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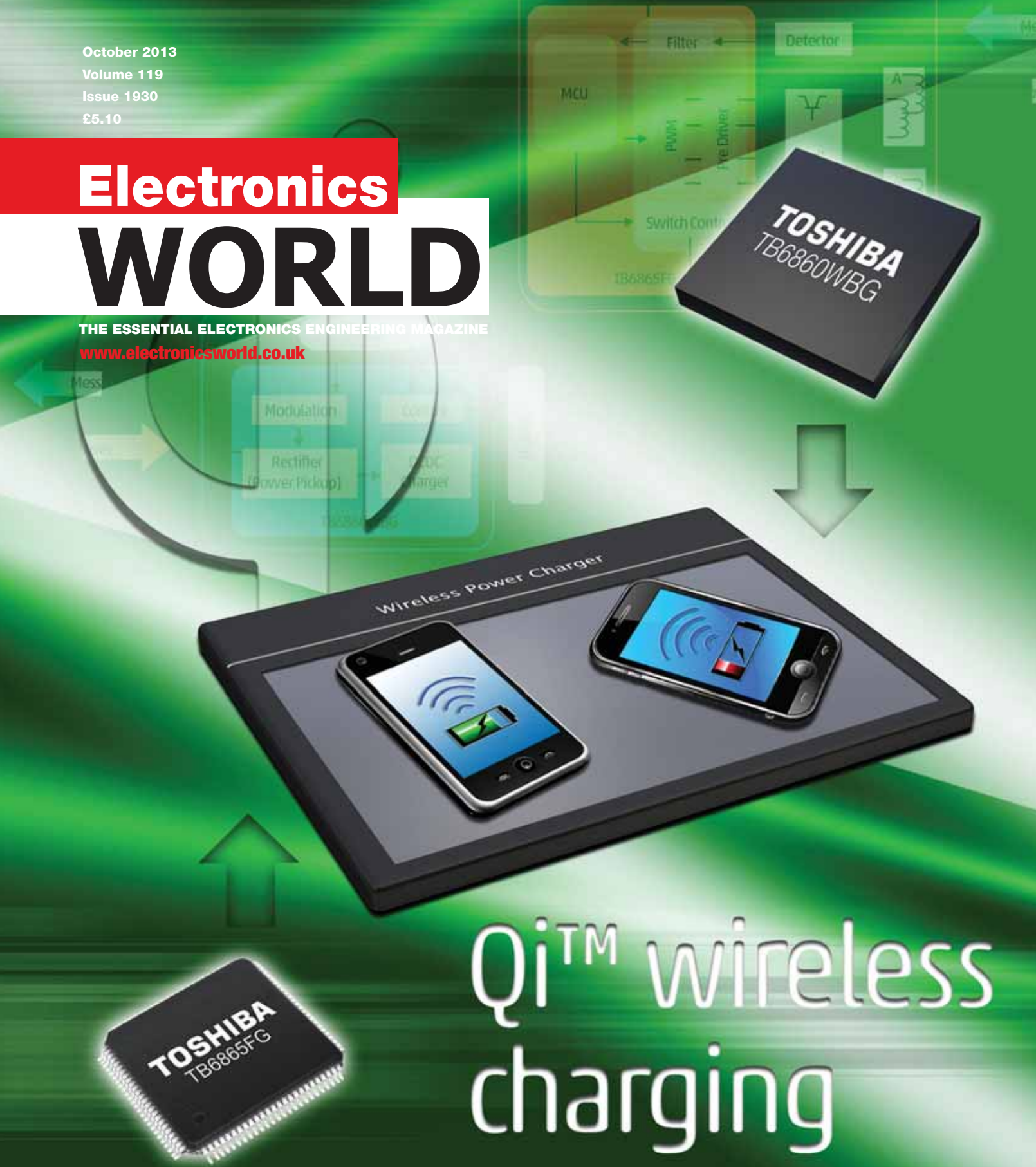
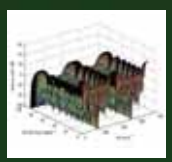


Qi™ wireless charging

Technology
Artificial sense of touch development

Special Report 1
Design with programmable logic



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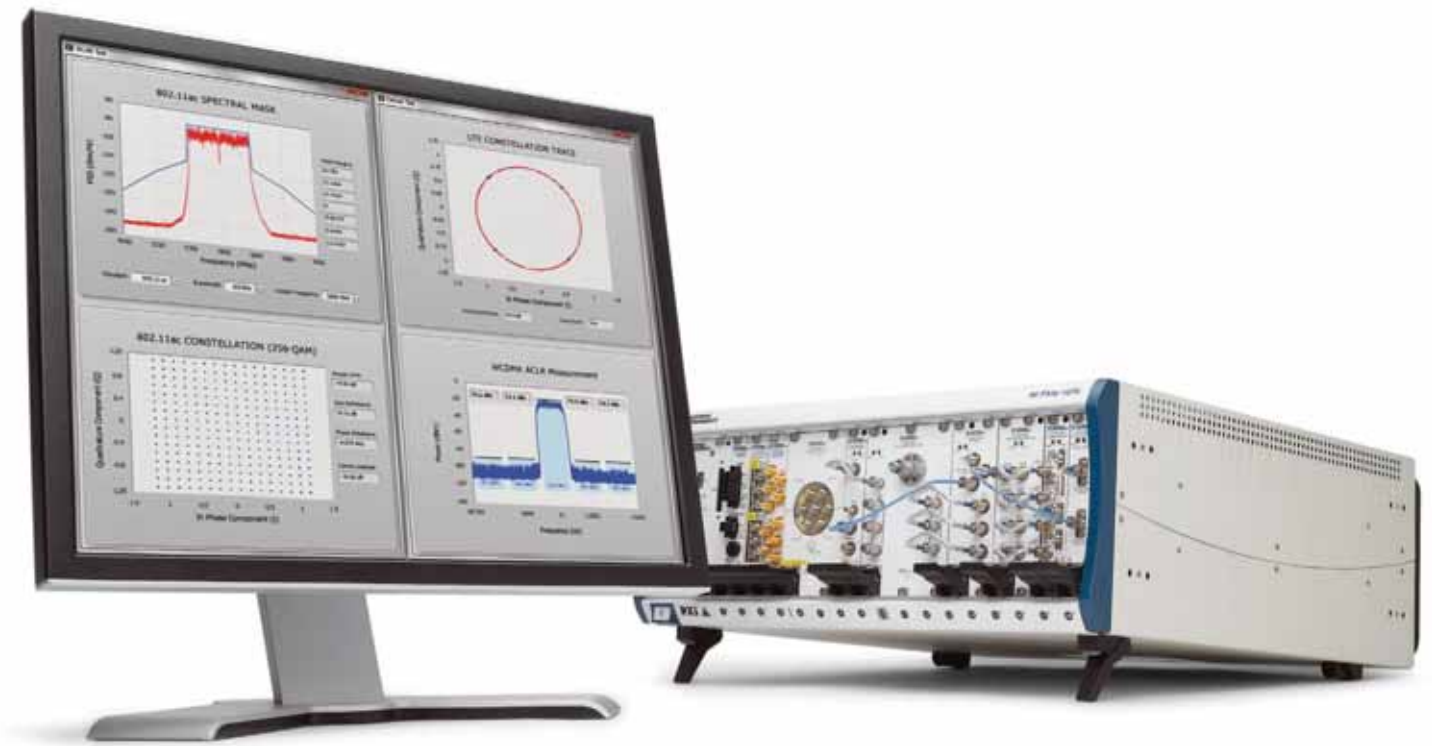

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NATIONAL INSTRUMENTS

IS THE ELECTRONICS PRODUCTION INDUSTRY IN GOOD SHAPE? THE TEAM BEHIND PRODUCTRONICA THINKS SO

> *The factories of the future will optimize and control their manufacturing processes largely by themselves*

The global economic problems which began to impact the electronics sector in 2007 had a dramatic effect on the electronic production equipment and services industry. As a result, the vast majority of component manufacturers made significant alterations to their production capability, cancelling proposed new plants, mothballing others and closing – forever! – facilities in expensive labour territories.

These same companies have spent much of the past six years trying to match a gradual increase in demand with a similar increase in production capability. And although product lead-times have sometimes been extended, manufacturers have successfully kept pace with that demand. At the same time, OEMs have begun to rely more heavily on the manufacturing services industry, reducing dependency on their own production capability while making use of the flexibility offered by a third party. It has all made for interesting times.

So how is the electronics production industry doing today? Pretty well, according to the team behind the industry's biggest trade show productronica that takes place every other year in Munich. This year, the show dates are November 12-15. The show features the entire value chain from materials to production equipment and on to test and manufacturing services, and many describe it as an accurate barometer for the health of an industry sector, key to everyone who sees electronics technology as vital to their own business. In its most recent publication, the Productronics Association within the German Engineering Federation (VDMA) forecasts moderate growth in sales for manufacturers of components, machines and systems for the electronics industry.

In 2009, at the first show following the global downturn, exhibitor levels were down and visitor levels fell significantly. By 2011 – and reflecting the industry it serves – productronica was back up to pre-crisis levels and this year's event is set to include a record number of exhibitors from more countries.

"The event's increase in the number of exhibitors this year – some of our halls are booked to capacity – can only confirm the VDMA's forecasts," said Christian Rocke, Exhibition Director of productronica.

To a large extent the electronics production industry has been saved from terminal damage by recession-busting products like tablets and smartphones, as well as the increasing implementation of automotive electronics and technologies like LED lighting. All of these require the continued development of new and smaller components and product technologies, which in turn means new generations of materials, production machines and test equipment.

To continue to flourish, however, the production industry will also need to manage the increasing penetration of IT and the growing integration of all industrial technologies – which is true across all industries. In a growing trend the IT and industrial control worlds are becoming more closely allied, with the need for tighter integration between factory data and machine networks.

At this year's productronica, a panel of CEOs from leading multi-national companies will come together in a roundtable format to discuss what many are calling the fourth industrial revolution. Known as Industry 4.0, it involves connecting intelligent machines, warehouse management systems and operating facilities in manufacturing in such a way that they exchange information autonomously, trigger activities and control each other independently. Industrial manufacturing and IT systems will be linked using cyber-physical production systems. This intelligence will be made possible by the use of miniaturized processors, storage units, sensors and transmitters embedded in every conceivable type of machine, unfinished products and materials, as well as smart tools and new software for structuring data flows. In other words, the factories of the future will optimize and control their manufacturing processes largely by themselves.

Although today Industry 4.0 is very much a German-led initiative, its potential merits will quickly be seen globally. It will be interesting to see how much progress has been made by the time productronica 2015 comes around.

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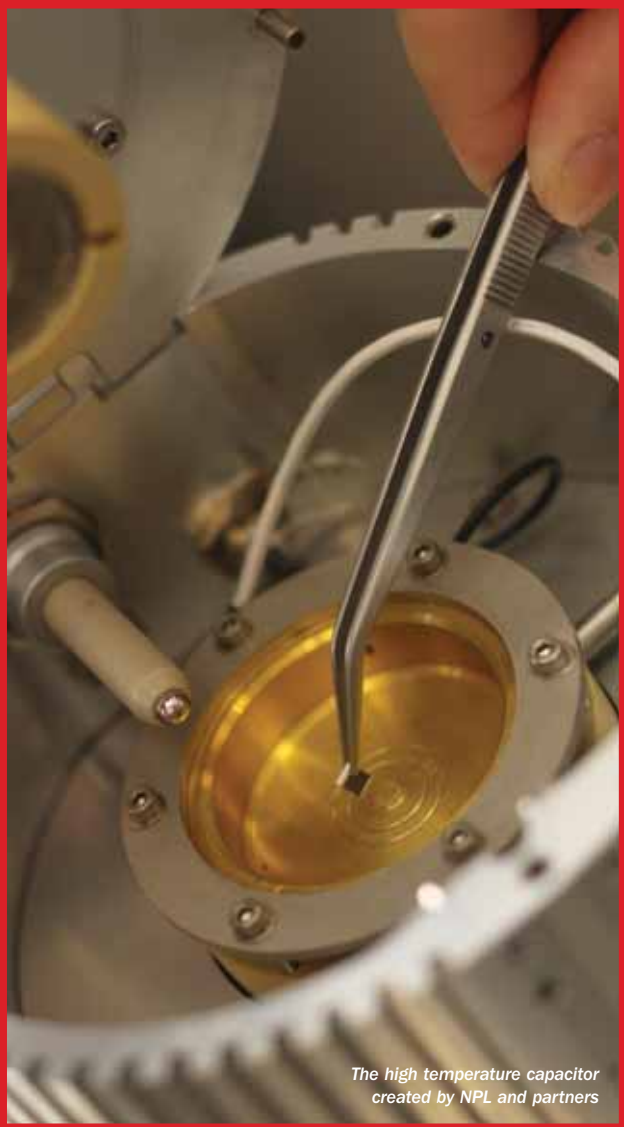
NEW, HIGH TEMPERATURE CAPACITOR TO ENABLE EV'S ELECTRONICS FUNCTIONS



The high temperature capacitor created by NPL and partners

Scientists at the UK's National Physical Laboratory (NPL) have developed a high-temperature capacitor, which may become instrumental in creating electronics capabilities for electric vehicles (EVs).

As devices that store energy, capacitors are vital to the process of converting DC power from the vehicle's battery into the AC power that drives the motor. However, present-day capacitors do not function reliably in the high-temperature environments created by electric vehicles.

NPL has overcome this issue, creating a capacitor called HITECA that can operate close to normal efficiency at over 200^{o}C, significantly higher than any other capacitor. It also offers high energy density – the measure of how much energy it can store. As such, it will help increase the mileage range for EVs and reduce maintenance.

To develop the capacitor, NPL investigated a range of lead-free materials that could have the desired properties to develop into a high-temperature capacitor. The scientists explored different compositions and different ways of fabricating them. The most promising materials were optimised to achieve the desired properties, with the resulting capacitor being made of a ceramic, based on doped-BiFeO3 compound.

"The opportunities for electric vehicles are huge, both financially and environmentally, but they are currently being held back by a few technical issues. With this high-temperature capacitor we believe we have solved an important one of those issues that will play a vital part in the move towards mass market electric vehicles," said Tatiana Correia, lead scientist on the project.

EVs are hoped to represent more than 50% of worldwide light duty vehicle sales by 2050, and a recent Frost & Sullivan report shows capacitors representing a £10bn global market in the automotive industry alone. The absence of suitable capacitors is one of the major barriers to meeting this goal.

Such a capacitor also offers potential in other areas of high-temperature electronics, including pulsed power applications (defibrillators and x-ray generators), energy conversion in photovoltaics and integrated circuits, and power electronics for the oil and gas industry, which need to work at high temperatures or are subject to overheating.

The capacitor project was funded by the Technology Strategy Board Project and involved the Queen's University of Belfast, Queen Mary University, Syfer and Valeo.

NPL is now seeking industrial partners to license the innovation.

Material	Operating Temperature Range	Dielectric Constant	DF	TCC	VCC (%)
C0G	-55 to 125°C	10-100	0.1%	±30ppm/°C (-55 to 125°C)	0
X7R	-55 to 125°C	2000-4000	3.5%	±15% (-55 to 125°C)	> 85% (at 25 °C)
Y5V	-55 to 125°C	> 16000	9%	< 82% (-30 to 85°C)	> 90% (at 25 °C)
HITECA	-55 to 200°C	> 1200	0.3%	±15% (-55 to 150°C)	< 50% (at 25 °C)

Advantages of the new capacitor
[TCC – Temperature Coefficient of Capacitance
VCC- Voltage Coefficient of Capacitance
** Typical values]*

The high temperature capacitor created by NPL and partners

Rockwell Automation Introduces Comprehensive Industrial Security Initiative

In response to growing cyber-security threats, Rockwell Automation has created an initiative to help manufacturers reduce security risks to control systems. The initiative will help automation and IT professionals more effectively secure their industrial processes with a combination of control system design and best practices, contemporary technologies and services.

"The rapidly evolving nature of the industrial security landscape makes it critical that today's manufacturers view security as an ongoing business imperative, rather than a one-time investment event," said Sujeet Chand, senior vice president and chief technology officer at Rockwell Automation. "A more secure network infrastructure will allow manufacturers to deploy contemporary technologies and emerging solutions, like mobility, virtualization and cloud computing, while still performing mission-critical automation functions."

The three-pronged Rockwell Automation initiative is designed to achieve a secure connected enterprise through Defence-in-Depth Methodology, Secure Automation Architecture and Enterprise-Ready Industrial Security.

The Defence-In-Depth methodology will address internal and external threats by forming multiple layers of defence to help mitigate various types of risks. The Secure Automation Architecture will represent the heart of production, therefore security of information used for control, configuration and monitoring is critical.

Rockwell is teaming up with various industrial partners, including Cisco, to offer Enterprise-Ready Industrial Security Solutions. Basing it on an open-standard technology, Rockwell Automation and Cisco want to ensure manufacturers build a unified, secure environment from the enterprise to the end device on the plant floor. A common network architecture approach will help decrease inconsistencies in network protocols, security practices and training.

In the future, Rockwell Automation and Cisco will offer guidance on topics such as resilient network design, access control, contextual identity management and protection of assets, through a portfolio of jointly-developed industrial products and industrial control system security resources.

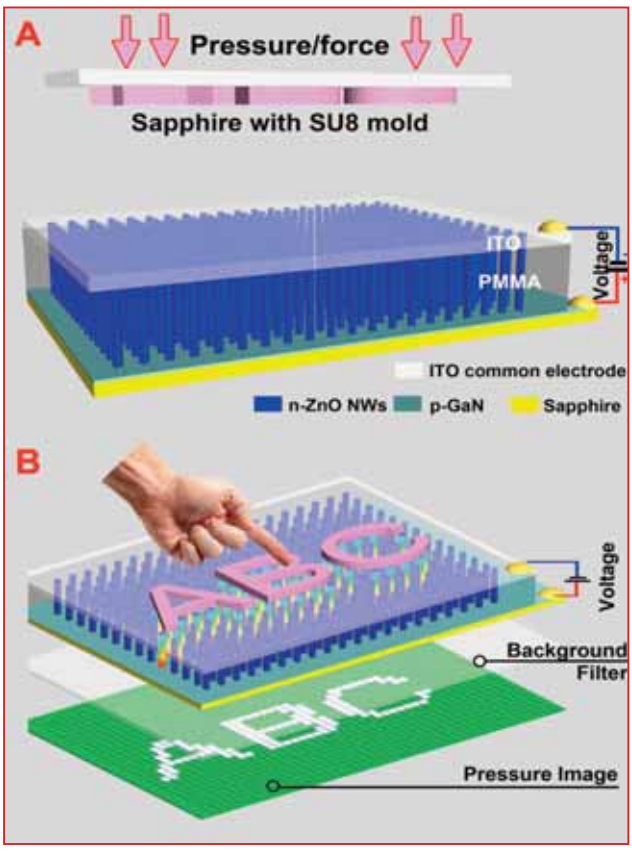
The industrial security initiative from Rockwell Automation is based on a multilayer network design approach offering resiliency in an infrastructure with security-enabled end-point devices to help manufacturers establish a sustainable security culture, conduct comprehensive security assessments and deploy a robust security infrastructure across both automation and industrial IT assets. Core to the initiative is implementation of a secure network infrastructure based on the use of the standard Internet Protocol (IP).

Researchers A Step Closer to Creating Artificial Sense Of Touch

Researchers at the Georgia Institute of Technology have developed a sensor that converts mechanical pressure from a signature or a fingerprint directly into light signals that can be captured and processed optically. The piezo-phototronic device could provide an artificial sense of touch, offering sensitivity comparable to that of the human skin.

Piezoelectric materials generate a charge polarization when they are placed under strain. The piezo-phototronic devices rely on that physical principle to tune and control the charge transport and recombination by the polarization charges present at the ends of individual nanowires. Grown atop a gallium nitride (GaN) film, the nanowires create pixeled light emitters whose output varies with the pressure, creating an electrolumi-nescent signal that can be integrated with on-chip photonics for data transmission, processing and recording.

"When you have a zinc oxide nanowire under strain, you create a piezoelectric charge at both ends which forms a piezoelectric potential," said Zhong Lin Wang from Georgia Tech. "The presence of the potential distorts the band structure in the wire, causing electrons to remain in the p-n junction longer, and enhancing the efficiency of the LED."



Graphic showing a device for imaging pressure distribution by the piezo-phototronic effect. The illustration shows a nanowire-LED based pressure sensor array before (a) and after (b) applying a compressive strain. A convex character pattern, such as "ABC", molded on a sapphire substrate, is used to apply the pressure pattern on top of the indium-tin oxide (ITO) electrode

Beyond collecting signatures and fingerprints, the technique could also be used in biological imaging and micro-electromechanical (MEMS) systems. Ultimately, it could provide a new approach for human-machine interfaces.

"You can write with your pen and the sensor will optically detect what you write at high resolution and with a very fast response rate," said Wang. "This is a new principle for imaging force that uses parallel detection and avoids many of the complications of existing pressure sensors."

LEADING THE CHARGE FOR WIRELESS CHARGING

Armin Derpmanns,
General Manager Solution Marketing,
Toshiba Electronics Europe.

WPC-compliant chipsets are the key to flexible and efficient free-positioning wireless charging designs.

The surge in interest and popularity of consumer electronics such as smartphones and tablets has caused a surge in interest in wireless charging with market research company MarketsandMarkets predicting the global wireless charging market to reach $7.61 billion by 2017 – a compound annual growth rate (CAGR) of 57.46%.

Consumers are becoming increasingly frustrated with the need to carry multiple chargers / charging cables in order to avoid running out of power. Some restaurants and cafes are now providing charging stations for phones and laptops; however, you will often need to have brought a cable with you to be able to benefit. With numerous documented incidents of charging devices being used to hack into smartphones, it has become a case of 'charger beware'.

Being able to recharge your smartphone or tablet simply by placing it on a wireless charging mat without having to fiddle with wires is a very convenient and secure concept as it separates the charging functionality from external communications. However, if someone bumps the charging pad and moves the device, the wireless charging connection may be broken leaving an uncharged device and a frustrated consumer.

While wireless induction charging is making waves because of the smartphone and tablet markets, the technology has been used in electric toothbrushes for some time as it enables the power circuitry of both the charger and the toothbrush to be completely isolated from any water present on the toothbrush.

