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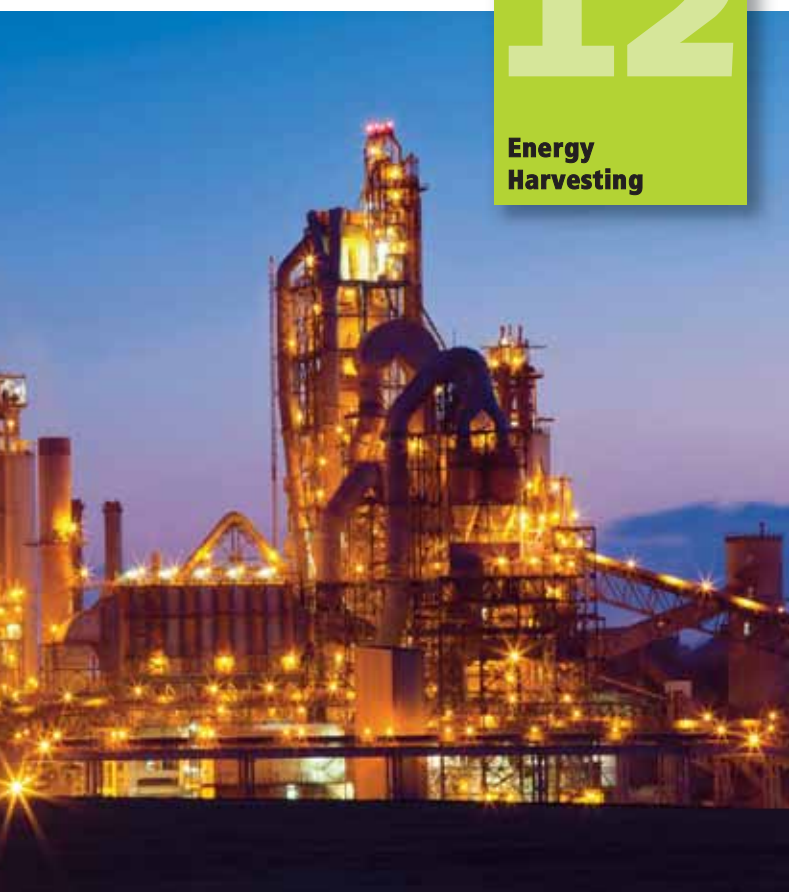

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THE INTERNET OF THINGS HAS COME OF AGE IN AUTOMATION

The Internet of Things (IoT) is already in the automation industry – not because of a seismic shift in manufacturing's conservative approach to IT and not because of a major product launch or a new player in the sector but because it has been here all along. Slowly growing as industry increasingly takes advantage of technologies that interpret data from things like SCADA, supervisory HMI, MES and EMI solutions on a single platform, and that's what happened with IoT in automation.

While it's certainly true that the IoT is much more readily associated with the consumer electronics IT sectors, it offers many benefits to the manufacturing and automation industries; actually it represents the next huge leap in automation, particularly where there is an advantage to be derived from the acquisition and organisation of previously unthinkable amounts of data.

This quantity of information, which in the IT world is referred to as 'big data', could be defined as a data set or sets so large and complex that they become awkward to work with using existing management tools. Part of the potential of the IoT is unleashing this data, sometimes through physical mash-ups of real-world physical services and the Cloud, so that it can be effectively analysed. Fictional detective Sherlock Holmes was one of the first to state: "It is a capital mistake to theorise before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to suit facts." This is particularly true in applications like process optimisation, where we used to be restricted to collecting just a few data points, limited by simple serial networks and the negligible storage capacity of the control devices, especially in PLCbased control.

The enterprise software manufacturer SAP defines the Internet of Things as "a world where physical objects are seamlessly integrated into the information network, and where the physical objects can become active participants in business processes. Services are available to interact with these 'smart objects' over the Internet, query and change their state and any information associated with them, taking into account security and privacy issues."

Fictional detective Sherlock Holmes was the first to state: "It is a capital mistake to theorise before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to suit facts"

The bottom structure of IoT is composed of sensors, networks, services and applications. Sensing products acquire the front-end data, and after convergence and processing, this data is sent to the service layer via the network. Ultimately, the database will be used in various fields with different strategies.

