting the entire industry. The lectures at this year's conference are divided into three subject areas, i.e. Lighting, Sensor Fusion and Connectivity. The conference will begin with keynotes from Dr. Wolfgang Huhn (Audi AG), Jean-Francois Tarabbia (Valeo) and Prof. Hermann Eul (Intel Corporation). Another conference highlight is the final discussion on the topic "What effects do massive market shifts eastward have on the European automobile industry's capacity for innovation?" Panel discussion participants include Klaus Meder (Robert Bosch), Kurt Sievers (NXP Semiconductors Germany), Karl-Friedrich Stracke (MAGNA STEYR Fahrzeugtechnik) and Prof. Andreas Wolf (Continental Automotive).

### Efficient ecosystems at the embedded platforms conference

To develop a successful electronic product, selecting the right embedded building blocks is not the only thing that matters. Interaction between the various components that is optimized for the respective application—i.e. the best hardware and software ecosystem—is also important. The embedded platforms conference is dedicated to these ecosystems. The conference, which is being held at the Messe München trade-fair center's Press Center East on November 12 and 13, also deals with basic issues that pertain to component selection and system design. Presentations by processor manufacturers and OS/RTOS companies such as IAR, Infineon MicroConsult, Silica and Texas Instruments will inform participants about the optimum selection of various tools, Open Source software, multicore migration and design challenges within ecosystems.

### IT2Industry

Digital interconnection is permeating all areas of our life and is thus shaping economic development worldwide as well as the emergence of new innovative products. So the fourth industrial revolution has long been more than just a vision. Through examples of best practice, visionary technical lectures and discussion rounds, the conference participants of IT2Industry find out about the specific consequences, the opportunities and risks of this increasing digital interconnection in industry and production. The conference takes place on November 11 at the Press Center East.

### Wireless Congress

At the Wireless Congress 'Systems & Application' at the ICM - Internationales Congress Center Munich on November 12 and 13, industry experts will discuss the technical aspects of present and future wireless technologies, primarily for industrial use.

An overview about all lectures within the conference and forum program is available at [www.electronica.de/en/events](http://www.electronica.de/en/events)

## Review: The world's leading trade fair for the electronics industry is 50

A half a century of trade fair history is also an opportunity to look back on the milestones of the past 50 years. After all, the future would be unimaginable without the fair's earlier developments. For example, the foundations for two of this year's main themes—Automotive and Lighting—were laid at one of the first shows in the 1970s. Companies such as International Rectifier or Bourns introduced technologies then that have continued to develop and are considered a matter of course today. Examples include optimized torque sensors for power steering systems, or more efficient semiconductors in modern LEDs. So one can't help but wonder what new developments at this year's electronica will simplify our everyday lives in the year 2064.



## A success from the beginning

electronica didn't have it easy in the beginning: Among other things, it didn't have the support of Germany's trade associations. But during its early years, it still developed into a magnet for visitors and exhibitors from throughout Europe, the United States, Japan and what was then the Soviet Union. Exhibition space was booked to capacity, and companies that decided too late were issued display cases instead of exhibition stands. At first, major German corporations were skeptical about the fair and kept their distance. Some only sent monitors to gather information about their international competitors' latest developments. But eventually, even they agreed that electronica was the right idea at the right time and that the concept of this progressive trade show worked. At the very latest, that became obvious the second time that the fair was held in 1966. The amount of exhibition space nearly doubled, as did the number of stands and the number of exhibiting companies.

## Growing numbers of exhibitors and visitors

Even the wildest optimists did not expect the fair, which has been held every two years since it was founded, to be such an enormous success: From 1964 to 1974, the number of exhibitors increased by a factor of ten and the number of visitors increased in leaps and bounds—from 13,000 to more than 73,000. electronica quickly developed into a platform where an extremely dynamic industry had an opportunity to present its technical innovations to the public for the very first time. And it contributed significantly to the electronics industry's most important inventions of the 60s and 70s such as the floppy disk in 1969, the first microprocessors in the early 1970s, and teletext in 1977.

The rest, as they say, is history. electronica quickly became a

sell-out event which resulted in sections of it emerging as new events. LASER World of PHOTONICS was launched as a separate show in 1973, followed by productronica (which alternates every other year with electronica) in 1975. Even with these two significant industry sectors departing electronica, the show continued to expand, finally outgrowing Munich's original exhibition grounds and in 1998, electronica moved to a new, purpose designed exhibition and conference center built by Munich and the State of Bavaria to house its major trade fairs where it will take place again this year from November 11.-14.

## Focusing on the future



Anke Odouli  
Project Manager

The fair has already laid the foundation for strengthening its position as a global market leader in the next 50 years and to expand it even further: It will further strengthen its clear profile as a user trade fair. For its 50th birthday electronica is also getting its own planet: Planet e allows the fair to give the industry a virtual home and take it on a journey into the future. The campaign is full of strong imagery that shows how circuit boards, semiconductors, sensors and displays can move the world of the future.

## electronica 2014: Facts and figures at a glance

**Dates :** Tuesday – Friday, November 11 – 14

**Times :** Tuesday – Thursday: 9:00 – 18:00  
and Friday: 9:00 – 17:00

**Web :** [www.electronica.de/en](http://www.electronica.de/en)

Tickets may be ordered online at [www.electronica.de/en/tickets](http://www.electronica.de/en/tickets)

## Conference dates

**electronica automotive Conference :**

Monday November 10

(ICM – Internationales Congress Center München)

**embedded platforms Conference :**

Wednesday – Thursday, November 12 – 13

(Press Center East)

**IT2Industry :**

Tuesday, November 11 (Press Center East)

**Wireless Congress :**

Wednesday – Thursday, November 12 – 13

(ICM – Internationales Congress Center München)

electronica event database: [www.electronica.de/en/events](http://www.electronica.de/en/events)



# High Density 3D Microelectronics



On August 2014, after a journey in Space of more than 10 years, the Rosetta spacecraft built by the European Space Agency completed a Comet Rendez-vous and is now preparing for landing thanks to 3-D electronic devices designed and built in Europe by 3D PLUS. Recognized for their high density, high speed, high reliability and Radiation Tolerance and their smallest form factors, our space qualified 3-D memory stacks were selected for this critical mission.



On Ground, as the board form factor decreases and as complexity of system-on-chip (SoC) semiconductor devices grows, designers are using more and more 3-D electronics that allow standard die to be stacked on top of one another. Available in extended temperature ranges and enabling today the next generation of memory density, our high density - wide data bus (72-bit) DDR-II SDRAM and DDR3 SDRAM memories, and NAND FLASH micro Solid State Drives ( $\mu$ SSD) help pushing the performance of PC104 industrial computer boards.

Although very distant, these applications have the same needs:

- Miniaturization (smaller physical systems),
- Increased Electrical performance (speed, low power),
- High reliability even under harsh environments.

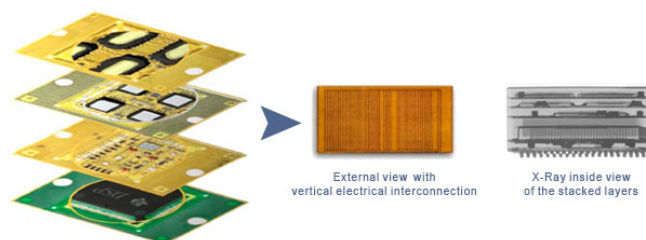


## FUSIO-II

147 443 cells Spartan®-6 FPGA,  
4 x serial links 2.5Gbp/s,  
2 x 128Mbits mDDR 166 MHz,  
NOR flash for secure boot,  
167 embedded decoupling capacitors.

19 x 19 x 3.9 mm All-in-One Computer Module

Founded more than 15 years ago in France, 3D PLUS is a world leading supplier of high density 3D microelectronic products and Die and Wafer Level stacking technology meeting the demand for high reliability, high performance and very small size of today's and tomorrow's electronics. By enabling the stacking of heterogeneous active and passive semiconductor devices in one single highly miniaturized package, its 3-D System-In-Packages (SiP) achieve a combination that cannot be realized with monolithic SoCs and a high yield that cannot be reached with semiconductor's TSV approach.



The 3-D stacked electronics concept

Its standard products allow gaining a factor of 10 on size and weight of the components comparing to other existing solutions, and with a capability of stacking up to 10 semiconductor devices within 1mm, 3D Plus Ultra Low Profile Modules are unique.



With design and manufacturing plant in France, 3D PLUS products meet the requirements of the most demanding applications in the industrial, computing/telecommunications, security and defense, avionics, medical and space markets.