The combination of wireless charging technology with Wi-Fi technology has enabled Toshiba to create a concept waterproof tablet that can be charged underwater – making concerns about spilling glass of water on a device a thing of the past.

However, for a wireless charging solution to prove effective and gain full market acceptance, several challenges need to be overcome: first a recognized standard needs to be agreed upon, secondly high efficiency solutions that detect when a device needs to be charged need to be developed and thirdly the systems need to be easy to use and reliably charge no matter the position of the device on the charging mat.

A smarter standard

In December 2008, the Wireless Power Consortium (WPC) was founded to establish a global standard for the wireless charging of electronic products so that all products adopting the standard would work together seamlessly, regardless of manufacturer or brand.

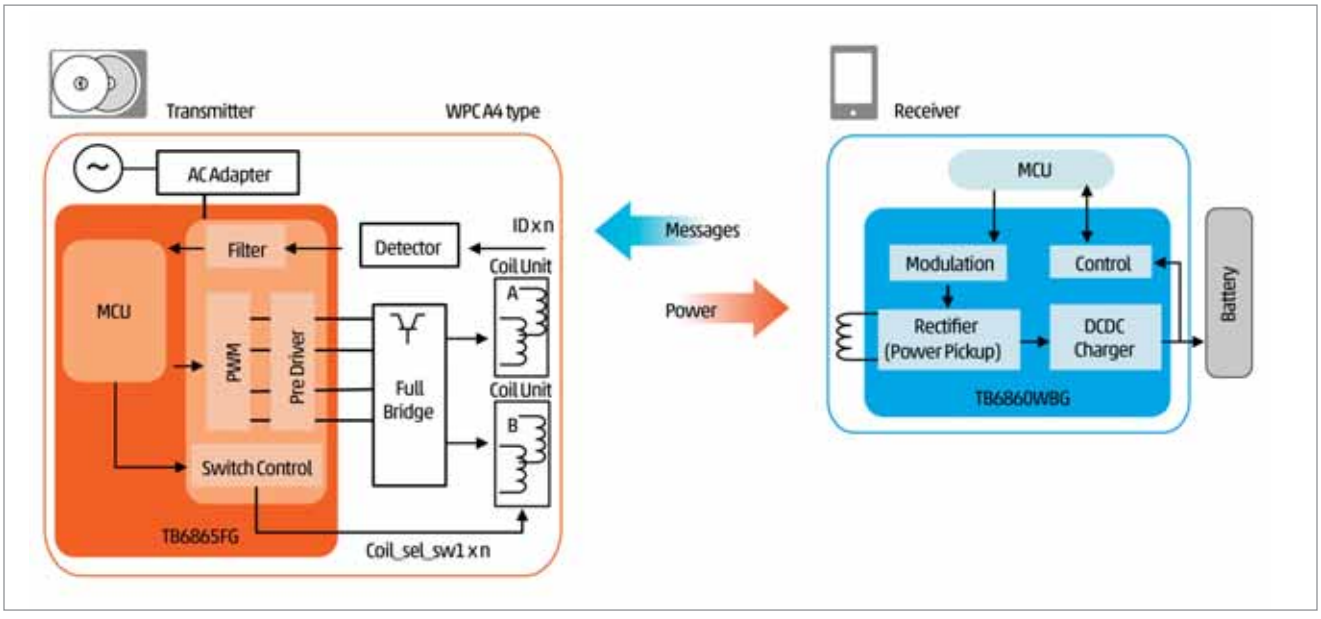
In 2010, the WPC released its Qi standard and it soon gained an early market leading position. The Qi standard still has competition from standards proposed by several other organisations including the Power Matters Alliance and the Alliance for Wireless Power, but with a spate of recent devices being developed in line with the Qi standard, the end game may be in sight.

The WPC currently includes more than 140 industry leaders with expertise in mobile phones, consumer electronics, semiconductors, components, wireless power technology and infrastructure.

Both performance requirement specifications and details of the tests needed to prove compliance are readily available, with version 1.0 describing the specifications needed to ensure the transmitter delivers 5 Watt of power into a Qi-compliant device. Work is currently ongoing to create a certification programme for transmitters that can provide 10-15 Watt.

A number of compliant transmitter and receiver designs are detailed within the Qi-standards; including guided and free positioning transmitters. The mobile device typically contains a single power-receiving coil as well as a communications and control unit that regulates the transmitted power to the level that is appropriate for the battery.

Guided transmitters use single coils and rely on the user to align the mobile device on a certain location of the base station's surface, and if placed (or knocked) out of alignment charging will not occur.



In contrast, free positioning, does not require the user to align the mobile device and this can be achieved in two different ways. The first of these uses a mechanical device that aligns the coil to the device using integrated sensors. The second of these uses a bundle of coils to generate a magnetic field at the location of the receiving coil.

The multi-coil architecture enables low-cost battery charging with increased freedom to position a Qi-capable phone on the charging surface, without having to incorporate any moving parts, which can add both bulk and weight.

Efficient transmission of power between the transmitter and receiver is also important, partly due to rising energy costs and partly because no-one wants to pick up a device that is warm to the touch after charging.

Engineering a wireless future

In late 2012, Toshiba launched its first free positioning wireless charging chipset that consisted of a high-efficiency power transmitter and receiver for charging smartphones and other mobile devices placed anywhere on the battery charging pad.

The WPC Qi compliant chipset includes a two-coil control architecture for cost-effective battery charging. The TB6865FG power transmitter detects the position of a compatible mobile device placed on the charging pad, energizing only the coil that is located closest to the device. This preserves efficiency and enables cost effective battery charging while enabling freedom of placement. In addition, the TB6865FG IC can control two sets of coils independently, enabling two mobile devices to be charged at once.

In order to preserve board space, minimise complexity and cost, the ICs feature high levels of integration. The TB6865FG transmitter integrates both microcontroller and analogue elements including PWM circuitry, switching control, on-board filter and a pre-driver circuit. The TB6860WBG receiver combines modulation and control circuitry with a rectifier power pickup, built-in high-performance DC-DC converter, widely configurable lithium-ion battery charger circuit and protection functions.

In order to support rapid design Toshiba has developed a number of evaluation boards featuring the transmitter and receiver ICs to enable customers to easily test and optimise new designs using the chipset.

CHARGING AHEAD

Future iterations of the Qi standards are looking at increasing the power that can be wirelessly transferred to a device to increase the speed of the charging process, while maintaining and improving efficiency. While it is currently working on standards for devices that can transfer 10-15 Watt, it has loftier plans than that. It can foresee a future where any device, be it a kettle requiring 1000 Watts of power, a food processor, a mobile phone or a tablet can be placed on a surface and receive the power it requires to function optimally.

While that dream may be a few years in the making, technology innovators are not standing idly-by. Toshiba has recently developed two new high efficiency receivers that improve the 5 Watt output efficiency of the receiving module from 87% to 95%. The most advanced of these receivers integrates the microcontroller within the IC itself producing a system that is able to output 5W without passing 45°C, this compares to less advanced chips that can reach well over 80°C under the same conditions.

This increase in efficiency is crucial if the WPC's dreams of the wireless home where any device can be powered on any surface are to come to fruition.

For more information
www.toshiba-components.com/wireless

Customers From Hell

MYK DORMER IS A SENIOR RF DESIGN ENGINEER AT RADIOMETRIX LTD
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"The customer is always right" is a common axiom, paraded out by almost every salesman I have ever worked with. While I agree that the customer must always be listened to, treated with respect and dealt with fairly, many years of experience in the industry have taught me that "right" is an inadequate adjective to describe them.

Allow me, by means of this humorous discourse, to shine a light on the more common problems in customer-supplier relationships that I have had the pleasure of experiencing in my time in the low-power radio industry.

"I need a radio" is probably the most frightening thing you can hear a customer say. It may not sound much different from "I need a UHF transceiver" or even "I need a data cable replacement modem to go from A to B", but do not be deceived. This customer has no idea what he needs, and absolutely no concept of what is or isn't possible.

Hours or days of protracted discussion later they probably decide to use "the office WiFi network"... or bells on a length of knotted string. Anything! It certainly won't be your product.

"Can we just add a...?" specifications get decided upon at the start of a contract for a reason: so it is possible to design (or source) just the right hardware, sufficient for the task but not overspecified and, hence, costly, oversized or awkward to use.

When a previously unknown requirement is thrown up well after these vital, early decisions have been made, the result is inevitably catastrophic.

Whereas with the "yesterday man" the job starts innocuously enough: there's a specification that is technically possible, at a reasonable price. The initial design work probably has already started and long lead-time parts may even be on order, before the bombshell drops: "The delivery date is next week".

With the "technical support scrounger" type customer there's always a very plausible request, usually for something straight out of your catalogue and always with a large (but not implausibly so) projected future-usage figure tagged on to the enquiry. Inevitably, the dollar signs start flashing in the sales department and every type of assistance and incentive get offered: Samples, development kits and unlimited man-hours of application support. Of course, the expected order never materialises, and you belatedly realise that the customer has bought elsewhere, or even designed their own radio hardware, based on the work you've done for them.

The "why don't you re-align the flux capacitor?" type customer has made out to his boss or investors that he is totally up to date on wireless technology. In fact, he probably thinks the whole design could be done in-house, if it wasn't for a "few minor details". To maintain his position and status as the technical guru, this customer sends numerous emails (copied to individuals throughout his company) full of comments and suggestions for "improvements", couched in technical sounding terms, which are invariably either irrelevant or just completely wrong.

"I can get this from China for two dollars" is another encountered comment from customers. A high performance product is never cheap, however. A custom design executed to specifically fit a given customer's requirements will never benefit from gross economies of scale. Tight specifications require complex designs. Unfortunately this is why (for example) an industrial radio modem can cost a few hundred pounds, while a low-end mobile phone (offering, to the non-technical observer, far more "functions") can be bought for little more than pocket change.

The "I expected a complete solution" type customer "didn't know" that he would need an aerial, a power supply, specific interface hardware, or whatever else. The assumption that absolutely everything needed is already included in a single, simple, works-right-out-of-the-box package is ingrained into us by simple consumer electronic goods, and is a very hard assumption to break, even when it is obvious that what is being supplied is only one component part of a much bigger system.

"Here's the circuit. Just build it!" All too infrequently you will come across a customer who not only thinks they know better than you, but actually do. They probably don't have either the manpower or the production facilities to build what they want you to sell them, but otherwise could design it in a lunchbreak. Swallow your pride (the part of all engineers that says "damn it, my design is better!", even when it probably isn't) and do what they ask. They know what they want is possible, and can express it to you in an understandable way. A customer like this is as valuable as diamonds – and about as rare!

Disclaimer: If, while reading this, you think you might recognise (from some inadvertently included detail) yourself or your company, please rest assured: I could not possibly be referring to you. Could I? ●

Haliplex cuts costs, waste and time to market using XJTAG

"Australian communication equipment producer Haliplex is saving over US$100,000 per year through time savings and reduced waste, by taking advantage of XJTAG's convenient features supporting fast, confident test development as well as advanced capabilities to identify faults well beyond the boundary scan chain."

Haliplex Pty Ltd, based near Melbourne, Australia, produces multi-service voice and data equipment for network-edge applications with enterprises such as transport operators, utilities and telecom carriers. Serving both domestic and export markets, the company prides itself on delivering products that are the smallest of their kind and can be deployed in flexible ways within existing or new networks supporting high-bandwidth standards such as Gigabit Ethernet and SDH/SONET.

Products such as the Haliplex HPX1600 series of multi-service access terminals contain PCBs that are densely populated with devices such as high-performance embedded processors, FPGAs and ASICs, as well as high-speed telecom data-path devices. Other components include optical fibre drivers, I^2C and SPI devices, and Ethernet switches. By using XJTAG boundary scan to debug prototypes and to test production units, Haliplex calculates it is saving over US$100,000 every year.

Anthony Merry, Chief Technical Officer at Haliplex, explains. "XJTAG allows us to achieve high test coverage for each board, and helps trace faults accurately to save debugging and repair time. This has reduced the typical time to commission a new design for production by around four days. Given the number of new boards we develop in a year, for example, this saves us around US$24,000 of engineers' time. This alone means that XJTAG pays for itself extremely quickly. But we are gaining further savings by also basing our production test strategy on XJTAG."

The boards are built by a manufacturing partner, which uses the XJRunner run-time version of XJTAG optimised for production-test applications, to test each production unit. Device programming and loading of serial numbers is also completed from within the boundary scan environment.

"XJRunner has diagnostic features that help our manufacturer track down faults that would otherwise consign a proportion of boards to our 'repair pile'. This has reduced the number of failed boards passed to us by around 90%, saving over US$64,000 of waste per year as well as around US$12,000 of our repair technicians' time," says Merry.

He explains that the high test coverage achievable, and the extra confidence XJTAG gives to engineers when developing tests are key factors contributing to these financial savings. "XJTAG's graphical environment and high-level test language enable our engineers to create tests for specific functions or areas of the board quickly and accurately. Other systems tend to hide details, which makes it difficult to be sure that certain aspects are covered."

"We can also test non-JTAG devices well beyond the boundary scan chain from within XJTAG, which helps boost productivity and quality," he continues. As well as providing convenient features such as automatic testability analysis, XJTAG is able to use board-level interconnects such as I^2C or SPI to reach non-JTAG devices not directly connected to those on the boundary scan chain. This allows engineers to achieve high test coverage using boundary scan, when testing boards containing components such as ADCs, DACs, serial memories, sensors, display drivers or switches.

"XJTAG combines powerful capabilities with an extremely competitive price, and represents outstanding value among boundary scan test systems."

opinion

Anthony Merry
Chief Technical Officer
Haliplex

"XJTAG saves us over US$100,000 per year by reducing the engineering time to commission new boards, enabling us to repair boards more quickly, and reducing the number of boards that are scrapped."

"Its graphical environment and high-level test language enable our engineers to create tests for specific functions or areas of the board, quickly and accurately. Other systems tend to hide details, which makes it difficult to be sure that certain aspects are covered. XJTAG combines powerful capabilities with an extremely competitive price, and represents outstanding value among boundary scan test systems."

Data Bank

Haliplex

Company	Haliplex Pty Ltd, HQ Australia
Nature of business	Leading manufacturer of next-generation edge access and multiplexing solutions
Main product	HPX-800, HPX-1600
Customers	Progressive Utility, Telecoms and Transport operators such as Nokia Siemens Networks, KAMO Power, KTM Berhad, Fibrerail Malaysia, BC Hydro, Bayly Communications...
Location	Melbourne, Australia sales offices in Australia, USA
Web site	www.haliplex.com

INCREASINGLY SOPHISTICATED SOCS HAVE INCREASINGLY SOPHISTICATED POWER REQUIREMENTS

RON WILSON FROM ALTERA DISCUSSES THE CHALLENGES THE DESIGNERS NEED TO MEET, BROUGHT ON BY THE POWER DEMANDS OF COMPLEX SYSTEMS AND DEVICES

There is no doubt that the availability of complex SoC devices, where many compute and interface functions are available on one die, have made an embedded developer's job easier. However, as the SoC's functionality grows, so does the need for a more complex power-delivery network. Look closer at the pin-out of a typical device and you will see that there is no longer a single Vcc supply pin.

Each additional SoC function brings its own voltage, noise, sequencing and transient response requirements. Also, as SoC designers have migrated their devices to smaller geometries, the increasing integration has allowed the lowering of supply voltages. This has further complicated the power network requirements by increasing peak current demands, making noise margins even more critical, and introduced the need for responsive dynamic power management. A high-end FPGA, for example, can have 15 external power rails, but where are they all going?

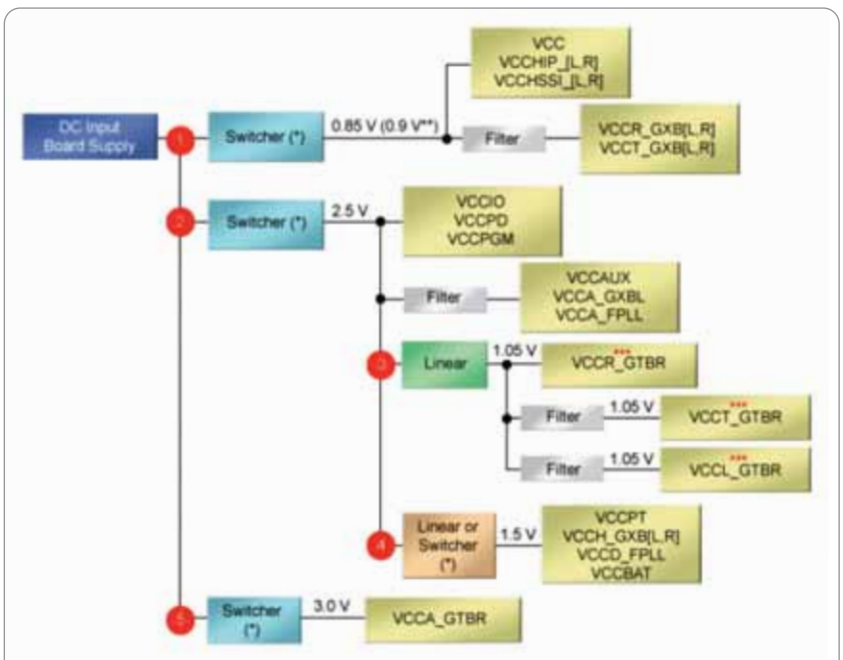

Figure 1: A modern SoC requires many different supply rails, each with its own regulation and conditioning requirements

Differing Voltage Requirements

Firstly, there are differing voltage requirements. Some supply voltages, such as core logic for example, have fallen to 1VDC in some cases, whilst other circuits such as IO cells may be tied to a particular supply rail by an industry standard. Also, reliability may dictate a high voltage (such as in SRAM cells) to ensure a voltage supply higher than logic level, even though a lower voltage can be used for standby. Techniques to reduce jitter and improve noise margins for precision analog circuits may also require a higher voltage supply. So, the increasing diversity of supply requirements have resulted in a sharp increase in the number of supply rails.

However, it doesn't stop with the number of supply voltages. The need to power low-noise amplifiers, PLLs and physical interfaces usually requires that the supply has very low noise limits. This demands isolation from sharing a supply rail with circuitry that creates high levels of noise, such as IO cells and digital logic.

One of the increasingly important challenges associated with powering these complex devices is due to the device complexity itself. The need for dynamic power management is a result of rigorous power reduction techniques such as fine-grained clock gating and on-voltage scaling. Such circuitry puts extraordinary demands on the transient response of the supply rails. It is not unusual for the load to change by orders of magnitude within microseconds. Likewise, the supply voltage may also have to change in response to SoC commands. Sequencing actions, such as those required for power-up, may also dictate separate supply rails.

Available Options

When it comes to providing a way forward, engineers have a number of options. While a bulk regulator is often placed on the board from the main supply, individual point-of-load converters can be used to supply each rail. However, with potential fifteen rails to supply this approach is not ideal. The key questions to consider will then be whether some degree of rail sharing is possible or not, the key criteria to consider for each, and if some reduction of performance or noise margin would be acceptable.

Having minimised the number of regulators, designers should closely examine their efficiency and footprint. Emphasis should be placed on high-efficiency switching

regulators rather than their linear counterparts. Power modules can improve board footprint but it can be a trade-off with some specific rail requirements, such as noise and line regulation. Once the choice of discrete power circuits or a modular approach has been made, the system design team needs to carefully verify that they will meet the supply requirements of the SoC in all possible use-cases. This will mean that verification will place heavy emphasis on the dynamic behaviour of the supply and noise immunity and, hence, needs to be based on simulation of the whole power network. Of course, before embarking on such detailed considerations and simulations, the design team needs to check if the SoC vendor has already provided a qualified reference design on which to base the power network.

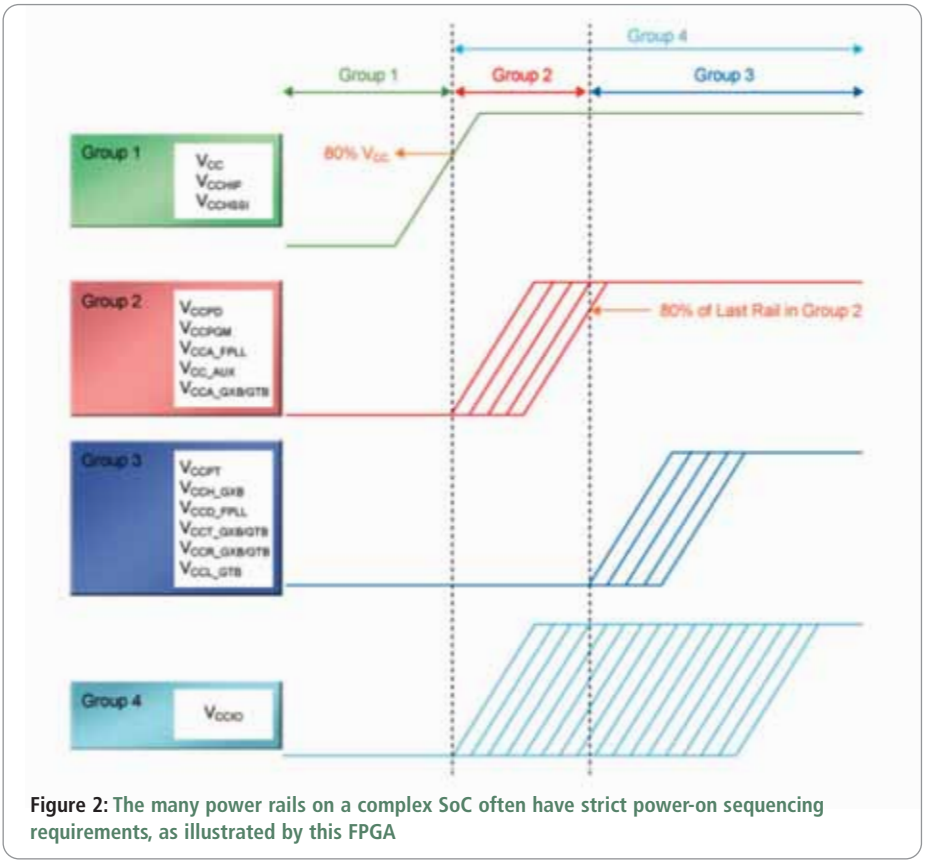

Figure 2: The many power rails on a complex SoC often have strict power-on sequencing requirements, as illustrated by this FPGA

On-Die Voltage Regulation

On-die voltage regulation is another consideration for the SoC selection and is a very convenient choice to avoid more complex power management requirements. However, in many cases on-die voltage regulation is provided to avoid the already large number of rails from rising. For example, on Altera's Stratix V FPGA, the PLLs and multi-GHz serial IO pins cannot share regulators due to noise sensitivity, that's why they are powered by on-die regulators.