In a discrete manufacturing plant, consider the value of having parts self-identify with RFID tags and automatically-controlled rolling-bins/forklifts moving parts around without human intervention, and always getting the right part to the right place at the right time. Then consider the further value of having all that information available in easily accessible databases wherever needed.

However, in the end, IoT means commitment to the value of data as a management tool. It can be about gathering data without knowing how ultimately will be used. Like the similarity between thin client and mainframe and cloud and virtualisation, this is a new concept founded on an old one: the Oxford English Dictionary states that scientific method is "a method or procedure that has characterized natural science since the 17th century, consisting in systematic observation, measurement, and experiment, and the formulation, testing, and modification of hypotheses."

Another driver for the IoT is the changing demographics of manufacturing IT. New engineers have a culture of implementing solutions that give a scope of creativity and use in a way not initially envisaged. For instance, there is a willingness to model all the things in the manufacturing world and make it easy to remix them in new ways to build new applications, which is a key characteristic of the IoT.

Ultimately though, manufacturing is characterised by a set of qualities that are different from those found in enterprise IT. For example, hardware has an extended service life, often being used for over a decade, compared to three of four years in the enterprise world. One of the reasons for this is that updates are much harder to apply.

Mike Lees is a business manager at HardwarePT, the Industrial IT division of SolutionsPT, which provides sensing products to acquire front-end data, thanks to its partnership with Advantech.

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MOST ACCURATE INSTRUMENT HAS IMPROVED THE WORLD'S ELECTRICAL MEASUREMENTS

The Cryogenic Current Comparator (CCC), developed by Cryogenic Ltd and the National Physical Laboratory, allows different electrical measurements to be related back to the ampere (the SI unit of current) with very high accuracy. This will be useful for anyone involved in precise electrical measurements

Cryogenic Ltd and the National Physical Laboratory (NPL) have designed and developed the most accurate instrument for comparative measurements of electric current. The instrument can now be used by National Measurement Institute (NMI) and laboratories around the world, to provide a more accurate standard for current ratio, and ensure current measurement is not a limiting factor in innovation.

Accurately measuring current is vitally important for a range of applications. It is essential for billing people for electricity use, to ensure a stable electricity market. The right current input is important for controlling doses of ionising radiation in cancer treatment.

Typically challenges arise when measuring current. For instance, ionising radiation is measured in picoamps, whilst undersea cables carry hundreds of amps. Some industries measure resistance or voltage, rather than current. These measurements all need to be related back to the ampere, the SI unit of current.

The new Cryogenic Current Comparator (CCC) provides the world's most accurate ratio of current. Together with the Quantum Hall effect – a phenomenon whereby electrical properties in 2D materials can be determined based on fundamental constants of nature – it allows resistance to be measured to very high accuracy, creating a primary standard of resistance. If you measure in milliamps or ohms, the CCC can relate this back to primary standards more simply and more accurately than ever before.

CCCs rely on superconducting materials and a quantum magnetic flux detector to measure current ratios. The CCC sits in a liquid helium dewar – a Thermos flask for very cold liquids – keeping it at four degrees Kelvin and allowing superconductivity. This delivers accuracy and sensitivity.

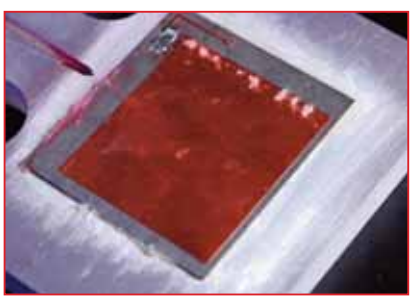
The CCC is accurate to better than 1 part in 10^9. Using the optically-isolated current sources, the resistance bridge can make comparisons between resistors with an accuracy and repeatability of better than 10^{-8}.

This CCC represents a significant accuracy upgrade on any previous system. It has provided, for example, the most accurate measurements to date of the electrical impedance of the quantised Hall effect in graphene, which is a key to understanding the material's properties. It is the first digitally driven CCC, with the setup and measurements being stored on a computer, reducing the chance of error.

Passive 'Smart Skin' of Sensors Could Provide Remote Monitoring of Aging Infrastructure

Major bridge failures in recent years have focused attention on the need to monitor bridges and other infrastructure. As thousands of bridges, parking lots and other structures age, improved methods for detecting deterioration could save lives and prevent economic disruption.

