

# what's **new** in **electronics**

March/April 2016 Vol.35 No.5  
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 **Raspberry Pi**

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Source: Distributor Evaluation Study, UBM Tech, May 2015



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Exactly four years ago, on 29 February 2012, the Raspberry Pi Foundation launched the original 256 MB Raspberry Pi Model B on a largely unsuspecting world. Since then, they've shipped over eight million units, including three million units of Raspberry Pi 2.

The new Raspberry Pi 3 was officially launched on 29 February 2016 by the Raspberry Pi Foundation and element14 (Premier Farnell in UK). The Pi 3 board is built on a new QUAD Core Broadcom BCM2837 64-bit ARMv8 processor (running an ARMv7 operating system) running at 1.20 GHz, a significant increase from 900 MHz on the Raspberry Pi 2. It has improved power management and an upgraded switched power source — up to 2.5 A — to support more powerful external USB devices.

With support for Bluetooth Low Energy and wireless LAN, the Raspberry Pi 3 can support new and exciting application areas 'out of the box', such as IoT connectivity, streaming to Bluetooth headphones or speakers, Wi-Fi gateways and home cloud storage.

element14, the manufacturer and distributor of the Raspberry Pi, is excited to once again be reaching another milestone on its Pi journey. Supported by element14's growing accessory portfolio, the company can't wait to see what engineers and hobbyists will develop and build.

element14  
[au.element14.com/raspberry-pi](http://au.element14.com/raspberry-pi)



WHAT'S NEW IN ELECTRONICS  
 MARCH/APRIL 2016

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# POWERING WEARABLES

*Chris Francis\**

Wearable electronic devices are small and so are their batteries. Therefore, the designers need to be careful and creative to ensure the device has a battery life of months or years instead of days or hours.





**W**earable device developers need to consider a lot of aspects when designing a low power system. They must pay careful attention to everything from clock start-up times to the switching times of MOSFETs. This article provides some pointers for making every minute of battery energy count. While some ideas may only save tiny amounts of energy, others are more significant. Lots of small savings can add up to make a significant saving.

### Sleep

Maybe the most obvious strategy for power saving is for the device to be in a low power 'sleep' state as much as possible, assuming it cannot actually be turned off completely. You obviously need a means of waking it, which can be periodically by time or an event (ie, interrupt), such as a button push or physical movement. You then have various parameters to juggle with such as how often the device wakes up and what it does when it wakes up. You can also have dynamic sleep intervals whereby the device sleeps for varying times depending on what is happening. For example, with a fitness monitor you may want to monitor and log data quite frequently when there is activity, but when the activity slows or stops, the monitor interval could be increased, thus saving battery power.

### Inter-IC communications

I<sup>2</sup>C has pull-up resistors that waste power — SPI doesn't need pull-up resistors. Pin capacitance consumes power between ICs. Minimise the amount of data you transfer if you can. If there are four lines of 5 pF each running at 20 MHz with a 3.3 V supply, it will draw 660  $\mu$ A due to pin capacitance alone (current =  $0.5 CVf$  where C is the pin capacitance, V is the supply voltage and f is the frequency). The pin capacitance will be both the sending and receiving all the IC capacitance combined. This current may be dwarfed by the actual IC current, but not always — it depends on the function of the device. It is a contributory factor

to why highly integrated chips can be the most efficient — access to peripherals, RAM and flash memory is all internal so no pin capacitance is involved when accessing those peripherals or memory. A large part of pin capacitance is due to the ESD protection diodes.

### Power supply efficiencies

Choosing a switching regulator for a switched mode power supply is a key factor in maximising efficiency, particularly synchronous regulators where efficiencies of over 95% are possible.

However, it is not just headline efficiency or even standby efficiency that is necessarily the most critical. It is necessary to look at the current in different modes for the device and determine the contribution to overall power consumption from each mode after taking account of the switching regulator efficiency at each current level.

There are some quite impressive regulators around though, such as the new Analog Devices ADP5301 step-down regulators. The quiescent current is down as low as 180 nA when not switching but still operating in hysteresis mode. It will switch for a short burst to add charge to the output capacitor using the inductor at very light loads then return to just the quiescent current. The low quiescent current can give you efficiencies as high as 80% at 1  $\mu$ A depending on the input and output voltages. You are more likely to see lower figures than that optimum value, but still above 40%. It also delivers up to 0.5 A and has a single pin programmable output with a fixed resistor. It is very impressive compared to older regulators which would take a few milliamps with no load.

If you are using a switching regulator with an external MOSFET, bear in mind that the MOSFET switching time can result in significant losses. The transition from non-conducting to conducting is the time when a switching MOSFET dissipates the most power. When it is turned fully on, the voltage drop will usually be very small and hence power dissipation will be low. However,



## POWER SUPPLY

partly turned on there will be a significant voltage drop across the MOSFET accompanied by significant current. You therefore want to minimise the time that transistor spends in that state by choosing a fast switching device and low gate capacitance. You obviously want a low ON resistance as well.

### Power supply shutdown

See if you can keep power supply capacitors small if the power supplies are shut down in sleep mode. It takes energy to charge them and if the power supply is shut down when in a sleep mode then the energy in the capacitors is wasted energy (unless it will still be there when you need it next). For example, a 1  $\mu\text{F}$  capacitor on the power supply of circuitry which is shut down 100 times per second will consume 165  $\mu\text{A}$  at 3.3V (same calculation as before).

Many ICs will take less than that in shut-down or sleep mode, so it is often better to keep circuitry powered but in a sleep state than to actually do power switching to save power. The exception would be if the device you were using didn't have a sleep mode or if its sleep mode was not very low current. If you can use 100 nF instead of 1  $\mu\text{F}$ , you could save a lot of energy.

### Low supply voltage

Devices will consume less power at lower voltage even if they don't consume less current. So, if a microcontroller is powered by 1.8 V instead of 3.3 V, power consumption will be half for the same current. Usually digital devices will also consume less current at lower voltage as well so the power is further reduced. Watch out for the maximum clock speed also reducing though — it is not uncommon for the maximum clock speed to be lower at lower voltages. So, while the current will be lower it will take twice as long to run the microcontroller's code.

For example, while the Microchip nanoWatt XLP PIC24F16KA102 microcontroller running at 2 MHz consumes 695  $\mu\text{A}$  at 3.3 V, it only requires 363  $\mu\text{A}$  at 1.8 V, which is 70% less power — a massive saving. However, at 3.3 V the microcontroller can run at 32 MHz, while at 1.8 V the maximum clock speed is 8 MHz.

### Clock speeds

Choose the clock speed to suit the application, not just the fastest possible. This probably won't be known until the code is finished. Most microcontrollers have an adjustable clock multiplier, allowing the clock speed to be changed by the application code. If the microcontroller code is the limiting factor in terms of executing the code and going



DEVICES WILL CONSUME LESS POWER AT LOWER VOLTAGE EVEN IF THEY DON'T CONSUME LESS CURRENT. SO, IF A MICROCONTROLLER IS POWERED BY 1.8 V INSTEAD OF 3.3 V, POWER CONSUMPTION WILL BE HALF FOR THE SAME CURRENT.

back to sleep, then the fastest may be the most efficient. However, if something else will actually be slowing things down and the microcontroller will be 'marking time', the microcontroller can be woken by a periodic interrupt instead.

An alternative approach would be to dramatically slow down the processor when it is just 'waiting' and then speed it back up when there is something to do. Ideally you would sleep instead but clock start-up times and the power wasted while waiting for the clock to stabilise can mean sleep is not the best option in some circumstances.

### Clock start-up

Power is wasted while waiting for the system clock to stabilise. If code can be run while the clock is still settling then that can help, but if there is any other part of the circuitry relying on a stable, accurate clock the processor has to wait, resulting in wasted energy. Some microcontroller manufacturers' clocks are quicker to start than others.

### 32-bit microcontrollers

Does every design really need a 32-bit processor? They seem to be everywhere but the work actually being done by them can be minimal. A 16- or 8-bit microcontroller may be more efficient. It does depend on what code is running and the efficiency of the compiler. If there is a Bluetooth or internet interface then more memory may be required and a 16- or 32-bit processor should be used. An TCP/IP stack with a web server requires a 32-bit processor. Creative software writing can minimise the resources needed and minimise power consumption.

Wider data width processors consume more power in a number of ways. Accessing 32-bit RAM and Flash memory is more power hungry than accessing 16-bit memory. Also, leakage current increases with wider memory. That points towards keeping memory size to a minimum both by efficient code structuring and writing, and also not choosing a processor with massive amounts of excess memory.

### RF power

If there is an RF wireless interface, eg Bluetooth Smart, consider the transmitting distance. Not only are there power savings by transmitting with lower power, the receiver sections can have adjustable sensitivity and will take less power when sensitivity is set lower. For example, the Nordic Semiconductor nRF52832 has a high receiver sensitivity mode taking 10.9 mA but normal sensitivity only takes 6.1 mA.

### Custom IC

The ultimate lower power solution might be a full custom IC design with only the needed circuitry. Circuitry that never drives off-chip consumes a lot less power. However, it is the slowest and most expensive way of developing a product. It is also probably why a Frederique Constant Smartwatch battery lasts two to three years and a Fitbit Flex lasts three to five days.

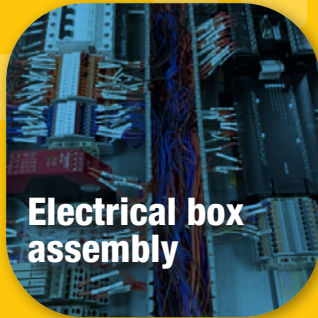
### Summary

It can be a good idea to create a spreadsheet with all the parts of the system listed, current consumption, required duty cycles, voltages and total power consumed. Then for each design scenario calculate the projected power consumption. The only way to find out some of the information needed is to actually build something and test it.

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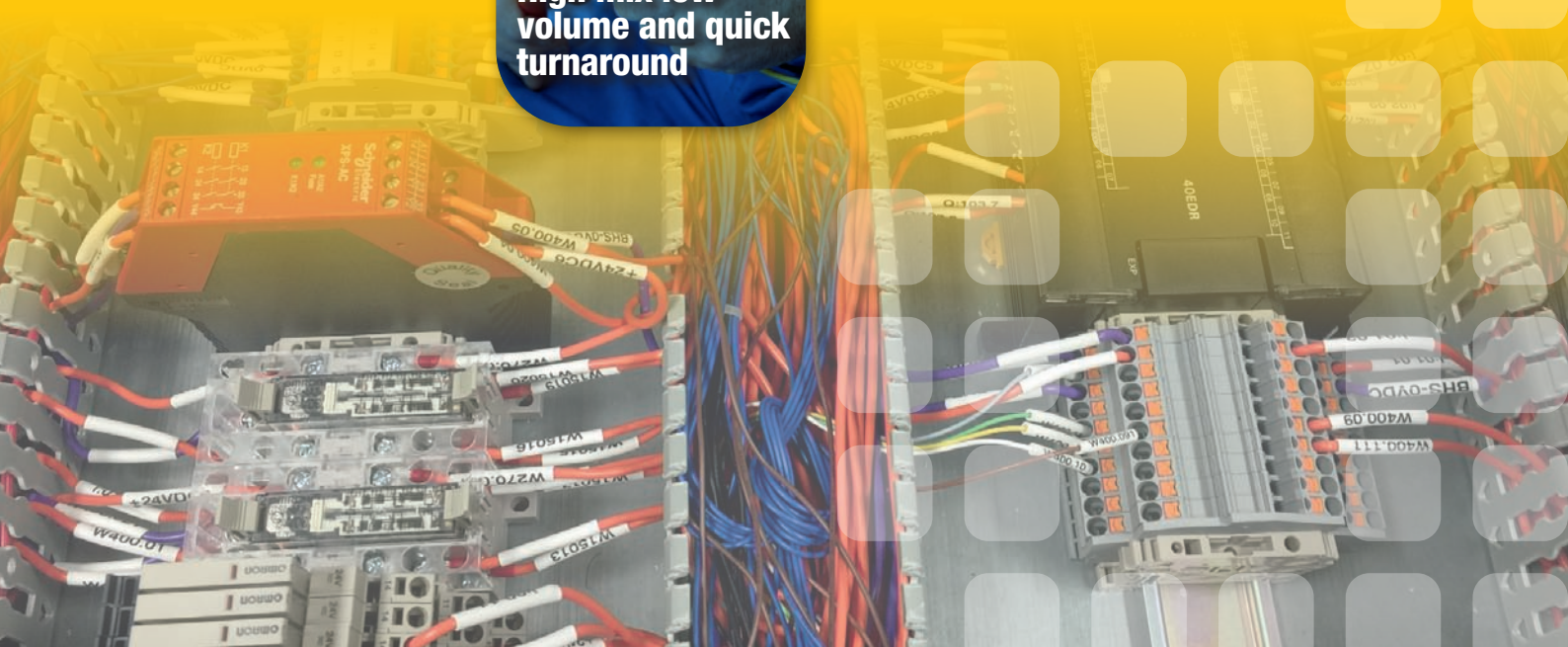
*\*Chris Francis, a contributing writer at Mouser Electronics, is a First Class Honors electronics graduate with 36 years of experience in the electronics industry, mostly as a freelance designer of analog circuitry and custom ICs covering everything from industrial, medical and aerospace to consumer products.*

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## LAB OSCILLOSCOPE

Rohde & Schwarz presents the R&S RTO2000, a compact lab oscilloscope for multidomain applications. When using it to check advanced embedded designs, developers are able to analyse how sophisticated functional units such as power supplies, the processor system and the sensor technology interact. The product is claimed to display the correlations between time, frequency, protocol and logic analysis measurement results like no other oscilloscope can.

Via the analog input channels, the user simultaneously sees the signal in the time and frequency domain and, if desired, the spectrogram. Functions such as peak list, max hold detectors and the logarithmic display make frequency analysis even more efficient.

The zone trigger enables the graphical separation of events in the time and frequency domain. Users can define up to eight zones of any shape. A trigger signal is activated when a signal either intersects or does not intersect the zone. This makes it easy to detect disturbances in the spectrum during EMI debugging or to separate read/write cycles of storage media in the time domain.