## 3D PLUS

408, rue Hélène Boucher  
78532 BUC France  
Phone: +33 130 832 654  
Contact: [sales@3d-plus.com](mailto:sales@3d-plus.com)  
Internet: [www.3d-plus.com](http://www.3d-plus.com)





# CONNECTING WITH YOU AT ELECTRONICA 2014

Visit us at **Hall B3, Booth 161** to learn more about our new amazing products and product demos as well as stand a chance to win trendy tablets!

Date : 11 – 14 November 2014

Venue : Messe München, Munich, Germany

HALL | BOOTH  
**B3 | 161**

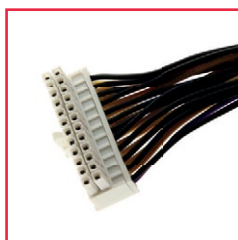
## New Products



BarKlip™ I/O Connector



PwrBlade ULTRA™  
Connectors



Minitek Pwr™ 3.0 & 4.2  
Connectors



Griplet™ Miniature  
IDC Connectors



Universal Contacts



ExaMAX®  
High Speed Backplane  
Connector System



SFP+ Active  
Optical Cables



25G SFP+ I/O Copper  
Cable Assembly



DDR4 Memory  
Module Sockets



12G SAS PCIe  
Connectors

For more information, please contact us at [communications@fci.com](mailto:communications@fci.com) or visit us at [events.fci.com/electronica](http://events.fci.com/electronica)

# Keystone Electronics Corp.

## Quality Interconnect Components and Electronic Hardware

Leading edge technology and precision manufacturing have defined Keystone's performance since 1950. Their new and expanded Catalog M60.2 reflects this tradition.

Keystone's personnel takes pride in meeting all requirements, efficiently and promptly. Our skilled and dedicated technicians, experienced production personnel and customer service teams have made us an industry leader.

All Keystone facilities are fully integrated with 3D/CAD product modeling and CAD/CAM precision tool and die operations. Application and Engineering specialists utilize progressive dies, four-slides, wire forming, in-die tapping and high-speed blanking along with automated machining to produce tight tolerance standards and custom products. Secondary operations include: Tapping, Drilling, Assembly and Finishing.

Application engineering services are available for product modifications or special design requirements. Products appearing in Keystone's new and expanded Catalog M60.2 comply with RoHS and REACH directives. Our quality system is certified to the ISO 9001:2008 standards.

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Fax: (718) 956-9040

**www.keyelco.com**  
**kec@keyelco.com**



### BATTERY CLIPS, CONTACTS, HOLDERS & RETAINERS

Advances in portable electronics and Lithium-Ion battery technology demand dependable battery connections. Keystone leads the way with a vast range of reliable, high-quality, cost-effective products for most battery types.



### SPACE-SAVING FUSE CLIPS & HOLDERS

Fuse clips and holders for Electronics, Datacom, Telecom, Automotive and Solar use. Keystone answers your needs with SMT, Thru-Hole and Rivet mount products.



### SPACERS, STANDOFFS/SUPPORTS – METALLIC & NON-METALLIC

Diverse insulated and non-insulated spacers and standoffs are available in a wide range of lengths, thread sizes, hole sizes, mounting styles & materials. Choose from English or Metric type products for your PCB, panel and mounting applications.



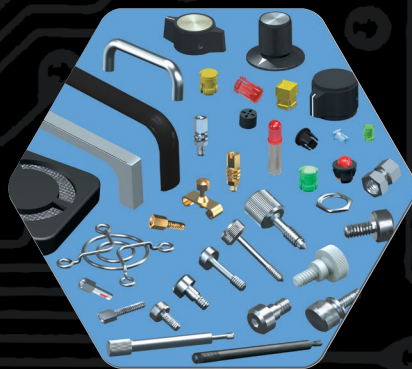
### PCB TEST POINTS & UL APPROVED TERMINALS

Low Profile and limited space drive today's PCB connectivity designs. Keystone is the right fit with solder and solderless PCB Quick-Fit Snap-on, Snap-Fit and Screw-on terminals as well as Color-coded Screw Terminals & THM and SMT Test Points and more.



### PINS, PLUGS, JACKS & SOCKETS, INDUSTRY'S MOST DIVERSE GROUP

Keystone's USB 2.0 & 3.0 Jacks and Plugs, Micro Pins/Jacks, Banana and Phono Plugs & Jacks are designed for use in the latest Mobile & Computer Electronics, Home Theatre, Test Gear and Industrial Interconnects.



### PANEL HARDWARE, HANDLES, SCREWS & LED SPACERS

Check out Keystone's value-added products: Fan Filters & Guards, LED Lens Caps, Holders & Spacer Mounts, Jack Screws and Connector Hardware, Instrumentation Handles, Cable Clamps, Knobs and more.

IT'S WHAT'S ON THE INSIDE THAT COUNTS

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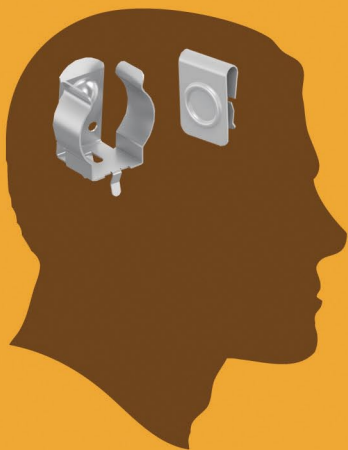
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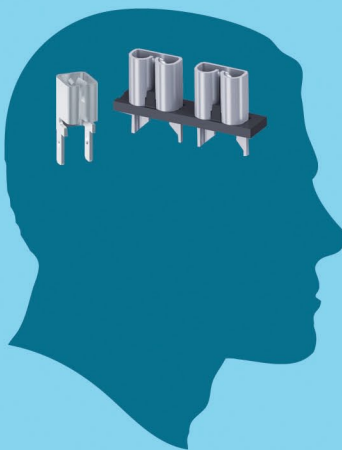


# THINK<sup>TM</sup>

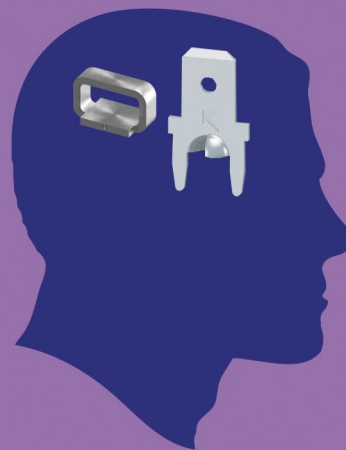
INTERCONNECT COMPONENTS & HARDWARE



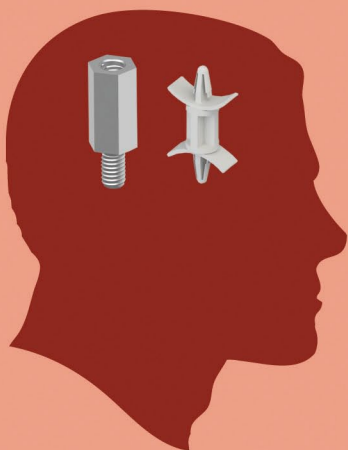
Battery Clips, Contacts & Holders



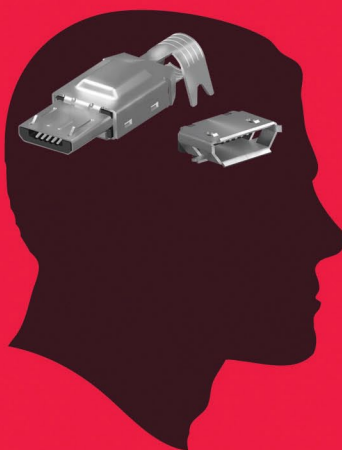
Fuse Clips & Holders



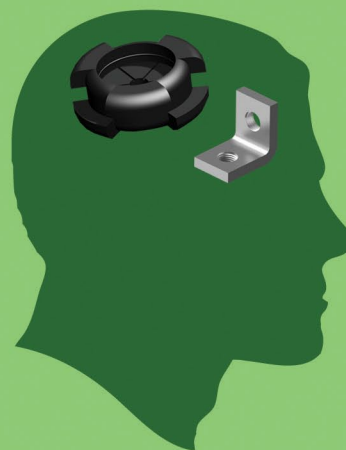
Terminals and Test Points



Spacers & Standoffs



Plugs & Jacks



Multi-Purpose Hardware

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CUI Inc is a technology company dedicated to the development and distribution of electro-mechanical products.

An unwavering commitment to create collaborative partnerships with customers and a drive to see that their design project is a success has been a hallmark of CUI's sustained growth since its founding in 1989. As a leader in the industry, CUI will continue to invest in the future through new technologies, talented employees, expanded manufacturing capabilities, and a growing global reach.