> The need for dynamic power management is a result of rigorous power-reduction techniques such as fine-grained clock gating and on-voltage scaling

Also, on-die regulation is a good candidate when opting for dynamic voltage-frequency scaling (DVFS). This approach, where the voltage and clock frequency are adjusted on the fly, can be extremely effective in anticipating load requirements. While earlier implementations did not easily adapt to unpredictable system behaviour, newer implementations are proving more responsive. Intel, for example, has recently implemented a very fine-grained DVFS on some of its processors. Rather than checking processor loading every millisecond in order to change voltage and frequency, it is now making these inspections at nanosecond intervals. The much faster DVFS means the chip can much more closely match energy consumption to the processing needs of individual blocks. However, it also puts huge demands on regulators – demands that external regulators simply can't meet.

To achieve this level of dynamic response Intel chips such as Haswell use programmable on-die linear regulators (Figure 3). These blocks, implemented in the processor's native digital CMOS, step the 2.4V primary voltage down to a selectable output in the range of 0.6-1.8V, in 12.5mV steps. The regulators can change voltages at rates of up to 100MHz, and they achieve a rather astonishing slew rate of 100A/ns in order to track the enormous load changes the power- and clock-gated digital blocks can produce. Such performance, needless to say, would be nearly impossible if there were a centimetre or two of circuit-board trace and a lead frame in the regulator's control loop.

Huge Challenges

The task of developing and modelling a voltage regulator network for a complex SoC device is a huge challenge for any design team. Being able to verify and test across the entire range of voltages and full load conditions, not to mention maintaining conversion efficiency, is not for the faint-hearted, but there is no doubt that the use of on-die regulators is the way to go. In addition to being able to quickly respond to changing SoC demands they save valuable board space by dispensing with external regulators. ●

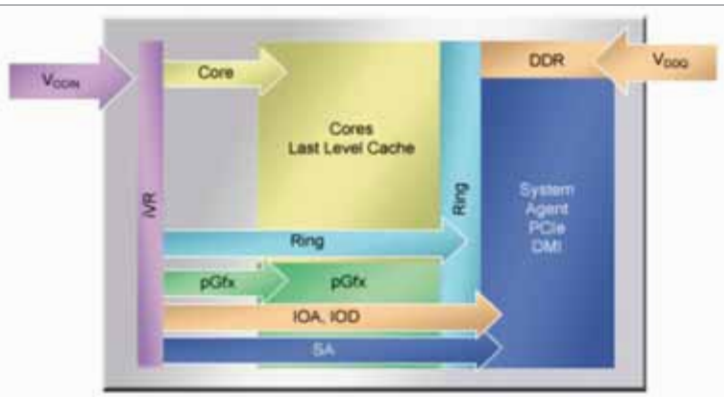

Figure 3: A high-level description of the power distribution grid in Intel's Haswell chip shows the internal voltage regulators supplying different blocks

RISK MITIGATION FOR POWERING LOW VOLTAGE PROCESSORS AND FPGAS DIRECTLY FROM INTERMEDIATE BUS VOLTAGE

WILLIE CHAN, SENIOR PRODUCT MARKETING ENGINEER, AND **JASON SEKANINA**, DESIGN ENGINEER, BOTH FROM POWER µMODULE PRODUCTS AT LINEAR TECHNOLOGY, EXPLAIN HOW TO EASILY AND SUCCESSFULLY PROTECT EXPENSIVE INVESTMENTS SUCH AS FPGAS, ASICS AND MICROPROCESSORS

Intermediate bus voltages of 24V~28V nominal are commonplace in industrial, aerospace and defense systems, whereas series-connected batteries may be a backup power source and 12V bus architectures tend to be impractical due to distribution losses.

The widening voltage gap between the system bus and the power inputs of digital processors present design challenges relating to power delivery, safety and solution size. If a single-stage non-isolated step-down DC/DC converter is used, it must operate with extremely accurate PFM/PWM timing.

Input surge events put further stress on the DC/DC converter, presenting another overvoltage risk to the load. Erroneous or counterfeit capacitors introduced in manufacturing may cause output voltage excursions exceeding the load's ratings, potentially causing the FPGA, ASIC or microprocessor to ignite. Depending on the extent of the damage, the root cause may be quite challenging to determine and the resulting high repair costs, downtime and harm to reputation extremely frustrating. Therefore, an overvoltage risk mitigation plan should be given careful consideration to minimize cost and inconvenience to customers.

Traditional overvoltage protection schemes involving a fuse are not suitable for protecting modern FPGAs, ASICs and microprocessors, particularly when the upstream voltage rail is 24V or 28V nominal. A new solution has been created, combining a 38V-rated, 10A DC/DC switching regulator with circuitry to defend against many faults, including output overvoltage. Power and protection for today's most advanced digital logic devices are now available in one compact device.

Accurate Switcher Timing Importance

When a wide differential exists between the input voltage and the desired output voltage, switching DC/DC regulators are favoured for their high efficiency. To achieve a small solution size, a non-isolated step-down switching converter is an obvious choice, operating at high enough frequency to shrink the size requirements of its power magnetics and filter capacitors. However, such a DC/DC switching converter must operate at narrow duty-cycles – as low as 3% – which demands accurate PWM/PFM timing. Furthermore, tight voltage regulation is required by digital processors, and fast transient response is needed to keep the voltage within safe limits. At higher input voltages, the margin for error in the on-time of the top side switch of the DC/DC regulator is reduced.

Bus voltage surges, which are often present in aerospace and defense applications, pose a danger not only to the DC/DC converter but to the load as well. The DC/DC converter must be rated to regulate through the overvoltage surge with a fast control loop, so that sufficient line rejection is achieved. If the DC/DC converter fails to regulate or survive the bus surge, an overvoltage will be presented to the load.

Overvoltage faults may also be introduced as the load's bypass capacitors degrade with age and temperature, which results in looser transient load response over the course of the end product's life. If

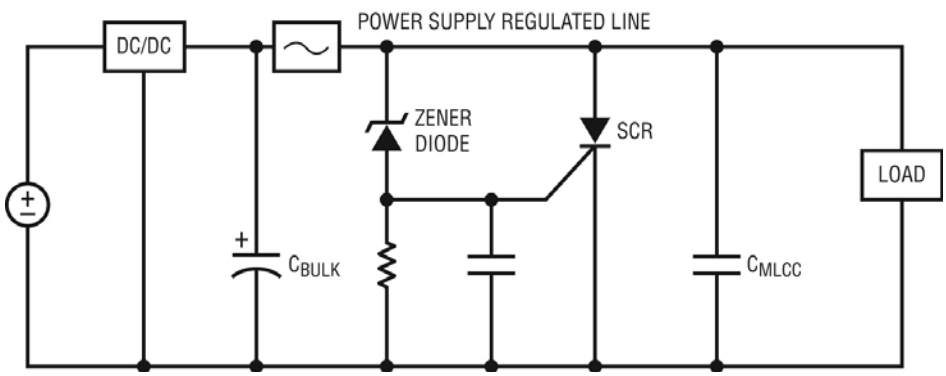

Figure 1: Traditional overvoltage protection circuit consisting of a fuse, SCR and Zener diode. While inexpensive, this circuit's response time is insufficient to reliably protect the latest digital circuits, particularly when the upstream supply rail is an intermediate voltage bus. Moreover, even the simplest recovery from an overvoltage fault is invasive and time-consuming

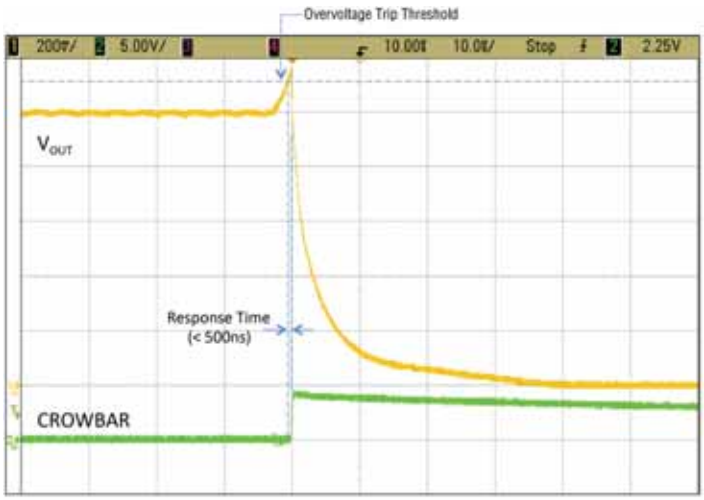

Figure 2: The LTM4641 responds to an overvoltage condition within 500ns, protecting the load from voltage stress (VIN = 38V, VOUT = 1.0V, with adjustable overvoltage trip threshold set at +11%)

the capacitors degrade beyond the limits of the control loop's design, the load can be exposed to overvoltage by two possible mechanisms. First, even if the control loop remains stable, heavy transient load-step events will demonstrate higher voltage excursions than were expected at the design's onset. Second, if the control loop becomes conditionally stable – or worse yet unstable – the output voltage can oscillate with peaks exceeding acceptable limits.

Capacitors can also degrade unexpectedly or prematurely when an incorrect dielectric material is used, or when fake components enter the manufacturing flow.

Cheap, Counterfeit Components Can Cause Expensive Headaches

Gray market or black market, the attractive cost of counterfeit components can be too enticing for some to resist, even though they don't meet the standards of the genuine article; e.g. they may be recycled, reclaimed from electronic waste, or built from inferior materials.

A short-term saving becomes a huge expense when a counterfeit product fails. Counterfeit capacitors, for example, can fail in a number of ways. Counterfeit tantalum capacitors have been seen to suffer internal self-heating with a positive-feedback mechanism to the point of reaching thermal runaway. Counterfeit ceramic capacitors may contain compromised or inferior dielectric material, resulting in an accelerated loss of capacitance with age or at elevated operating temperatures. When capacitors fail catastrophically or degrade in value to induce control loop instability, the voltage waveforms can become much greater in amplitude than originally designed, endangering the load.

Unfortunately for the industry, counterfeit components are increasingly finding their way into the supply chain and electronics manufacturing flow, even in the most sensitive and secure applications. A US Senate Armed Services Committee (SASC) report released in May 2012 found widespread counterfeit electronic components in military aircraft and weapon systems that could compromise their performance and reliability. These systems were built by top contractors in the defence industry. Coupled with the increasing number of electronic components in such systems, for example over 3,500 integrated circuits in the new Joint Strike Fighter, counterfeit components pose a system performance and reliability risk that can no longer be ignored.

> An overvoltage risk mitigation plan should be given careful consideration to minimize cost and inconvenience to customers

Any risk mitigation plan should consider how the system would respond to and recover from an overvoltage condition. Is the possibility of smoke or fire resulting from an overvoltage fault

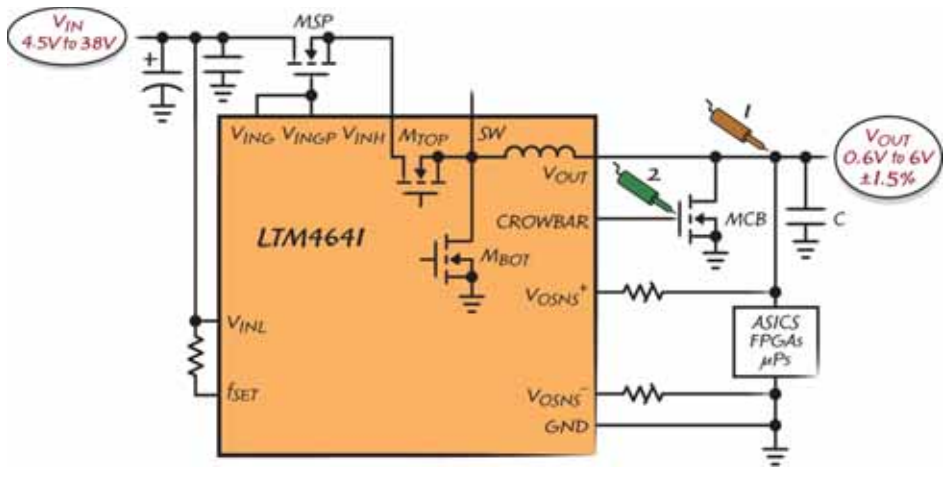

Figure 3: LTM4641 output overvoltage protection plan. The two probe icons correspond to the waveforms in Figure 2

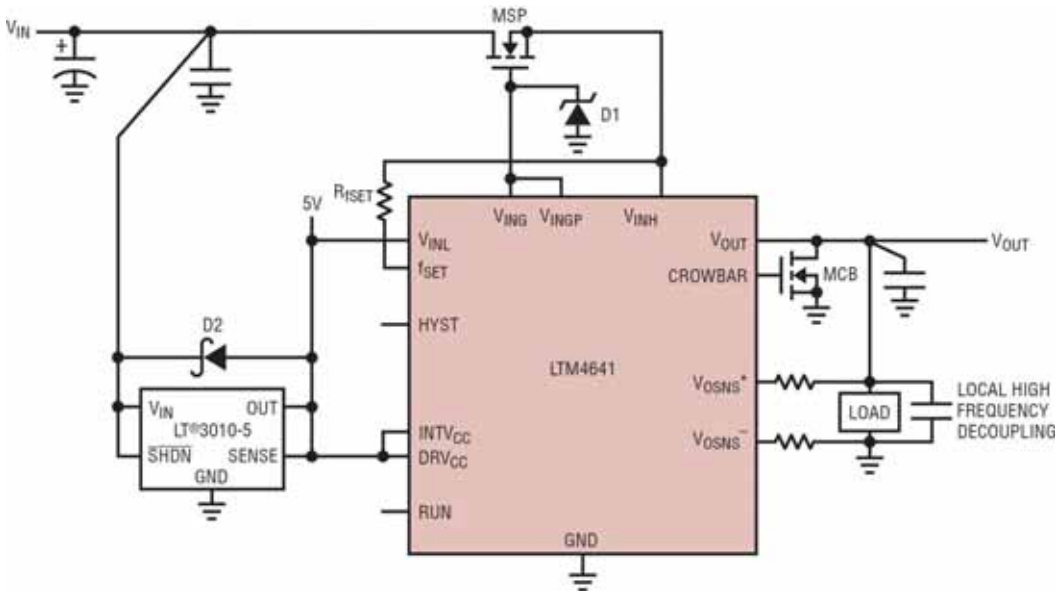

Figure 4: Input surge protection up to 80V, using the LTM4641 and external LDO

acceptable? Would efforts to determine root cause and implement corrective actions be hampered by damage resulting from an overvoltage fault? If a local operator was to power-cycle (reboot) a compromised system, would even greater harm to the system result, further hindering recovery efforts? What is the process and time required to determine the cause of the fault and resume normal system operation?

Traditional Protection Circuit Inadequacies

A traditional overvoltage protection scheme consists of a fuse, silicon controlled rectifier (SCR) and Zener diode. This circuit (Figure 1) protects the load in the following manner. If the input supply voltage exceeds the Zener breakdown voltage, the SCR activates, drawing sufficient current to blow open the upstream fuse. It is relatively simple and inexpensive, however, drawbacks of this approach include accuracy of the Zener diode breakdown voltage, SCR gate trigger threshold variation, varying response time of the SCR and fuse and the level of effort required to recover from a fault (i.e. physically servicing the fuse and restarting the system).

If the voltage rail under consideration powers the digital core, the SCR's protection capability is limited since the forward drop at high currents is comparable to or above the core voltage of the latest digital processors. Because of these drawbacks, the traditional overvoltage protection scheme is not suitable for high voltage to low voltage DC/DC conversion, powering loads such as ASICs or FPGAs, that could be valued in the hundreds if not thousands of dollars.

Combining Power And Protection

A better solution would be to accurately detect an imminent overvoltage condition and respond by quickly disconnecting the input supply while discharging excess voltage at the load into a low impedance path. This is now possible with the extensive protection features included within the LTM4641 step-down µModule regulator.

At the heart of the device is a 38V-rated, 10A step-down regulator with the inductor, control IC, power switches and compensation all contained in one surface-mount package. However, to add a level of protection for high-value loads such as ASICs, FPGAs and microprocessors, extensive monitoring and protection circuitry are included. The LTM4641 maintains a constant watch for input undervoltage, input overvoltage, overtemperature and output overvoltage and overcurrent conditions, and acts appropriately to protect the load. To avoid false or premature execution of the protection features, each of these monitored parameters has built-in glitch immunity and user-adjustable trigger thresholds, with the exception of overcurrent protection, which is implemented reliably, cycle-by-cycle with current-mode control. In the case of an output overvoltage condition, the LTM4641 reacts within 500ns of fault detection (Figure 2).

Not only does the internal architecture of the LTM4641 allow it to respond nimbly and reliably, it can even automatically reset and re-arm itself after fault conditions have subsided. A differential sense amplifier is employed to regulate the voltage at the load's power terminals, minimizing errors stemming from common-mode noise and PCB trace voltage drops between the LTM4641 and the load. The DC voltage at the load is regulated to better than ±1.5% accuracy over line, load and temperature. This accurate output voltage measurement is also fed to the fast output overvoltage comparator, which triggers the LTM4641's protection features.

> A US Senate Armed Services Committee report found widespread counterfeit electronic components in military aircraft and weapon systems that could compromise their performance and reliability

When an overvoltage condition is detected, the µModule regulator rapidly takes multiple simultaneous courses of action. An external MOSFET (MSP in Figure 3) disconnects the input supply, removing the high-voltage path from the regulator and the high-value load. Another external MOSFET (MCB in Figure 3) implements a low impedance crowbar function, quickly discharging the load's bypass capacitors. The DC/DC step-down

regulator within the LTM4641 enters a latched-off shutdown state and issues a fault signal indicated by the HYST pin, which can be used by the system to initiate a well-managed shutdown sequence and/or system reset. A dedicated voltage reference independent of the control loop's reference voltage is used to detect fault conditions. This provides resilience against a single-point failure, should the control loop's reference happen to fail.

The improvement in protection offered by the LTM4641 over the traditional fuse/SCR protection scheme is futher bolstered by how the system recovers from a fault. In the traditional overvoltage protection scheme, a fuse is relied upon to separate the power supply from the high-value load. Therefore, someone must physically be present to remove and replace the fuse in order for the system to resume normal operation after a fault has occurred. In contrast, the LTM4641 can resume normal operation quickly once the fault condition has cleared either by toggling a logic level control pin or by configuring the LTM4641 for autonomous restart after a user-specified timeout period expires. No components need to be physically replaced, which is a critical requirement for systems with high uptime needs and/or operating in remote locations. If fault conditions reappear after the LTM4641 resumes operation, the aforementioned protections immediately engage to protect the load.

Input Surge Protection

In some cases, output overvoltage protection alone is insufficient, and input overvoltage protection is desired. The LTM4641's protection circuitry can monitor the input voltage and activate its protection features, should a user-configured voltage threshold be exceeded. If the anticipated maximum input voltage exceeds the 38V rating of the module, input surge protection can be extended up to 80V with the LTM4641 still fully operational by adding an external high voltage LDO, which keeps control and protection circuitry alive (Figure 4).

Risk Mitigation Planning

With market requirements for higher system performance and uptime, coupled with the tremendous cost of the latest digital processors, engineers must consider risk mitigation strategies, particularly when a distributed power bus in the 12V-28V range or those with surges are involved.

The latest and often very costly FPGAs, ASICs and microprocessors have supply voltages with a maximum limit as low as 3% to 10% of the intermediate voltage rail, which makes them extremely susceptible to damage, potentially even igniting from an overvoltage fault. Such faults might be caused by timing errors in the switching regulator, an input voltage surge or improper components introduced during manufacture. Overvoltage protection schemes are now available that meet these challenges far better than the traditional fuse-SCR combination. ●

UTILIZING STRATOSPHERIC COMMUNICATION PLATFORMS WITH NEW DISTRIBUTION OF MICROWAVE BANDS

STOJCE DIMOV ILCEV, IVAN SKORYK AND **OLUDAYO O. OLUGBARA** FROM DURBAN UNIVERSITY OF TECHNOLOGY (DUT) DESCRIBE A NEW COMMUNICATION SYSTEM OF GEO SATELLITES AND STRATOSPHERIC COMMUNICATION PLATFORMS THAT WILL REDUCE SIGNAL DELAYS FOR USERS AND INCREASE SATELLITE LIFE-SPAN FOR OPERATORS

Most modern satellite applications, including GPS receivers, mobile phones, tracking devices and other similar terminals, do not need high data-rate operations in the microwave bands L (1-2GHz), S (2-4GHz) and C (4-8GHz). However, High Definition Television (HDTV), Direct to Home (DTH) and Internet communication for maritime (FleetBroadband) and aeronautical (SwiftBroadband) services do. These applications need greater spectrum bandwidth due to the large information capacity and data rates they handle. For such purposes the bandwidths of the Ku (12-18GHz), K (18-26.5GHz) and Ka bands (26.5-40GHz) will work well.

Satellite Communications

Currently there are two types of satellites constellations used for satellite communication: the Geostationary Earth Orbit (GEO) and Non-Geostationary Earth orbit (NON-GEO) satellites. The altitude of the GEO satellites constellations above the Earth's surface is 36,000km.

The existing NON-GEO constellation currently uses two types of satellites: Low Earth Orbit (LEO) and Medium Earth Orbit (MEO) satellites. The altitude of the LEO and MEO satellite constellations is around 1,000km and 10,000km, respectively. The high altitudes of the GEO satellites tend to cause a signal propagation delay, and to compensate for them, suitable hardware or software solutions are used. The LEO and MEO satellites have shorter signal propagation delays, but due to their fast rotation close to the Earth's surface, they use handover technology to prevent interruptions to the communication of users' mobile terminals.