The product is available as a two- or four-channel model with a bandwidth of 600 MHz, 1 GHz, 2 GHz, 3 GHz or 4 GHz.

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Both converter series are rated for 1 W and offer up to 6.4 kVDC isolation between the input and output for 1 s. In contrast to the RK/H6 series, the RH/H6 series comes with dual outputs. Both models are available for input voltages of 5, 12, 15 and 24 VDC and supply 3.3, 5, 12 and 15 VDC (RK series) or  $\pm 3.3$ ,  $\pm 5$ ,  $\pm 12$  and  $\pm 15$  VDC (RH series) at the outputs. They have an efficiency of up to 80%, are permanently short-circuit proof and can be operated without a minimum load.

Both converter series come in the compact SIP7 housing (19.6 x 7 x 10.2 mm) and can be operated at full load over a temperature range of -40 to + 90°C. They are also IEC/UL60950-1 certified.

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## ROUTER

The Robustel R3000 Router is a ruggedised cellular router in a metal housing measuring 125 x 108 x 45 mm. It allows operation on global 4G and 3G networks with fallback to 3G/2G and allows data speeds up to 100 Mbps download and 50 Mbps upload. It has RCM certification for Australia and New Zealand.

The routers have dual SIM card holders to ensure cellular connectivity remains when continuity of service levels is important. Options include Wi-Fi and GPS/GLONASS communications. Modbus gateway is supported, which makes it easy to integrate into any industrial automation project. An SDK is also available for those who want to develop their own user application.

The product comes with up to four ethernet ports, allowing various WAN/LAN configurations including support for wireless WAN and wired WAN backup. It has RS232, RS485, digital I/O and one USB host serial port. A micro SD card port is available for data logging.

The router has a wide operating voltage range of 9–60 VDC and a temperature range of -40 to 85°C. Applications include smart transportation, wireless CCTV, ATM/vending kiosks and power generation/distribution equipment. The product supports RobustVPN and RobustLink.

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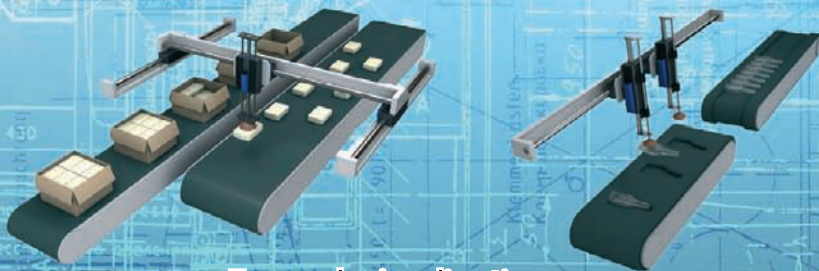
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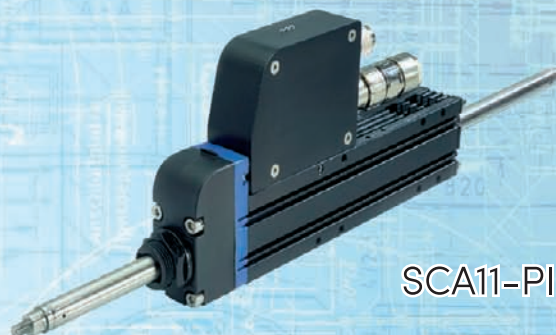
The easy-use form factor of the ServoTube linear motor coupled with its highly effective internal feedback now offers high performance and mechanical simplicity of linear motors in today's typical industrial applications.

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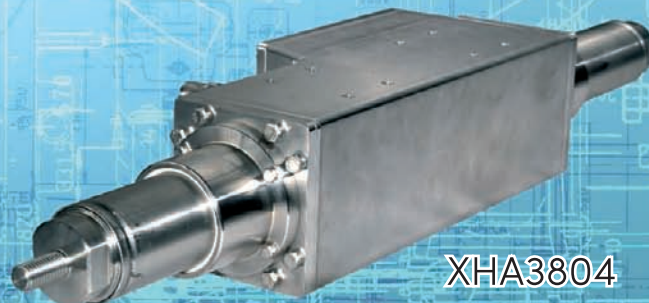
Example Applications



SCA11-PI



XTA3806



XHA3804





GETTING THE MOST OUT OF YOUR

# MIXED SIGNAL OSCILLOSCOPE

Measurement trips and tricks for getting the most out of your MSOs

**A** mixed signal oscilloscope (MSO) is a 2- or 4-channel oscilloscope with 8 or 16 (rarely more) logic analysis channels built in for timing analysis.

The main benefits of this integration are time correlation between signals on the analog and digital channels of the oscilloscope and more powerful triggering between the two.

## MSOs — a brief history

If the 1980s were the decade of the microprocessor, the 1990s were the decade of the microcontroller. Miniaturisation and digitisation of electronics was happening, and happening fast. Classically, a design engineer had two key tools on their bench: an oscilloscope and a logic analyser. These were purpose-built tools with amazing performance and capabilities.

Oscilloscopes were unmatched in showing signal quality and integrity at the physical layer, with high resolution and fast waveform update rate. Logic analysers traditionally had 64 or more digital lanes with ultradeep memory, timing analysis, state analysis and full customisation of the user interface. They were useful for debugging and designing even the most complex FPGAs, ASICs and

microprocessors. But the needs of engineers were changing, and with that, the tools changed too.

Microcontrollers of the time were usually 8- or 16-bit devices, and the swing from parallel to serial communications was already happening. Logic analysers were a tool of last resort — often way overpowered for the task at hand. People who weren't power users often struggled to set up and use the device. Engineers needed an easy-to-use and portable logic analyser with a familiar interface. The solution was the Hewlett Packard 54620A, a 16-channel timing-only logic analyser in a 54645A oscilloscope's housing, with an oscilloscope user interface. This product was successful with engineers who needed simple timing analysis, without the other 95% of capabilities in comparatively complex and expensive logic analysers.

## Target applications

Engineers were, for the first time ever, able to make analog and digital acquisitions simultaneously with fast update rate. This was, and still is, important for designers who are conscious of transients and physical layer phenomena in digital design. Let's take a look at some popular applications for mixed signal oscilloscopes today.





Being able to trigger on the digital channels is the most powerful capability of MSOs. Triggering on a specific condition — eg, a memory write to certain address, and then viewing the signal integrity on the data bus under that target condition — is important because data dependent inter-signal interference, crosstalk and jitter all impact the ability to transfer data over the data bus.

There are times when a specific target condition creates the perfect storm for inadequate signal integrity. In other situations, it is more than just a specific state of the operation that creates a signal integrity or timing issue, but rather the transition from one state to another where the issue arises. Signal integrity cannot be easily viewed on digital channels alone, so having access to four 8-bit channels to view physical phenomena with a fast refresh rate is critical.

Observing basic timing relationships on control signals and data buses is another key capability of an MSO. Although not nearly as accurate as analog scope channels, the 16 digital inputs do allow a view of basic timing relationships across related input signals, with low channel-to-channel skew and very tight correlation between channel samples. This is because the 16 channels are all derived from the same timebase sampling process. The use of symbol names

and bus representation views also allows an intuitive view of state machine condition reporting or data bus values to validate or debug digital systems.

Another helpful use of digital input channels in an MSO is the ability to trigger the oscilloscope on a signal integrity issue detected on an analog input channel, and then observe the condition of the target system when that problem happens. This can be accomplished through observing the target condition via the digital input channels to see a state machine condition, see command/control signal condition, or data values.

### Measurement tips and tricks

Autoscale is generally an engineer's best friend on the bench, especially when you haven't picked up a scope in a while. Keysight InfiniiVision X-Series scopes have an autoscale that, when pressed, will monitor all analog and digital channels for activity, and turn them on for you if signals are present. If your digital channels have somewhat constant activity, a simple autoscale can get your screen looking much cleaner.

Next, let's quickly discuss the fundamental differences between traditional logic analysers (LA) and MSOs. First, an MSO does not provide any state analysis, or definition of states within a system. MSOs provide purely timing analysis. There is a pseudo state mode in which the scope can decode the digital channels and read out a bus value on screen, but that's it. You can see it on the bottom of Figure 1, as x14. Second, the digital channels of an MSO share a timebase with the analog channels. This means the digital channels are constantly being sampled and saved into acquisition memory, not just at transitions like a dedicated LA. This means you need to be conscious of your sample rate on the digital channels. Any transitions that occur between samples will be reported as happening at the next sample period, and any glitches that occur within a sample period may not be recorded. This can be an issue when you are viewing very long traces of data. The scope has been set up to decode 50 ms of data, and thus the sample rate has lowered to 2.5 Msa/s on the digital channels to accommodate. This means there are 400 ns gaps between samples. The uncertainty between samples is shown as a filled in box, to let you know that the real transition could have occurred anywhere within that time period.

Another tip is that you can define channels individually to two separate buses that can be decoded simultaneously on screen. In Figure 2 on the left, we've defined two 4-lane buses as B1 and B2, being decoded in real time on the bottom of the display. B1 is assigned digital channels 0–3, and B2 is assigned digital channels 4–7. In Figure 2 on the right, we've only defined one bus, B1, and assigned digital channels 0–7. Each bus can be between 1 and 16 channels, and there can be overlap if needed (eg, B1 = channels 0–11, B2 = channels 4–15).

Finally, there are some neat math functions built into the scope to better visualise the bus. Figure 3 shows the timing chart function,



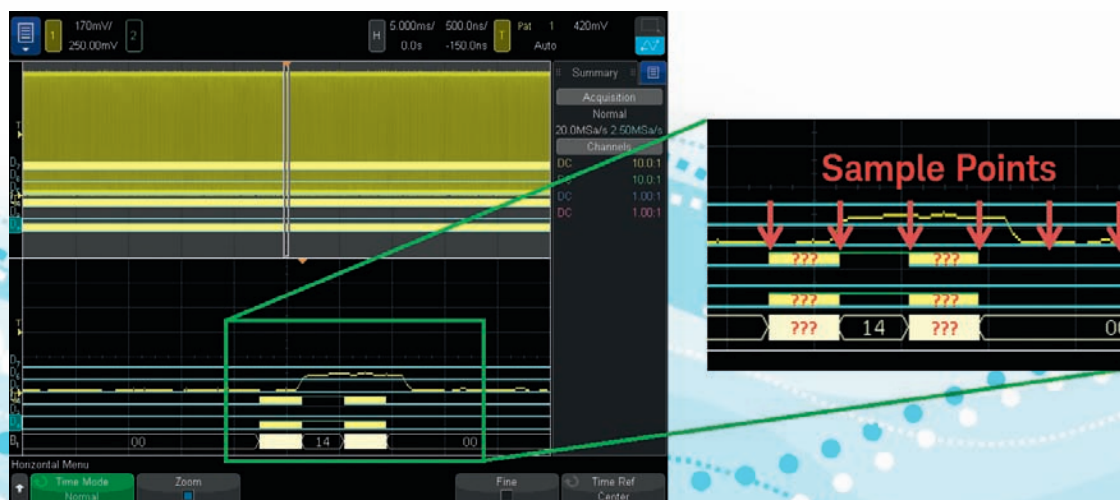


Figure 1: There are 400 ns gaps between samples and this uncertainty between samples is shown as a field in the box.

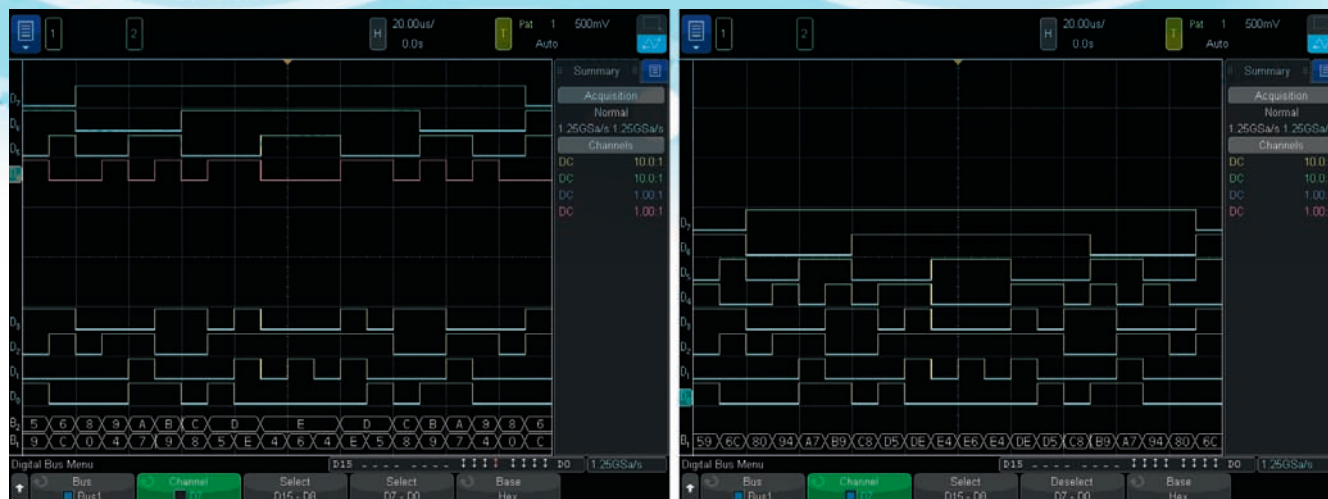


Figure 2: Channels can be defined individually to two separate buses that can be decoded simultaneously on screen.