Founded	1989
Funding	Subsidiary of CUI Global, Inc. NASDAQ: CUI
Technology	Solus® Power Topology AMT Capacitive Encoder Technology
Markets	Communications, industrial, medical, consumer electronics, renewable energy and lighting.
Products	Novum® Advanced Power, Ac-Dc Power Supplies, Dc-Dc Converters, Buzzers, Connectors, Encoders, Microphones, Speakers, Thermal Management
Locations	USA, Japan, UK and China

## POWER

As a leader in the power supply industry, we realize that power is playing an increasingly critical role in your designs. We also know that it can be difficult to stay current on the latest power trends and regulations. To keep you one step ahead, we seek to integrate cutting-edge technologies and design techniques in our ac-dc and dc-dc power modules. Our mission is to be the trusted power expert for your most demanding applications, now and in the future.



- Novum® Advanced Power
- Ac-Dc Power Supplies
- Dc-Dc Converters

## COMPONENTS

Accelerating technological advances are allowing individuals across the globe to connect like never before. As you work to develop tomorrow's innovative designs, we are here to support you with a portfolio of proven electromechanical products. CUI's Components line combines a strong distribution presence with a global network of engineering, manufacturing, and logistics resources to provide you with the necessary expertise needed to successfully complete your project.



- Buzzers
- Encoders
- Speakers
- Connectors
- Microphones
- Thermal Management



Matt McKenzie

### A Message from CUI'S President

In many ways CUI is an unique company. It's a business in which relationship, excellence, and service are core values that facilitate innovation and commercial success. These values have been with us since the company was founded in Oregon, USA in 1989. Today, as part of CUI Global, Inc., we

continue to carefully nurture our relationships with employees, customers, suppliers and the communities in which we operate. The happy outcome of this philosophy is a growing global recognition that CUI is no ordinary manufacturer of advanced power supplies and electromechanical components.

Rather, it's an extraordinarily innovative technology company that seeks to make conducting business a pleasurable and rewarding experience for all concerned. If we don't share this experience with you today, I hope that we will have the opportunity to do so in the very near future. **-Matt McKenzie**



# Your power expert.



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10 ~ 720 W

Intermediate Bus  
Digital Point of Load



## Ac-Dc Power Supplies

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Board Mount | Chassis Mount  
DIN Rail | External



## Dc-Dc Converters

1 ~ 600 W

Board Mount | DIN Rail  
Chassis Mount

Visit CUI's Booth  
Power Hall B2, Booth 113  
[www.cui.com/electronica\\_2014](http://www.cui.com/electronica_2014)







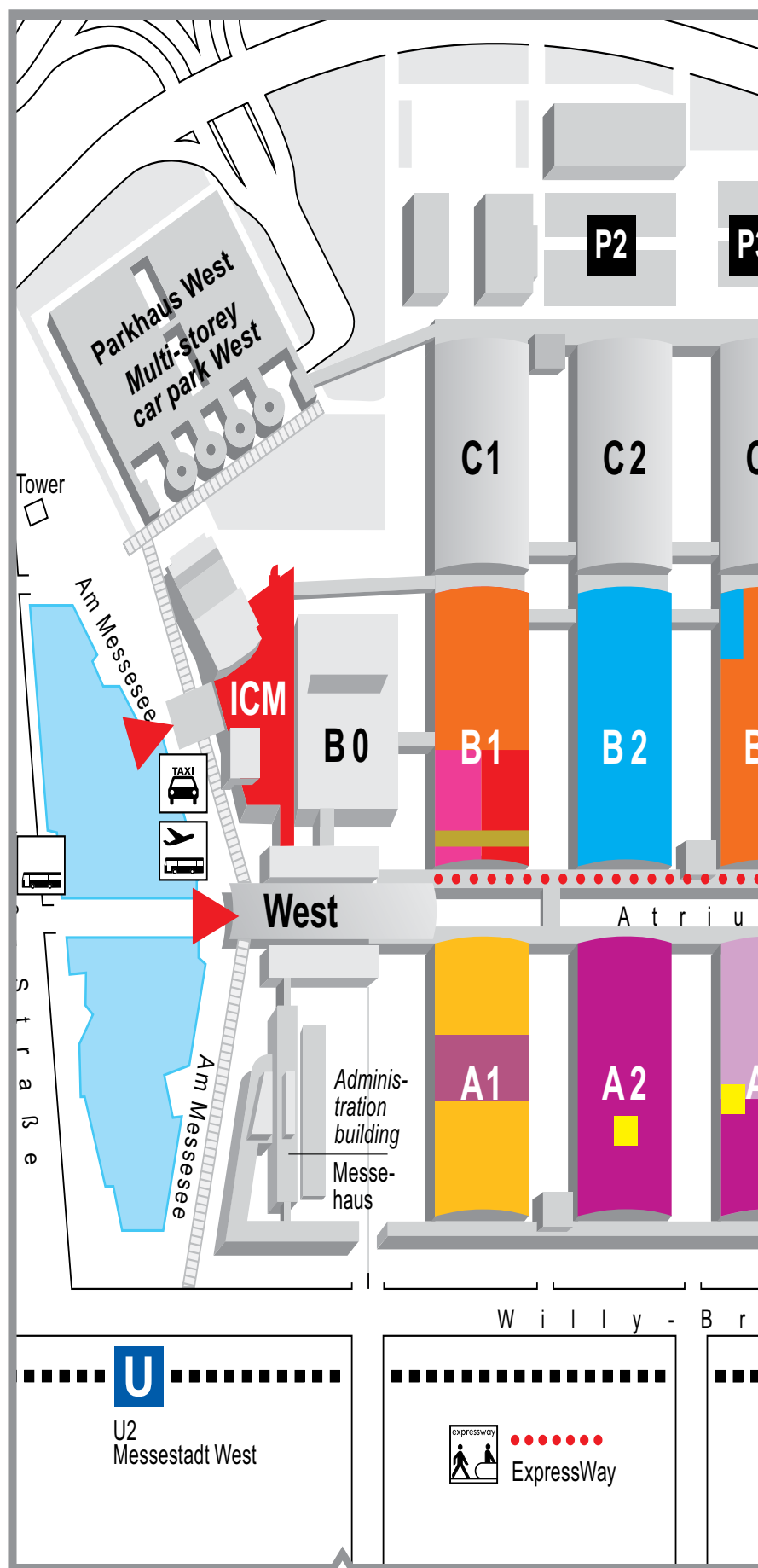
- A1** Electronic Design (ED/EDA)\*
- A1** Test and measurement
- A2 A3** PCBs and other circuit carriers/  
EMS Electronic manufacturing services
- A3** Displays
- A3-A6** Semiconductors
- A4** Wireless
- A6** Automotive
- A6** Embedded systems
- B1** Micro- and nanosystems
- B1** Servo-technology/Drive elements
- B1** Sensor technology
- B1** Electromechanics/System peripherals—Casing technology
- B2 B3** Power supplies
- B3 B4** Electromechanics/System peripherals—Interconnection components/systems
- B5** Electromechanics/System peripherals—Relays, switches, keyboards
- B5 B6** Passive components
- in all halls** Services, assemblies and subsystems