A close-up of a crack-testing specimen with a wireless antenna sensor. The device could be used to provide close monitoring of bridges, parking decks and other structures for early signs of strain, stress and formation of cracks
[Credit: Gary Meek]



Researchers at the Georgia Institute of Technology are developing a novel technology that would facilitate close monitoring of structures for strain, stress and early formation of cracks. Their approach uses low-cost wireless sensors that require no power, can be implemented on tough yet flexible polymer substrates and can identify structural problems at a very early stage. The only electronic component in the sensor is an inexpensive radio-frequency identification (RFID) chip.

Moreover, these sensor designs can be inkjet-printed on various substrates, using methods that optimize them for operation at radio frequency. The result would be low-cost, weather-resistant devices that could be attached by the thousands to various kinds of structures.

"For many engineering structures, one of the most dangerous problems is the initiation of stress concentration and cracking, which is caused by overloading or inadequate design, and can lead to collapse – as in the case of the I-35W bridge failure in Minneapolis in 2007," said Yang Wang, assistant professor at the Georgia Tech School of Civil and Environmental Engineering. "Placing a 'smart skin' of sensors on structural members, especially on certain high-stress hot-spots that have been pinpointed by structural analysis, could provide early notification of potential trouble."

The Georgia Tech research team is focusing on wireless sensor designs that are passive, which means they need no power source. Instead, these devices respond to radio-frequency signals sent from a central reader or hub. One such reader can interrogate multiple sensors, querying them on their status at frequent intervals.

The researchers' approach utilizes a small antenna mounted on a substrate and tuned to a specific radio frequency. This technique enables the antenna itself to function as a stress sensor.

As long as the structural member to which the antenna/sensor is affixed remains entirely stable, its frequency stays the same; however a slight deformation in the structure also deforms the antenna and alters its frequency response. The reader can detect that change at once, initiating a warning months or years before an actual collapse.

DORMA Time + Access





Access-Control Pioneer cuts Time to Market with XJTAG

"DORMA, a leader in security and access automation, is increasing testability for future generations of its assemblies by using XJTAG boundary scan as well as in-circuit test. This approach has enabled rapid progress, taking advantage of long-standing test-development partnerships while also gaining the extra reach and flexibility of boundary scan."

DORMA, of Ennepetal, Germany has produced innovative, high-quality equipment for doors since 1908, and believes in delivering "the best, at a good price". The company evolved throughout the 20th century to become the dominant name in automatic door closers and now – through its business unit DORMA Time + Access GmbH – is a market-leading developer of automation solutions. Its product range includes custom components and systems for time recording, access control and data acquisition, targeting diverse applications from domestic and office markets to security equipment.

Manufacturing is done in-house, and the company also builds boards for selected customers. Examples in production include the DORMA electronic closing cylinder for doors, an extremely small unit with embedded electronics based on a high-performance, low-power microcontroller. Boards for the closing cylinder are built alongside other complex assemblies including a customer board for an advanced weighing system, which has a 32-bit processor and four large BGAs.

The high I/O densities of these boards challenge test coverage, and impose high pin counts for in-circuit test fixtures. This complicates fixture design, and also tends to increase lead-time. In addition, when large numbers of BGAs or similar devices are on board, implementing test points can become impossible for many of the signals. This is a common problem for test engineers, and can preclude achieving the required test coverage using fixtures or probes.

To overcome the challenges surrounding test coverage and fixture design, DORMA engineers discussed the issue with the company's test fixture manufacturer. The fixture designers suggested using boundary scan to test those parts of the circuit outside the reach of the fixture, and recommended XJTAG in particular. XJTAG combines readily with other test techniques, and includes many features that speed up the creation of tests and promote efficiency. These include automatic scan-chain detection, downloadable test scripts that are device-centric and reusable, and automatic connectivity testing.

DORMA's Hans Schmitz explains the thinking behind his team's hybrid test solution, "Our in-circuit test partners have a good understanding of our products and technologies, and this is valuable for us. XJTAG has allowed us to increase test coverage for future generations of boards, while retaining our investment in these established relationships."