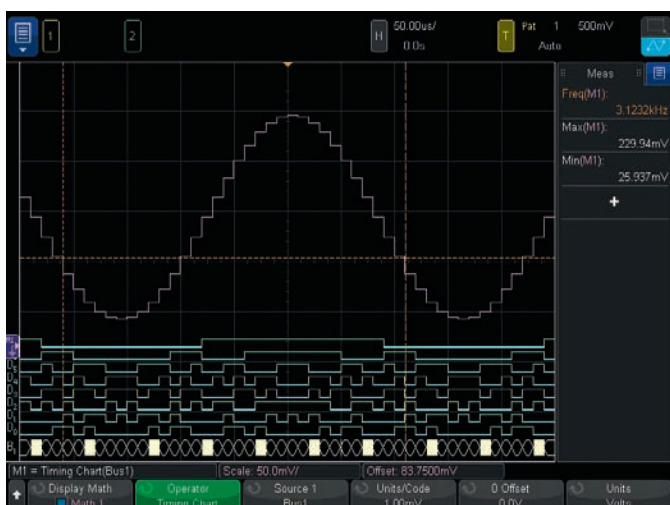


Figure 3: Signals displayed with the timing chart function.

assigned to Bus1 as channels 0–7. The chart will be visualised as a quasi-DAC, with a simulated analog output based on the state of the bus when a channel transitions. Scaling factors and units can be assigned if you wish to make measurements on the output, where we are measuring the frequency of the output, as well as max and min based on the below factors of 1 mV per code (eg, as an 8-bit bus, the simulated output range would be 0–256 mV).

There is also a state analysis function that is similar to the timing chart, except instead of looking for changes on the bus, it uses a separate clock line to visualise changes on the simulated output.

### Conclusion

Due to the popularity of serial protocols over parallel buses, logic analysers of the past have largely fallen out of favour with engineers, who are more likely to reach for an MSO-enabled oscilloscope to make their measurements. MSO technology is offered by nearly every vendor, on a wide range of scopes from a few thousand dollars to over two hundred thousand dollars. The ability to cross trigger between analog and digital channels, as well as decode and view states on screen, are powerful features that engineers leverage to design and debug today's most challenging mixed signal designs.

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## PORTABLE OSCILLOSCOPE



The R&S Scope Rider, from Rohde & Schwarz, is equally impressive in the lab and in the field. The portable oscilloscope features an acquisition rate of 50,000 waveforms/s, a 10-bit A/D converter and a maximum bandwidth of 500 MHz for the analog input channels.

The product integrates five functions to offer a high level of versatility. It is based on a high-performance oscilloscope featuring a precise digital trigger system, 33 automatic measurement functions, mask test and XY diagram mode.

The device can function as a logic analyser with eight additional digital channels; as a protocol analyser with trigger and decoding capability; as a data logger; and as a digital multimeter. This makes it suitable for a wide range of tasks.

The oscilloscope is equipped with a large-format capacitive touch screen, allowing it to be operated as intuitively as a tablet PC. It also features large buttons for use with gloves and a practical multifunction wheel for convenient parameter adjustment. Users can confidently read their results at any time, as all measurement information is displayed in a clear, application-oriented manner on the screen.

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## AROMATIC-FREE ACRYLIC CONFORMAL COATING

Electrolube, a manufacturer of specialist chemicals to the electronics industry, has said it can offer a conformal coating for virtually every type of application. AFA (Aromatic Free Acrylic Conformal Coating) is the latest addition to the company's range.

Offering good clarity, AFA is completely free of aromatic solvents and transparent, ensuring suitability for LED applications. A fast touch dry time (5–10 min at 20°C) combines with a UV trace to aid visual inspection. If required, the coating can be removed with an Electrolube solvent such as ULS.

The product has an operating temperature range of range of -65 to +125°C. It meets IPC-CC-830 and UL746 industry standards, with an additional qualification to BMW Group Standard GS95011-15.

**Electrolube**  
[www.electrolube.com.au](http://www.electrolube.com.au)



## WEARABLE ENCLOSURES

The BODY-CASE series of wearable enclosures is suitable for applications on or near the body. Due to its small, compact format, it can be worn on the arm, around the neck, in shirt and trouser pockets or carried loose in an article of clothing.

The body case has a three-part design consisting of a top and a bottom part and a matt TPE sealing ring. The enclosures are made of ASA material in the colour traffic white and have polished surfaces. The top parts are available either with or without a recessed surface for decor foils or membrane keyboards. The sealing ring is available in the colours vermilion and lava and allows protection classes IP65 and IP67.

The dimensions of the enclosure are 54 x 45 x 17.5 mm. Internal power can be supplied with round or button cells, which are mounted directly on the PCB. Alternatively, it is possible to charge the device inductively after the installation of a rechargeable battery with copper loop.

Applications include mobile data recording and data transmission, measuring and control engineering, digital communications technology, emergency call and notification systems, and biofeedback sensors in the fields of health care, medical technology, leisure, sports, etc.

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# PARALLELING POWER SUPPLIES

Arthur Russell\*

Using a cluster of smaller DC-DC power converters in parallel offers many potential benefits along with design flexibility, but doing so requires understanding the performance attributes of the different approaches.

**T**here are a number of reasons why a system designer may want to consider paralleling of DC power supplies. Some of these are related to the bill of materials and logistics issues, others are focused on satisfying system current, performance or reliability objectives.

On the non-design side, the ability to parallel supplies may allow a single supply model to be used singly or in combinations across a broad product line. This can simplify sourcing, increase per-unit volume and streamline inventory management.

The technical reasons to consider paralleling supplies are more complex, of course. First, using parallel supplies can be a form of 'insurance' in case the product actually needs more current than budgeted, perhaps due to unavailability of lower-power components or new features and capabilities added by marketing. Second, parallel supplies may support N+1 and even N+2 redundancy to safeguard against single-point failures, or to enable hot-swapping of a failed supply without system impact. Third, it permits the use of a known, proven supply with well-understood features, characteristics and form factor, thus reducing design-in risk and uncertainty. Finally, it allows for 'heat spreading' by adding flexibility in physical placement of the power converters, if a single higher-capacity unit would dissipate too much heat in a highly localised area.

The paralleling of power supplies also raises an obvious question: can any supply be used, as is, in parallel configuration? The answer

is no. It depends on the design of the supply, the technique used to connect the supplies, and the reason the supplies are being used in parallel. The most obvious and simplest way to put supplies in parallel is to simply tie their outputs together. In general, this won't work, as each supply has its own output voltage regulation, and so you would be trying not only to maintain this regulation versus changes in load, but also attempting to regulate against the closed loops of the other supplies.

For supplies which include their own traditional internal error amplifier and reference, just placing multiple supplies in parallel is not an effective way to make a high power array. Parametric differences from supply to supply will always cause one supply — the one with the highest output-referred reference voltage — to carry all of the load current, while all of the remaining supplies will carry no load.

In this case, as the load exceeds the capability of this 'lead' supply, it may enter a constant-current limit mode (which may or may not be a rated mode of operation), or it may interpret the overload as a fault and shut down. Depending on the supply in question, these responses could lead to overstress, especially if they occur as part of regular operation in the application. Further, for cases where the supply shuts down due to an overload, the supply in the array with the next-highest reference voltage will be forced to carry the entire load, and will similarly shut down. This will quickly lead to collapse of the entire supply rail.



### This 'OR' that?

A simple solution to this direct-connect dilemma is to just use a diode between each supply and the common tie point of all supplies, a technique commonly referred to as diode-ORing, Figure 2. ORing diodes are very effective at preventing a supply from sinking current away from the shared output, but are generally insufficient to address sharing errors among supplies with independent error amplifiers, because the conduction knee is abrupt enough that parametric differences in the supplies' setpoints will still lead to significant sharing imbalances.

Diode ORing is generally required for supplies acting independently, whose outputs can both sink and source current (two-quadrant operation). The effect of directly paralleling such supplies without ORing diodes is far worse than it is for single-quadrant supplies. While single-quadrant supplies will only suffer from load-sharing errors, two-quadrant supplies will actively contend for control of the common output voltage. This will cause current in excess of the load current to circulate among the supplies in the array, and likely lead to immediate overload of one or more of the supplies.

Also, if the diodes have a negative temperature coefficient for their conduction threshold, they will actually promote current hogging in the array. One way to minimise the problem is to use a method of rectification with a positive tempco — Schottky diodes, or via a diode-like function but built using FETs and a rectifier in an active-ORing implementation — but diodes can reduce efficiency due to forward voltage drop, and active-ORing can add cost and complexity.

Under some circumstances, diode ORing can still offer reliability improvements at the system level. The chief case of interest is where one of the supplies suffers a shorted output FET or capacitor which could jeopardise the common output voltage rail. ORing diodes will quickly decouple that short from the output bus, and improve reliability and system robustness.

### Who's in charge here?

Supplies generally must be designed specifically for parallel operation in order to operate reliably and predictably in an array. Start-up synchronisation, fault-protection coordination and control-loop stability must all be considered.

For a parallel array of supplies to deliver increased levels of usable current to a load, some type of control-loop strategy that factors in array use is needed. A popular control strategy is to run the supplies with no internal voltage regulation amplifier, but instead group them together with a common control-signal input which is controlled by a single error amplifier. This error amplifier regulates the output of the system, and then its single feedback signal is distributed to all of the power supplies in the system.

A major benefit of this popular control strategy is the regulation of the output voltage is excellent, and sharing errors are dominated by part-to-part variations in modulator gain. On the downside, use of a single error amplifier and single wired control bus represents a single point of failure, which may present a problem for some types of high-reliability systems. Also, parametric errors on modulator gain can be difficult to control, often leading the manufacturer to trade off yield to control sharing errors.

For a single control-loop approach, sharing errors are minimised if the supplies feature tight tolerance on their control-node inputs.

One way this direct-connect topology can work well is if one supply is set to constant-voltage (CV) mode and the others are set to constant-current (CC) mode, but at slightly higher output voltage; note that not all supplies allow choice of output mode. The supplies which are set to the higher output voltage will provide constant-current output, and each of their output voltages will drop until it equals the output of the CV supply. The load must draw enough current to ensure that the supplies which are in CC mode must stay in that mode. Note that use of the two modes does mean that the multiple supplies are no longer strictly identical, thereby negating some of the advantages of the parallel configuration.

The direct-connect approach is viable if the supply is specifically designed to support that topology, or if there is a single control-loop error amplifier which feeds the error signal back to all of the other supplies, so they share the load. However, the latter method also requires a 'share bus' for the control signals from the master to the slaves.

Another approach adds small ballast resistors in series with each supply's output, to equalise the distribution of the load current among the supplies in the array even when their control loops are seeking dissimilar output voltages, as shown in Figure 1. The ballast resistors create some loss of load regulation, depending on the spread of setpoint errors that the ballasting intends to overcome. However, these ballast resistors also dissipate heat, which degrades system efficiency.



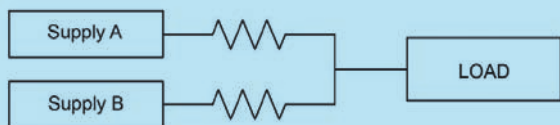


Figure 1

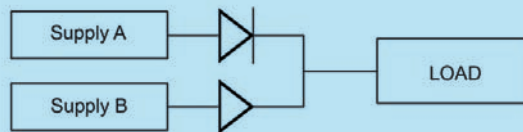


Figure 2

If the sharing errors are large, then either the power rating of the array must be reduced to avoid overloading of any single supply in the array due to sharing imbalances, or specific countermeasures need to be used.

Techniques for sharing errors which result from part-to-part variations of the control node can include a production-based adjustment to calibrate out errors (an expensive approach), or adding a current-control loop around local to each supply inside the array to cancel such errors (which adds some complexity and parts). Sensing current for these local loops typically involves adding a shunt resistor to the supply.

There's a second obstacle for isolated power supplies that have their control nodes referred to the primary side of the DC-DC: transmitting the output of the error-amplifier across the primary-to-secondary isolation boundary. Isolation techniques often add cost, take valuable board real estate and can have adverse effects on reliability, depending on the isolation components used.

A second control-loop strategy which permits separate supplies to be arranged in a parallel array uses a load line to emulate the path resistance of the ballast resistor method. By implementing what is called the 'droop-share' method of load sharing, each supply has a separate reference and integrating error amplifier, but the reference is deliberately and linearly reduced by some nominal amount as the load current of the supply increases.

Paralleling supplies may have negative consequences on transient response and load regulation. The droop-share method deliberately uses a negative load-regulation term to distribute the load across modules in the array. Therefore, load regulation tends to be worse for droop-share arrays than for arrays created with a single traditional error amplifier. If this is a problem, an external control loop can be used around the droop-share array, to effectively cancel out the negative-regulation term. The resulting static-regulation error is identical to the traditional error-amplifier case, since the external loop is itself an error integrator.

## Supply design

Supply vendors can take steps to ease the paralleling challenge. For example, Vicor's DCM DC-DC converters in Converter housed in Package (ChiP) packaging feature a built-in negative-slope load-line; thus, as the load increases, the DCM's internal regulator reduces the output voltage slightly. This effectively acts like the small ballast resistor approach but without any actual resistors and with a few additional key differences.

First, it's a different way to implement a ballast resistor, and one which doesn't involve wasted heat as there is no physical resistor and no  $V \times I$  heat generated. A second difference relates to dynamic response, since for frequencies up to hundreds of kilohertz, a real resistor can be considered as having unlimited 'bandwidth' in its I-V transfer-function curve due to lack of high-frequency parasitic concerns. As a result, any instantaneous change in voltage across the resistor results in an immediate corresponding change in current.

In the DCM converters, the load line is implemented through a discrete-time modulation of the digital/analog converter that creates

the reference for the error amplifier. The correct reference value is calculated primarily based on an estimate of the DCM's output current, and involves some averaging to reduce noise. Therefore, the resistor that the DCM load-line emulates is one that acts like it has a significant capacitor in parallel with it, and the resulting RC-time constant is evident when looking at the datasheet figures which show the supply's response to a load step.

Nonetheless, having this load-line output characteristic permits multiple DCM outputs to be placed directly in parallel, while each still has its own error-amplifier control-loop still active. The distribution of the load current over the DCMs in the array is ideally equal if all DCMs have the same external (real) path resistances to the load, have the same trim setpoint and are at the same temperature. Parallel DCMs thus behave like a single DCM but with a higher output current.

With the DCM converter family, temperature changes in individual units are not a problem due to their negative voltage-temperature coefficient. If one supply is loaded more than the others, its temperature will rise relative to the others, which in turn will cause its output voltage to decrease. Since the output voltages of the other parallel DCMs match that of the loaded DCM, their outputs would follow their load lines, increasing their share of the load current and bringing the circuit back to equilibrium.