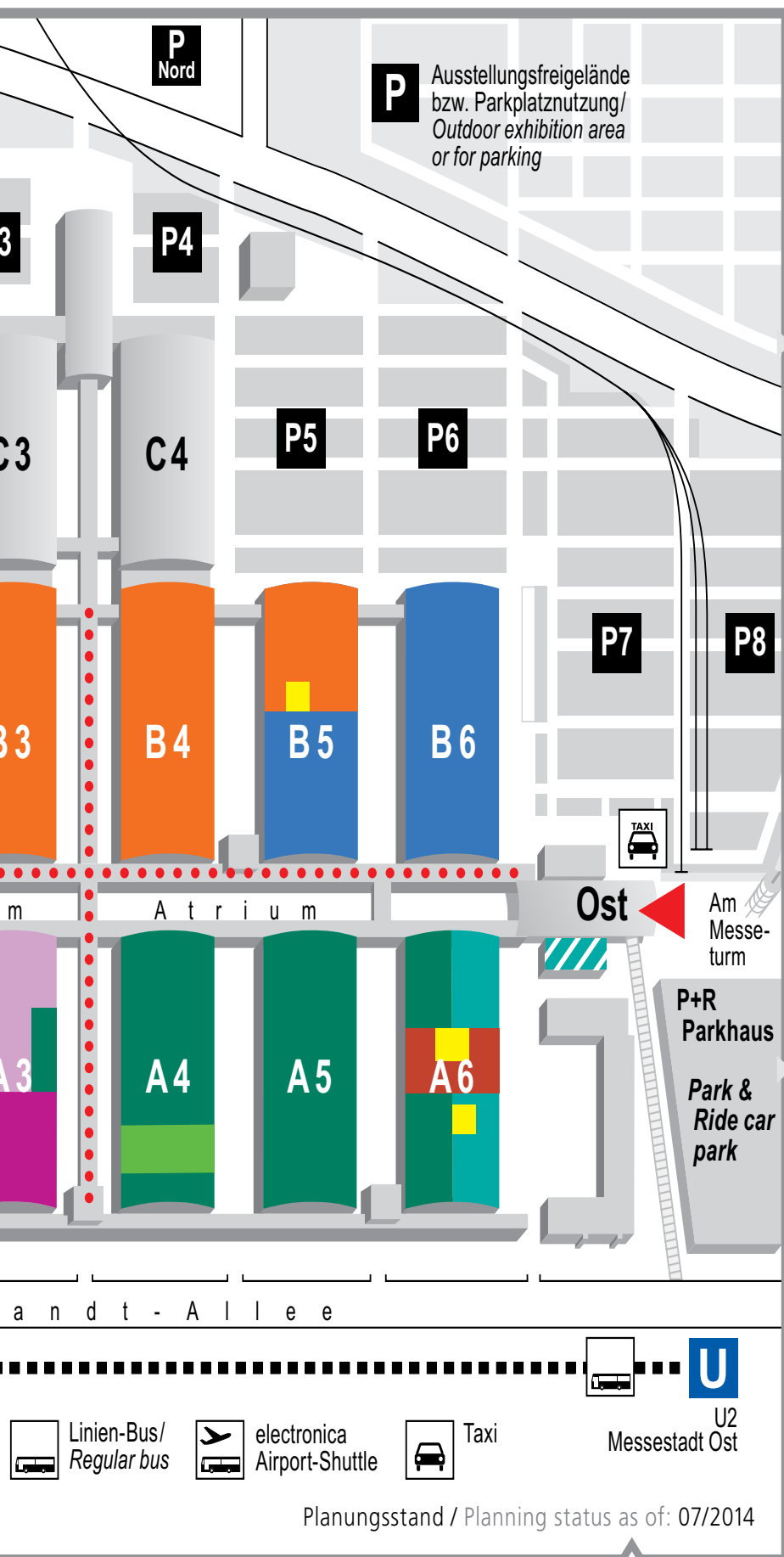
## electronica automotive

- ICM** electronica automotive conference
- A6** electronica automotive Forum and Exhibition

## electronica embedded

- embedded platforms conference**
- A6** electronica embedded Forum and Exhibition
- A2** PCB & Components Marketplace
- A3** electronica Forum
- B5** Exhibitor Forum
- IT2Industry Conference**
- ICM** ICM Wireless Congress: Systems & Applications





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Hall B5 – Booth 431





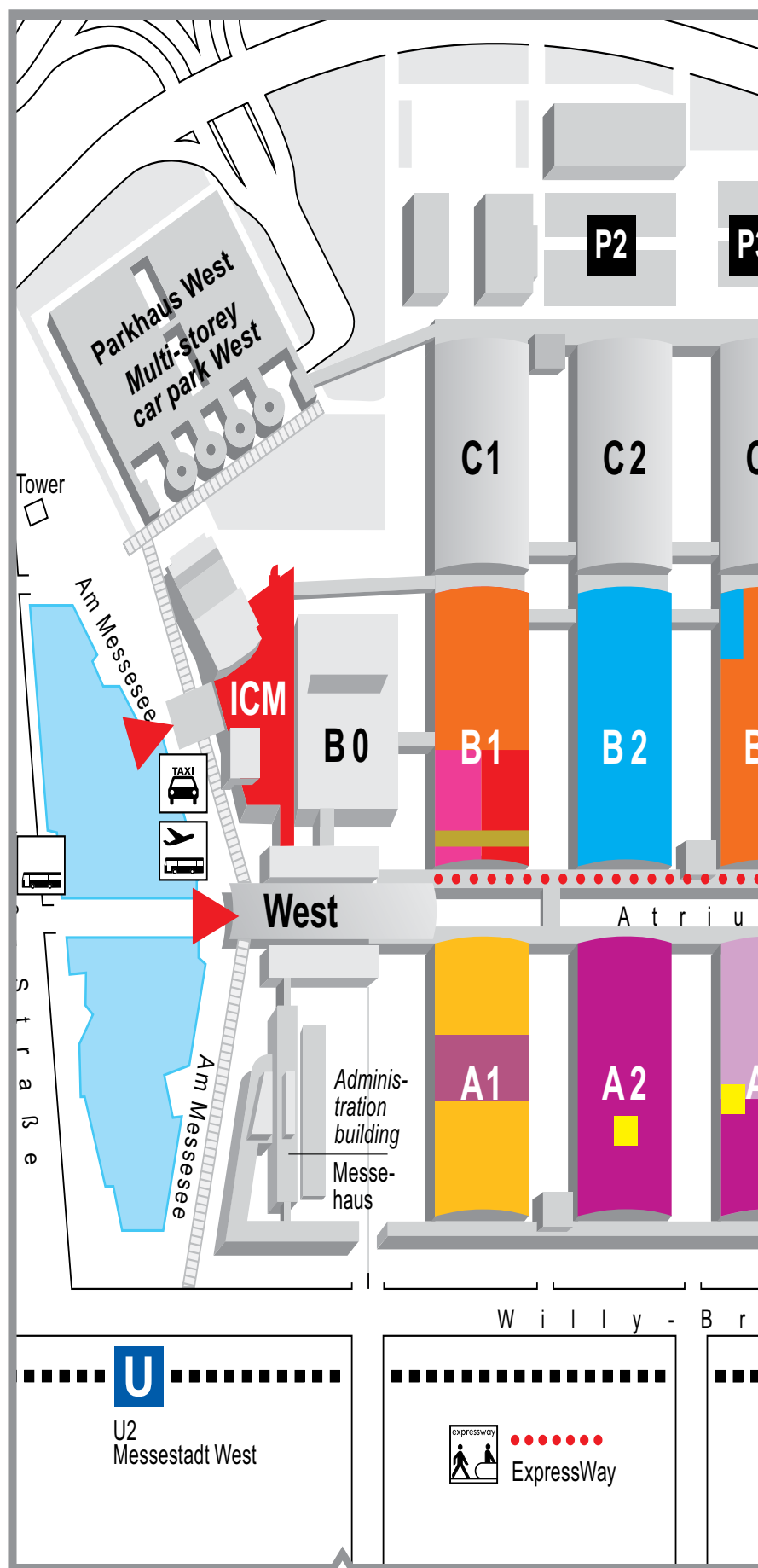
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- B1** Sensor technology
- B1** Electromechanics/System peripherals—Casing technology
- B2 B3** Power supplies
- B3 B4** Electromechanics/System peripherals—Interconnection components/systems
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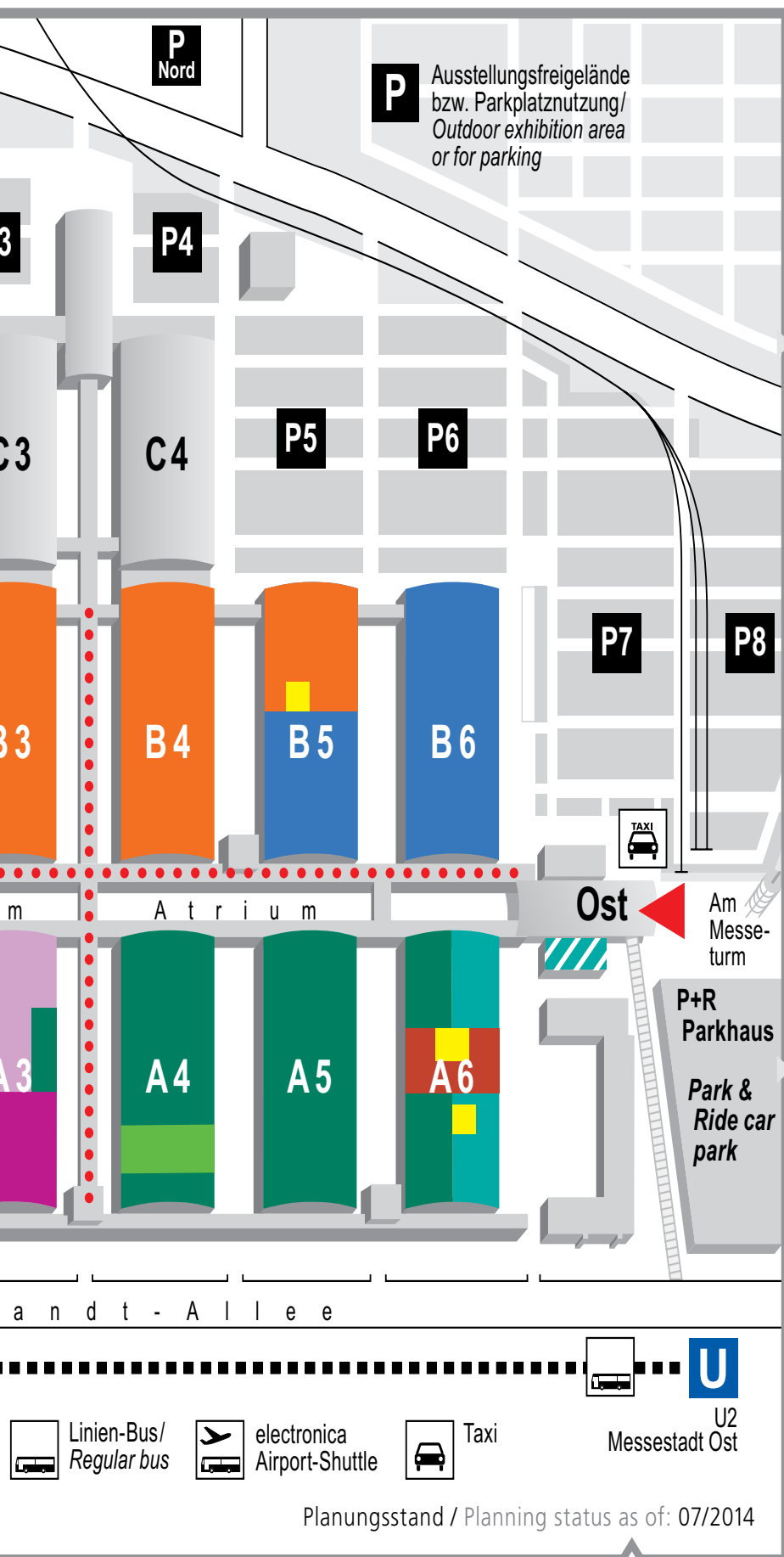
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- A2** PCB & Components Marketplace
- A3** electronica Forum
- B5** Exhibitor Forum
- IT2Industry Conference**
- ICM** ICM Wireless Congress: Systems & Applications