The propagation of satellite signals is affected by two important parameters, such as the usual free-space losses and absorption. Signal absorption is the strongest in the lower atmosphere layers, where there's high density of water vapours and gases. Of course, the attenuation of the signal also depends on its frequency or wavelength.

A perceptible absorption of the signal due to atmospheric components begins above 40MHz. The rain attenuates the signals in the microwave bands significantly too, which has to be considered. So the L, S, C, K and Ku-bands, including the Ka-band

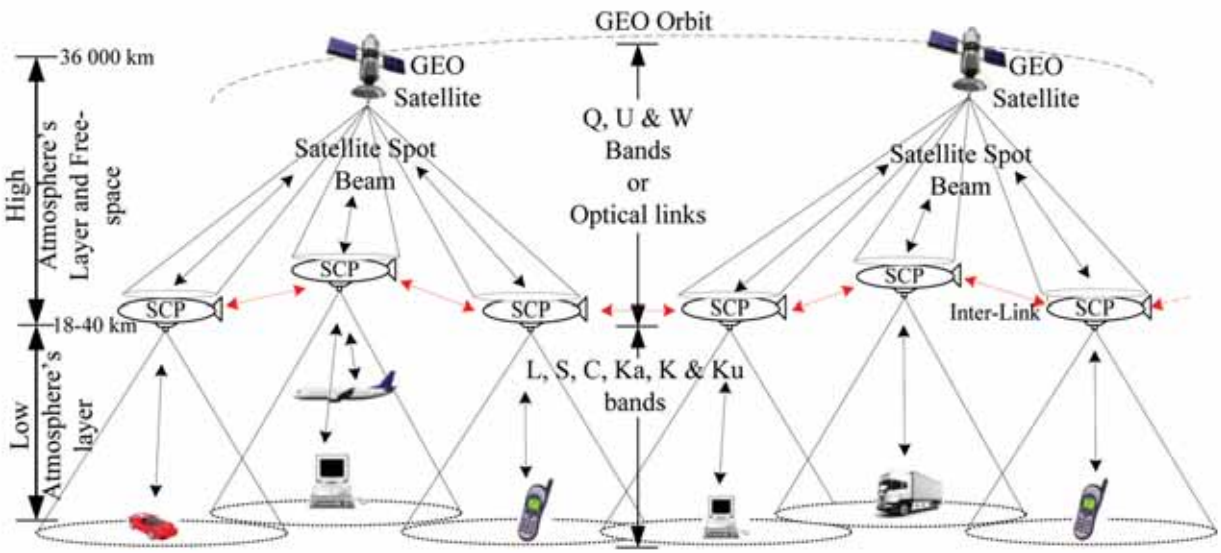

Figure 1: General structure of a new distribution of microwave bands using SCP and GEO satellites

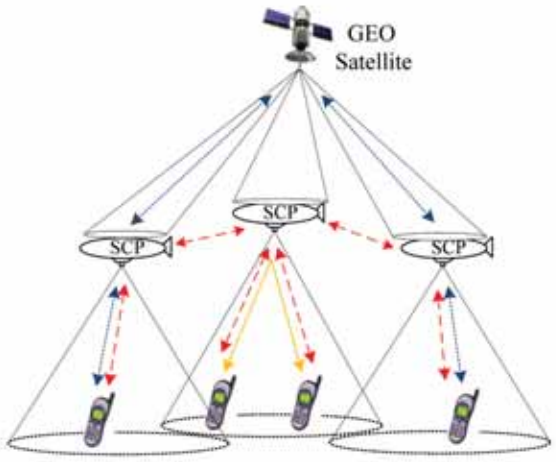

Figure 2: Simplified structure of using SCP and a GEO satellite for cell phones (voice and data)

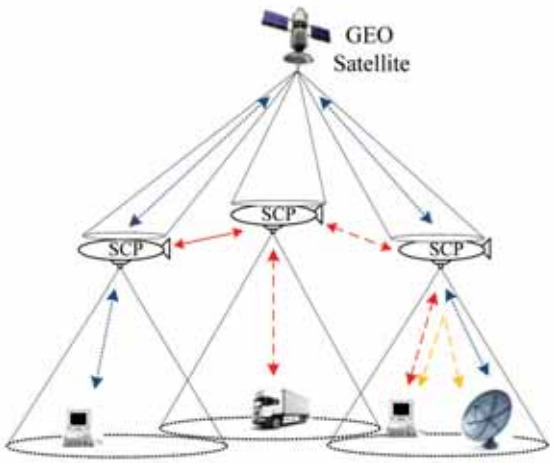

Figure 3: Simplified structure of using SCP and a GEO satellite for Internet access

can be used, but the higher bands (above the Ka-band) are not recommended as the absorptions are the highest there.

Fast-growing data communication technologies demand faster data transmission and higher data capacities and this requires the involvement of the higher frequency bands with their broader bandwidths. The problem of signal attenuation cannot be solved completely, but attenuation losses must be reduced as much as possible to enable efficient energy use of satellites and mobile terminals alike.

For high frequency bands, using small-size communication antennas and smaller satellite payloads are important. On the other hand, to transmit a signal and compensate for its attenuations, the transmitting power has to be higher, which is critical for the satellite's lifespan. Therefore, we are suggesting a new structure for organizing satellite telecommunications by using a combination of Stratospheric Communication Platforms (SCP) and GEO satellite constellations with a special distribution of the microwave bands between them.

The Recommended Structure

Our proposed structure is shown in Figure 1. The configuration consists of an SCP constellation (the altitude of the SCP is anywhere between 18km and 40km above Earth), with an interlink depicted with red arrows. Interlinks provide faster data exchange between points on the ground, with minimum delay to all users, even when they are served by different SCPs. However, the communication between GEO satellites and SCPs over longer distances is achieved via multi-spot beams from the GEO satellites. The distribution of different microwave bands in this combination should allow the use of microwave frequencies above the Ka-band, as in the upper atmosphere layers there's low attenuation of the free space link. The Q, U and microwave W-bands (optical links) provide communication channels with high capacity, which allows for high data-rate exchange. The use of microwave bands such as L, S, C, Ka, K and Ku-band in the low atmospheric layer for communication between satellite applications and SCP is not affected much, as here the attenuation due to water vapours, gases, etc, is not so significant.

As shown in Figure 2, the system based on this structure can be useful for communicating with aircraft navigation systems and pilots, ships, trucks and cars to provide tracking information. Thus, those users who need access will be interfaced to the terrestrial network through the GEO satellite or SCP to the Internet, cellphones (for voice and data), HDTV and other mobile satellite applications.

Communication Delays

A system based on the suggested structure will provide voice and data communication between two users directly through SCP, bypassing the GEO satellite, but only if they are covered by the same SCP, as shown in Figure 2 by the yellow arrows. If some of the users are served by a neighbouring SCP, then communication can be established through interlinks from SCP to SCP (SCP-SCP), as shown in Figure 2 by the red arrows. Appropriately, if users are a considerable distance from each other, then all communication links will be provided through the SCP to the GEO satellite and back to the SCP (SCP-GEO-SCP), connecting them as shown in Figure 2 by the blue arrows.

In order to provide Internet access to users or for tracking vehicles and other mobile devices, communication can be implemented in three ways. For Internet users, each SCP has a HUB (gateway antenna) connected to the terrestrial network, so communication can be arranged directly through the SCP, bypassing the GEO satellite, as shown in Figure 3 by the yellow arrows.

For users covered by one SCP, or in tracking vehicles or aircraft,

Item	Communication delay (ms)		All round signal trip (ms)	
	Min	Max	Min	Max
SCP	0.0003	0.002	<<1	<<1
Satellite	0.0005	0.02	200	270
SCP-CSP	0.0004	0.0005	<<1	<<1
SCP-GEO-SCP	0.0008	0.0025	200	280

Table 1: Communication delays

	Rain (mm/hr)				
Bands	5	15	25	35	45
L	—	—	—	—	—
S	—	—	—	—	—
C	0.296	0.88	1.48	2.072	2.66
Ku	1.836	5.5	9.18	12.85	16.52
K	3.145	9.435	15.72	22.015	28.3
Ka	5.224	15.675	26.12	36.57	47

Table 2: Rain attenuation (dB/km) versus volume of rain

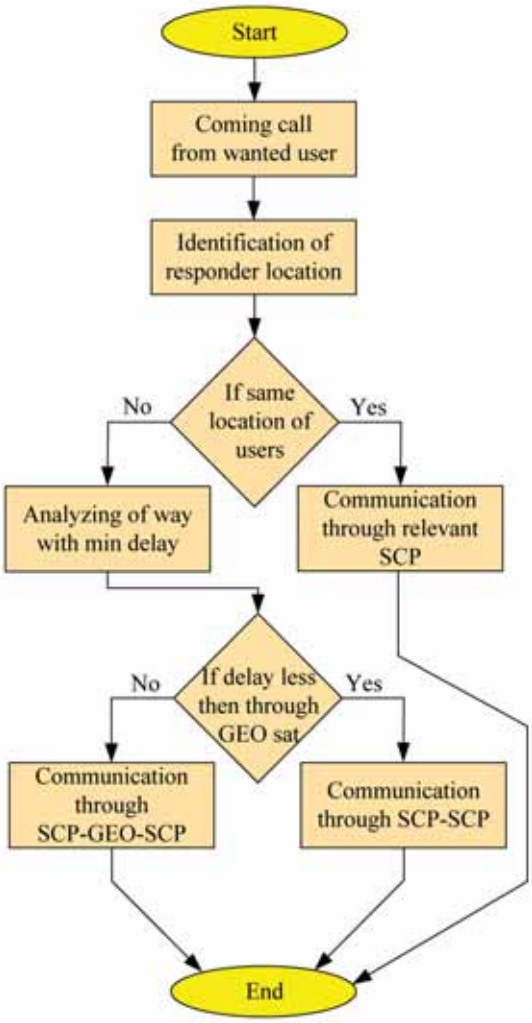

Figure 4: The algorithm that determines a communications link with the shortest delay between users

when an object is permanently moving, or a HUB is covered by another SCP, communication can be implemented as SCP-SCP connectivity with the help of interlinks, shown by the red arrows in Figure 3. Finally, for those users communicating at a considerable distance from each other, the link can be implemented as shown by the blue arrows in Figure 3.

The described communications can significantly reduce signal delays compared to the usual satellite systems used, where communication is implemented only via satellites. Comparisons of communication delays through SCP and GEO satellites are presented in Table 1.

It can be seen from the table that the main contributor to communication delays is the GEO satellite, due to the signal's round-trip, but with SCPs such delays are negligible. The communication between users is according to a simple algorithm (see Figure 4), which will identify their location and provide a more efficient way of communicating with the shortest delays before connecting them.

The algorithm works as follows: If a user makes a call, the system automatically identifies their responder's location. If the other user is covered by the same SCP, then their communication will be via that SCP. If one of the users is not covered by the same SCP, then the system looks to find the most effective way of communication, with the shortest delay. If this proves not to be via the GEO satellite, then it selects the SCP-SCP route, otherwise, communication is via the SCP-GEO-SCP link. The execution of the algorithm is instantaneous, and its application will provide faster and more reliable communication and data transmission.

Efficient Use of Distributed Microwave Bands

Our proposed structure is based on using distributed microwave bands as described earlier. Such distribution is necessary to achieve the most energy-efficient way of transmitting signals. To take into account the various types of attenuation due to free space losses (FSL), oxygen, water vapour and rain absorption, two optional layers and two groups of distributed microwave bands can be considered:

1) The first layer covers the atmosphere and space (≈ 36,000km) and it's for the Q, U and W bands, typically used for communication between SCPs and GEO satellites;
2) The second layer covers the lowest atmosphere (≈ 18,000-40,000km) and is for the L, S, C, Ka, K and Ku bands, used for communication between users and SCPs.

To identify the signal attenuation in the first layer, water vapours and gases can be neglected due to the low density, so the

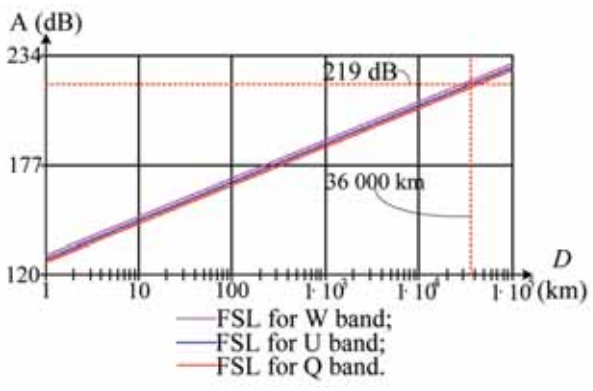

Figure 5: FSL attenuation of microwave bands of 40GHz-75GHz

only attenuation will be due to long communication distance between the SCP and the GEO satellites. This can be calculated with the help of a well-known equation from the literature [4]:

$$FSL(\mathrm{dB}) = 32.4 + 20\lg(f) + 20\lg(D) \quad (1)$$

where D is the distance in km, and f is the central frequency for the band in MHz.

Using Equation 1 and MathCAD software, we have plotted graphs of FSL attenuation versus distance for the Q, U and W microwave bands, see Figure 5. The graph shows that FSL attenuation for the three microwave bands is approximately 219dB for the 36,000km distance. Such a high attenuation can be easily overcome with the help of a high-gain antenna system, which concentrates its transmitted energy into a narrow beam.

The approximate distance between the GEO satellites and SCP can be considered as the same distance between the GEO orbits and Earth's surface.

In the second layer, the FSL attenuation due to signal distance is not as significant, however here high concentration of water vapours and oxygen are considered. Such attenuations can be calculated using the following two empirical equations [5]:

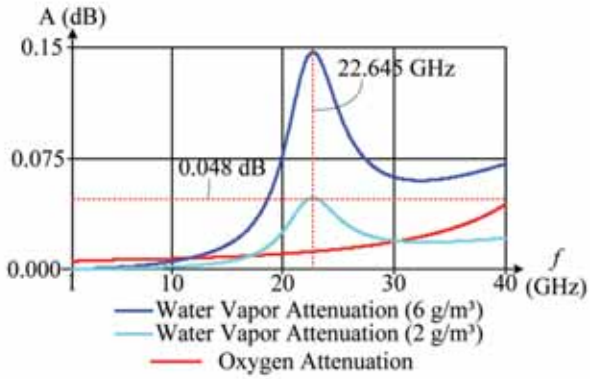

Figure 6: Attenuation of microwave bands from 1GHz to 40GHz due to atmospheric components

$$A_{oxygen}(\mathrm{dB/km}) = \left[0.05 + 0.0021\rho + \frac{3.6}{(f-22.2)^2+8.5} + \frac{10.6}{(f-183.3)^2+9} + \frac{8.9}{(f-325.4)^2+26.3}\right] \times f^2 \rho 10^{-4} \quad (2)$$

where f is the central frequency for a particular frequency band (GHz) and ρ is the water vapour concentration (g/m³).

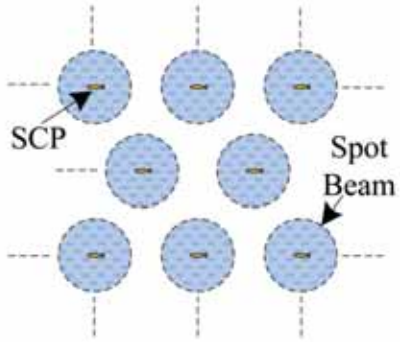

Figure 7: Part of the radiation pattern of a GEO satellite's multi-spot antenna system for communication with SCPs

$$A_{water}(\text{dB/km}) = \left[7.19\cdot10^{-3} + \frac{6.09}{f^2+0.277} + \frac{4.81}{(f-57)^2+1.5}\right] \times f^2 10^{-3} \quad (3)$$

Using Equations 2 and 3 and MathCAD, we have been plotted the attenuation graphs seen in Figure 6. For the water vapour attenuation with have plotted two graphs: one with ρ = 6g/m^3 as the average concentration of water vapour for the tropical regions, and with ρ = 2g/m^3 for all other regions.

Figure 6 shows that the most significant attenuation due to water vapour for the K bands is around 22GHz and the average attenuation is between 0.075 and 0.15dB.

Beside high-density water vaporus and oxygen, in the lower layer attenuation can be due to rain too. Rain attenuation can be calculated with the following equation [6]:

$$A_{rain}(\text{dB/km}) = (0.0308f - 0.1872)R \quad (4)$$

where f is the operational frequency in GHz, and R is the rain rate (mm/hr). Results of Equation 4 are shown in Table 2.

The Ku, K and Ka bands are significantly affected by the volume of rain, and the signal is heavily attenuated by the high humidity. The average magnitude of attenuation in the Ku, K and Ka bands in the lower layer varies between 2 and 48dB/km.

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Antenna Equipment Requirements

Since all atmospheric layers cause signal attenuation, it is worth applying high-directivity antenna systems for communication between GEO satellites and SCPs and between SCPs and users. Such a system can provide transmission and reception of signals with minimal power loss.

Communication between the SCP and GEO satellite can be implemented in two ways. One is through use of a high-directivity multi-spot antenna, with its beams directed toward each SCP; the spots, however, should not overlap (see Figure 7). This type of system requires a narrow frequency band.

With the help of a multi-spot antenna system, maximum signal energy can be directed toward each SCP, which reduces the power loss during signal attenuation. This will also help extend the satellite's life-span.

For multi-spot antenna systems for the W, U and Q microwave bands, smaller size antennas can be used because of their shorter wavelengths.

The second way of communication between SCPs and GEO satellites is via optical links. This requires relatively small optical antenna systems, with very low power consumption. But if optical links are used then the SCPs' positions must be stabilized with the highest precision. Optical communications channels can also be used for links between SCPs. Radio communication between SCPs and users can be implemented with the usual non-multi-spot microwave antenna without frequency reuse. Every SCP can be a single spot, and between SCPs frequency reuse can be considered [7].

The Benefits

In this article we described a system that uses GEO satellites and SCPs with a new distribution of microwave bands, which offers the following advantages:

- It minimizes communication delays for users, as interlinks between SCP are used and special algorithms applied to calculate the optimal connections through SCP-SCP or SCP-GEO-SCP;
- It reduces propagation losses by using multi-spot antenna systems on GEO satellites. It also efficiently uses the satellite's power, hence extending its life-span;
- Such a system based on the described structure doesn't need to use handover technologies, as GEO satellites and SCPs are completely synchronized with a period of Earth's rotation;
- As we recommend using SCPs (and they are quite close to the Earth's surface and as sich to users too), the Ku, K and Ka bands can be employed, which also helps with reduce the power consumption of mobile satellite terminals;
- This structure can be integrated with the already deployed GEO satellites in the Earth's GEO orbit, the only need would be to put up new SCPs;
- This is a cost-effective solution, as SCPs can be reused and re-equipped at any time;
- Finally, the SCP can be used as multifunctional platform for other purposes and services too, such as emergency response, navigation, Earth observation and other applications. ●

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MODELING AND SIMULATION OF ACTIVE CANCELLATION STEALTH SYSTEM BASED ON RF

SHENG XU AND **YUAN-MING XU** FROM THE SCHOOL OF AERONAUTICS SCIENCE AND ENGINEERING AT BEIHANG UNIVERSITY, BEIJING, DESCRIBE A MATHEMATICAL MODEL OF AN ACTIVE CANCELLATION STEALTH SYSTEM BASED ON DIGITAL RADIO FREQUENCY MEMORY (DRFM)

Active cancellation stealth technology can be used in airplane- and other-type equipment. In these systems the target must emit a cancellation wave to coincide with an incoming pulse, with the right amplitude and phase to cancel the reflected wave. The difficulty lies in achieving the cancellation accurately and in real time; including obtaining its wave's parameters as well as controlling it precisely [1].

We designed a model of an active cancellation stealth system based on digital radio frequency memory (DRFM), and a radar signal processing system for a coherent video simulation model using Matlab/Simulink.

Coherent Video Signal Simulation Model

According to the literature [2], a target echo signal can be expressed as:

$$s_r(t) = \left[\frac{\lambda^2}{(4\pi)^3 R^4}\right]^{1/2} G(t)\gamma(t)s_t[t-\tau(t)] \qquad (1)$$

where λ is the radar signal's wavelength; R is the distance from target to radar; $G(t)$ is the power gain of the antenna in the direction of the target, in one way; $\gamma(t)$ is the complex reflection coefficient of the target, representing the scattered electric field amplitude and phase, which affect the target echo's fluctuation characteristics. So, $s_t(t)$ is calculated by:

$$s_t(t) = u(t)\exp[j2\pi(f_0 + f_d)t] \qquad (2)$$

where $u(t)$ is the complex envelope of the transmitted narrowband pulse; f_0 is the fundamental carrier frequency; and f_d is the Doppler frequency, $f_d = 2v_d/\lambda$ (v_d is the radial velocity of the target relative to the radar, and $v_d > 0$ means the target moves away from the radar). The time-varying delay $\tau(t)$ is:

$$\tau(t) = 2\frac{R(t)}{c} \cong \frac{2R_0}{c} + \frac{2v_d t}{c} = \tau_0 + \frac{2v_d t}{c} \qquad (3)$$

where R_0 is the initial range position; τ_0 is the initial time delay; and c is the speed of light.

Note that $G(t)$, $\gamma(t)$ and $\tau(t)$ are slowly-changing functions, varying with time. Assuming the goal is a point target, the scanning beam gain in the direction of the target (a function of the elevation and azimuth angles) is given by G; f_d can be approximated as a constant because $v_d \ll c$ and time-bandwidth product $B\tau \ll c/2v_d$ (B is the signal bandwidth, τ is the pulse width); $\gamma(t)$ is only concerned with σ (σ is the radar cross section of the target or scatterer, namely RCS). Therefore Equation 1 can be simplified as:

$$s_r(t) = \left[\frac{\lambda^2}{(4\pi)^3 R^4}\right]^{1/2} G(\theta,\varphi)\sqrt{\sigma}u(t-\tau)\exp(j2\pi f_d t) \qquad (4)$$

where θ is the azimuth and φ is the elevation. From Equation 4 it can be noted that the point target's coherent video signal simulation includes the complex envelope of the radar's transmitted signal $u(t)$, the antenna pattern function $G(\theta, \varphi)$ and the target's parameters, including its distance, radial velocity, acceleration and RCS.