Using power supplies in parallel is an attractive and viable technique to realise benefits in inventory and stocking, product commonality, additional output current and N+1 redundancy. However, it must be done with an understanding of the possible paralleling topologies, as well as how the closed-loop supply regulation will be maintained across the multiple supplies.

*\*Arthur Russell serves as a Product Line and Applications Engineer with the Vicor Power Components division of Vicor Corporation in Andover, Massachusetts. He supports customer design-in activities for new product offerings, creates requirements for roadmap products and performs typical applications engineering activities such as datasheet generation, system-level validation and design of reference systems to showcase new products.*

Vicor Corporation  
www.vicor-asia.com

## References

1. "Application Note AN-030: Parallel DCMs", Ugo Ghisla, Vicor Corp.
2. "Back to Basics: What is Active ORing?", Vicor Corp.
3. "Learn to connect power supplies in parallel for higher current output", Keysight Technologies.
4. "Power Tip 27: Parallel power supplies with droop method", Robert Kollman, Texas Instruments.
5. "Application Note 140: Basic Concepts of Linear Regulator and Switching Mode Power Supplies", Henry J. Zhang, Linear Technology Corp.



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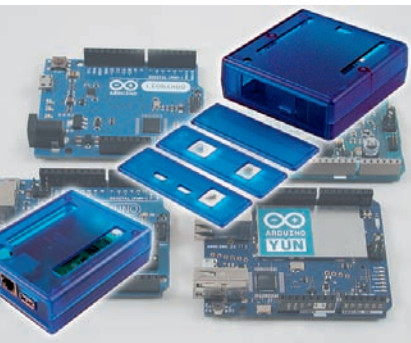
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## DEVELOPMENT BOARD ENCLOSURES

Hammond Electronics has extended its family of design-specific plastic enclosures for housing small form factor development boards with the introduction of the HAMAR,

configured for the Arduino LEONARDO, M0 PRO, UNO or YÚN, and the HAMBB, optimised for the BeagleBone Green.

The enclosures are based on the general-purpose 1593 Series and are supplied ready to use with machined or moulded I/O, power and expansion ports to suit the layout of components on the various boards. They are available in translucent blue, grey or black general-purpose ABS with a satin finish and are intended for use by both professional developers and hobbyists.

The HAMAR is supplied with four end panels, giving one unit that can be used with the four different Arduino boards. The HAMBB is specific to the BeagleBone Green. The BeagleBone and BeagleBone Black are also supported with individual design-specific enclosures.

The traditional base and lid designs provide good mechanical protection combined with easy access for external interconnects.

**Hammond Electronics Pty Ltd**  
[www.hammondmfg.com](http://www.hammondmfg.com)



## GAUSS/TESLA METER

The FW Bell 4190 is a handheld, extremely low frequency (ELF) gauss meter designed to measure magnetic fields generated by electrical equipment. It can be configured to display either gauss or tesla units and is available to rent from TechRentals.

Applications include detecting magnetic field emissions from overhead AC power lines, video display terminals, office equipment and household appliances. The product maintains accuracy regardless of orientation and also includes data logging and a USB interface.

Features include: accuracy  $\pm (1\% + 1 \text{ digit})$  typical; frequency response 30 Hz to 2 kHz; auto range 0.1 to 1999 mG (0.01 to 199.9  $\mu\text{T}$ ), minimum resolution 0.1 mG/0.01  $\mu\text{T}$ ; and analog output sampling at 8 kSa/s.

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## IGBT POWER MODULES FOR TIG WELDING MACHINES

Vishay Intertechnology has introduced four half-bridge and single-switch IGBT power modules designed specifically for TIG welding machines. Built on the company's Trench PT IGBT technology, the VS-GP100TS60SFPbF, VS-GP250SA60S, VS-GP300TD60S and VS-GP400TD60S provide low collector-to-emitter voltages down to 1.10 V and turn-off switching energy down to 11 mJ for output inverter stages.

The modules are said to achieve a smaller size than planar IGBTs, providing designers with higher current density and lower thermal resistance (junction-to-case) without compromising on performance. The devices' low collector-to-emitter voltage enables low conduction losses, while their turn-off switching energy is 50% lower than previous-generation devices.

The half-bridge VS-GP100TS60SFPbF, VS-GP300TD60S and VS-GP400TD60S combine Trench PT IGBTs with HEXFRED and FRED Pt antiparallel diodes in the INT-A-PAK package and dual INT-A-PAK package with a low profile of 17 mm. The single-switch VS-GP250SA60S features the SOT-227 package, provides low stray inductance of  $\leq 5$  nH typical and is UL-approved file E78996.

The RoHS-compliant modules feature operating frequencies to 1 kHz, 600 V collector-to-emitter voltages and continuous collector current from 100 to 400 A. The devices can be directly mounted to heatsinks and offer low EMI to reduce snubbing requirements.

**Digi-Key Corporation**  
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## CAN TRANSCEIVER

The Microchip MCP2551 is a high-speed CAN transceiver that can operate at speeds of up to 1 Mbps. Serving as an interface between a CAN controller and the physical bus, the product provides differential transmit and receive capability and is fully compatible with ISO 11898. It is suitable for both 12 and 24 V systems.

The transceiver has high noise immunity due to the differential bus implementation. It has an externally controlled slope for reduced RFI emissions and implements ISO 11898 physical layer requirements. Other features include slope control input, permanent dominant detection and low-current standby operation.

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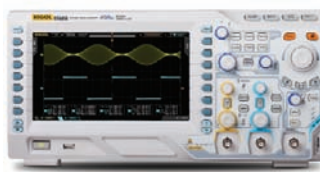
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## SIMPLIFIED IoT DEVICE TESTING

Anritsu addresses the market need for efficient manufacturing test solutions to verify IoT/M2M products with the introduction of software for its MT8870A Universal Wireless Test Set. With the three software packages, the set now supports 802.11p, Bluetooth DLE and Z-Wave, creating a fast, all-in-one test set that can simultaneously measure multiple wireless systems used in connected cars, wearables, smartphones and industrial equipment.

802.11p RF tests are supported for the 700 MHz and 5.9 GHz bands designed into automotive roadside and vehicle-to-vehicle wireless communications systems. When used with the MT8870A PC application software, it conducts RF tests of 802.11p-compliant chipsets, modules and dashboard equipment.

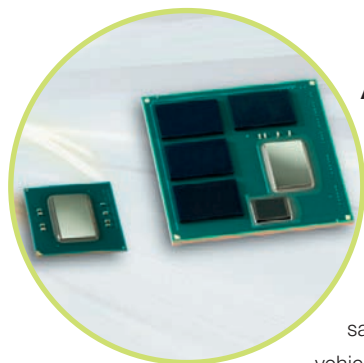
Support for Bluetooth Core Specification version 4.2 is included. The test set can measure components and devices that support the specification, which expands the Bluetooth low energy data length from 37 to 255 octets to improve system throughput by reducing the data transmission overhead and expediting communications between a host device and nearby sensing device.

The software package also supports ITU-T G.9959 Z-Wave RF tests to verify home security systems, home appliance remote controls and other home automation products utilising Z-Wave, a low-power wireless technology using the 900 MHz band.

The MT8870A mainframe can contain up to four TRX test modules, each capable of independent control by an external PC. An integrated vector signal generator and vector signal analyser that can perform transmitter and receiver RF tests is housed in each module. With four modules installed, four test devices can be connected and measured simultaneously. By allowing different technologies to be measured in parallel, the test set can reduce measurement times as well as the footprint of line test equipment.

**Anritsu Pty Ltd**

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## AUTOMOTIVE COMPUTING PLATFORM

Renesas Electronics has unveiled the third-generation R-Car, an automotive computing platform solution for driving safety support systems and in-vehicle infotainment systems. The

R-Car H3 system-on-chip (SoC) delivers CPU performance, image recognition processing, ISO 26262 (ASIL-B) compliance and a system in package (SiP) with external memory to enable a wide range of automotive applications.

The product provides enhanced computing performance that can process large volumes of information from vehicle sensors accurately in real time and enables system manufacturers to run applications that require complex processing, such as obstacle detection, driver status recognition, hazard prediction and hazard avoidance. To further accelerate the driving safety support systems, the device conforms to ISO 26262 (ASIL-B).

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## CAMERA LINK FRAME GRABBERS

The PIXCI EB1mini series of camera link frame grabbers, released by Epix, provides solutions for locating connectors in airborne, automotive, industrial, mobile, rugged and underwater applications.

The PIXCI EB1miniH has an SDR camera link connector and FPGA on a separate circuit board for mounting to the side of a small chassis. Two cables connect to a half-length mini card for the PCI express connection. This allows for more mounting options in space-constrained embedded systems.

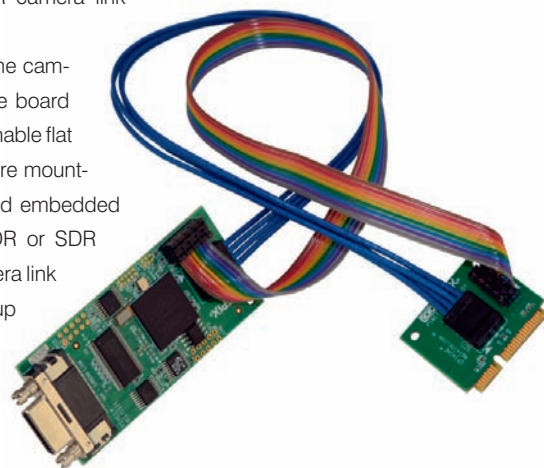
The PIXCI EB1mini frame grabber provides a vertical camera link SDR connector with FPGA on a single PCB using a full-size mini card slot. At a camera link clock rate of 85 MHz, cables up to 10 m long can be used for this version and the EB1miniH.

The PIXCI EB1miniG requires less space on the panel for more mounting options in space-constrained embedded systems. It is available with an MDR or SDR camera link connector.

The PIXCI EB1miniF moves the camera link connector to a separate board and connects the two with detachable flat ribbon cable. This allows for more mounting options in space-constrained embedded systems. It comes with an MDR or SDR camera link connector. At a camera link clock rate of 85 MHz, cables up to 7 m can be used for this version and the EB1miniG.

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## FANLESS SURVEILLANCE SYSTEM

The Nuvo-3616VR is a surveillance platform that integrates 16 PoE+ ports, an i7 CPU and RAID in a compact, fanless chassis. It is capable of not only video recording but also high-end video analytics.

The product features 16 PoE+ ports and built-in disk array for video recording. Each of its 802.3at PoE+ ports can supply 25.5 W to power a bullet, dome or PTZ camera. As electrical power is passed along with data on a single CAT5/6 cable, the device reduces the cost of deployment for a surveillance system supporting up to 16 cameras.

The unit also incorporates four built-in drives with a RAID 0/1/5/10 storage system to offer up to 1 GBps disk access and 8 TB capacity. Two of four drives are installed with easy-swap HDD trays so the user can replace the HDD/SSD in just a few seconds. The product also comes with a quad-core i7 CPU, which delivers high computing performance to facilitate advanced video analytics algorithms.

The system inherits fanless architecture to ensure true wide-temperature operation between -25 and +60°C. It also features 8–35 V wide-range DC input and ignition control supporting both stationary and in-vehicle applications.

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## NEW RASPBERRY PI 3 FEATURES BUILT-IN WIRELESS AND BLUETOOTH

Built on the latest Broadcom 2837 ARMv8 64-bit processor, the new-generation Raspberry Pi 3 Model B is faster and more powerful than its predecessors. The processor speed has increased from 900 MHz on the Raspberry Pi 2 to 1.2 GHz on the Raspberry Pi 3 Model B.

The new Raspberry Pi 3 Model B has improved power management to support more powerful external USB devices. The latest model features an upgraded switched power source up to 2.5 A. It can now power even more powerful devices over USB ports. It can take far greater connectivity from other peripheral products now and they could be powered via Raspberry Pi's power supply, said Luke Grigg, regional sales director ANZ, element14.

So far, more than six million Raspberry Pi units have been sold globally. Element14 has sold "just short of 100,000 units in Australia alone", said Grigg.

Other key features include:

- 1 GB RAM
- 40-pin extended GPIO
- 4 x USB2 ports
- 4-pole Stereo output and Composite video port
- Full-size HDMI
- CSI camera port for connecting the Raspberry Pi camera
- DSI display port for connecting the Raspberry Pi touch screen display
- MicroSD port for loading your operating system and storing data

Raspberry Pi 3 Model B



## AUSTRALIAN SCIENTISTS TURN CONTACT LENSES INTO SCREENS

Australian scientists have made a breakthrough in optoelectronics that could turn contact lenses into computer screens.

Scientists from UniSA's Future Industries Institute (FII) have successfully completed proof-of-concept research on a polymer thin-film coating that conducts electricity on a contact lens, with the potential to build miniature electrical circuits that are safe to be worn by a person.

"Building on the technologies we pioneered in thin-film coatings for the development of the world's first fully plastic car mirrors, we have been working on the development of conducting polymers with a UK partner that specialises in contact lenses," said Associate Professor Drew Evans, UniSA researcher from the FII.

"We have always known that our film coating technologies had potential for many applications and now we have taken that a step further by proving that we can make biocompatible, conducting polymers at the nanoscale and grow them directly on a contact lens.

"The fluids in the eye provide markers of a person's health, so our goal now is to build electrical sensors on a contact lens from our polymers to sense in real time a person's wellbeing.

"The next big leap is to develop complementary technologies to read the information transmitted by the conducting polymers."

Professor Evans said this exciting research has brought personal, wearable, computer technologies one step closer. "What is really significant is that the materials we are developing are not only safe but also have the potential for a range of personalised health monitoring applications that could make life simpler for people struggling with chronic health problems."

The complete proof-of-concept research results have recently been published in *ACS Applied Materials and Interfaces*.