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# sonitron®

*Sonitron is a manufacturing company specialized in piezoceramic audible components.*

Since 1977, headquartered in Belgium, with a total in-house capability. Today the Sonitron products are distributed and sold through an international network of distributors and representatives to reach world-wide customers.

Continuous research, intensive development and specialized know-how have resulted in a wide range of high quality and reliable products, from the smallest and most cost effective buzzer to highly sophisticated alarms. This allows Sonitron to meet the needs of many different applications within the industrial, consumer, medical and military industry.

Ongoing investments in the in-house disciplines enable Sonitron to maintain their market reputation and being your first choice supplier of audible components and application support in acoustic technology.

## Excellence in physical acoustics

Founded	1977
Technology	Piezoelectric audible components
Products	piezo Buzzers & Transducers piezo Alarms & Sirens piezo Speakers & Amplifiers
Markets	Industrial, Medical, Automotive, Military
Main office	Belgium

Future activities will be focused, not only on research and development of new applications and products, but also on the development of buzzers or speakers for special customer requests.

The engineers of the technical support department will carefully study your application and give their support for the realisation of your audio project with Sonitron products

They will be pleased to help you! Send your request to...

**Support@sonitron.be**

Today several new products are released such as piezo audio speakers (SPS series, Blue Line SPS series), piezo amplifiers (PAA series), Low voltage miniature buzzers (SMA-13LV, SMA-21LV), Robust Application and Vehicle Control Standard buzzers (SRA & SVC series), Reverse drive alarms - 112dB(A)@1.2m (SAP series), Acoustic and mechanical stabilization Foam Patches, ...

A complete overview of all our products can be found in the Sonitron product catalogue 2014 and on the website...

**<http://www.sonitron.be>**

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## SMA-13LV

More sound - Lower Voltage - Small design  
80 dB(A)      3Vdc      13mm



For all your portable applications with battery feed, ask your personal piezo sample.

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November 11 – 14, 2014

## **America II is exhibiting at Electronica**

Visit America II's booth in **Hall A4 Stand #421**  
to speak with executives and representatives  
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**AMERICA II**  
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Quality, inventory, people. Making a difference.



A COMPANY OF THE **SWATCH GROUP**

## Micro Crystal – Swiss Quality is an Attitude!

Micro Crystal AG, a company of the Swatch Group Inc. Switzerland, was founded in 1978 in Grenchen, Switzerland, as a producer of Tuning Fork Crystals for watches. Today, Micro Crystal AG is a leading manufacturer of Miniature Tuning Fork Quartz Crystals (32 kHz to 250 MHz), Real Time Clocks, Oscillators and OCXOs for the world's leading manufacturers of mobile phones, consumer products, computers, automobile electronics, watches, industrial controls, as well as medical implantable devices and other high-reliability product applications. With offices located around the globe, Micro Crystal AG provides in-depth support for our customers from design-in to mass production.

### Product Range:

#### Real Time Clock Modules

- RTC Modules 32.768 kHz Crystal embedded

#### Crystals

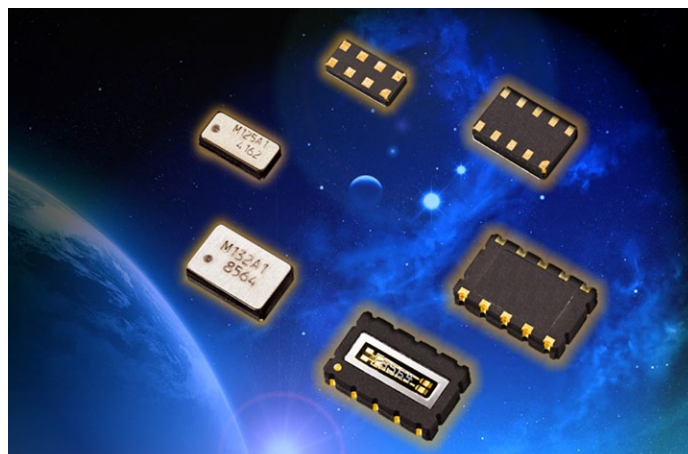
- Tuning Fork Crystals 10 kHz – 2.1 MHz
- AT Crystals 8 MHz – 30 MHz
- Inverted Mesa AT Crystals 30 MHz – 250 MHz

#### Oscillators

- Low Power Oscillators 32.768 kHz
- Clocks up to 220 MHz
- OCXOs up to 60 MHz

### Highlight:

The RV-8803-C7 is the first high accuracy / temperature compensated RTC optimized for ultra low power consumption. The ultra low current consumption of 250 nA and low operating voltage down to 1.5 V significantly increases the operational life of backup supplies and allows for potential use of low cost MLCC capacitors instead of costly batteries or supercaps as a short term backup solution. All this while providing accuracy of  $\pm 3.0$  ppm ( $\pm 0.26$  seconds/day) over a temperature range of -40 to +85°C. In addition to the lowest current and best accuracy of all temperature compensated RTCs, the RV-8803-C7 also has



the smallest ceramic package in the industry with an integrated 32.768 kHz quartz crystal.

The RTC's accurate timekeeping in combination with its ultra low power consumption allowing simple power supply backup makes it ideal for a wide range of applications such as metering applications, embedded modules, data loggers, white goods, automotive, portable/wearable medical equipment and all types of POS systems.

- Ultra-miniature ceramic SMD package: 3.2 x 1.5 x 0.8 mm
- Very high accuracy  $\pm 3.0$  ppm from -40 to +85°C
- low current consumption of only 250 nA
- Integrated 32.768 kHz Quartz Crystal
- I<sup>2</sup>C interface
- AEC-Q200 qualified

### Micro Crystal AG

Muehlestrasse 14  
CH – 2540 Grenchen - Switzerland  
[www.microcrystal.com](http://www.microcrystal.com)  
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Temperature Compensated up to +125°C,  
High Accuracy +/- 3.0ppm -40 to +85°C  
Ultra Low current consumption down to 50 nA



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# SENSIRION

## THE SENSOR COMPANY

### A sensor pro in every discipline



Sensirion, the world's leading provider of humidity and temperature sensors, is taking sensor technology to a new level this year. At the electronica 2014 in Munich, the technology pioneer is presenting the most advanced platform for humidity and temperature sensors: the Platform3x with the powerful SHT3x sensor series. As the market leader, Sensirion is launching an innovation that excels across the board and a sensor that outperforms all previous models.