Simulation Of The Complex Envelope Of The Radar's Transmitted Signal

Conventional radar's signal bandwidth is smaller than the emitted carrier's frequency, and most of the energy is concentrated in the carrier frequency, therefore it is a

narrowband signal. Common signal forms include a coherent pulse train signal, linear frequency modulation (LFM) signal and phase coded signal. The three complex envelope functions of the modulation signal $u(t)$ are shown below [3]:

$$u(t) = A\sum_{i=0}^{N-1} \mathrm{rect}\left[\frac{t - iT_r}{\tau}\right] \quad (5)$$

$$u(t) = A\sum_{i=0}^{N-1} \mathrm{rect}\left[\frac{t - iT_r}{\tau}\right]\exp\left[j\pi\frac{B}{\tau}t^2\right] \quad (6)$$

$$u(t) = \frac{A}{\sqrt{P}}\sum_{i=0}^{N-1} \mathrm{rect}\left[\frac{t - iT_r}{\tau}\right]\cdot \exp\left[j\sum_{i=0}^{P-1} c_i\,\mathrm{rect}\left[\frac{t - iT_r}{\tau}\right]\right] \quad (7)$$

where $\mathrm{rect}\left(\frac{t}{\tau}\right) = \begin{cases} 1, \left|\frac{t}{\tau}\right| \le \frac{1}{2} \\ 0, \left|\frac{t}{\tau}\right| > \frac{1}{2} \end{cases}$

is the rectangular window function; A is the signal amplitude; T_r is the pulse repetition cycle; N is the burst pulse number; c_i is the phase-coded sequences in the i sub-code value (the value is only desirable as 0 or π for binary code) and P is the phase-coded length.

Simulation Of The Phased Array Antenna's Pattern Function

According to the characteristics of the phased array antenna, based on the literature [4] the antenna pattern function model can be simplified, as described below:

$$F(\theta) = \begin{cases} ASa\left[\frac{a\theta}{\theta_1/2}\right]K_0, \ |\theta| \le a_1 \\ BSa\left[\frac{a(\theta \pm a_{1.5})}{\theta_2/2}\right]K_0, \ |\theta| > a_1 \end{cases} \quad (8)$$

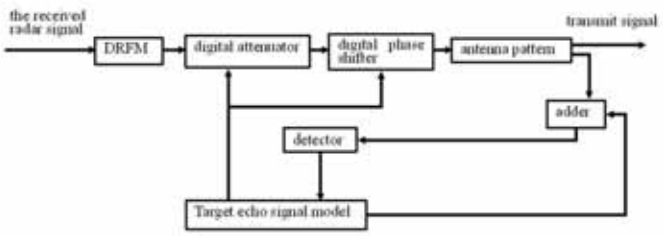

Figure 1: Block diagram of an active cancellation system's simulation structure

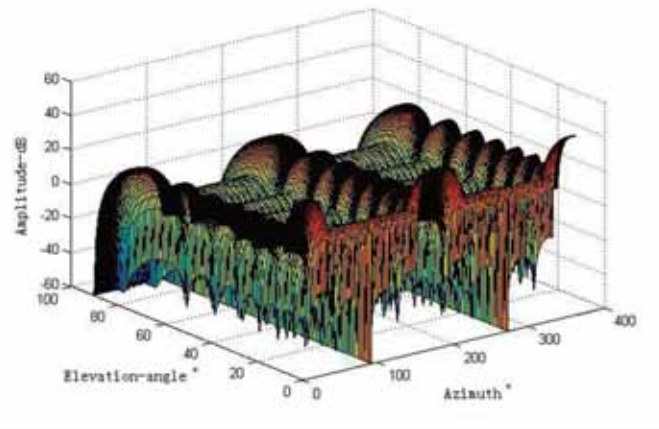

Figure 2: 16×16 array antenna pattern

where $K_0 = \sqrt{\cos\theta_0}$ is the control function of the phased array antenna beam gain with a scanning angle variation factor. θ_0 is the beam scanning angle; θ_1 is the unbiased beam main lobe beamwidth of 3dB; θ_2 is the unbiased beam first side-lobe with 3dB width; A is the unbiased beam main-lobe gain value; B is the unbiased beam first side-lobe gain value; a = 2.783; $a_1 = \pi\theta_1/a$, is the unbiased beam first zero (rad); $a_{1.5} = \pi(\theta_1 + \theta_2)/a$ is the unbiased beam first side-lobe peak point of view (rad). The three-dimensional pattern can be simplified into azimuth and elevation pattern multiplication result, as in:

$$F(\theta,\varphi) = F_\theta(\theta)F_\varphi(\varphi) \quad (9)$$

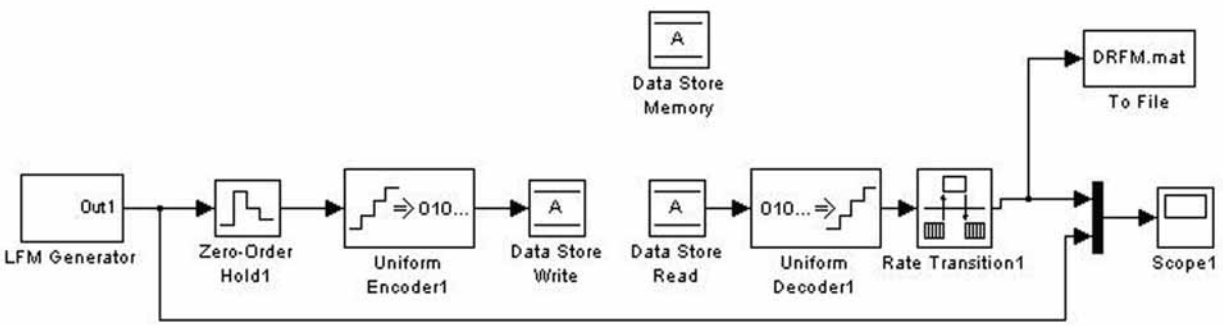

Figure 3: DRFM simulation in Simulink

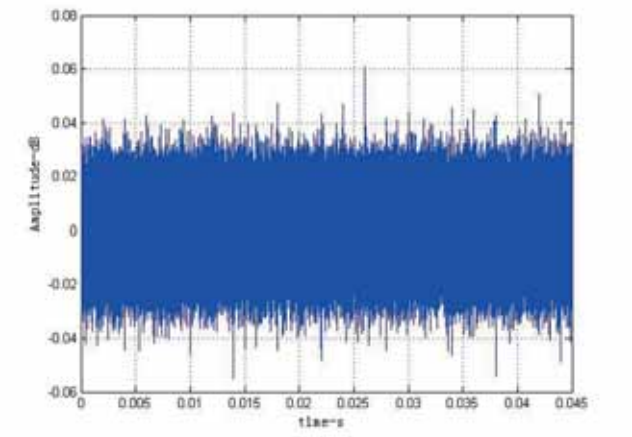

Figure 4: Clutter and noise in the echo signal (LFM)

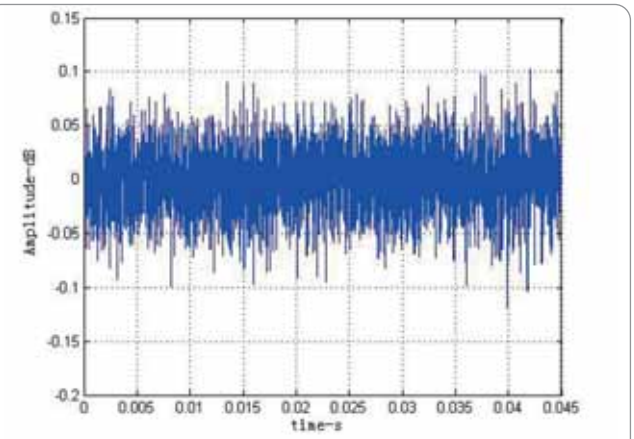

Figure 5: Clutter and noise in the echo signal (coherent pulse train signal)

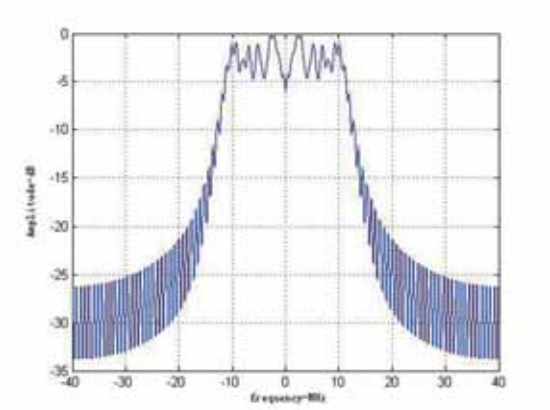

Figure 6: LFM signal spectrum

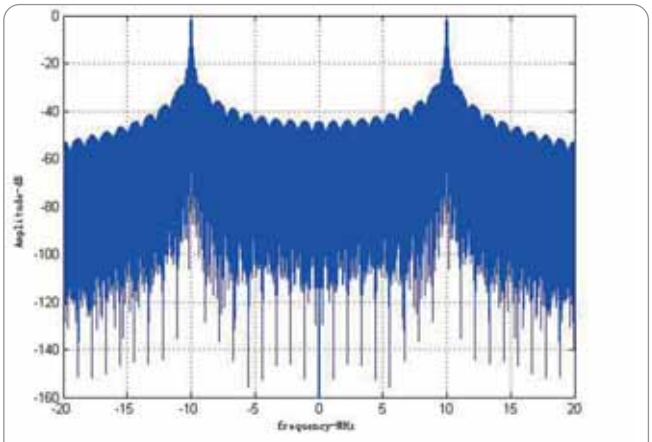

Figure 7: Coherent pulse train signal spectrum

where $F_\theta(\theta)$ is the azimuth pattern and $F_\varphi(\varphi)$ is the elevation pattern. We've assumed the radar antenna's vertical main lobe beamwidth is 2°, the main lobe's gain is 40dB; and the first side-lobe's width is 1° and gain 9dB.

Target Parameters Simulation

Setting the initial time as 0, the distance is R_0, the radial velocity is v_0 and radial acceleration is $a(t)$, so the target radial velocity in time is:

$$v_d(t) = v_0 + a(t)t \tag{10}$$

The target distance is:

$$R(t) = R_0 + a(t)t^2/2 \tag{11}$$

The target RCS is simulated by the χ^2 distribution model, with the random numbers being determined by the rejection method, whose steps are described as follows:

(1) Calculate the constants $a = \sqrt{2k-1}$ and $b = 2k - \ln 4 + 1/a$;
(2) Generate uniformly distributed, independent, random number r_1 and r_2 in [0, 1] intervals;
(3) $y = k[r_1/(1-r_1)]^k$;
(4) If $y > b - \ln(r_1^2 r_2)$, refuse r_1 and r_2, then return to the step 2;
(5) If $y \le b - \ln(r_1^2 r_2)$ use a random variable $x = \frac{y}{\left(\frac{k}{\sigma_{av}}\right)} = \sigma_{av}[r_1/(1-r_1)]^k$ which will be the random variable in compliance with the χ^2 distribution.

The Marcum model and Swerling model can be simulated by changing the k value [5].

Receiver Noise Simulation

Receiver noise is the Gaussian white noise, and through a narrowband filter output envelope it obeys the Rayleigh distribution. The following expression is obtained according to the transform sampling method:

$$\begin{cases} x_1 = \sigma\sqrt{-2\ln\lambda_1}\cos 2\pi\lambda_2 + \mu \\ x_2 = \sigma\sqrt{-2\ln\lambda_1}\sin 2\pi\lambda_2 + \mu \end{cases} \quad (12)$$

where λ_1 and λ_2 are independent and are in a uniformly distributed random sequence of [0, 1] intervals; σ is the noise variance; μ is the noise mean. Here x_1 and x_2 are used as the real and imaginary part of the complex data respectively. So the plural is the noise data with an amplitude distribution in accordance with the Rayleigh distribution. The noise variance σ^2 can be determined by the receiver noise coefficient N_F and the noise bandwidth Δf [6], i.e:

$$\sigma^2 = \frac{1}{2}kT_0N_F\Delta f \quad (13)$$

where $k = 1.38\times10^{-23}$ J/K is the Boltzmann constant; and T_0 is receiver reference temperature, which generally is $T_0 = 290K$.

Clutter Simulation

Clutter is an important part of the radar environment, including the clutter emanating from ground, sea and meteorological events among others. The model of the clutter power spectrum includes the Gaussian spectrum, Cauchy spectrum and All-pole models.

There are five types of amplitude distribution models: Exponential distribution, Rayleigh distribution, Log-normal distribution, Weibull distribution and K distribution. According to the three spectral models and five distribution models, coupled with other considerations, there could be over twenty kinds of model combinations.

The clutter model can be established with reference to the literature [7]-[15]. This article is prepared according to the Gaussian spectrum of the Rayleigh clutter model.

Active Cancellation System Simulation

An active cancellation system's simulation module mainly consists of digital radio frequency memory (DRFM), a digital phase shifter, digital attenuator, adder and detector (see the block diagram in Figure 1).

DRFM stores the received radar signals, which then passes through the digital attenuator (amplitude adjustment), digital phase shifter (phase adjustment) and then through the adder to couple with the target echo signal model. The results will be fed to the detector, and the detection of a DC voltage is sent for comparison with the target echo model. When the detector reaches the minimum output value, the system is at zero balance. At this time, the active cancellation system is moved to the transmitting state.

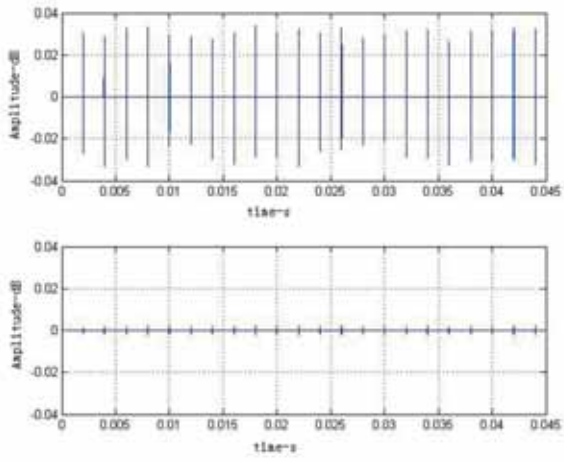

Figure 8: LFM signal echo cancellation before and after the contrast waveform

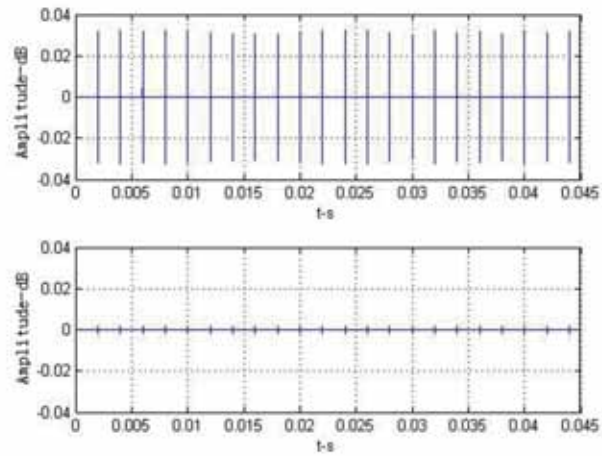

Figure 9: Coherent pulse train signal echo cancellation before and after the contrast waveform

Antenna Pattern Cancellation System Simulation

For the purposes of this article we considered a cancellation system for an M × N array antenna. According to the literature [16], the phased array antenna pattern can be described as in:

$$g(\theta,\varphi) = G(\theta,\varphi)|E(\theta,\varphi)||e(\theta,\varphi)| \quad (14)$$

where $g(\theta,\varphi)$ is the antenna pattern; $G(\theta,\varphi)$ is the directivity factor, only affecting the antenna's gain variation; $E(\theta,\varphi)$ is array factor, determining the beam shape; $e(\theta,\varphi)$ is the array element factor, so make $e(\theta,\varphi) \approx 1$; θ, φ are the azimuth angle and elevation angle of the array of spherical coordinates, $\varphi \in \left[0,\frac{\pi}{2}\right]$ and $\theta \in [0,2\pi]$. For the array element spacing of $d = \lambda/2$ in the x and y directions, $E(\theta,\varphi)$ can be expressed as:

$$E(\theta,\varphi)=\sum_{m=1}^{M}\sum_{n=1}^{N}I_{mn}\exp\left[jkd\left(m\tau_x+n\tau_y\right)\right] \quad (15)$$

where $k=2\pi/\lambda$ is the wave number; I_{mn} is the weighting coefficient (this study uses the 20dB Chebyshev weighting).

$$\begin{cases}\tau_x=\sin\theta\cos\varphi-\sin\theta_0\cos\varphi_0\\ \tau_y=\sin\theta\sin\varphi-\sin\theta_0\sin\varphi_0\end{cases} \quad (16)$$

In Equation 16 (θ_0,φ_0) is the beam pointing, and we assume it is $(0,0)$. If M=16 and N=16, the 16×16 array antenna pattern is shown in Figure 2.

DRFM Simulation

The amplitude quantization DRFM generally has five basic parts: a downconverter, analog-to-digital converter (ADC), memory, digital-to-analog converter (DAC) and upconverter [17]. The modeling and simulation is mainly for the ADC, memory and DAC, not taking into account the mixer. The Simulink block diagram for the DRFM is shown in Figure 3.

Simulation Results

The simulation conditions are:

(1) The radar's transmitting signal is a LFM signal or a coherent pulse train signal;

(2) The signal bandwidth is 10MHz, the pulse width is 10μs, and the pulse repetition frequency is 500Hz;

(3) The target moves with uniform speed in a straight line. The initial distance is 200km, initial radial velocity 300m/s, the elevation angle and azimuth angle are both 0 degrees, the target RCS is $2m^2$, using the Sweling II model. The simulation results are shown in Figures 4-9.

Figure 4 and 5 show the LFM signal and coherent pulse train signal superimposed on to the clutter and noise waveforms. It can be seen that the target signal is completely submerged in clutter and noise. Figures 6 and 7 show the spectrum of the LFM signal and the coherent pulse train signal.

Based on [18], we can define the cancellation as:

$$S=20\log\left[1+\left|\frac{\Delta\bar{E}}{\bar{E}_S}\right|\right] \quad (17)$$

where $\Delta\bar{E}$ is the cancellation's residual field and $\bar{E}_S$ is the target scattering field. When S = 0, then complete stealth is achieved.

Figures 8 and 9 show the echo cancellation before and after the contrast waveform of the LFM signal and coherent pulse train signal (excluding clutter and noise). It can be seen from Figure 8 that $\Delta\bar{E}_{max}=2.05\times10^{-3}$dB, and the corresponding cancellation S = 0.57dB, so the radar's maximum detection range is reduced to about 26% of the original value. In Figure 9 $\Delta\bar{E}_{max}=1.6\times10^{-3}$dB, the corresponding cancellation S = 0.45dB, so the radar maximum detection range is reduced to about 23% of the original value.

Accuracy And Validity

The simulation results show the accuracy and validity of the system model based on Matlab/Simulink. The system of the coherent pulse train signal cancellation effect is better than that of the LFM signal cancellation effect. Using active cancellation means the radar's maximum detection range can be reduced significantly. The simulation can be used as a technical reference for active cancellation system applications.

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REVIEW OF A UHF BAND TAG ANTENNA DESIGN

SIGNIFICANT ISSUES NEED TO BE ADDRESSED WHEN DESIGNING A TAG ANTENNA IN THE 860-960MHZ FREQUENCY RANGE. **PHANG WAI SAN**, **THIAN SU KIAN, ASHWINI SUGUMARAN** AND **JS MANDEEP** FROM UNIVERSITY KEBANGSAAN MALAYSIA, ANALYSE THE DESIGN CONSTRAINTS

Radio-frequency identification (RFID) technology is one typical scheme used in identification recognition. A typical UHF RFID system consists of several system applications, a read/write reader system and microchip-controlled tag attached to the object to be recognised.

Nowadays, RFID tags are more complex and are based on integrated circuit technology which offers embedded analogue, radio frequency (RF) and digital circuits. The tag consists of a chip, memory and antenna, and it can be one of three types: passive, active or semi-passive.

An active tag contains its power source, whereas in the passive RFID system, the tag antenna gains power from electromagnetic waves of the reader antenna, converting it into power to drive the tag chip. The tag comprises a charge capacitor (chip), thus the capacitance impedance (reactance) of the chip is fairly large.

Antenna Parameters

The antenna's main parameters include:

- Resonant frequency;
- Directivity;
- Gain;
- Input impedance;
- Voltage standing-wave ratio; and
- Polarization mode.

The most notable tag performance feature is the read range, which is sensitive to the material the tag is attached to and the propagation environment. The read range also depends on the antenna's gain, the reader's gain, transmitted power and transmission coefficient. Prerequisites for a good antenna include:

- Small size;
- Large gain;
- Low price;
- Commercially viable;
- Insensitivity to position and orientation; and
- Insensitivity to nearby objects.

The tag antenna should be very small so that it can be embedded into or attached to a particular object, such as a cardboard box, airline baggage strip, identification card or a printed label, for example. Nevertheless, small size tag antennas are also not very efficient and have lower reading ranges. Equally, the tag antenna must have adequate gain to transfer the identification data, even when the environment it is in changes. In Table 1 we outline the characteristics of existing UHF-band tag antennas.