XJTAG connects to the unit under test using a small, lightweight, USB hardware device called XJLink. DORMA engineers have taken advantage of XJLink's portable form factor to mount the unit in a movable test head to test and program boards within a panel. "Features like adjustable signal termination and automatic skew control in the XJLink allow us to connect to many different types of boards. This is typical of the flexibility of XJTAG, which allows us to apply boundary scan in whichever way suits us best."

"In some of our smaller assemblies, we can meet our testability target using XJTAG alone," he adds. "This has simplified testing, accelerated product introduction, and delivered valuable cost savings."

opinion

Hans Schmitz
Test Manager
DORMA Time + Access GmbH

"XJTAG has combined easily with our existing in-circuit test equipment and methodologies, and this has been critical in helping us achieve the test coverage we need for our latest generations of boards."

"Features of the system, including the lightweight and easy-to-use XJLink connector capable of adapting to many different types of boards, make XJTAG especially flexible and allow us to use boundary scan in whichever way suits us best. We have been able to meet our testability targets for some boards using XJTAG alone, which has simplified testing, accelerated product introduction, and delivered valuable cost savings."

Data Bank

DORMA

Company	DORMA Group HQ Germany
Nature of business	Global supplier of door technology products and systems
Major products	World market leader in automatic door controls, movable walls, glass fittings and accessories
Customers	Airports, Banks, Hospitals, Hotels Offices, Railway Stations...
Locations	HQ Ennepetal, Germany. Operates with 71 wholly-owned companies in 46 different countries
Incorporated	1908
Web site	www.dorma.com

QSEVEN MAKES IT POSSIBLE: QUICK MIGRATION TO ARM

ARM systems impress with their low power consumption and high graphics performance, but until now they have been hard to integrate. The quickest and safest way to migrate is to use turnkey pre-integrated modules (COMs).

Because of the low power consumption and high processing power that is possible today, many analysts consider ARM to be the future technology for mobile and ultramobile applications particularly in medical technology. Easy-to-use and intuitive graphical user interfaces, requiring an appropriate graphics performance, play an important role in the acceptance of modern devices. And this is where current ARM-based multi-core systems are unrivaled: Even though AMD and Intel have beefed up their systems substantially, their x86-based CISC systems use considerably more power for the same graphics performance. Special multimedia processors such as the i.MX6 family from Freescale are a fraction of the cost, plus they are perfectly scalable by varying the number of cores and the clock frequency in an identical pin layout.

TOO GOOD TO BE TRUE?

All of these benefits were offset by the relatively high cost of needing to assemble one's "own" SoC. Of course, this is not a problem for big companies that have separate development departments for every niche, and annual consumer sales in the hundreds of thousands. But what about mid-sized companies, where the expertise is contained in the application and the hardware is only a means to an end?

THE SOLUTION: COMS (COMPUTER-ON-MODULES)

In the x86 world, the module principle has proven itself over the last decade for embedded applications with quantities of up to a few thousand per year. Here, standardized modules with clearly defined, uniform interfaces are bought pre-integrated ("application-ready"), and only the part of the circuitry that is unique to the firm or the application is developed with its required interfaces on a carrier board (or "baseboard"). This has the advantage that the standardized processor technology can be purchased as a finished

Figure 1: Prepared for new ARM challenges: Qseven module conga-QMX6 and evaluation carrier board conga-QEVAL

COM in the appropriate shape and simply mounted to the carrier board, letting developers concentrate on their core competencies. The performance and power consumption of the circuitry can be scaled and updated with new developments by replacing the COM. In theory, it has been possible in the ARM world to place a random project-specific processor and a meaningful assortment of peripheral chips on a modular carrier board, then lead as many processor connections as possible outside of the processor on a plug. However, the problem of high (project-) specific integration costs has at best been mitigated, but not completely solved. Costly Board Support Packages (BSPs) still need to be created.