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## M RUTTY AND DUNKERMOTOREN CELEBRATE 10-YEAR PARTNERSHIP

Australian motor drive technology supplier M Ratty & Co and German manufacturer Dunkermotoren are celebrating their 10-year partnership this year.

Established in 1883, M Ratty is one of Australia's oldest privately owned companies.

Dunkermotoren manufactures over four million motors every year. The company engineers and manufactures system solutions based on brushless DC servo motors, brush types, DC motors, and integrated power and logic controllers to suit a wide range of applications. Dunkermotoren manufactures electric drives that offer output powers of 1100 W.

Dunkermotoren is an ISO 9001:2008 and ISO 14001:2004 global manufacturer with operations in Germany, the United States and China. It provides rotary and linear motion systems for original equipment manufacturers in the building automation, factory automation, transportation, healthcare, life sciences, semiconductor and energy industries.



## APPLE-BASED SUSTAINABLE BATTERIES

A carbon-based active material produced from apple leftovers and a material of layered oxides might help reduce the costs of future energy storage systems. Both materials were found to have excellent electrochemical properties and enable environmentally compatible and sustainable use of resources.

Sodium-ion batteries are not only far more powerful than nickel-metal hydride or lead acid accumulators, but also represent an alternative to lithium-ion technology, as the materials required to make them are abundant, easily accessible and available at low cost.

Researchers at the Helmholtz Institute of Ulm of Karlsruhe Institute of Technology have made an important step towards the development of active materials for sodium-based energy storage systems. For the negative electrode, the researchers developed a carbon-based material, which can be produced from apple leftovers. The researchers demonstrated more than 1000 charge and discharge cycles of high cyclic stability and high capacity.

The material developed for the positive electrode consists of several layers of sodium oxides. This active material avoids having to use cobalt, the expensive and environmentally hazardous element that is frequently used in active materials of commercial lithium-ion batteries. The new active material, in which electrochemical energy storage proper takes place, reached the same efficiency, cyclic stability, capacity and voltage without any cobalt under laboratory conditions.

## NEW POTENTIAL FOR SILICON CHIPS

Scientists at the University of Salford and the University of Surrey have shown that light can be generated by an electron 'jumping' directly between silicon and rare-earths.

"The electronic data in silicon chips needs to be converted into light to send down optical fibre, then back to electronic data, by separate devices. If the conversion between electronic and light signals can happen on a silicon chip, it would streamline the way data travels around the world," said Dr Mark Hughes, lecturer in physics at the University of Salford.

"It's the Channel Tunnel factor. Instead of having to change from a train to the ferry and then back to the train, you would have one single train journey. It would be a major step forward." Rare-earths usually give off light at very specific colours or 'wavelengths', and silicon doesn't usually give off any light at all. However, the physicists implanted the rare-earth elements cerium, europium and ytterbium into silicon and found that not only did it give off light, but the wavelengths emitted by the rare-earths had been shifted to those that can be used in optical fibre. The shift in wavelength showed that there must have been a jump or 'transition' of an electron from silicon to the other elements.

The researchers also made high-performance light emitting diodes (LEDs) and optical detectors using their rare-earth implanted silicon technology. These devices are able to produce and detect telecommunication wavelength light using silicon.

## GOVERNMENT FUNDING FOR SEMICONDUCTOR COMPANY

Semitech Semiconductor is one of the 17 innovative Australian companies to benefit from the Australian Government's latest round of funding worth AU\$7.8 million.

The latest funding offers, part of the Entrepreneurs' Programme, saw companies receive grant offers between \$69,000 and \$1 million in commercialisation assistance, helping them to develop their products and services.

Semitech provides the semiconductor devices that enable the transformation of the electricity grid into a smart grid. Their chips help to transform homes into energy-aware 'smart homes' that react to conditions on the grid, thus implementing a worldwide communications network based on the existing power grid. The recipients include NewSouth Innovations, Amaero Engineering, Kinetic Elements and Vector International amongst others.

"I'm pleased to see such groundbreaking ideas coming from Australian companies, including yield maximising technologies for the minerals industry, production technologies for effective and cheaper solar cells and 3D printing for aerospace manufacturing," said Assistant Minister for Innovation Wyatt Roy.



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## THE INTERNET OF THE FUTURE?

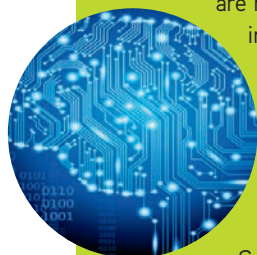
New research claims to have found a scientific solution that enables future internet infrastructure to become completely open and programmable while carrying internet traffic at the speed of light.

The solution, developed by researchers in the High Performance Networks (HPN) group at the University of Bristol, introduces new concepts of open source optical internet enabled by optical white box and software-defined network technologies.

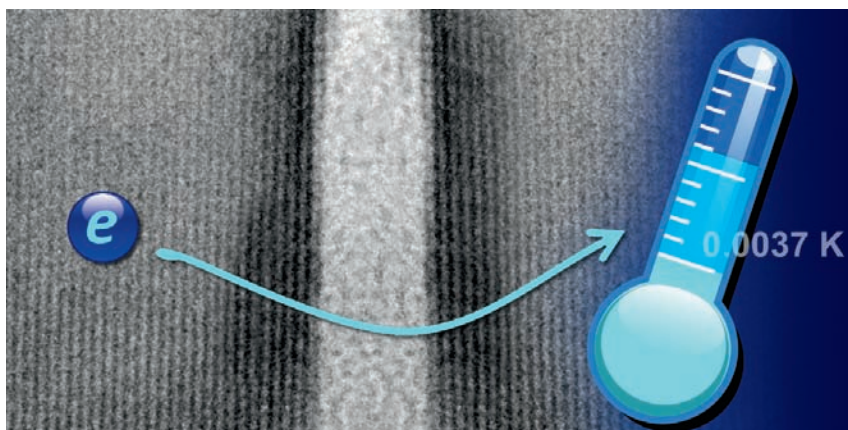
Dr Reza Nejabati, Reader in Optical Networks in the HPN group in the University of Bristol's Department of Electrical and Electronic Engineering, said: "Hardware and software technologies reported in this paper can potentially revolutionise optical network infrastructure the same way that Google Android and Apple iOS did for mobile phones. These technologies will hide complexity of optical networks and open them up for traditional programmers and application developers to create new types of internet applications taking advantage of speed of light."

Dimitra Simeonidou, Professor of High Performance Networks and who leads the HPN group, added: "New internet technologies frequently emerge, but most of them rarely result in new and revolutionary internet applications. The technologies suggested could pave the way for the creation of new internet services and applications not previously possible or disruptive. The technologies could also potentially change the balance of power from vendors and operators that are monopolising the current internet infrastructure to wider users and service providers."

The research is published in the *Philosophical Transactions of the Royal Society A* journal.



## NANOELECTRONICS TEMPERATURE BREAKTHROUGH



*Illustration of single-electron tunnelling through an oxide tunnel barrier in the primary thermometer device. The measured tunnel current is used in determining the absolute electron temperature.*

Researchers have managed to make electrons in a circuit on a silicon chip colder than had previously been achieved.

A joint project by VTT Technical Research Centre of Finland, Lancaster University and Aivon demonstrates the first ever measurement of the temperature of electrons in a nanoelectronic device a few thousandths of a degree above absolute zero.

Although it has long been possible to cool samples of bulk metals even below 1 millikelvin, it has proved very difficult to transfer this temperature to electrons in small electronic devices, mainly because the interaction between the conducting electrons and the crystal lattice becomes extremely weak at low temperatures. By combining state-of-the-art micro and nanofabrication and pioneering measurement approaches the research team realised ultralow electron temperatures reaching 3.7 millikelvin in a nanoelectronic electron tunnelling device.

This breakthrough paves the way towards sub-millikelvin nanoelectronic circuits and is another step on the way to develop new quantum technologies including quantum computers and sensors. Quantum technologies use quantum mechanical effects to outperform any possible technology based only on classical physics. In general, many high-sensitivity magnetic field sensors and radiation detectors require low temperatures simply to reduce detrimental thermal noise.

This work marks the creation of a key enabling technology that will facilitate research and development in nanoscience, solid-state physics, materials science and quantum technologies. The demonstrated nanoelectronic device is a so-called primary thermometer, ie, a thermometer which requires no calibration. This makes the technology very attractive for low temperature instrumentation applications and metrology.

The breakthrough was made possible by bringing together internationally leading groups and experts with achievements in the fields of nanotechnologies and high-performance sensors (VTT Technical Research Centre of Finland), custom low-noise electronics (Aivon, Finland) and ultralow temperature refrigeration and device characterisation (Ultra Low Temperature Physics group and Quantum Technology Centre at Lancaster).

VTT is looking into possibilities together with BlueFors Cryogenics to commercialise the primary thermometer component.

Dr Mika Prunnila, Nanoelectronics Research Team Leader at VTT, said: "Creating a new measurement tool for calibration-free thermometry is a big step forward. This is an important device for quantum machines which need the low temperature environment in order to work and the device is available right now for benchmarking different systems."



## MICROCONTROLLERS

STMicroelectronics' STM32F767/769 microcontrollers with rich memory, graphics and communication peripherals bring ARM Cortex-M7 processing power and efficiency to a range of applications, such as portable or wearable consumer devices, smart-building and industrial controllers, smart appliances, and personal or point-of-care medical equipment.

Suited to simplifying the design of high-performance controls and user interfaces, the MCUs feature a 216 MHz/462 DMIPS/1082 EEMBC CoreMark Cortex-M7 core with double-precision floating-point unit and DSP instructions. Integrated alongside the core are up to 2 MB of dual-bank Flash, ST's Chrom-ART Accelerator for powerful graphics performance, a hardware JPEG accelerator, a TFT-LCD controller and an MIPI-DSI host controller.

The generous on-chip resources enable graphics applications to benefit from good richness and rendering. There are also powerful audio features, including an I<sup>2</sup>S interface, serial audio interface (SAI), audio PLLs and DFSDM (digital filter for sigma-delta modulators) for connecting a digital microphone or external sigma-delta ADC.

The units feature 512 KB of integrated RAM, as well as large 16 KB data and instruction caches, while the flexible memory controller (FMC) and Quad-SPI interface simplify off-chip memory expansion. The on-chip Flash allows read-while-write for seamless application performance and continuous operation, even while simultaneously updating software.

The products provide the option of a crypto/hash engine for security-conscious applications. The associated ecosystem has features that help developers achieve high graphics performance for applications such as human-machine interfaces.

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### 12-PORT INDUSTRIAL PoE+ GIGABIT MANAGED SWITCH

Antaira Technologies' LMP-1204G-SFP series is a 12-port industrial gigabit PoE+ managed ethernet switch line with a 48–55 VDC power input. It has been designed for outdoor industrial application environments such as high-density traffic control equipment within ITS applications, remote PoE wireless radios, security surveillance systems, GigE vision systems and quality inspection systems within factory automation.

Each unit is designed with eight 10/100/1000Tx gigabit ports that are IEEE 802.3at/af compliant (PoE+/PoE) with a PoE power output up to 30 W per port and four dual-rate 100/1000Tx SFP slots for fibre connectivity. With a 24 Gb backplane speed, the product supports jumbo frames and wide bandwidth for large ethernet data packet transmissions. The switch is made with high-density port counts for edge-level connectivity solutions.

The units provide high EFT, surge (2000 VDC) and ESD (6000 VDC) protection. They are built to support a dual power input design with reverse polarity protection and there is a built-in relay warning function to alert maintainers when any ports break or power failures occur.

The series is built to withstand industrial networking hazards like shock, drop, vibration and electromagnetic interference. There are two operating temperature version models for either standard temperature (-10 to +70°C) or extended temperature (-40 to +75°C).

**Antaira Technologies**  
[www.antaira.com.tw](http://www.antaira.com.tw)



### PROGRAMMABLE DC ELECTRONICS LOAD

Prodigit Electronics has announced the 3310F series programmable DC electronics loads.

The electronics load module is designed to test, evaluate and burn-in for DC power supplies and batteries. Each module has its own control and display panel, CC/CR/CV/CP/dynamic modes and 150 sets of store/recall memory, which provides load set-up efficiently.

Dynamic set can be simulated under CC or CP mode. The current rise/fall slew rate can be adjusted individually and there is an external signal input so that load can have a simulated arbitrary waveform. Programmable load ON/OFF voltage, GO/NG meter check and voltage meter display is selectable for different applications.

The series can serve applications such as voltage/current sources, SMPS transient response, current limit testing, battery emulation, battery chargers, ATE systems, etc.

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### BIDIRECTIONAL BUS CONVERTER MODULES

Vicor Corporation has introduced a family of non-isolated, fixed conversion ratio, bidirectional bus converter modules (NBMs). Utilising the company's Converter housed in Package (ChiP) packaging technology, and exploiting improvements in magnetic and semiconductor technologies, the modules are said to feature improved efficiency and power density when compared to contemporary best-in-class isolated bus converters.

True bidirectional power transfer capability allows the units to be started up and controlled by applying voltage to either the primary or the secondary side. This capability can enable more efficient transmission of power from low-voltage sources to remote low-voltage loads by means of a higher voltage intermediate bus, with the NBMs providing the voltage step-up and step-down functions at each end.

Initially available in a 61 x 23 mm ChiP through-hole package, and providing up to 98.3% operating efficiency, the devices are suitable for space-constrained, board-mounted applications where galvanic isolation is managed at the system level. Potential applications include telecom and datacom systems employing batteries and battery chargers; Power over Ethernet (PoE) systems; and emerging automotive applications, such as those envisioned by the proposed LV148 hybrid vehicle standard.

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## NARROWBAND LOW-CURRENT RECEIVER

The Radiometrix RX1L receiver module has low current consumption of 1 mA and offers a good data link in an industry-standard pinout and footprint. The product is useful for low-power operations where existing narrowband modules are not suitable for prolonged battery-powered application.

RX1L is compatible with the Radiometrix TX1 and BiM1T transmitters. Two versions on the 151.300 and 173.225 frequencies are available.

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## WIDESCREEN MULTITOUCH PANEL PC

The TPC-1881WP is the latest 18.5" touch panel PC from Advantech and allows the user to use all 10 fingers simultaneously to control all aspects of an application.