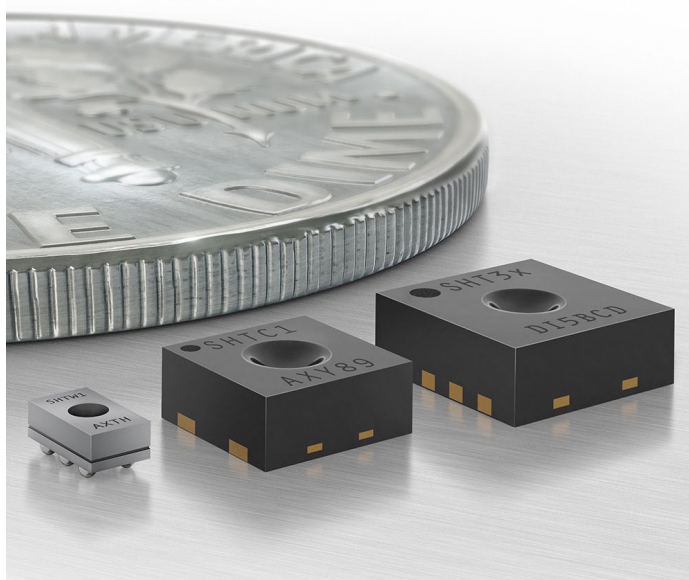
The versatile Platform3x consists of a group of humidity and temperature sensors with different precision levels and features. The Platform3x is thus optimally designed for individual applications on the market. Whether for the cost-conscious, the groundbreaking or the high-end product that demands the best humidity and temperature sensor, the Platform3x impresses in every discipline and provides the ideal solution for all precision classes and various interfaces.

The SHT3x combines the strengths of the established SHT1x, the revolutionary SHT2x and the advanced SHTC1 series in a single, unique product. But that's not all by a long way. The SHT3x includes a user programmable alert function, where the sensor can be used as a humidity and temperature guard. Moreover, Sensirion's latest innovation contains another world premiere, an analog ratiometric voltage output. This is the first fully calibrated and linear digital/analog humidity and temperature sensor. The SHT3x series thus combines multiple functions and various interfaces (I2C, voltage out) with a user-friendly, very wide operating voltage range (2.4 to 5.5 V). Like all sensors from Sensirion, the SHT3x is based on the unique CMOSens® Technology, which allows a high production volume at an exceptional price/performance ratio. In addition, the technology enables a small footprint of 2.5 x 2.5 mm with a height of 0.9 mm. So Sensirion has once again launched one of the smallest humidity sensors for applications over 2.4 V.

More about Sensirion's humidity and temperature sensor series SHT3x: [www.sensirion.com/sht3x](http://www.sensirion.com/sht3x)

### About Sensirion

Based in Staefa, Switzerland, Sensirion AG is the world's leading manufacturer of digital micro sensors and systems. Its product range includes humidity and temperature sensors, mass flow controllers, flow sensors for gases and liquids as well as differential pressure sensors. An international network with offices in the US, China, Japan and Korea supports international OEM customers with custom sensor system solutions for a vast array of applications. Its products are used in analytical instruments, consumer goods and applications in the automotive, entertainment electronics, medical technology and HVAC sectors, among others. Sensirion products are distinguished by their use of the innovative CMOSens® Technology and are patent protected. CMOS-based sensor elements and systems provide intelligent system integration, including calibration and a digital interface. Sensirion's quality as a reliable OEM partner has been recognized through certification according to ISO/TS 16949.



### Sensirion

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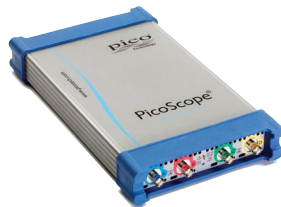
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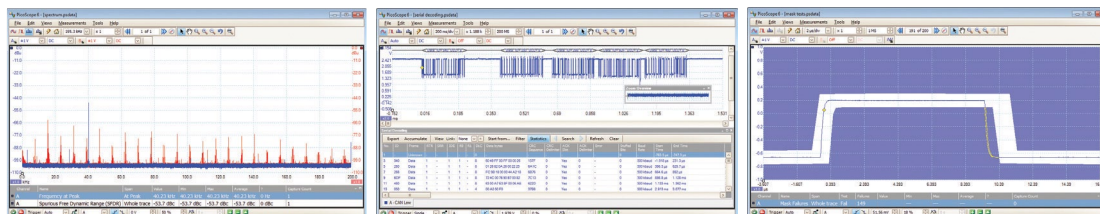
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The supplied drivers and software development kit allow you to both write your own software and interface to popular third-party software packages such as LabVIEW and MATLAB. You can now use most PicoScopes on Linux and Mac OSX.




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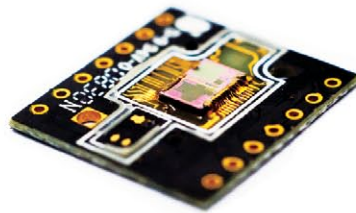
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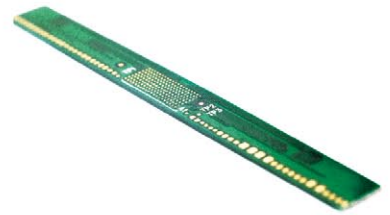
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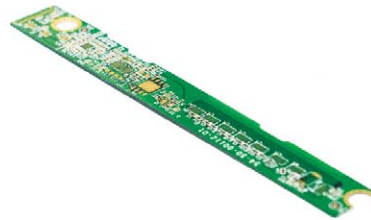
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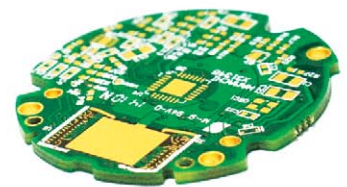
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# INFRATEK AG

electronic products

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Infratek, represented at Electronica 2014 by CompuMess Elektronik GmbH, displays the latest state of the art Power Analyzer 108A. This instrument is at the top end of Infratek's product range and offers countless features and measurement functions.

The device is available from single- up to six-phases. Four measurement functions are integrated such as: standard, logging, transient and power speed. Almost all setting changes are accomplished with two touches on the display screen or two clicks with the mouse. The Power Analyzer is provided with a wide angle touch screen with TFT color display and a resolution of 800 x 480 pixels. Another major advantage is the unique modular concept of the 108A Power Analyzer; upgrading at any time is feasible.

Furthermore, Infratek's product range offers various other Power Analyzers depending on application and budget. They are versatile in use and are found in fields such as: automotive, home appliance, lightening sector, motor- and transformer manufacturers, technical schools and many more. All instruments have one thing in common. "They are user friendly and easy to operate", says Ronald Sommerer, CEO of Infratek.

*Energy saving is a current issue. What is your view on this topic?*

RS: We should deal carefully with our energy resources. Today, manufacturers of electric apparatus are forced to optimize energy consumption for their products. One of the means to achieve this is to increase the efficiency with the assistance of a Power Analyzer.

*Are you going to introduce new products into the market?*

RS: We will soon present our new PC11. This kind of Power Analyzer is completely operated via PC and offers no display.

*What are the advantages of being located in Switzerland?*

RS: Switzerland provides a business friendly environment and offers high productivity. We maintain a long-lasting business relationship with our domestic suppliers.

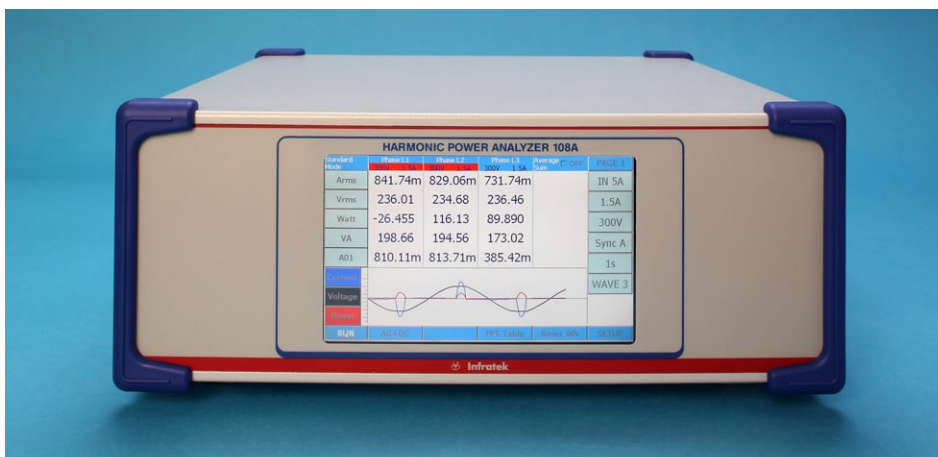
In addition to the Power Analyzers Infratek provides Battery Test products, which enable user to either measure battery voltage

and internal resistor, monitor the remote battery or test its state. Moreover, the DC27 Controlled DC- and AC-Loads measure the capacity of back-up batteries by means of a discharge test. The user obtains the complete battery information or UPS- and generator characteristic.