In addition to these parameters, there are a few more important considerations to be made in getting the right tag antenna:

- The frequency band range needs to be between 860MHz and 960MHz.
- The resonant frequency is the centre frequency of the UHF band (910MHz).
- The radiation pattern has to be omnidirectional, which means that the radio wave's power is radiated uniformly (isotropic) in all directions in a single plane.
- Directivity is 0dB in an omnidirectional antenna. Increased directivity indicates a more concentrated or directed antenna. Lower directivity prevents a constant information feed when the items are moving within the supply chain.
- The gain must be greater than 1dB to transmit the power, with 1dB higher at the receiver end, received from a lossless isotropic source with the same input power.
- To realize maximum power transmission, the input impedance of the tag antenna must be matched to that of the tag chip. The input

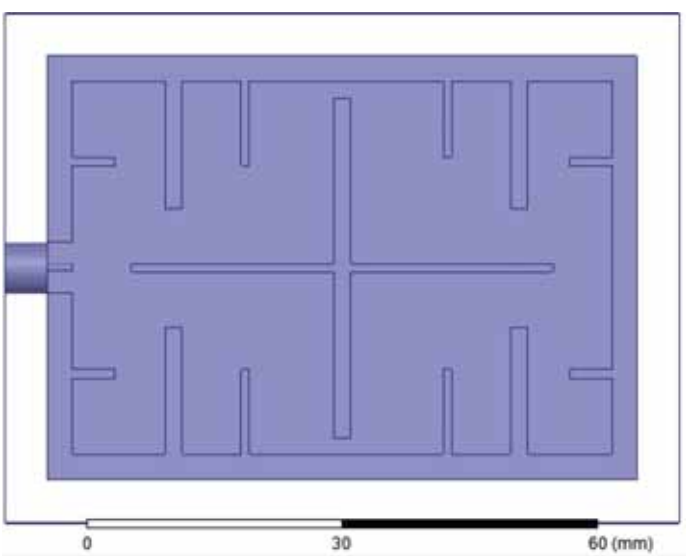

Figure 1: Design of a UHF tag antenna

	[4]	[5]	[6]
size (mmxmm)	-	66x13	80x30
gain (dB)	-	-	-
resonance frequency (MHz)	925	925	922.5
frequency range (MHz)	840-985	914-934	920-925
achieved impedance (Ω)	-	13+j131	18.95+j197.1
input impedance (Ω)	27-j198	11-j131	21.3-j191.7
read range (m)	-	6.2	2.3
chip	Alien H3 RFID chip	EPC Global class-1 gen-2	NXP G2XL IC chip
simulation software	HFSS	HFSS	CST@ microwave studio
substrate	FR4	FR4	FR4
Dielectric constant	4.2	4.4	4.3
Thickness (mm)	0.4	1.6	0.15
Radiation pattern	Omnidirectional	-	Omnidirectional
Return loss (dB)	-	-20.3	Less than -10

	[7]	[8]	[9]
size (mmxmm)	89x10 & 72x10	-	70x70 (47x47 patch)
gain (dB)	1.43 & 0.91	1.19dBi	-4.2dBic
resonance frequency (MHz)	922.5	922.5	925
frequency range (MHz)	920-925	920-925	922-928
achieved impedance	22.29+j194.67 and 25.56+j192.09	22.39+j196.49	-
input impedance	21.29-j191.7	21.29-j191.7	13.5-j110
read range (m)	6.25&6.02	7	6.5 - 7
chip	NXP G2XL IC chip	NXP G2XL IC chip	Alien IC Higgs
simulation software	CST@ microwave studio	ALR 9780	HFSS
substrate	FR4	FR4	FR4
Dielectric constant	4.3	4.3	4.4
Thickness (mm)	0.15	0.25	1.6
Radiation pattern	Omnidirectional	Omnidirectional	-
Polarization	Linear	Linear	-
Return loss (dB)	-22.60 and -25.07	-18.97	-18.97

	[10]	[11]	[18]
size (mmxmm)	-	-	65x65
gain (dB)	2	7.7dBic	-
price	-	-	-
resonance frequency (MHz)	912	922.5	870 & 935
frequency range (MHz)	908-914	920-925	860-960
achieved impedance (Ω)	-	23.43+j186.7	-
input impedance	43-j800	21.3-j191.7	-
read range (m)	2.5	2.6	2.1m (100X100mm)
chip	Philips EPC UCODE Gen 2 RFID	NXP G2XL IC Chip	Alien Chip Higgs-2
simulation software	HFSS V1000	CST	FastAnt, Agilent 8753ES VNA
substrate	Polymide	FR4	FR4
Dielectric constant	3.4	4.3	-
Thickness (mm)	0.0254	0.764	2
Radiation pattern	Omnidirectional	Omnidirectional	-
Return loss (dB)	-18.97	cover 887-960MHz	-3dB (855-

Table 1: Specifications of existing UHF-band tag antenna systems (continues on the next two pages)

	[19]	[20]	[21]
size (mmxmm)	95x14.5	9.8X1.5cm(EU)&9.7X1.3cm(NA)	44.1x44.1
gain (dB)	1.038	-	-
resonance frequency (MHz)	915	-	915
frequency range (MHz)	860-960	866-868(EU)&902-928(NA)	860-960
achieved impedance	16.46 +j148.04	-	6.3274+j127
input impedance	16-j148	-	6.2-j127
read range (m)	-	-	-
chip	UCODE G2XM TSSOP8	NXP UCODE G2XM	ALN-9338-R
simulation software	Ansoft HFSS	Ansoft HFSS	Ansoft HFSS
substrate	FR4	Kapton HN	FR4
Dielectric constant	4.4		4.6
Thickness (mm)	0.5	125um	1
Radiation pattern	Omnidirectional	Omnidirectional	-
Return loss (dB)	-	-	-

	[23]	[24]	[25]
size (mmxmm)	36x36	60x26x0.8	36x28
gain (dB)	-	-	6
resonance frequency (MHz)	920	915	915
frequency range (MHz)	860-960	916-926	902-928
achieved impedance (Ω)	27+j204	50.3+j800.5	49.2+j787.6
input impedance	27-j204	43-j800	49.2-j787.6
read range (m)	-	-	2.6
chip	Higgs-3 Alien technology	Philips U-CODE Gen 2 RFID chip	FEC-MMGen2/ MM3BS microchip
simulation software	Ansoft HFSS	-	HFSS

3

substrate	FR4	FR4	Polyethylen Terephthalate (PET)
Dielectric constant	4.4	4.4	-
Thickness (mm)	3	0.8	0.05
Radiation pattern	Omnidirectional	Omnidirectional	-
Return loss (dB)		0.02	

	[28]	[29]	[30]
size (mmxmm)	36x28	65x48	23.5x34
gain (dB)	-	2	3.03
resonance frequency (MHz)	915	915	910
frequency range (MHz)	-	860 - 960	915-924
achieved impedance (Ω)	9.5+j143.9	-	8.5+j154.3
input impedance	10.0-j143.0	6.2-j127	14- j143
read range (m)	-	-	7
chip	-	-	Aliens higgs 2 microchip
simulation software	-	-	HFSS
substrate	RF4	Polyamide	FR4
Dielectric constant	-	3.9	4.4
Thickness (mm)	1.6	50um	0.6
Radiation pattern	-	-	similar to typical dipole antenna
Return loss (dB)	5.5	10(887-953MHz) & 3(860-960 MHz)	-

	[31]	[32]	[33]
size (mmxmm)	95x8.2 (Tag 1); 95x7 (Tag 2)	-	40x44
gain (dB)	9.5	-	3
resonance frequency (GHz)	0.865, 0.915, 0.965	0.915	0.911
frequency range (MHz)	-	860-960	500-1500
achieved impedance	-	-	2+j146
input impedance (Ω)	17-j145	65-j110 (IFA); 40 – j800 (ILA)	- j146(short); 2 - j146 (match)
read range (m)	1	-	4
chip	Higgs chip	ASIC chip	-
simulation software	FEM	ADS-momentum	-
substrate	Polyethylene	-	PET
Dielectric constant	-	-	4.2
Thickness (mm)	0.15	-	0.018
Radiation pattern	omnidirectional	-	Isotropic CP RGS
Return loss (dB)	-	-	-

Table 1 (continued): Specifications of existing UHF-band tag antenna systems

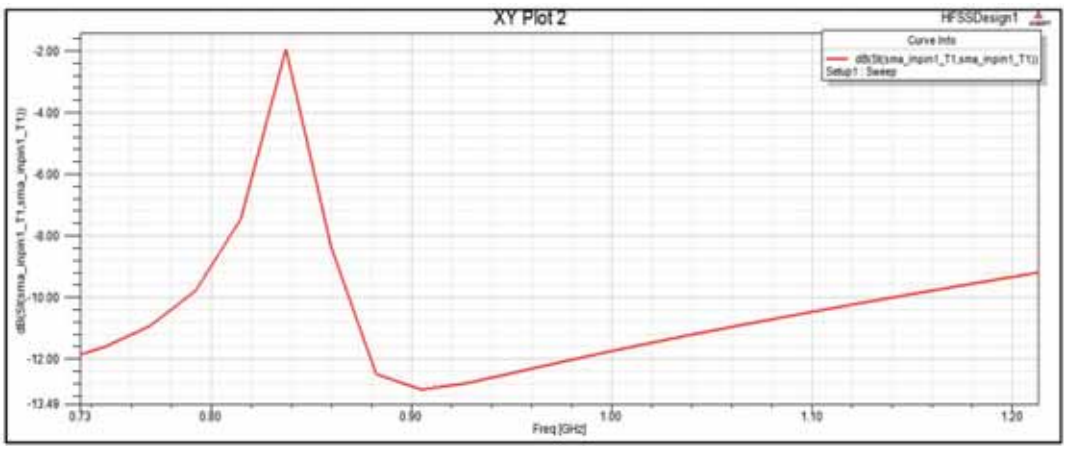

Figure 2: Return loss vs frequency

impedance of the chip is capacitively high, having high negative-reactance. Losses will be incurred if the antenna impedance is not an exact match with that of the chip impedance.

Approach And Methods

The voltage standing-wave ratio (VSWR) is the function of the reflection coefficient, which describes the power reflected from the antenna VSWR = (1+|Γ|)/(1-|Γ|), where the return loss RLdB = -20log(Γ) and Γ is the reflection coefficient.

The tag antenna is designed to be circularly polarized to ensure the power received by the CP antenna can be increased by 3dB and, therefore, the maximum reading range increased by 41%.

We've designed a simple cross tag antenna (see Figure 1) by using HFSS software. The substrate of the tag antenna is FR4 with dielectric constant of 4.4 and thickness of 0.5mm. The design parameters of this UHF antenna can be found in Table 2.

From the simulation results, we found the resonant frequency to be 906MHz, which is close to the expected frequency of 910MHz. In addition, the frequency band range is 867MHz to 1132MHz, compliant with the desired band-range. In addition, the return loss we get from simulation is less than -10dB in this frequency range, which was our goal. The results are shown in Figure 2.

The radiation pattern of our proposed design is omnidirectional and is shown in Figure 3.

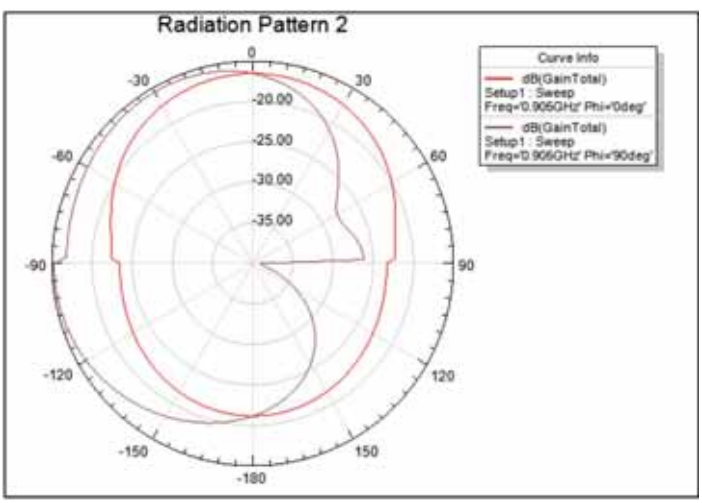

Figure 3: Radiation pattern

	OUR PROPOSED DESIGN
Size (mmxmm)	50 x 70 (Ground) 44 x 64 (Patch)
Resonance Frequency (MHz)	906.5
Frequency Range (MHz)	867.0-1132.0
Simulation Software	HFSS
Substrate	FR4
Dielectric Constant	4.4
Thickness(mm)	0.5
Radiation Pattern	Omnidirectional

Table 2: Design parameters of the proposed tag antenna

Meeting the Challenges of a UHF RFID Tag Antenna

To achieve better and more efficient antenna designs, we need to do future work to achieve the following results:

The gain must be greater than 1dB to transmit power 1dB higher to the receiver end, from a lossless isotropic source with the same input power.

To avoid extra work associated with creating RFID tag designs specific to a limited number of environments, they should be modelled and included in the application of the design in great detail. ●

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SOFTWARE: THE LEGAL DOS AND DON'TS

INFORMATION TECHNOLOGY AND INTELLECTUAL PROPERTY LAWYER **DR MICHAEL SERVIAN** OF FREETH CARTWRIGHT'S STOKE ON TRENT OFFICE SHARES HIS EXPERTISE ON LEGAL MATTERS RELATING TO SOFTWARE

There isn't a business today that doesn't use software in one form or another, and many companies commission or create their own software for use in the workplace. However, with the increasing popularity of 'Bring Your Own Technology' schemes and the prevalence of mobile devices and open-source software, it is also increasingly difficult to keep a handle on exactly what software is being used for, by whom and in what way. Sadly, the pitfalls of losing track of software usage could lead to legal infringements and expensive litigation.

Copyright

By and large, it is copyright which governs what can and cannot be done with software. As a key area that is becoming ever more fraught with new complications, it's crucial to understand what software copyright actually covers, how to get these rights and what can and can't be copied.

Someone who creates a piece of work will not necessarily own any rights in it, far less any absolute right against the work being copied. First off, copyright only protects specified works. This is, however, a very long list, ranging from music to paintings. So far as software is concerned, the list can include:

- What the user sees on screen (the "GUI"), and this might in turn cover static images, frames and movement;
- The functional specification: written record of what the software is meant to do;
- Preparatory design materials, for example, diagrams showing how the software will hang together;
- Algorithms: the logical steps that will be taken by aspects of the software, perhaps written out algebraically;
- Source code: the instructions to the computer written out in a way that a person can understand, and written in one or other of the "languages" understood by computers;
- Object code: the computer's translation, or "compilation" of source code into binary numbers;
- Databases;
- Means to prevent software from being copied (as the law says, "circumventing" this is a definite no-go);
- Manuals;
- Computer-generated works (again, from music to paintings).

The second thing to understand is that copyright doesn't last forever; however, with the rapid development of software and a copyright term lasting until 70 years after the death of its author, it may as well. Computer-generated works are discriminated against here, since they only enjoy 50 years' protection.

Copyright only protects "original" works. However, the threshold is modest. The work must merely have involved a degree of skill, labour and judgment and not have been copied from another work. Finally, copyright arises automatically when a relevant work is recorded, and this is without the need to register, pay or do anything more.

Works Ownership

The most important thing to understand is who owns software copyright. The starting point is that the person who puts fingers to keyboard will own the copyright in the software they write. However, unless this person is writing software speculatively on his own account, things are seldom that straightforward. If the software writer is an employee, unless the contract of employment says otherwise and if the software was written in the normal course of the employee's duties, then the copyright belongs to the employer. There might be issues here about, for example, the extent to which the employee had already written the software before his employment, whether software written "out of hours" also belongs to the employer or not, and whether an employee's duties extend to software writing. Marking software with the "©" symbol, stating the owner and year it was written, helps to prove ownership and establishes rights in some countries.

> Sadly, the pitfalls of losing track of software usage could lead to legal infringements and expensive litigation

Unless there's a written transfer of the rights, a consultant (e.g. an external software designer or software house) will be the first owner of the copyright in any functional specification, source code or other works that they write. If there is something in writing about the uses to which the commissioner may put the software, for how long, etc, then that will normally apply. However, if he is paid for the work, the consultant will be deemed to have granted an "implied licence" to the commissioner to use the work for the purposes for which it was commissioned. It goes without saying that the latter approach leaves room for serious dispute: e.g. whether the commissioner is allowed to use the same software for other projects.

Another area to watch out for is where software is developed by two or more people. If the respective contributions can be

Figure 1: It's crucial to understand what software copyright actually covers, how to get these rights and what can and can't be copied

easily separated, then each will own the copyright in his own input. However, where the contributions can't be separated out in this way, the works will be jointly owned. If there is no agreement on how things will pan out, then each of the authors can use the software and sue if it is found to be misused.

However, each author will need the consent of the other/s if he wants to allow third parties to use the software or if he wants to sell his copyright. If one of the joint authors dies, then his share of the copyright passes not to the other author/s but to his heirs.

Finally, whilst software writers generally keep hold of their ownership of their software and give others permission to use it to a limited extent, software copyright itself can be sold either outright or in part (e.g. for a particular period of time).

Copyright Infringement

Once ownership is established, the key thing to understand is what constitutes software copyright infringement.

An owner can sue someone who copies his software. Copying covers a multitude of sins, ranging from photocopying manuals to re-keying code. Even "transitory" copying is caught, e.g. running or storing the software. Translating source code from one computer language to another infringes, as does (apart from one exception that we'll come back to) decompiling object into source code. Other types of prohibited copying include getting around code designed to prevent the software from being copied!

One key area is the difference between literal and non-literal software copying. In another field of endeavour, there's quite a difference between "copying" a chef's recipe by photocopying it or by watching the chef carry out the recipe and making notes of your own.

There is also another type of activity that infringes software copyright, and this is where someone knows that they are holding an infringing copy of the software (say on a CD-ROM), and distributes that copy without the owner's permission. In fact that, as well as knowingly copying software, can also amount to a criminal offence.

What doesn't infringe software copyright?

A copyright owner can give one or more people the right to use his software under the terms of a licence. There may be rules on the period of use, number of users, where the use can take place, payments, and so on. Under such an arrangement, a licensee may study the way his software works. He may make a back-up of his copy of the software and, unless his licence forbids this, he may correct errors in the software. Whatever his licence says, he may also "decompile" the software (translate the computer-readable object code into human-readable source code), but only to the extent that this is required for him to link this software with some other software. The more senior an employee the more likely that a job specification which does not expressly mention software writing will be read to include writing software. It is possible to sell software copyright even before it is written, so long as this is done in writing.

Open Software

How "free" is open source software?

Some open-source software can be used as you like with little significant obligation to its publisher beyond, perhaps only redistributing it on the same basis as you received it (maybe acknowledging its author and offering royalty-free use may be linked with a request for a donation to its author).

More normally, however, open-source software is subject to a bundle of serious can- and can't-dos. As we have seen, software is subject to copyright, and any use of another's software (however "free" it is expressed to be) will be subject to some limited form of licence. Some open-source software can be used for developing other software. This might be fine if you are only using that open-source software to develop applications for your own use. However, if you want to on-sell or license the developed software, there could be issues that need addressing. Some open-source software is made available on the basis that if you use it to develop other software, then you must make that developed software available for the world to use on the same terms as the original software.

> If you are writing software for use by others, it would be helpful if you could always identify any open-source element in your software

In other cases you are allowed to charge for the use of the developed software, but only if you make it possible for the user to separate out the open source software and give them the same permissions to use that open-source element as you had when you used it.

Whilst open source software writers do not generally offer access to that software in order to trap users into accepting financial commitments to them, the terms of use of open-source software are increasingly consolidating around a number of standard forms. This, in turn, might be expected to create common interest amongst writers of open-source software, encouraging joint action to object to unlawful use.

Whether or not that happens in practice, a software writer will likely be making actual (or implied) promises to his licensees that they have the right to use their software without complaints from others, including complaints from the writers of embedded open-source software. Any company thinking of investing or perhaps buying the software writer's business will be concerned to see it is not picking up responsibility for promises that could not be kept. A possible investor will also think twice if the writers' software portfolio is based upon the use of open-source software the subject of inappropriate open-source licences.

If you are writing software for use by others, it would be helpful if you could always identify any open-source element in your software. If needs be, for example if you want to change your licensing strategy, it will be invaluable if you can easily pinpoint the open-source coding in issue and re-write that aspect yourself, or use some less restrictive open-source software. ●

Figure 2: Copyright only protects specified works; this is, however, a very long list, ranging from music to paintings

SSLs SEE BRIGHT FUTURE IN AUTOMOTIVE PLATFORMS

By Chris A. Ciufo, Mouser Electronics

The world is positively aglow with rapidly changing technology trends in solid state lighting (SSL) LEDs. According to the Department of Energy (DOE) costs dropped by a third in 2011 to about $12 per thousand lumens and will be on their way down to $2 per thousand lumens by 2015 (Strategies Unlimited, August 2012). In 2013, tech innovation will be focused on volume SSLs, where payback is fastest in streetlights, office buildings and automobiles per the DOE's Multi-Year Program Plan 2012.

SSL costs do not scare automobile OEMs. High Brightness LED SSLs proliferate in vehicles due to their brightness, microsecond diode turn-on speed, long life, and shock/vibration reliability. Exterior and daytime running lamp SSLs using multichip chip-size packages will be molded directly into the vehicle body without consideration for replacement, or used to add design elements. SSLs can change colors, giving owner personalization and brand differentiation. Mercedes recently demonstrated a vehicle with embedded LED panels to create a moving digital sign; high density OLED SSL flex circuits embedded on taxis or service vans are a marketer's dream.

SSLs will find their way inside the vehicle, too, but efficient dimmers remain a challenge as in commercial sectors. SSLs facilitate changeable analog instrument and switchgear backlighting, and OLED SSLs from TVs and smartphone screens will backlight LCD displays in "glass cockpit" instrument and in-vehicle infotainment center stacks. As on the exterior, SSLs will create cabin ambience lighting but here using InGaN medium-power LEDs by illuminating foot wells, door handles/panels and storage compartments. SSLs will be selected for Kelvin color temperature. "Cold" (6000K) white keeps drivers alert, while warm (<4000K) colors accentuate premium interiors.

Automotive SSLs have other benefits including: low current means light-weight alternators in concert with regenerative breaking charging, plus reduced gauge wire weight - possibly satisfied by on-board digital networks such as PoE, CANbus, or Ethernet AVB.

Driven by streetlights and office HID fixture replacement, SSLs as chip-on-board headlights might replace medium reliability (2,000 hour) HID Xenon bulbs, or hot low reliability (450 to 1000 hour) halogens. White LEDs at 5500K approximate daylight, may outlast the vehicle at 25,000 to 50,000 hours, and can be assembled into intelligent "smart" lamp/sensor arrays that see through rain by DSP-controlled dimming, or adjust from flood, to spot, to "corner."

New technologies for LED light engine arrays containing LEDs, drivers, phosphor/optics, thermal over-protection and heatsinks will be critical to keeping automotive LEDs below maximum Tjunction due to an automobile's environment.

Other design considerations for 2013 will be reducing headlight output at cold temperatures to stay within regulations. Also, backside emitter heat could move conductively to the lens face to melt snow and ice.

For more information, visit uk.mouser.com/applications

WHAT THE READERS SAY

THE DECLINE OF SCIENCE

The reality in science today is massively divorced from its image.