The 16:9 ratio and 15.6" HD display has an integrated 7H hardness antiscratch glass screen, meaning that it can be touched by workers carrying tools without fear of damage. The product also features a powerful Intel 4th Generation Core i3 1.7 GHz processor with 4 GB DDR3 RAM, which makes multitouch operation even smoother and provides greater power efficiency and faster processing to process large amounts of data and 3D files.

In line with Advantech's dedication to producing modular technology for greater flexibility, the PC features a comprehensive mini-PCIe iDoor Technology slot to enable users to easily add a wide range of functionality such as isolated digital I/O, Fieldbus Protocol, 3G/GPS/GPRS/Wi-Fi communication and MRAM to the panel computer. The application-ready computer includes PanelExpress, WebAccess and SUSIAccess as a bundled software solution and has a remote control and recovery function.

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# DEVICE 'FINGERPRINTS'

## IMPROVE INDUSTRIAL AND GRID SECURITY



**A** new device fingerprinting technique could improve the security of the electrical grid and other industrial systems. The technique has been successfully tested in two electrical substations.

Taking a cue from the human body, Georgia Tech researchers have developed a new approach to identify devices on electrical grid control networks, using their unique electronic 'voices' — fingerprints produced by the devices' individual physical characteristics — to determine which signals are legitimate and which signals might be from attackers.

Human voices are individually recognisable because they're generated by the unique components of each person's voice box, pharynx, oesophagus and other physical structures. Researchers are using the same principle to protect networked industrial control systems in oil and gas refineries, manufacturing facilities, wastewater treatment plants and other critical industrial systems.

"We have developed fingerprinting techniques that work together to protect various operations of the power grid to prevent or minimise spoofing of packets that could be injected to produce false data or false control commands into the system," said Raheem Beyah,

an associate professor in the School of Electrical and Computer Engineering at the Georgia Institute of Technology.

"This is the first technique that can passively fingerprint different devices that are part of critical infrastructure networks. We believe it can be used to significantly improve the security of the grid and other networks."

The networked systems controlling the electrical grid and other industrial systems often lack the ability to run modern encryption and authentication systems, and the legacy systems connected to them were never designed for networked security. Because they are distributed around the country, often in remote areas, the systems are also difficult to update using the 'patching' techniques common in computer networks. And on the electric grid, keeping the power on is a priority, so security can't cause delays or shutdowns.

"The stakes are extremely high, but the systems are very different from home or office computer networks," said Beyah. "It is critical that we secure these systems against attackers who may introduce false data or issue malicious commands."

Beyah, his students and colleagues in Georgia Tech's George W. Woodruff School of Mechanical Engineering set out to develop security



*Georgia Tech researchers have developed a device fingerprinting technique that could improve the security of the electrical grid and other industrial systems. The system would be used in electrical substations like this one. (Credit: Fitrah Hamid, Georgia Tech)*

techniques that take advantage of the unique physical properties of the grid and the consistent type of operations that take place there.

For instance, control devices used in the power grid produce signals that are distinctive because of their unique physical configurations and compositions. Security devices listening to signals traversing the grid's control systems can differentiate between these legitimate devices and signals produced by equipment that's not part of the system.

Another aspect of the work takes advantage of simple physics. Devices such as circuit breakers and electrical protection systems can be told to open or close remotely, and they then report on the actions they've taken. The time required to open a breaker or a valve is determined by the physical properties of the device. If an acknowledgement arrives too soon after the command is issued — less time than it would take for a breaker or valve to open, for instance — the security system could suspect spoofing, Beyah explained.

To develop the device fingerprints, the researchers, including mechanical engineering assistant professor Jonathan Rogers, have built computer models of utility grid devices to understand how

they operate. Information to build the models came from 'black box' techniques — watching the information that goes into and out of the system — and 'white box' techniques that utilise schematics or physical access to the systems.

"Device fingerprinting is a unique signature that indicates the identity of a specific device, or device type, or an action associated with that device type," Beyah explained. "We can use physics and mathematics to analyse and build a model using first principles based on the devices themselves. Schematics and specifications allow us to determine how the devices are actually operating."

The researchers have demonstrated the technique on two electrical substations and plan to continue refining it until it becomes close to 100% accurate. Their current technique addresses the protocol used for more than half of the devices on the electrical grid, and future work will include examining application of the method to other protocols.

Because they also include devices with measurable physical properties, Beyah believes the approach could have broad application to securing industrial control systems used in manufacturing, oil and gas refining, wastewater treatment and other industries. Beyond industrial controls, the principle could also apply to the Internet of Things (IoT), where the devices being controlled have specific signatures related to switching them on and off.

"All of these IoT devices will be doing physical things, such as turning your air conditioning on or off," Beyah said. "There will be a physical action occurring, which is similar to what we have studied with valves and actuators."



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The bq76200 is a low-power, high-side, N-channel FET driver. High-side protection avoids ground disconnection in the system and also allows continuous communication between the battery pack and host system.

The device has additional P-channel FET control to allow low-current pre-charge to a deeply depleted battery, and a PACK+ voltage monitor control for the host to sense the PACK+ voltage. The independent enable inputs allow CHG and DSG FETs to be turned on and off separately, offering great implementation flexibility in battery systems.

The device can be used with a companion analog front-end device such as the bq76920/30/40 family, cell analog front-end monitoring and a host microcontroller or dedicated state-of-charge (SOC) tracking gas gauge device.

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### BOARDS AND MODULES

congatec has introduced versions of its COM Express and Qseven modules, as well as Mini-ITX boards, with the Intel Atom x5-E8000 processor. The 64-bit quadcore processor offers developers an alternative to competing platforms based on ARM technology.

Due to its integrated quadcore SoC, with a processor TDP of 5 W and an SDP of 4 W, the boards and modules with the processor deliver high multithread performance for applications in the lower performance segment. Applications range from embedded mobile devices, industrial gateways and terminal, ticket and cash register systems right up to gaming machines and digital signage systems. Other applications can also be found in compact industrial PCs, medical devices and systems in the transport sector.

congatec offers the processor with a burst frequency of up to 2 GHz on its conga-QA4 Qseven, conga-MA4 COM Express Mini and conga-TCA4 COM Express Compact modules as well as on its Thin Mini-ITX board conga-IA4. These all feature up to 8 GB of DDR3L RAM with 1600 MT/s. The integrated Intel HD Graphics Gen 8 supports DirectX 11.2, OpenGL 4.2 and OpenCL 1.2 for up to three independent displays via DisplayPort or HDMI, with up to 4k resolutions as well as LVDS or eDP. Due to hardware acceleration, even 4k video playback in real time presents no problem.

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## NETWORK SERVER FOR AVIONIC APPLICATIONS

The network server MP70S, developed according to ARINC 600, is suitable for versatile usage in an aircraft. It can, for example, be used for entertainment, wireless data transmission or maintenance purposes.

The robust, conduction-cooled housing contains equally robust electronics, which are based on CompactPCI Serial. It uses firmly soldered components and does not need any sensitive and maintenance-prone

cables. Due to the open CompactPCI Serial standard, the system also provides scalable performance, flexible I/O configuration and long-term availability.

The heart of the unit is a powerful Intel Core i7 processor, which prepares the airborne server, along with an integrated 16-port ethernet switch and a storage capacity of up to 1.8 TB, for data-intensive processing and networking tasks. The ethernet switch, along with two hot-pluggable HDD/SSD shuttles, ensures uninterrupted passenger entertainment.

To connect to legacy aircraft equipment, the product provides an interface for ARINC 429 and ARINC 717, as well as a discrete I/O. Two antenna interfaces enable Wi-Fi or 3G/4G-based data transmission. Two USB 3.0 interfaces allow fast data upload and are easily accessible via the front flap of the device. An OLED status display completes the functionality of the network server.

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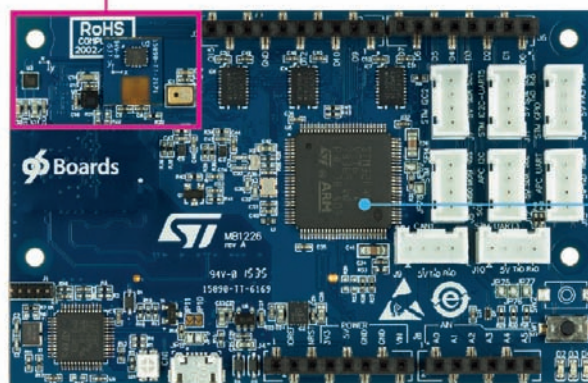
ANADIGICS has released the AWL5911 power amplifier, an easy-to-use module that delivers high levels of linearity and efficiency for high data rate applications. Designed for the 5 GHz WLAN standards, it supports IEEE 802.11a/n/ac applications.

The product reduces system power consumption by offering a low leakage current while the amplifier is shut down. The detector facilitates good power control ( $\pm 0.5$  dB) over varying load conditions (3:1 VSWR). No external circuits are required for RF impedance matching, which reduces component costs and makes it easy to incorporate the device into new designs.

The device is manufactured using InGaP HBT technology that offers good temperature stability and ruggedness. It is offered in a 4 x 4 x 0.80 mm surface mount package optimised for a 50  $\Omega$  system. It is suitable for access points, media gateways, set-top boxes and smart TV applications.

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## MEZZANINE BOARD

STMicroelectronics is now sampling an STM32 microcontroller mezzanine board for 96Boards Consumer Edition (CE) platforms that simplifies the development of smart mobile, embedded or digital-home devices. The B-F446E-96B01A simplifies development of context-aware functionality and integrates ST's powerful and efficient STM32F446 microcontroller.

Arduino Uno and Seeedstudio Grove connectors simplify adding extra-function extensions using expansion boards or modules from either ecosystem. These include light sensors, humidity sensors, wireless communication interfaces, user interface devices and many others.

The 96Boards CE specification streamlines product development based on ARM Cortex-A processors and Linux operating systems by specifying a compact compute-board form factor, baseline I/Os such as Wi-Fi, BLE, USB, MicroSD and HDMI, and standardised connector positions. The specification also standardises low- and high-speed peripheral connectors to allow functional expansion by adding mezzanine boards.

Developers can work with the B-F446E-96B01A using the same ecosystem as ST's STM32 Nucleo boards. This gives access to resources including the STM32CubeMX initialisation code generator, as well as application-code samples, software snippets and a hardware API. The mezzanine board comes with an embedded ST-Link debugger, which eliminates any need for a separate debug probe, and allows drag-and-drop Flash programming. It also enables direct access to ARM mbed online tools, allowing projects to start immediately without having to install any software.

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## STM32F446

### MULTICORE SBC

Based on the Intel Xeon D processor, the G25A is MEN's first Compact-PCI Serial SBC that supports two times 10 Gb Ethernet on the front as well as PCIe 3.0 via the backplane. This enables the smooth handling of high data volumes.

The models with four, eight and 16 cores provide concentrated computing performance and are at the same time the basis for virtualisation applications. The required abstraction of software from hardware is achieved by the CPU's built-in hardware virtualisation support, the organisation of the 32 GB DDR4 RAM and the scalability of the G25A standard models.


While the product is prepared for conformal coating and can be equipped with a heat sink as well as being embedded into a conductive cooling frame, all components are by default firmly soldered, ensuring shock and vibration resistance. The SBC is therefore suitable for applications outside of a protected server room, such as in a train or aeroplane, as well as for complex applications in industrial environments.

For security reasons, a Trusted Platform Module (TPM) is available. Safety functions are implemented using ECC for the RAM storage, a board management controller and a watchdog for the operating system.

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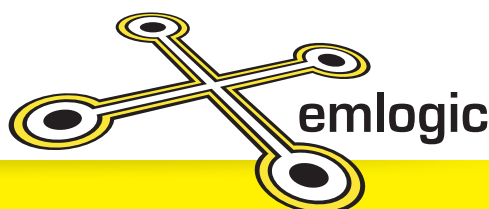
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## ETHERNET I/O MODULE

ICP DAS's ET-2260 is an IP-based ethernet I/O monitoring and control module. The module can be remotely controlled through a 10/100 M ethernet network by using Modbus TCP/UDP protocol. It is easily integrated within HMI, SCADA, PLC or other software systems.

The product provides six wet contact digital input channels and six Form A electromechanical relays. With two ethernet ports, the module allows daisy-chain connection, which enables flexibility in locating devices, easy installation and lower infrastructure costs.

The device features 8 kV ESD protection, 4 kV EFT protection, 3 kV surge and 3000 VDC I/O isolation to enhance noise protection capabilities in industrial environments. Each input channel can be used as a 32-bit counter. The power-on value and safe value of the relays are configurable.

The module can be used to create DI to DO pair-connect through the ethernet. After configuration, the module can continuously poll the status of the local DI channels and then write to the remote DO devices via the Modbus/TCP protocol.

The unit is equipped with a removable terminal block connector for easy and robust wiring in industrial applications. It features a powerful 32-bit ARM MCU to handle efficient network trafficking.

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# Compliance

## NEW LABELLING REQUIREMENTS

Chris Zombolas\*

On 1 March 2013, the Regulatory Compliance Mark (RCM) commenced the transition to replace the C-tick and A-tick marks. The transition period ended on 29 February 2016. The new Electrical Equipment Safety System (EESS) replaces the current state- and territory-based electrical safety approval systems and requires the use of the RCM for all in-scope equipment.

The RCM system requires Australian-based manufacturers, importers or suppliers to register prescribed products on the EESS national database. The RCM is a single compliance mark and can only be used by Australian/New Zealand suppliers after establishing compliance with all applicable regulations including EMC, Telecoms, Radiocom, Electromagnetic Radiation (EMR) and electrical safety. While the transition period has already ended, existing stock having the C-tick or A-tick labels may be sold until the stock is exhausted.

This article will explain the new Australian Communications and Media Authority (ACMA) and EESS regimes including the testing, certification and administrative requirements. Those using the RCM for ACMA compliance must first register as the ACMA Responsible Supplier on the EESS website. Next, they must identify the ACMA applicable standards and obtain the appropriate test reports. Products that do not have wireless or telecoms function are relatively straightforward and only require an EMC Test report to an EMC standard listed on the ACMA list of applicable standards.