## Electrical and Mechanical Power Measurement

Engineers, Technicians and Electronics meet an increasing number of power measurement problems requiring state-of-the-art Infratek Power Analyzers. All these instruments can be used

for measurements on modern power electronics. Infratek products help electrical engineers and technicians improve and optimize their design, for example a design for minimal energy consumption. In addition, all of the Infratek tools offer computer interfaces and software to document the results.



## About Infratek

Infratek AG is located in Uetikon am See, Switzerland, and manufactures high precision Power Analyzers, Battery Test Equipment and Battery Load Systems. The company maintains a worldwide net of sales agencies which represent the full range of their products. Infratek has been dedicated to measurement and test engineering for more than 30 years.

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## Cicor Group – Innovation for success

Cicor is a solutions provider with worldwide operations and a globally unique portfolio of services and technologies. The latest discoveries combined with many years of experience, state-of-the-art technologies together with exceptional expertise make Cicor a dependable and innovate partner in the development and production of compelling solutions for every aspect of electronics.

The Cicor Group offers comprehensive outsourcing services and expert consulting for electronic applications. As a complete solutions provider, we work with clients to develop innovative products and services that meet market needs while both staying abreast of the latest trends and ensuring effective practical application.



Our broad portfolio of innovative technologies, services and global production capacities offer the right solution for even the most demanding needs such as high-tech and high-reliability applications. Consistent high quality, maximum traceability, rapid prototyping, flexible choice of materials,

miniaturization, cost-control and development and assembly services make Cicor an excellent partner, meeting the needs with new ideas and innovative solutions.

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Cicor is an electronics service provider with an international structure and a broad range of production capabilities in printed circuit board assembly, system assembly and box building, control cabinet construction, cable assembly and in the areas of toolmaking and plastic injection molding. We offer complete outsourcing solutions for development and manufacturing of electronic component assemblies as well as complete devices and systems. As a company with global operations and production sites in Switzerland, Romania and Asia (Singapore, Vietnam, Indonesia and China), we employ our synergies to offer solutions based on long-term know-how.

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As a leading manufacturer of sophisticated microelectronics and high-quality substrates, we offer a broad range of state-of-the-art products and services. In the area of microelectronics we can offer you the latest technologies in packaging, assembly and interconnection techniques. In the field of substrate manu-



facturing and processing, we are characterized by the production of highly complex rigid, flexible and rigid-flexible printed circuit boards and substrates using thin- and thick-film technology. In close collaboration with you, we develop and produce sophisticated products from prototype to large-scale production. Throughout, we offer the utmost process consistency and continually updated production facilities, to ensure customer satisfaction through consistent high quality with absolute adherence to delivery deadlines.



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**Hall B1 - Booth 207**



### Chinsan Capacitor at Electronica 2014

Taiwan Chinsan Electronic Ind. Co., Ltd. was established in 1970 and is a publicly listed company in the Taiwan Stock Exchange (code : 8042). For 45 years Chinsan has manufactured the ELITE brand aluminum electrolytic capacitor ranging from radial, snap-in, lug, and screw type capacitors and more recently the conductive solid aluminium polymer capacitors. Manufacturing and Research & Development facilities are located in Taiwan, Thailand and China, and our sales locations are strategically placed in Europe, Turkey, and throughout Asia to provide the most efficient and effective sales and product support service to our customers.

Together in a joint venture partnership, Chinsan Capacitor is able to benefit from the advanced technical support of Hitachi AIC.

With a knowledgeable and dedicated team, we will continue to provide high cost-effective products suiting the needs of our valuable customers. With our customers trust and support, we firmly believe Taiwan Chinsan will continue to be a leader in the capacitor industry.

With a fiercely proud tradition of providing innovative solutions and highly reliable capacitors, Chinsan has become a strategically valued supplier of many fortune top 500 companies as well as other industry leaders throughout the world with customers across a range of markets from consumer to commercial and industrial power supply, PC

peripheral, home appliance and energy industry applications.

Chinsan has implemented the ISO9001 Quality Management System since 2001 and has certified by the ISO/TS16949 Automotive Industry Quality Management standard in 2006. Chinsan has also set up the ISO14001 Environment Management System since 2003 in all facilities, to ensure environment quality and reach the standards on environment protection. Chinsan Capacitor strives to be a leader in the new digital age with an objective of developing eco-friendly energy efficient green products.

Chinsan is a member of the Electronic Industry Citizenship Coalition (EICC) and we adhere to the EICC Code of Conduct. As an EICC member we have joined the Conflict-Free Sourcing Initiative (CFSI) which is an initiative of EICC and Global e-Sustainability Initiative (GeSI). The initiative is a way for companies to address conflict minerals issues. Taiwan Chinsan Electronics Industrial Co. Ltd. is in full support of sourcing conflict free minerals and have implemented due diligence programs to verify conflict mineral free sourcing.

Taiwan Chinsan Electronic will be exhibited at Electronica Trade fair at Messe München, Germany at Hall B5 431 from November 11-14, 2014. Experience our innovative and reliable products. We look forward to your visit and welcome to Chinsan Capacitor at Electronica 2014 in Munich!!!

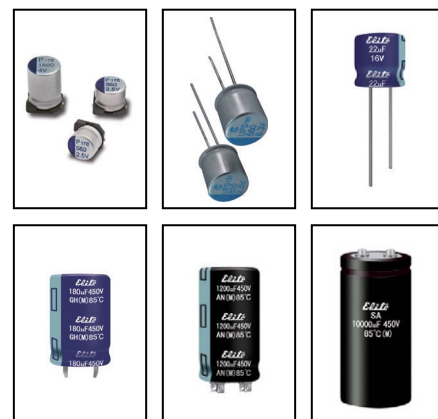


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# A question of Europe

Sir Peter Bonfield sits on the board and has advisory roles in many international companies and universities. With more than 45 years of experience in electronics, computers and communications, here he discusses the role Europe can play on the world semiconductor stage.

**Hanns Windele:** European Commissioner for Digital Agenda Neelie Kroes wants Europe to produce 20% of the world's semiconductor devices, while Chancellor Angela Merkel wants to make a million electric cars by 2020. Is this only political wishful thinking?

**Peter Bonfield:** I believe that to have a big vision is useful. For Kroes and Merkel to be ambitious is generally the right thing to do, except they focus too much on manufacturing. To focus on market share in the manufacture of chips is too restrictive. We need to ask where is the big push to make sure that Europe stays competitive in the whole eco-system of technology. This should include education, R&D, patents: all of these. Europe is more competitive than they think, but needs to do more.

**HW:** What do you think should be the mechanism for promoting these visions?

**PB:** I'm not sure that governments need to be involved in the details; they should focus big on eco systems. The European car industry is currently very vibrant in electronics, not just in control systems, but in communications too. Manufacturers such as BMW, Mercedes, Audi and Jaguar are leading the world in terms of electronics in cars. This is an area where we can be extremely proud and keep pushing. In terms of electric cars, per se, if you have an overall approach, that will start to become a focus in itself. If you look at the congestion charge in London it is cheaper for hybrid vehicles to come into the city. So electric car use goes up. Can governments make tax allowances to kick-start this? Absolutely. But in the longer term they need to make sure that there is outstanding education focused on engineering, science and tech-



*"We need to ask where is the big push to make sure that Europe stays competitive in the whole eco-system of technology"*

nology in Europe, to build a long term competitive advantage.

**HW:** Where are the European companies when it comes to smartphones today? Have they all disappeared?

**PB:** Maybe in terms of the handsets themselves. But when it comes to what goes into the handsets, Europe is still pretty good at that. ARM is in 98% of all handsets. Yes, maybe we've missed out on the actual hardware of the final unit, but we should not underestimate the value of the European contribution to what goes inside the product.

**HW:** Do you think that ARM could replace Intel at some point in time?

**PB:** I would think that they are going to give Intel a pretty good focus, because they have been particularly successful in anything to do with low power. I think that as the market moves into Cloud and the Internet of Things, the importance of low power will increase. ARM has a significant advantage architecturally. Do I think they'll exploit that? Yes. Do I think they'll be successful? Yes, I do. How successful, I don't know. But they have some smart people and the market place is going in their direction, rather than the previous Intel domination direction.

**HW:** Would you agree that being smart about power is more difficult than being smart about other things?

**PB:** Absolutely, because you have to look at the whole system. As we get more into Cloud computing where everything is networked together, the size of data centres is going to be massive and the biggest issue will be power. If you can reduce the power consumption by, say, 20% then you'll save yourself a bundle of money. Do I think that's going to be a trend going forward? Absolutely. It's the same thing in wearables. It's all about low power.