I think that, through nobody's fault, a structure has developed which will prevent any major scientific advance in the future. To modify the last sentence, even if nobody was ill-motivated, the blocking structure would still have developed. The problem is not caused, but only exacerbated by, miscreants.

Dr Ivor Grattan-Guinness pointed out to me many decades ago that the introduction of compulsory universal education was a major factor in what later developed. This occurred in Europe in 1800 and in England in 1870. The result was that a major new social group, which I call professional knowledge brokers, developed. The economic, prestige and other base of a professional knowledge broker is the body of knowledge that he administers – teaches, "researches into", publishes on, examines on, and so on.

"Researches into" is the pivotal factor among those factors cited above. For a century, it was thought that research could be pursued by professional knowledge brokers, and that it was compatible with, and encouraged by, the other activities in the above list.

To quote Wikipedia: "Newton himself had been rather more modest of his own achievements, famously writing in a letter to Robert Hooke in February 1676: 'If I have seen further it is by standing on the shoulders of giants.'"

Here we see Newton downplaying his achievements and re-classifying them as what T S Kuhn calls "Norman Science", not what they really were – "Revolutionary Science". This is because a "Paradigm Shift", such as Newton's work, far from "standing on the shoulders of giants", cuts down the past giants and destroys their work. When the theory of oxidation took over for burning, all of the pre-existing phlogiston theory was destroyed, and disappeared. Today, such a change would mean that lecture notes and text books would have to be destroyed. As Kuhn says: "normal science" advances by accretion, whereas "revolutionary science" advances by way of destruction. Even back then, Newton knew that his "revolutionary science" would meet with opposition. Today, an attempted paradigm shift threatens to destroy a professional knowledge broker's lecture notes, text books, prestige, salary, promotion and pension.

Onto this stage comes the "lateral arabesque"; the supposed situation where academia controlling a discipline – electromagnetic theory for example – maps onto the real subject, is unstable. If at any moment the professors administering a discipline happen to be weak in one branch of it, they will tend to not examine their students in it, and so will tend to select out those up and coming students who have that sub-discipline as their strength. Positive feedback down the generations of students will further the retreat from that particular sub-discipline. (Sir James Jeans and Einstein could be said to be telling us that academia have selected out budding scientists who showed a grasp of the physics, rather than the maths, of their subject.) Similarly, the whole of academia will move deeper and deeper into any misconception or aberration, and there is no corrective force. In my view, 'The Lateral Arabesque' makes it possible for an academic subject's content to end up with no overlap at all onto the real subject from whence that branch of academia sprang."

> *As Kuhn says: "normal science" advances by accretion, whereas "revolutionary science" advances by way of destruction*

This was published in 1985. I did not then realise, but realise now, that professors and students today have more or less fully replaced real electromagnetic theory by a collage of dubious, complex mathematics.

When discussing "The Scientific Referee System", MacRoberts and MacRoberts say that those who defend the established theory do not understand the new theory. However, my recent research shows that they also have a very poor grasp of the theory they are defending against paradigm shift.

The eruption of digital electronics onto the scene in electromagnetic theory was rapid and brutal. Academia were horrified at the crude use of amplifiers in digital electronics, replacing the elegant class A with a crude Class D, which however rapidly ousted Marconi-style radio electronics in the marketplace, and today represents 95% of all electronics. Academia successfully blocked the intrusion of any insights gained in digital electronics, and continues to do so today, more than half a century later. Today – worldwide – academics have a very poor grasp of Heaviside's Morse pulse, now reappearing as the logic signal, or a *pulse* in a USB cable in the computer in your bedroom.

Groups on the periphery of science include Philosophy of Science, Sociology of Science, History of Science, Politics of Knowledge, Research into Censorship, general media and scientific media.

For science to survive, it would be necessary for these groups to discipline science, and to look into possible misconduct by professional science. However, the problem is probably that they also are professional, and rely on fringe funding and reputation from mainstream (decadent) science. The role they play in practice is to validate the behaviour of mainstream (decadent) science.

In pursuit of reputation (and funding) will probably reflects the behaviour of these groups – Philosophy of Science, Sociology of Science, History of Science, Politics of Knowledge, Research into Censorship, general media and scientific media. Their writings and behaviour all tend to validate and support a decadent mainstream, again for reasons of pursuit of prestige.

Ivor Catt
UK

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FANGCHENG LÜ, CHUNXU QIN AND **YUNPENG LIU** FROM NORTH CHINA ELECTRIC POWER UNIVERSITY INTRODUCE LEAKAGE CURRENTS OF ±800KV UHV DC (ULTRA-HIGH

Fibre-Optic Technology For Online Monitoring of Leakage Currents Of ±800kv UHV DC Insulators

±800kV UHV DC (Ultra-High Voltage Direct Current) transmission lines are being widely used in high altitude areas. The insulator's leakage current is one of the most important parameters to monitor. It is typically in the microamps range and it can easily be affected by outside conditions, such as environmental contaminants, moisture and the ultraviolet radiation found at high altitudes. As such, power grid operators regularly check the status of their UHV DC equipment, making sure the insulators are operating correctly.

We developed a fibre-optic transmission system to overcome external electromagnetic interference affecting the monitoring equipment.

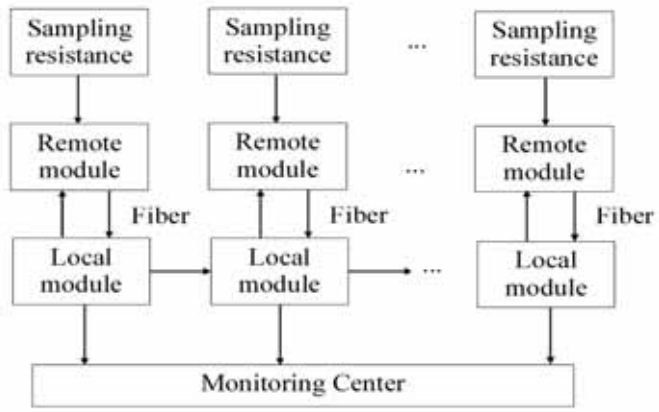


Figure 1: Schematic diagram of the monitoring system

System Design

The schematic diagram of the monitoring system is shown in Figure 1. The leakage current of the insulator flows to ground through the sampling resistance, which is a high-precision earthing resistor. The OPDL (Optically Powered Data Link) detects the voltage across the sampling resistor and transfers it to the local server through optical transmission. The local server's software 'restores' the value of the real-time leakage current and displays it, enabling an easy long-term monitoring of the ±800kV UHV DC insulator's leakage current.

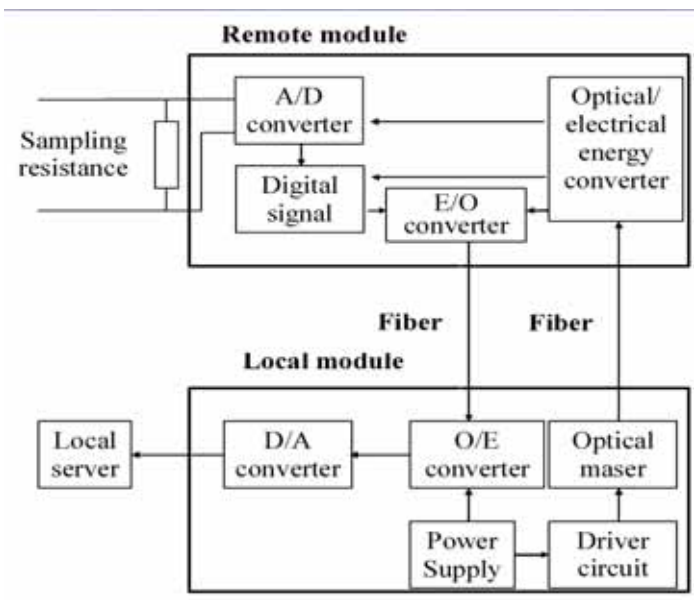


Figure 2: Schematic diagram of the OPDL

Avoiding interference during signal transmission ensures data reliability. So, the system measures the UHV DC insulator's leakage current by using the OPDL (see Figure 2). As such, it benefits from several advantages of optical transmission technology, such as high insulation, immunity to EMI and so on.

The Hardware

The OPDL consists of a remote module and a local module. The signal and data between the two modules are transferred by optical fibres. When the leakage current of the insulator transfers across the high-precision sampling resistor, the remote module part of the OPDL captures the value of the voltage drop, which is then modulated into a digital signal and transferred as an optical signal through the optical fibre. This data is then displayed by the server as a real-time insulator leakage current.

Each remote module can collect three voltage signals at the same time. Since they collect and convert the data, they also contain optical/electrical and vice-versa conversion circuits, an A/D conversion circuit and other components.

The local module of the OPDL is installed in the control room. It is responsible for the synchronization and

THE LABORATORY OF POWER TRANSMISSION AT THE A FIBRE-OPTIC ONLINE MONITORING SYSTEM FOR VOLTAGE DIRECT CURRENT) INSULATORS

THIS REGULAR FEATURE COVERS CHINESE RESEARCH AND DEVELOPMENT (R&D)

consolidation of signals coming from each remote module, and it communicates with the server via a USB serial port. It also includes other circuits, such as the power supply, laser, driver circuits, signal processing, optical/electrical conversion as well as a D/A conversion circuit. Electric signals are converted into light by the driver circuit and the laser device.

To ensure high reliability, the system uses Advantech's PCI-1761 relay card for restarting. When there's a communication failure of the OPDL, the software controls the relay terminal of the PCI-1761 relay card to restart the corresponding local module. If the module fails to restart, the system then restarts the server. That way monitoring the leakage current of UHV DC insulators continues steadily and reliably.

The Software

The software is based on virtual instrumentation technology and uses the LabVIEW graphical programming language as the development tool. Data transmission and communication between computer and modules are driven by VISA, based on the LabVIEW virtual instrument. The storage, analysis and management of the leakage current are based on the SQL Server 2005 database management system. The monitoring system acquires the information and manages the remote control by using the ASP.NET technology and remote front panels of LabVIEW.

The software is modular in nature and is based on hierarchical classification. It contains a graphics, monitoring and information inquiry systems. The graphics system provides the graphical user interface. The monitoring system analyses and calculates the leakage current and returns the data to the device information database. The information inquiry system can complete the local queries and web publishing, and it can also transmit the data to the monitoring centre through LAN or Internet. The monitoring system's structure is shown in Figure 3.

The real-time status of the OPDL is displayed dynamically, and the system also has an alarm function. When the leakage current exceeds a warning value, the system will send a visual and audible alarm to warn the operator. The monitoring system can check the real-time data, the historical data and the year/month/day trend curve of a specific insulator. That way staff can observe the long-term changes of insulator leakage current to know the contamination conditions of the corresponding insulator at all times.

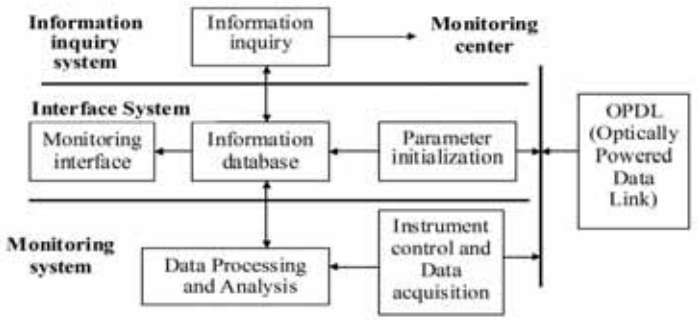


Figure 3: Structure chart of the monitoring system

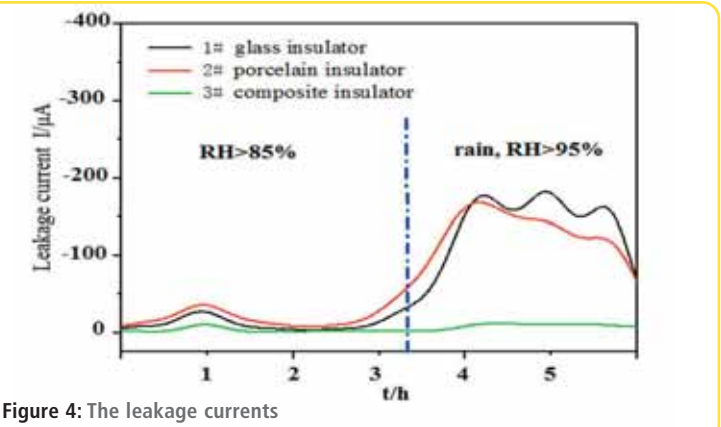


Figure 4: The leakage currents

Applications

The described fibre-optic online monitoring system has been installed on a site for long-term live monitoring of UHV DC insulators. It monitors leakage currents of insulators from different manufacturers, stores the data and allows assessment of the insulators' conditions at all times.

The system has been running for about a year, analyzing the leakage current of a glass insulator, a composite insulator and a porcelain insulator. Their leakage current curves are shown in Figure 4. The leakage current was monitored when the ambient relative humidity was greater than 85% and in light rain.

As shown in Figure 4, it is obvious that the leakage currents of the glass and porcelain insulators are much larger than that of the composite insulator. This phenomenon is particularly significant in rainy conditions. Moreover, the leakage currents of the glass and porcelain insulators increase rapidly in the rain, which is not found on the current curve of the composite insulator. This phenomenon is due to the better hydrophobic qualities of the composite insulator.

A MONTHLY COLUMN ON TEST AND MEASUREMENT (T&M) ISSUES

T&M Discovering New Sources Of Visibility

BY **REG WALLER**, EUROPEAN DIRECTOR, ASSET INTERTECH INC

Engineers expect one thing above all else from their test and measurement (T&M) tools: They always want visibility – that elusive ability to see what's happening so they can be assured the chip, board or system is behaving to expectations. And if they are misbehaving, the engineer has to have visibility to fix the problem.

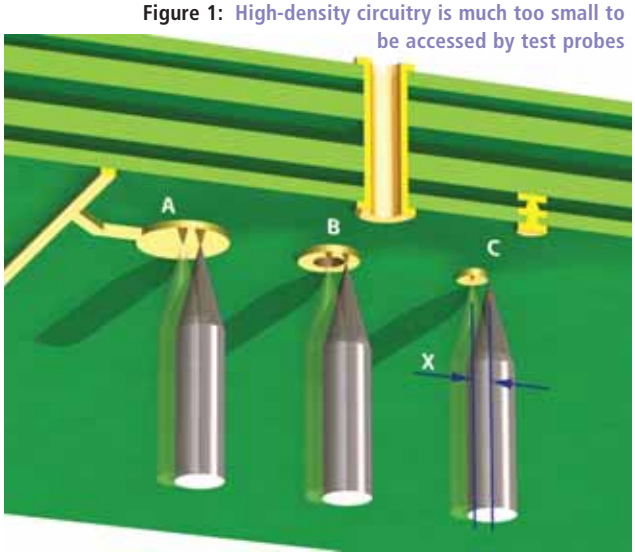
This need for visibility doesn't change, but what does change, and rather rapidly at times, is the underlying technology engineers are working on. The inevitable progress of technology often affects the visibility provided by T&M systems. Recent advancements in chips and board design have made it abundantly clear that only a more introspective perspective – a look from the inside out – will provide this visibility moving forward.

Hardware, Software or Both?

Even over the relatively short period of the last five years, the advancements in microprocessors, communications chips, memory, even software and firmware design, as well as other base technologies have been phenomenal. Practically all aspects of technology have advanced by leaps and bounds.

Simultaneous with the many breakthroughs, innovations in packaging techniques have made physical access to chip pins for test equipment nearly impossible. Moreover, new circuit board design and fabrication techniques have sacrificed T&M visibility to take advantage of technological innovations. External physical access for intrusive probes, which has been a mainstay of T&M equipment for decades, has become harder and harder to come by.

Figure 1: High-density circuitry is much too small to be accessed by test probes



Increasing circuit density offers just one of the many examples of disappearing probe access. Recently, the geometry of chips in ball grid array (BGA) packaging has shrunk considerably, dropping from 0.4mm ball pitch (centre-to-centre spacing) to 0.3mm. This seemingly small shift has had tremendous effects on probe access. A 0.4mm ball pitch allows enough room for a via – those vertical interconnects that span multiple layers on a printed circuit board (PCB) – to be routed through the PCB and connected to the chip on the opposite surface by way of a high-density interconnect (HDI). But fine pitch 0.3mm BGAs do not offer enough room on the board surface for a via, except directly into a ball or pad on the device (see Figure 1).

To accommodate smaller device geometries and greater circuit densities, new circuit board manufacturing methods like micro-vias for HDI have been adopted. These board design and assembly methods have made physical access for probe-based testers like in-circuit test (ICT) systems even more difficult to come by, since the surface features – if there are any – are much too small to access by test probes.

Alongside the advancements in hardware technologies, a radical shift in the system's software and firmware environment has taken place. In a word, it has exploded. Firmware has become the glue that binds together today's multiple processing elements and the many intellectual property (IP) cores, to say nothing of the multi-threaded, multi-module software programs that constantly interact with each other through firmware. More so than ever before, developers must now be able to trace and track through the tangled web of firmware/software to understand why a system is functioning the way it is.

Historically, debugging software and validating/testing hardware have been separate disciplines, each with its own set of challenges. But now, the interaction of hardware and software has become just as critical to the T&M engineer as the way hardware and software function on their own. This adds a third dimension to the challenge T&M faces today.

Merged Methodology

Today, software debug and hardware validation/test have more in common than ever before. They are a truly integral parts of the same system bring-up process (Figure 2) that occurs on prototype hardware just prior to transitioning a new design into volume manufacturing. A merged methodology is able to combine software/hardware debug, validation and test in one holistic approach; the bring-up process is shortened as a result and systems get to market sooner.

The basis for this sort of merged or holistic approach is embedded instruments, those IP cores that are commonly embedded in chips these days to overcome the absence of external physical access for probes and to act as internal, or inside-out, engines for debug, validation and test.

In addition to the T&M functionality provided by embedded instruments, a tools platform able to take advantage of them can become the basis for collaboration between hardware and software engineers and accelerate a new design's transition from design into manufacturing. With a tools platform based on embedded instrumentation, both disciplines could leverage the expertise of the other without individual engineers being forced to climb a steep learning curve and become expert in the other's discipline.

For example, software engineers might want to collaborate with their hardware colleagues, but they don't have the time or inclination to become experts in hardware design. A merged methodology would allow the software engineer to leverage his colleagues' hardware knowledge by deploying simple push-button tests that rule out hardware-based discontinuities between the firmware and hardware, or faults in the underlying hardware. System bring-up is accelerated by immediately limiting and focusing the debug investigation. The more possible causes that can be ruled out, the sooner the bug or fault can be found. The real cause of the problem is isolated sooner and the system moves into manufacturing on schedule or before.

And that's why test and measurement engineers are constantly seeking greater visibility. With it, they can do wonders. ●

> *To accommodate smaller device geometries and greater circuit densities, new circuit board manufacturing methods like micro-vias for HDI have been adopted*

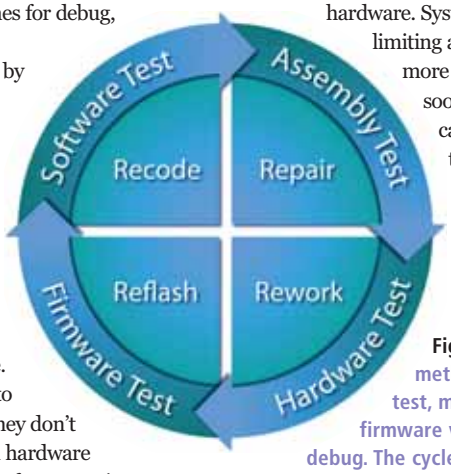


Figure 2: A merged bring-up methodology might begin with assembly test, move into hardware validation and firmware verification before reaching software debug. The cycle could be repeated on subsequent lots of prototype hardware

NEW 10/40GIGABIT ETHERNET SWITCH FROM KONTRON

At the DSEI 2013 (Defence Security and Equipment International) Exhibition in London, Kontron has presented a new 10/40 Gigabit Ethernet switch that is designed to significantly enhance and standardize data throughput in network-centric OpenVPX applications. The outstanding feature of the fully managed Layer-2/Layer-3 switch Kontron VX3920 is its 24 high-throughput 10Gbit/s ports to the data plane. These can be scaled through channel bundling even up to 40Gbit/s bandwidth.

By using this new rugged switch for inter- and intra-system communication, OEMs can achieve an enormous performance boost for their applications. Also, other highly individual data buses can now be replaced. Rugged COTS systems profit from the application of Ethernet – the standard high bandwidth network protocol of the IT business – by reduced costs, comprehensive enterprise class switching functionalities and a stable technology roadmap, which can also increase long-term system availability.

www.kontron.com

PC Oscilloscopes With Deep Buffer Memory And USB 3.0 Superspeed Interface

With up to 500MHz bandwidth on four channels and an industry-leading 2G samples of buffer memory, the new PicoScope 6000 Series has both the performance and the advanced analysis capability to speed debug of today's complex electronic designs.

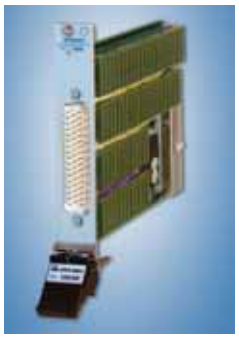
The PicoScope 6000 Series employs hardware acceleration and a USB 3.0 interface to acquire and display many megasamples of data per screen update without slowing down. Engineers can observe large portions of their design's electrical behaviour at one time, and in great detail, which helps reduce debug cycles and enables electronic design projects to be completed on schedule.

All models include an integrated function generator or arbitrary waveform generator (AWG), advanced triggering, automatic measurements with statistics, an FFT spectrum analysis mode, comprehensive waveform maths, mask limit testing and serial decoding for popular industry standards such as I2C, SPI, UART, CAN, LIN and FlexRay.

www.picotech.com

PICKERING INTERFACES ANNOUNCES NEW SWITCHING MODULES AND CHASSIS

Pickering Interfaces has launched five new switching modules and chassis at AUTOTESTCON 2013 in Chicago. These products include a new 3U 16-Amp PXI switching module, a 5-Amp PXI power multiplexer module, a 32-Channel PCI digital I/O card, an upgrade to its popular LXI modular chassis and an upgrade to one of its PXI microwave multiplexers.