Products that include a wireless transmitter such as Bluetooth, Wi-Fi, portable radios etc must also comply with the relevant

ACMA Radiocommunications (Radcom) standard and the ACMA Electromagnetic Radiation (EMR) standard. The former C-tick label applied to the latter types of product. If a product also includes connection to the mobile phone network or the Public Switched Telephone Network (PSTN), it must comply with the relevant standards prescribed in the Telecommunications Labelling Notice (TLN) 2014. If it includes a Mobile Phone Network interface, determining the applicable ACMA requirements is often fraught with risk. It may be prudent to consult with an ACMA accredited Certification Body. The former A-tick label used to apply to equipment within the scope of the TLN.

There are some exemptions from the ACMA RCM labelling requirements and these are listed in the ACMA EMC Labelling Notice. RCM Labelling of some battery-powered equipment is voluntary; however, care should be taken when interpreting the 'Battery Powered' definition. The battery must be internal to the product and it must not be possible to operate when it is being charged by an external supply. Devices that use an automobile 12 V supply are not exempt. Nor are devices that have a wireless transmitter such as Bluetooth or Wi-Fi.



A documentary proof of compliance (compliance folder) must be kept at the disposal of the ACMA for audit purposes. It must include a signed Declaration of Conformity (DoC), the relevant test reports and a description of the product. The labelled product can then be sold in Australia and New Zealand.

Most mains-powered products other than Prescribed Articles are Compliance Level 1 under ERAC regulations. Registration is not mandatory; however, compliance with an appropriate safety standard is required under various state and federal laws. A valid safety test report should be kept on file in case of regulator request.

Domestic appliances and AC adapters/chargers are considered high-risk devices and are classified as Compliance Level 3 devices. A complete list of Compliance Level 3 (in-scope) equipment can be found in AS/NZS 4417.2:2012. Under the EESS RCM rules Compliance Level 3 products must be registered on the ERAC National Data Base by the Responsible Supplier (also the importer). A Certificate of Conformity must first be obtained from an accredited Certification Body. Imported Level 3 products must be registered by each importer (must be in Australia/NZ), even if another importer has registered the same product. Overseas entities cannot register as a Responsible Supplier.

The importer based in Australia/NZ will be solely responsible for safety compliance of the product. This responsibility cannot be

delegated by a Local Representative Agreement with an overseas manufacturer. However, the importer can delegate the registration process to their Authorised Representative (consultant), who must be located in Australia/NZ. Registration and certification fees can be avoided by using a charger/adaptor that is sourced from an Australian- or New Zealand-based supplier located in one of the two countries.

ACMA suppliers now have a less onerous labelling system; however, suppliers of Compliance Level 3 products have a more strict and transparent regime to comply with.

EMC Technologies  
[www.emctech.com.au](http://www.emctech.com.au)

*\*Chris Zombolas is the Technical Director of EMC Technologies, an internationally recognised NATA accredited testing company with labs in Melbourne, Sydney and Auckland (NZ). The company specialises in EMC, EMF/EMR, SAR, Safety and Radiocomms testing and approvals. He has over 35 years' industry experience and is a member of the ACMA Technical Working Group in the area of technical regulations. He is also a member of the FCC TCB Council (USA) and the European R&TTE Compliance Association.*



### HARDWARE-VISUALISED GPUs

AMD has revealed the AMD FirePro S-Series GPUs with Multiuser GPU (MxGPU) technology. The company's hardware-virtualised GPU architecture responds to emerging user experiences such as remote workstations, cloud gaming, cloud computing and virtual desktop infrastructure (VDI).

AMD MxGPU technology brings the modern virtualisation industry standard to GPU hardware, resulting in consistent performance and enhanced security across virtual machines. It delivers hardware GPU scheduling logic with high-precision quality of service to the user; preserves the data integrity of virtualised machines (VM) and their application data through hardware-enforced memory isolation logic; and exposes all graphics functionality of the GPU to applications.

The AMD FirePro S7150 and AMD FirePro S7150 x2 server graphics cards will combine with OEM offerings to create high-performance virtual workstations and address the IT needs of simple installation and operation, critical data security and good performance. Typical VDI use cases include computer-aided design (CAD), media and entertainment, and office applications.

AMD Far East Ltd  
[www.amd.com](http://www.amd.com)



### INDUSTRIAL PANEL PC

IEI Integration's intelligent 10.4" metal panel PC, the PPC-F12B-BT, is powered by the Intel Celeron J1900 Quad-Core SoC. The heavy industrial panel PC can support up to 8 GB DDR3L SO-DIMM.

It features a 10.4" LCD screen and a robust, ultraslim, aluminium front bezel equipped with 5-wire resistive touch screen. The full-function LCD panel PC features multi I/O, including 2x gigabit LAN ports, 2x USB 3.0, 2x USB 2.0, 1x RS232, 1x RS232/422/485 and an audio connector.

The product meets the IP65 rating providing resistance to dust and liquid ingress. It also offers full- and half-size PCIe Mini slots for expansion opportunities. It has a wide DC input range of 9–30 VDC.

The multifunction panel PC can be used in various applications, including industrial, commercial, entertainment systems and hospitality.

ICP Electronics Australia Pty Ltd  
[www.icp-australia.com.au](http://www.icp-australia.com.au)



## ULTRALOW-JITTER PROGRAMMABLE OSCILLATOR EVALUATION MODULE

The LMK61E2EVM evaluation module provides a complete platform to evaluate the 90 fs RMS jitter performance and configurability of the Texas Instruments LMK61E2 ultralow-jitter programmable differential oscillator with integrated EEPROM and frequency margining capabilities. The module can be used as a high-performance clock source for jitter-critical applications and can easily be customised to any user-desired frequency and output format.

The onboard USB to I<sup>2</sup>C interface allows for device configuration via a software graphical user interface (GUI) and requires no external input or power for device operation. The edge-launch SMA ports provide access to the LMK61E2's differential clock output for interfacing to test equipment or reference boards using commercially available coaxial cables, adapters or baluns (not included).

**Texas Instruments Australia Ltd**  
[www.ti.com](http://www.ti.com)

## DIGITAL POWER CONTROL DESIGN KIT

Designed to help analog power supply designers and embedded software programmers to accelerate their understanding of digital power control, the XMC Digital Power Explorer Kit includes an XMC control card, synchronous buck power board, DAVE v4 IDE and digital power APPs.

The kit's power board features a synchronous buck converter with onboard resistive load banks that can be switched between 10%, 55% and 100% of maximum load to test the transient response and quality of control loop under different load conditions. Multiple test points are provided, in addition to PMBus for easy integration in more complex power management systems.

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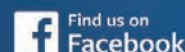
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## AWG SIGNAL GENERATORS

The AG051 and AG051F single-channel multifunction generators, from Owon, combine arbitrary waveform and function generation using advanced direct digital synthesiser (DDS) technology to provide stable, precise, low distortion signals at up to 5 MHz.



With a 125 MSa/s sample rate and 14-bit vertical resolution, the products have a 64 MB memory for generation of five basic waveforms (sine/square/pulse/ramp/noise) and 45 built-in arbitrary waveforms at up to 20 Vpp. They can create user-defined, editable waveforms, 5 MHz square or pulses waveforms and up to 1 MHz linear ramp waveforms.

Each unit is housed in a 9.25 x 4.3 x 11.6" benchtop enclosure. The user-friendly panel layout features a 4" 480 x 320 pixel TFT colour LCD display for ease of use. Menu navigation is intuitive and the graphical interface ensures that all functions and parameters are within easy reach.

A USB communication interface is provided for SCPI-compatible configuration or arbitrary waveform loading. The provided PC communication software allows remote setting of the instrument's parameters and output. It also allows the PC's display to synchronously mimic the screen on the waveform generator.

**Saelig**

[www.saelig.com](http://www.saelig.com)

## 1U PROGRAMMABLE AC/DC POWER SUPPLY

IDRC Taiwan has launched DSP HD/HR, a 1U programmable AC/DC power supply with an LXI interface. The series uses a modern digitalised design with a high-resolution D/A (16 bits) setting for output voltage/current, as well as high-resolution A/D (24 bits) measurement for output voltage/current.

Up to 104 models with 6–600 V and 1–400 A are available. An upgrade option of up to five units in parallel and two units in series will allow users to select higher voltage and current based on their application requirement. A five-digit current and voltage meter gives users the confidence they are tuning the correct output.

The series can store up to 16 sets of memories, which can be recalled manually in the front panel or by external recall control. A standard GPIB and RS485 interface with an optional LXI interface allows users to configure the device remotely.

The device is suitable for ATE for QC testing, energy, R&D, satellite communication, factory automation, semiconductor manufacturing and solar applications.


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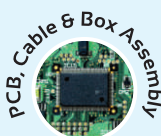
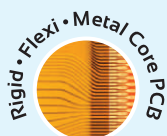
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## TFT LCDs WITH PROJECTED CAPACITIVE TOUCH SCREENS

Kyocera has announced three TFT LCDs with projected capacitive (PCAP) touch screens, suitable for medical equipment, factory automation, test and measurement, and marine applications. PCAP touch screens are highly sensitive and can support multiple touches, with the screen activated by gentle contact.

Kyocera's 7" TFT LCD with PCAP (TCG070WV) features 800 x 480 resolution, 800 cd/m<sup>2</sup> brightness for outdoor sunlight readability and a 750:1 contrast ratio. The 10.4" TCG104XG features 1024 x 768 resolution, 1040 cd/m<sup>2</sup> brightness for outdoor sunlight readability and 700:1 contrast ratio. The 12.1" TCG121XG features 1024 x 768 resolution, with a brightness of 960 cd/m<sup>2</sup> and contrast ratio of 750:1.

The touchscreen surface features anti-glare and anti-fingerprint treatments and offers the option of either I<sup>2</sup>C or USB touch interface. All three products incorporate advanced wide view (AWV) technology and achieve 170° viewing angles from both vertical and horizontal directions. They also feature an LVDS interface and a wide operating temperature range of -30 to 80°C.

It's easy to incorporate Kyocera's PCAP LCD displays into compact equipment designs, because no additional components are required to drive the backlights. The company's constant-current, high-efficiency LED driver circuit is integrated into the LCD module, providing the backlighting with a long LED lifetime of 70,000 h.

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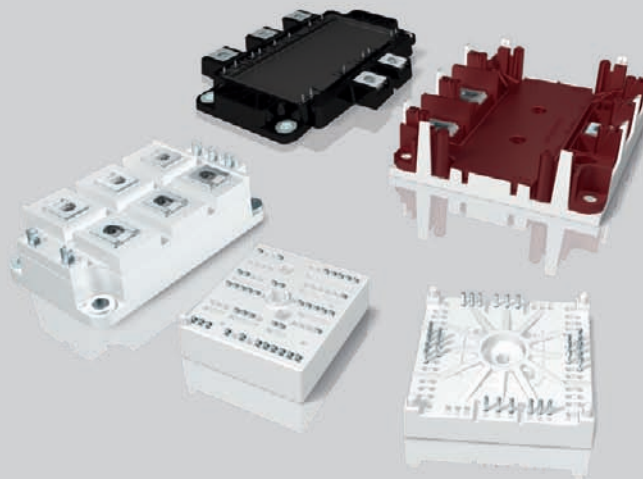
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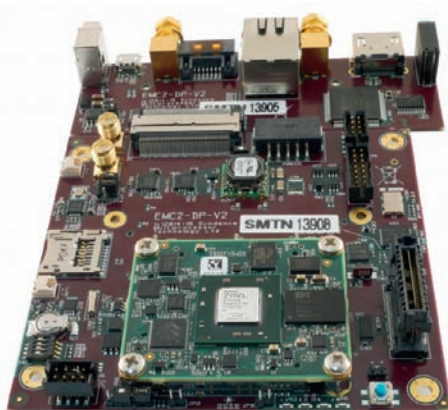
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## 3-Level Topology Power Modules for Your 3-Level Solutions







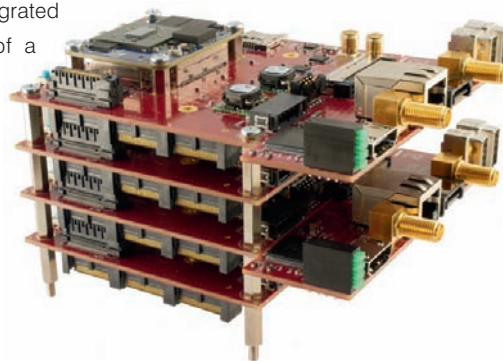
## SINGLE-BOARD COMPUTER

Sundance Multiprocessor Technology has integrated Xilinx's SDSoC development environment into its EMC<sup>2</sup>-Z7030 single-board computer. Sundance's EMC<sup>2</sup> range is a family of industrial-grade and deployment-ready SBCs that feature a Xilinx Zynq SoC with integrated dual-core ARM-A9 CPUs coupled to 1 Gb of DDR3 memory, four lanes of PCI-Express and reprogrammable logic with Kintex-7 FPGA technology.

The Xilinx SDSoC development environment has a system-optimising C/C++ compiler that allows system and software engineers to take advantage of the speed increase offered by running processing-intensive algorithms on the programmable logic of the Zynq Z7030. The development flow offers a familiar software development environment using an Eclipse-based GUI, programming in C/C++ and debugging from the ARM-A9 CPUs.

The EMC<sup>2</sup>-Z7030, combined with the Xilinx SDSoC development environment, offers an industrial-grade and deployment-ready PC/104 embedded computing solution that can benefit from the flexible concept of the Zynq SoC with integrated dual-core ARM-A9 and Kintex-7 FPGA fabric. The addition of a VITA57.1 FMC-LPC makes it easy to migrate R&D efforts from Xilinx's development bread-board to a fully rugged environment. The SDSoC development environment and Sundance EMC<sup>2</sup> board bundle is especially suitable for embedded systems design.