**HW:** The next wave of systems will come in the form of wearable electronics such as Google Glasses. I don't see any European

## QUICKFIRE QUESTIONS with Peter Bonfield

### What's your idea of the perfect holiday?

Skiing and sailing. But I also relax by reading and listening to music

### Who would you most like to sail around the world with?

If you're going to do that you need to go with the best, so I choose Sir Robin Knox-Johnston

### What are you reading at the moment?

The Drugs Don't Work, by Professor Dame Sally Davies, the Chief Medical Officer for England, a scary examination about the rise of resistance to antibiotics

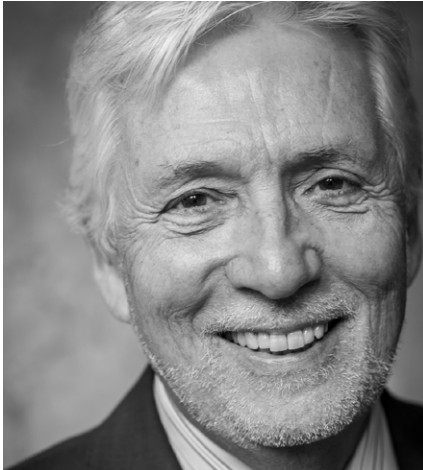
### If you had to spend time in prison, who would be your ideal cellmate?

Houdini. I would definitely try to escape!

### As an experienced traveller, is there anywhere in the world left for you to visit?

I would really like to visit the ruins of the ancient city of Machu Picchu, or to take a trip up the Amazon River.

**HANNS WINDELE** is Vice President, Europe and India at Mentor Graphics. [www.mentor.com](http://www.mentor.com)



*"To ignore China as a competitor would clearly be mad"*

devices aren't hacked into is all going to be part of the development of the Internet of Things. And we can play a big part in that, too. Security is an area where Europe has a long history in technology with companies like NXP and yet we are only in the foothills of some pretty big mountains at the moment. It's going to be a very big issue.

**HW:** China has announced it will invest billions per annum in technology. What effect will this have on European markets?

**PB:** To ignore China as a competitor would clearly be mad. They are going to be a big competitor, as were Japan and Korea. Competition is what drives industry and so we should welcome them putting more money into it. But it is not a foregone conclusion that just because they are putting big money into it that they will be successful. It's going to be a question of where the money goes and how successful they are in getting sufficient engineers involved, their links with universities and patent protection. What this says to Europe is that we've got to keep the top end of innovation up there and will have to be into smart differentiation and not just focused on manufacturing.

**HW:** As a board member of TSMC located in the Far East would it make sense for you to team up with a European initiative and set up a fab over here?

**PB:** TSMC works on the assumption that it can have efficient manufacturing by starting up gigafabs. The thesis is that the capital expenditure is large while the cost in direct labour is small. TSMC believes that by having engineers in close proxim-

ities, they can move from fab to fab. A big hub in Taiwan is extremely important to achieve what they are doing. They've started another fab 90 minutes from Taipei, which allows thousands of engineers to be involved in starting up a new fab, and they can travel by train. You can't do that in Europe.

**HW:** Is success dependent on developing technology clusters?

**PB:** The point is that clusters work. It's a bit like Silicon Valley: you get more innovation and spin-off from a concentration of engineers working in the same area, because if one company goes down the talent can move somewhere else. If you're the only person in town, it's going to be much harder to attract engineers because if anything happens, they're out of work...



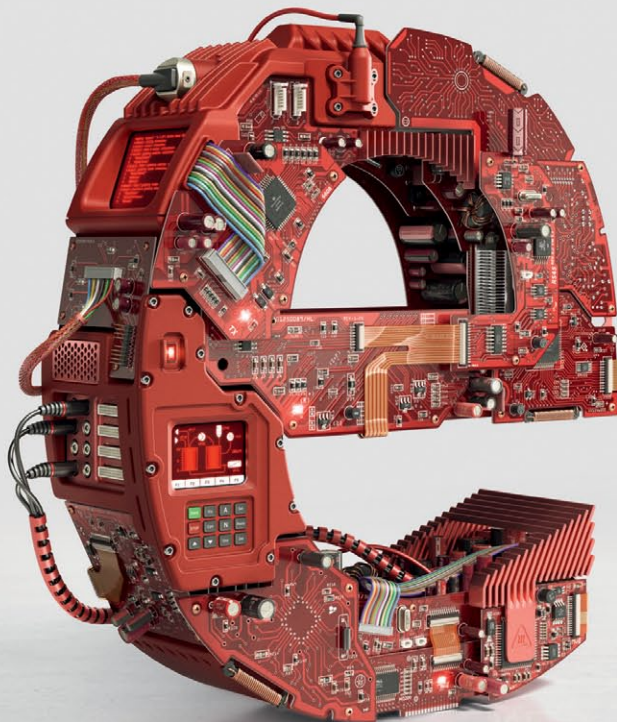
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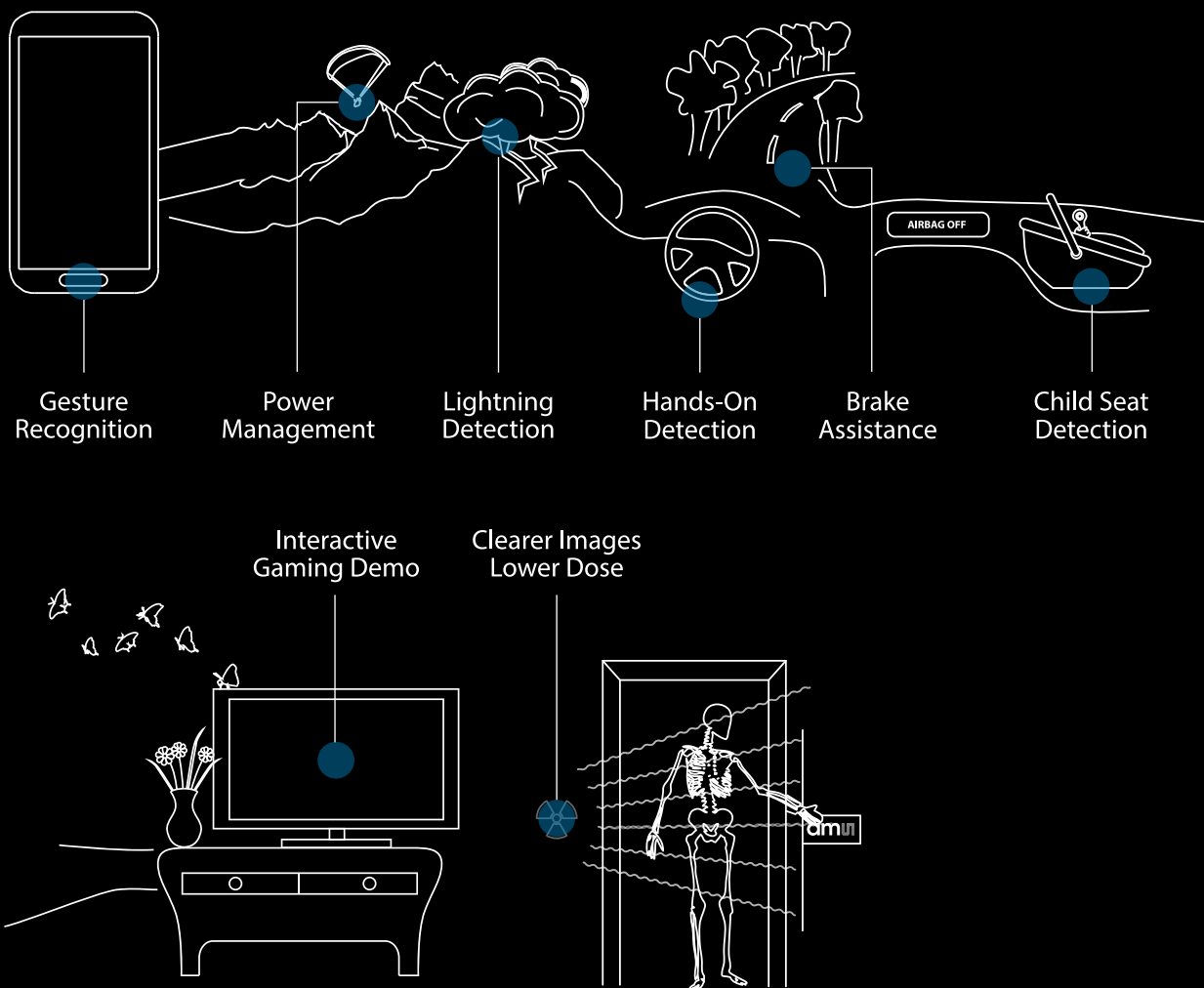
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