The new 3U 16-Amp PXI switching module (40-161) is capable of switching currents up to 16A and voltages up to 300VDC/250VAC with hot switch power of 480W at 30VDC and 4000VA at 250VAC. The new switching module is available with configurations of 16, 12, or 10 SPST, or 12 or 6 SPDT relays. It occupies one slot of a 3U PXI chassis, and user signals are carried on one or two GMCT 24-way connectors fitted with 16A contacts. It is supported in any PXI chassis, a PXIe hybrid slot on a PXIe chassis, or on the Pickering Interfaces LXI modular chassis for applications where Ethernet control is preferred.

www.pickeringtest.com

Wider Range Of Hi-Rel Connectors From Harwin Available From Stock

Harwin has broadened its range of Datamate Mix-Tek mixed-technology connector series that is available as standard off-the-shelf products. Now horizontal and coax versions of the popular 2mm pitch hi-rel family are immediately available for designers, reducing design time.

Harwin's Datamate Mix-Tek connector range can be customer specified in a huge number of configurations of signal, power and coax contacts. But in order to respond to industry demands for fast turnaround, the company has made the most commonly-chosen variations available as standard items. The new horizontal format and coax contact variants add to 41 other configurations that are also stocked as standard items, these include power only configurations from 2-10 power contacts and mixed contact configurations from 2-signal/2-power through to 12-signal/4-power. The standard range focuses on the most popular male PCB contact styles mated with female crimp options. Hexagonal slotted jackscrews are offered across the range.

www.harwin.co.uk

MOUSER AND INTEL ANNOUNCE GLOBAL DISTRIBUTION AGREEMENT

Mouser Electronics has signed a global distribution agreement with Intel to represent its entire portfolio of mobile, desktop and server products. Included in the Mouser's Intel portfolio are the latest 22 nm Core i7, i5, i3, Pentium, Celeron and Xeon processors – ranging from the most advanced fourth generation Core through previous generation Core and Atom processors. Also available are Express chipsets, Ethernet controllers, system controllers and Intel's Next Unit of Computing (NUC) to round out the Intel lineup.

"We are extremely excited to announce our agreement with Intel," said Jeff Newell, Mouser Electronics' Senior Vice President. "Offering the newest Intel products at Mouser will allow design engineers to build tomorrow's electronic products using today's most advanced semiconductor technologies."

"With Intel's robust product portfolio and Mouser's global network of design engineers, the new partnership enables innovative new designs for the future," added CJ Bruno, Intel VP, GM of Americas.

www.mouser.com/intel

OMC'S ACTIVE ALIGNMENT BASED FIBRE OPTIC LINKS SOLVE CONSISTENCY PROBLEMS

OMC now offers a fibre optic link service specifically tailored to meet the demanding requirements of the high voltage (HV) market. HV applications, such as power distribution networks and power supplies, often require optical isolation because of the voltages; however, achieving consistency of performance has proven a challenge for many providers.

During manufacture of its housed optical transmitters (Tx) and receivers (Rx), OMC powers each active element and tunes the performance of the device to ensure that the electro-optical characteristics of each and every device fall within a customer-specific performance window, exactly matching the required performance specification. Equally, when manufacturing the corresponding optical fibre cable assembly to be used between the Tx/Rx, OMC's unique production techniques can ensure a very high level of consistency of link attenuation, which is matched to the Tx/Rx performance window, meaning that each and every link will function regardless of how the transmitters, receivers and cables are paired during assembly/installation.

www.omc-uk.com

EFFICIENT LED DRIVER SUITS BACKLIGHTING APPLICATIONS

Advanced Power Electronics Corp (USA), a Taiwanese manufacturer of MOS power semiconductors for DC-DC power conversion applications, has launched a new step-up converter capable of efficiently driving up to eight white LEDs in series for backlighting applications. The APE1612-3 uses current mode, 1.2MHz fixed frequency architecture to regulate the LED current, which is set using an external current sense resistor.

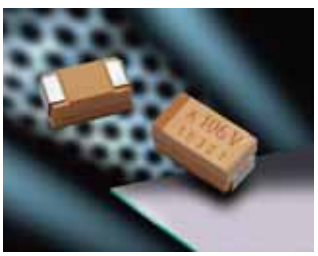
The APE1612-3 features a low 300mV feedback voltage that reduces power loss and improves efficiency. The OV pin monitors the output voltage and turns off the converter if an over-voltage condition is present due to an open circuit condition. The APE1612-3 includes under-voltage lockout, current limiting and thermal shutdown protection preventing damage from an output overload.

"Small size and high efficiency make the APE1612-3 ideally suited for backlighting applications. A wide 200Hz to 200kHz range enables the device to be used in PWM dimming," said Ralph Waggitt, President/CEO, Advanced Power Electronics Corp (USA).

www.a-powerusa.com

AVX Expands Its Portfolio Of Tantalum Polymer Capacitors

AVX Corporation has announced significant expansions to its portfolio of tantalum polymer capacitors, which is currently comprised of its TCJ, TCM, TCN and F38 series. AVX has released 34 new tantalum, solid electrolytic chip-capacitors with conductive polymer electrodes or multi-anodes since May 2013, which enlarged its portfolio to over 50 parts, including both the highest voltage tantalum polymer capacitors in the industry at 125V and the highest CV tantalum polymer capacitors currently available in a 0603 case size. Moreover, an additional 32 components are scheduled for release by the end of this calendar year, at which point the portfolio will have grown to include more than 80 unique devices.



AVX's tantalum polymer capacitors are available in voltages spanning 2.5V to an industry-leading 125V and in case sizes ranging from the miniature 0603 to the large, but low-profile 7343-20 and 7361-20, exhibiting high capacitance, high voltage and low ESR capabilities.

www.avx.com

NEW LED DOWNLIGHT REFERENCE DESIGN FROM POWER INTEGRATIONS

Power Integrations announced RDR-347, an LED-downlight reference design. The new circuit demonstrates the capabilities of the recently launched LYTSwitch IC family, which offers the industry's best high-end dimming performance from a single-stage LED driver – together with all the associated efficiency, space and cost benefits that the single-stage approach brings.

The RDR-347 12W reference design, based on the LYT4313E, delivers a power factor greater than 0.95 and reduces total harmonic distortion (THD) to less than 10% – easily meeting the EN61000-3-2C requirements. Efficiency is greater than 86% at 120 VAC – industry-leading performance for an isolated solution capable of operating with a wide range of dimmers. This performance is possible because LYTSwitch ICs use one combined PFC and CC power conversion stage, which minimizes losses and cuts component count and in turn increases reliability and decreases cost.

TRIAC dimming is challenging, especially deep-dimming where TRIAC asymmetry between half-cycles can have a significant effect.

www.powerint.com

Single LNB Regulator IC Offers Higher Switching Frequency

The new A8304 from Allegro MicroSystems Europe is the latest member of a family of single low-noise block regulator (LNBR) ICs for satellite receiver applications. It is a monolithic linear and switching voltage regulator, specifically designed to provide the power and interface signals to an LNB down-converter via coaxial cable.

The A8304 requires few external components, with the boost switch and compensation circuitry integrated into the device. The 704kHz switching frequency and user-controlled output current limit minimise the size of the passive filtering components.

An I2C-compatible interface provides control capabilities for complex system requirements, as well as diagnostic information for system fault reporting. A "sleep" pin is also available to maximise power savings and to quickly shut down the device if required, without using I2C control. New control features for output source and sink current are also incorporated.

The A8304SESTR-T is provided in a 3 × 3mm QFN package (suffix ES) with exposed pad for thermal dissipation.

www.allegromicro.com

BULGIN ANNOUNCES BUCCANEER 7000 MAINS POWER CONNECTORS

Bulgin, an Elektron Technology connectivity brand, launched the latest addition to its extensive range of environmentally-sealed circular connectors – the Buccaneer 7000 Series for mains power applications. Designed to offer rapid and secure mains power connectivity in harsh environments, the Buccaneer 7000 is highly compact for its 25A and 600V rating, and has been developed to provide excellent sealing characteristics to IP67, IP68 and IP69K standards.

The all new Buccaneer 7000 Series features the Buccaneer range's tried and tested one-piece body construction, and has a unique twist locking system with positive feedback, providing quick and convenient, 'fit and forget' connectivity in less than quarter of a turn, without the need for technical expertise or specialist tools. Available in 2, 3, 6, 10 and 32 pole options, with a choice of fully interchangeable nickel plated, cast zinc alloy or UV-resistant, UL94-V0 flammability-rated plastic bodies, the Buccaneer 7000 Series will offer engineers and designers the greatest possible flexibility in system design.

www.bulgin.co.uk

NEW 4-PAIR PROFINET CABLES ENABLE HIGHER DATA RATES

Harting has introduced a new range of 4-pair PROFINET cables in a strategic move to expand the company's industrial Ethernet portfolio in the fast-growing market of Ethernet systems in industrial environments.

Profinet offers a number of benefits in automation applications including real-time transmission, robust cabling technology and high reliability, as well as simple installation and fast commissioning. Harting's new 4-pair cables also allow data rates to be boosted from 100Mbit/s up to 10Gbit/s to take into account future developments in network infrastructure.

Harting has designed the new Profinet cables in two versions: Type A for fixed installation and type B for flexible installation. While the Profinet cable for fixed installation requires only inner wire conductors, the necessary mobility in the variant for flexible applications is ensured by the use of tinned stranded wires. In line with the Profinet guidelines, the outer sheath in the PIMF versions is made of green PVC.

www.harting.com

MODBUS TCP/RTU BRIDGE ALLOWS POWER SUPPLIES' CONTROL OVER THE INTERNET

PSU manufacturer VxI Power has developed a new bridge device that allows power supplies with Modbus RTU communications capability to be controlled and monitored over the Internet or any other WAN or LAN.

As well as acting as a communication bridge between the Modbus RTU and Modbus TCP protocols, the IPM01 device features an embedded HTTP server that enables the user to view and configure PSU parameters via a web browser.

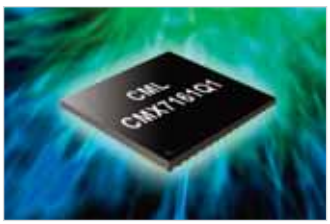
The device incorporates an RJ45 Ethernet socket and a 3-wire serial interface for either RS232 or RS485 communications, able to support multiple RTU clients. Both versions can deliver baud rates of up to 57600, and LED indicators are provided for serial TX and RX activity.

Housed in an industrial DIN-rail-mount enclosure measuring just 73 x 59 x 22mm, the device has an input voltage range of 9 to 32V and an operating temperature range of -20 to +50degC as standard, which can be extended down to -40degC on request.

www.vxipower.com

Processor Delivers High-Performance Digital Mobile Radio Capability

Solid State Supplies has announced availability of a new digital radio processor from CML Microcircuits, a provider of low-power semiconductors for global wireless and two-way radio communications markets.



The CMX7161 is a new low-power Digital Radio Processor specifically targeted at two-slot TDMA digital radio systems, including Digital Mobile Radio (DMR). It is based on CML's FirmASIC technology with Function Image 7161FI-1.x and implements a high-performance half-duplex digital radio modem that complies with the ETSI TS 102 361 DMR standard. The device uses root-raised cosine 4FSK modulation in a 12.5kHz radio channel to automatically handle slot timing and synchronisation. An integrated analogue interface removes the need for external audio codecs and provides maximum support to a host microcontroller, when combined with a range of intelligent auxiliary functions.

The CMX7161 provides a direct connection to the market-leading CMX994 Direct Conversion Receiver (DCRx), enabling the implementation of a highly integrated DMR radio.

www.sssltd.com

Micro Analog Systems Releases New VCTCXO IC

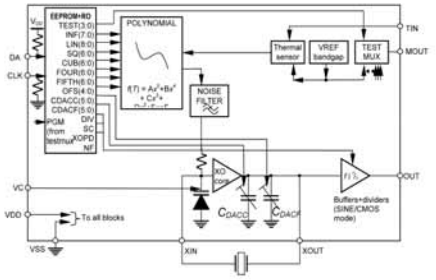
Micro Analog Systems Oy announced the launch of MAS6279, a miniature VCTCXO IC primarily intended for the most stable TCXO and VCTCXO modules.

The device uses fully analogue compensation method making it possible to achieve frequency stability of ±0.14ppm or better.

MAS6279 has a typical power consumption of only 1.3mA and low phase-noise of -136dBc/Hz at 1kHz, which makes it suitable for demanding applications. The frequency stability against load or supply voltage changes is excellent. It has programmable divider function allowing the output frequency range of 5MHz to 64MHz. The output waveform can be selected from a sine wave or CMOS.

Among its key features are : very small size, minimal current consumption, wide operating temperature range, very low phase-noise, minimum operating temperature of -40°C, oscillator frequency output selectable by EEPROM direct or fc/2, output waveform selectable by EEPROM: a clipped sine wave or CMOS.

www.mas-oy.com



TECH ENTREPRENEUR TELLS BANK OF ENGLAND GOVERNOR

"ITS TIME TO SUPPORT SMEs AND START-UPS"

Powa Technologies CEO Dan Wagner offered his insight into what the business community would like to hear from the new Governor of the Bank of England. Among others, he would like to see the foundations laid down to help the investment community support entrepreneurial talent in the UK. "We have some fantastic, inspirational entrepreneurs who start great businesses, but unfortunately many of them have to go abroad to get the funding they need to grow and succeed, and that is a shame. Britain has great innovation across all areas and it needs to be nurtured and supported because it will be the lifeblood for the return of economic strength."

He said that the small business and start-ups sector needs targeted tax incentives for investment. "We need to see real momentum behind encouraging start-ups and small businesses to grow further and faster, this will allow more exports and more jobs to be created. I would like to see capital gains tax completely removed from the funding of start-up businesses. Any funds that are invested to create opportunities and jobs should see a full capital and profit return because of the great risks involved. This would be a political saviour. Small businesses represent 50% of the economy and its new small businesses that will drive future economic growth."

As a visionary technology entrepreneur himself, Dan Wagner sees the UK's knack for innovation as the driving force for economic growth. "We have fantastic innovation here in the UK. We invented the World Wide Web and we should be a global leader in technology. We need to fund the start-ups and provide the right environment so investors who have earned their money and paid their taxes can risk an investment in a speculative start-up behind an entrepreneur they think might succeed. If they do this they don't want to see their one successful investment out of the ten they have made get taxed at 30%. It doesn't seem right."

Speaking to business leaders in Nottingham, Carney announced a £90bn loosening of liquidity requirements on banks, in a bid to free up lending to businesses and consumers. "The Bank of England's task now is to secure the fledgling recovery, to allow it to develop into a period of sustained and robust growth," he said.

PROFESSOR DR DOGAN IBRAHIM, Near East University in Nicosia, Cyprus: The UK has always been a country of innovation and a leader in technology, thanks to small businesses.

Dan Wagner is absolutely right. Attractive investment opportunities and funds should be made available to small businesses to keep the innovation and technology within the UK. Many institutions, such as the banks, should support and encourage the healthy growth of small businesses.

MAURIZIO DI PAOLO EMILIO, Telecommunications Engineer, INFN – Laboratori Nazionali del Gran Sasso, Italy: A start-up, in general will be an SME (small to medium size enterprise) by definition, but an SME is not necessarily a start-up. Every day more and more people choose the route of starting a small business.

The biggest advantage of being a start-up is that you can be flexible, agile and reactive to both the needs of customers and the market. Big companies find it very difficult to change anything. In fact, a big business can be started at a very high cost and on a full-time basis. Small business, instead, is also well suited to Internet marketing, as it is typically easier to respond to market demands quickly.

IVOR CATT, Engineer and Scientist, UK: "Help the investment community support entrepreneurial talent in the UK"... "According to Dan Wagner the small business and start-ups sector needs targeted tax incentives for investment." – Mark Carney

I've been there. The experience was appalling. Dealing with the Department of Trade and Industry, who did fund three research projects of my invention at universities, I concluded that the Department was deeply hostile to trade and to industry. It could have been staffed by Oxford graduates with third-class degrees in history or some such, facing me – a Cambridge engineer.

Very late, the taxman showed me rules which said that the invention, on which I had spent decades and patented worldwide, faced income tax at 60%, not the more obvious capital gains tax at 30%. Thus, the amount of money I retained was halved. I realised that since selling patents was a rare event, MPs interested in maximising their vote would not be interested in gaining the votes of inventors with patents to sell.

However, on another innovative idea, I found that when in the City I was a little minnow in a sea of predators. The primary objective of the city men was to cheat me, rather than maximise profit from the proposed venture. I told one group they would rather get 80% of one million pounds than 50% of ten million pounds. That was after four months of "negotiation".

BARRY MCKEOWN, RF and Microwave Engineer in the Defence Industry, and Director of Datod Ltd, UK: It has been said of inherited wealth that a fool and his money are soon parted. Wagner is clearly no fool but the question is: Has he been lucky and now just does not want to act foolhardily?

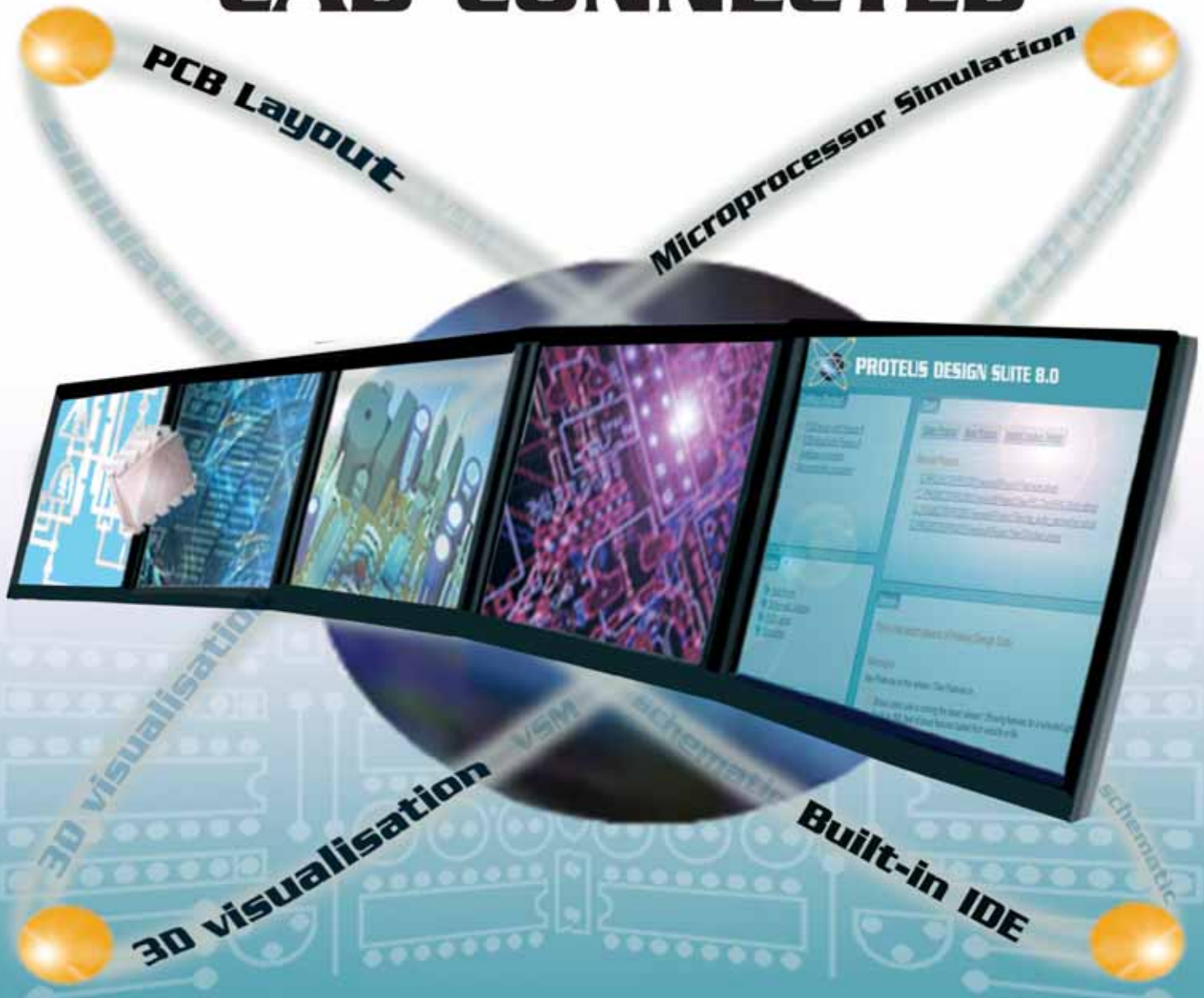
Ignoring the banks, currently the FT reports that the UK's balance sheet is £670bn or nearly 50% of GDP. The Chancellor has stated that "We are all in this together" – the trouble is we are not! I have previously expressed my view of the VC brigade. But what high net-worth individuals like Wagner miss in addressing the long-term investment requirements of the technology cycle are the market-cycle- and political-cycle effects. The quarterly reporting is a necessary evil and a change from a 5-year to a 10-year political mandate is just not going to happen. Consequently, Wagner can make a business case to protect his wealth but therein he fails to address the wider political case.

Let us assume that we just address the app market, due to exponentially explode with the 4G roll-out, and assume that behind each app there are 20 jobs and a 3-year success/failure exposure period behind Wagner's 1-in-10 success ratio. Consequently, over the 3-year period Wagner has successfully supported 180 jobs before market conditions prevail. What his special pleading is really about is protecting his wealth instead of focusing on reducing his cost of supporting 180 high-salaried jobs for three years, the latter case being of more interest to the Treasury. Hence, Wagner should, with other entrepreneurs, commission a political think-tank to fully work up a portable NI/tax-credit/break policy for these 180 people to augment the now negated sweat-money element for bona fide start-up/spin-out companies.

It always comes down to people. The Chancellor is more likely to support this financial-risk-exposure reduction strategy as the vested interest group who shall be most against such a policy are the Trade Unions. Such a portable policy would, of course, be of interest and benefit to EW readers. Enjoy!

If you are interested in becoming a member of our panel to comment on new developments and technologies within the electronics sector register your interest with the Editor by writing to svetlanaj@sjpbusinessmedia.com

CAD CONNECTED



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