**Sundance Multiprocessor Technology**  
[www.sundance.com](http://www.sundance.com)



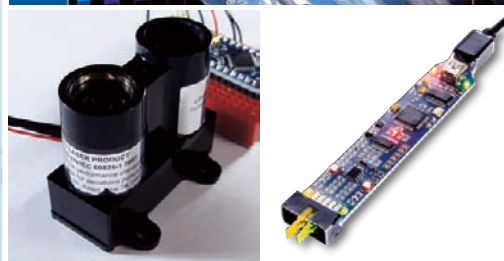
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# HACK-PROOF RFID CHIPS

New technology could secure credit cards, key cards, and pallets of goods in warehouses.

Researchers at Texas Instruments and MIT have developed a new type of RFID chip that is “virtually impossible to hack”. Texas Instruments has built several prototypes of the new chip, to the researchers’ specifications, and in experiments the chips have behaved as expected.

The new chip is designed to prevent so-called side-channel attacks, according to Chiraag Juvekar, a graduate student in electrical engineering at MIT and first author on the new paper. Side-channel attacks analyse patterns of memory access or fluctuations in power usage when a device is performing a cryptographic operation, in order to extract its cryptographic key.

“The idea in a side-channel attack is that a given execution of the cryptographic algorithm only leaks a slight amount of information,” Juvekar said.

“So you need to execute the cryptographic algorithm with the same secret many, many times to get enough leakage to extract a complete secret.”

One way to thwart side-channel attacks is to regularly change secret keys. In that case, the RFID chip would run a random-number generator that would spit out a new secret key after each transaction.

A central server would run the same generator, and every time an RFID scanner queried the tag, it would relay the results to the server, to see if the current key was valid.

Blackout

Such a system would still, however, be vulnerable to a ‘power glitch’ attack, in which the RFID chip’s power would be repeatedly cut right before it changed its secret key. An attacker could then



## RFID

run the same side-channel attack thousands of times, with the same key. Power-glitch attacks have been used to circumvent limits on the number of incorrect password entries in password-protected devices, but RFID tags are particularly vulnerable to them, since they're charged by tag readers and have no onboard power supplies.

Two design innovations allow the MIT researchers' chip to thwart power-glitch attacks: one is an on-chip power supply whose connection to the chip circuitry would be virtually impossible to cut and the other is a set of 'non-volatile' memory cells that can store whatever data the chip is working on when it begins to lose power.

For both of these features, the researchers use a special type of material known as a ferroelectric crystal. As a crystal, a ferroelectric material consists of molecules arranged into a regular three-dimensional lattice. In every cell of the lattice, positive and negative charges naturally separate, producing electrical polarisation. The application of an electric field, however, can align the cells' polarisation in either of two directions, which can represent the two possible values of a bit of information. When the electric field is removed, the cells maintain their polarisation.

Texas Instruments and other chip manufacturers have been using ferroelectric materials to produce non-volatile memory, or computer memory that retains data when it's powered off.

### Complementary capacitors

A ferroelectric crystal can also be thought of as a capacitor, an electrical component that separates charges and is characterised by the voltage between its negative and positive poles. Texas Instruments' manufacturing process can produce ferroelectric cells with either of two voltages: 1.5 or 3.3 V.

The researchers' new chip uses a bank of 3.3 V capacitors as an on-chip energy source. But it also features 571 1.5 V cells that are discretely integrated into the chip's circuitry. When the chip's power source — the external scanner — is removed, the chip taps the 3.3 V capacitors and completes as many operations as it can, then stores the data it's working on in the 1.5 V cells.



TEXAS INSTRUMENTS AND OTHER CHIP MANUFACTURERS HAVE BEEN USING FERROELECTRIC MATERIALS TO PRODUCE NON-VOLATILE MEMORY, OR COMPUTER MEMORY THAT RETAINS DATA WHEN IT'S POWERED OFF.

When power returns, before doing anything else the chip recharges the 3.3 V capacitors, so that if it's interrupted again, it will have enough power to store data. Then it resumes its previous computation. If that computation was an update of the secret key, it will complete the update before responding to a query from the scanner. Power-glitch attacks won't work. Because the chip has to charge capacitors and complete computations every time it powers on, it's somewhat slower than conventional RFID chips. But in tests, the researchers found that they could get readouts from their chips at a rate of 30 per second, which should be more than fast enough for most RFID applications.

The MIT researchers' work was also funded by the Japanese automotive company Denso.

The new BODY-CASE is the latest product series in the range of wearable enclosures by OKW and is ideal for applications on or near the body.

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### THREE-PHASE BRIDGE POWER MODULES

Vishay Intertechnology has introduced a series of 45 to 100 A three-phase bridge power modules in the low-profile MTP PressFit package. Compared to devices incorporating solder contact technology, the VS-40MT160P-P, VS-70MT160P-P and VS-100MT160P-P are said to lower production costs for welding machines, UPS, switchmode power supplies and motor drives.

The solderless PressFit technology of the power modules allows for easy one-step PCB mounting to reduce assembly time while simplifying in-field maintenance. Offering direct mounting to heatsinks, the devices' 17 mm profile maximises space savings while optimising electrical layouts for application-specific power supplies.

Providing long-term durability, the power modules' PressFit package offers increased resistance to shock and vibration while eliminating issues such as cold spots, voids, splatter and cracks. The devices are not subject to solder fatigue, a common failure mechanism in power modules operating at high temperatures.

Optimised for AC/DC input rectification, the 45 A VS-40MT160P-P, 75 A VS-70MT160P-P and 100 A VS-100MT160P-P offer 3500 V<sub>RMS</sub> insulation voltage, low forward voltage and low junction-to-case thermal resistance. Designed and qualified for industrial-level applications, the RoHS-compliant devices are UL-approved.

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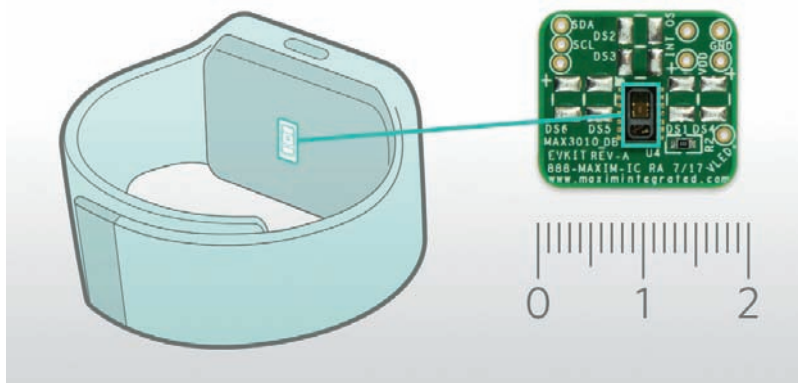
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## PULSE OXIMETER AND HEART RATE INTEGRATED SENSOR MODULE

System designers can speed up time to market for wearable and healthcare products with the MAX30102 pulse oximeter and heart rate integrated sensor module from Maxim Integrated. The module provides a complete system to ease the design-in process for mobile and wearable devices.

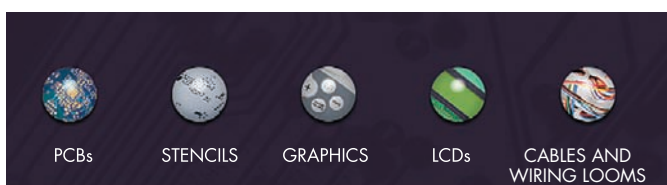
Wearable equipment for vital-sign monitoring is evolving, and analog integration is at the heart of this. System-on-chip (SoC) and integrated module solutions are rapidly replacing discrete, multicomponent designs. The MAX30102 integrates red and IR LEDs to modulate LED pulses for oxygen saturation and heart rate measurements.

The module maintains a small size (5.6 x 3.3 x 1.55 mm) without sacrificing optical or electrical performance. It integrates internal LEDs, photodetectors, optical elements and low-noise electronics with ambient light rejection. An evaluation platform with the integrated module and an accelerometer enables users to quickly evaluate the module.

The ultralow-power product operates on a single 1.8 V power supply and a separate 5 V power supply for the internal LEDs. It has an operating temperature range of -40 to +85°C.

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## PROGRAMMABLE AC/DC POWER SUPPLY

The Mercury-Flex programmable AC/DC power supply, from Astrodyne TDI, provides 3.8 kW of power digitally controlled as either a current or voltage source up to 400 V or 170 A. The product is a suitable rectifier for applications that require a flexible, digitally controlled industrial power supply.

It features a universal 90 to 264 VAC 50/60 Hz single-phase input and a wide choice of adjustable DC output voltage range models: 0–28, 0–56, 0–85, 0–125 and 0–400 V. Power conversion techniques deliver efficiency of up to 93%, with a power factor of 0.97 or better. Additionally, the series features a fixed 14 VDC auxiliary output, useful for powering miscellaneous user circuits.

Using the digital CAN-Bus or ethernet interface, the device can be factory preset or field programmed to operate in a constant voltage, constant current or constant power mode. The digital read-back feature provides output voltage and current values, operating temperature and protection alarm status. For higher power applications, the rectifier can be connected into parallel current sharing groups with the aid of a four-module shelf assembly, enabling designs of upwards to 228 kW in a single universal 19" rack.

**Benbro Electronics Pty Ltd**

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## HIGH-VOLTAGE DC-DC CONVERTERS

SynQor has released a higher power, non-isolated DC-DC converter in a quarter-brick package for a range of industrial and telecom applications.

The NiQor NQ60W60QTx25 converter offers a 9–60 V input range and 0–60 V output range. With a maximum output power of up to 1500 W, the buck boost DC-DC converter provides the engineer with higher efficiency, greater power and more design flexibility than previous similar specification devices in the NiQor family. The converter can be used alone or combined with isolated bus converters to provide even high-density power solutions.

The company has also added two further high-voltage, non-isolated DC-DC converters to the NiQor family. The NQ40W40QTx35 has a 9–40 V input range, a 0–40 V output range and a maximum current capability of 35 A. The NQ90W90QTx18 has a 9–90 V input range, a 0–90 V output range and a maximum current capability of 18 A. Each converter can achieve up to 96% efficiency.

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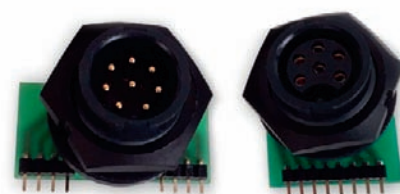
## RIGHT-ANGLE PCB MOUNT CONNECTOR

Switchcraft and Conxall have introduced the right-angle PCB mount version to their Mini-Con-X line of connectors, allowing for easy mounting directly to a PCB. In applications where the board is perpendicular to the panel, the connectors can be soldered directly to the PCB.

The units are available in both narrow and wide arrangements and in 2–8 #20 contacts (7–8 available as male only). They meet NEMA 6P when mated.

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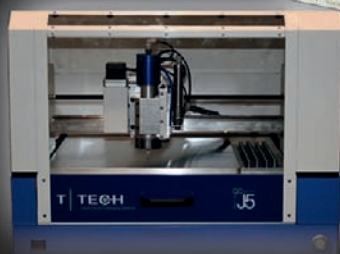
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# NEW PASSIVE WI-FI USES 10,000 TIMES LESS POWER

Engineers have generated Wi-Fi transmissions using 10,000 times less power than conventional methods.

The new Passive Wi-Fi system, developed by electrical engineers and computer scientists at University of Washington, can transmit Wi-Fi signals at bit rates of up to 11 megabits per second that can be decoded on any of the billions of devices with Wi-Fi connectivity. These speeds are lower than the maximum Wi-Fi speeds but 11 times higher than Bluetooth.

Aside from saving battery life on today's devices, wireless communication that uses almost no power will help enable an 'Internet of Things' reality where household devices and wearable sensors can communicate using Wi-Fi without worrying about power.

To achieve such low-power Wi-Fi transmissions, the team essentially decoupled the digital and analog operations involved in radio transmissions. In the last 20 years, the digital side of that equation has become extremely energy efficient, but the analog components still consume a lot of power.

The Passive Wi-Fi architecture assigns the analog, power-intensive functions — like producing a signal at a specific frequency — to a single device in the network that is plugged into the wall.

An array of sensors produces Wi-Fi packets of information using very little power by simply reflecting and absorbing that signal using a digital switch. In real-world conditions on the UW campus, the team found the passive Wi-Fi sensors and a smartphone can communicate even at distances of 30 m between them.

In Passive Wi-Fi, power-intensive functions are handled by a single device plugged into the wall. Passive sensors use almost no energy to communicate with routers, phones and other devices.

"All the networking, heavy-lifting and power-consuming pieces are done by the one plugged-in device," said study co-author Vamsi Talla, an electrical engineering doctoral student. "The passive devices are only reflecting to generate the Wi-Fi packets, which is a really energy-efficient way to communicate."

Because the sensors are creating actual Wi-Fi packets, they can communicate with any Wi-Fi-enabled device right out of the box.

"Our sensors can talk to any router, smartphone, tablet or other electronic device with a Wi-Fi chipset," said co-author and electrical engineering doctoral student Bryce Kellogg. "The cool thing is that all these devices can decode the Wi-Fi packets we created using reflections so you don't need specialised equipment."

The technology could enable entirely new types of communication that haven't been possible because energy demands have outstripped available power supplies. It could also simplify our data-intensive worlds.

For instance, smart home applications that use sensors to track everything from which doors are open to whether kids have gotten home from school have typically used their own communication platforms because Wi-Fi is so power hungry.

"Even though so many homes already have Wi-Fi, it hasn't been the best choice for that," said co-author Joshua Smith, UW associate professor of computer science and engineering and of electrical engineering. "Now that we can achieve Wi-Fi for tens of microwatts of power and can do much better than both Bluetooth and ZigBee, you could now imagine using Wi-Fi for everything."

The research was funded by the National Science Foundation, the University of Washington and Qualcomm.



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September 2015 Total CAB

Audited Circulation

4,737 (84% personally requested)

Printed and bound by Dynamite Printing  
Print Post Approved PP100007394  
ISSN No. 0728-3873

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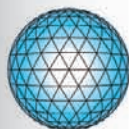
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