QSEVEN: LESS IS MORE

In most cases, it makes more sense to concentrate on established standards and interfaces which can then be more or less completely pre-integrated by the COM manufacturer. For compact, battery-

Technology	ARM Cortex A9	x86 (AMD)	x86 (Intel® Atom™)
Processors	Freescale® i.MX6 Series	AMD Embedded G-Series Processors	Intel® Atom™ processor E6xx series
Board family	conga-QMX6	conga-QAF	conga-QA6
RAM	2-4 Gbyte DDR3L-1066	2-4 Gbyte DDR3L-1066	1-2 GByte DDR2-667/800
Flash	eMMC up to 8 Gbyte onboard MicroSD	SATA SSD up to 32 Gbyte	SATA SSD up to 32 Gbyte
Ethernet	1x Gbit	1x Gbit	1x Gbit
PCI Express x1 Lanes	1x	4x	3x
SATA	2x	2x	2x
USB 2.0 / Client	5x / 1x	8x / -	6x / 1x
SDIO	1x	1x	1x
Sound	I²S, SPDIF	HDA	HDA
Graphic	2x 24 Bit LVDS and 1x HDMI or 2x HDMI	2x 24 Bit LVDS and 1x DisplayPort/HDMI or 2x DisplayPort/HDMI	1x 24 Bit LVDS
Miscellaneous	CAN, I²C, Bootloader Add. connector: MIPI CSI-2 Camera Interface, JTAG	2x Express Card, LPC, I²C (400 kHz, Multimaster) embedded BIOS	CAN, LPC, I²C (400 kHz, Multimaster) embedded BIOS
Operating temperature	0..60°C, exp. option -40..+85°C	0..60°C	0..60°C, exp. option -40..+85°C

Figure 2: Feature comparison for Qseven: x86 (Intel, AMD) vs. ARM (Freescale)

saving mobile and ultramobile applications, Qseven has proven itself in the market in recent years with its compact form factor of only 70x70 mm^2. Conceived from the beginning as a multi-platform standard, Qseven only needed to provide minimal enhancements in the summer of 2010 to officially release revision 1.20 for the ARM platform.

Fundamental new features which were introduced as part of version 2.0 last year include support for USB 3.0 and Embedded DisplayPort as well as the additional, even more compact form factor "µQseven", with an area of only 70x40 mm^2 for ultracompact applications. Figure 2 shows the features and interfaces currently supported by Qseven for both ARM and x86 technologies. It's easy to see the advantages that Qseven provides for newcomers or those switching to ARM, as well as the pre-integrated interfaces available for the PC or x86 worlds, such as up to 4 PCI Express lanes.

Driven by the enormous success of the chips installed in smartphone and tablet computers, most chip manufacturers over the past few years have realized the embedded market's potential. To that end, they have added high-performance universal processors with powerful graphics capabilities to the highly specialized niche CPUs in their ARM portfolios and brought at least parts of these interfaces to the market.

Currently, the specified profile is best covered by the Freescale i.MX6 family: the processors are perfectly scalable (1-4 cores, diverse high-performance graphic variants), have long-term availability (10 years or more) and an industrial temperature range, plus all important interfaces such as PCIe lanes, CAN bus, and DisplayPort are available. Other advantages include the embedded application experience of Freescale, which was established in the embedded market as Motorola more than 30 years ago, and the experiences and successes of Freescale's predecessor family i.MX5.

THE RESULT: QMX-6 IS A POWERFUL ARM MODULE IN EVERY REGARD

As co-founder of the Qseven standard, congatec kept a particular focus on interchangeability of modules between the various CPU platforms from ARM, AMD, and Intel. Interfaces for the following inputs and outputs are available across platforms: Gigabit-Ethernet, 5x USB 2.0, 2x SATA II (3GB/s), 1x SDIO, 1x PCIe 2.0, I²C bus (multi-master, with fast-mode interface up to 400kHz), 1x USB OTG Client and CAN bus. An LPC bus is not required with ARM processors; this is a common option for the x86-based platforms, where it can be used for the fully address-compatible and interrupt-compatible RS232 ports. As graphical user interface HDMI v1.4 is supported, once directly and a second time combined with the LVDS channel #0. The second LVDS port supports 18-bit and 24-bit dual channel up to WUXGA 1920x1200. I²S and SPDIF serve as sound interfaces from the PC world. A JTAG debug interface and an optional MIPI CSI-2 camera interface through an FPC connector are also available. The position of the additional connector is also specified in the Qseven specification to ensure maximum interchangeability. The maximum power loss of the entire module depends on the type of CPU used (number of cores and graphics) and is approximately 2 watts for a single core and up to 5 watts for a quad core with maximum graphics usage.

FAST DEPLOYMENT AND MIGRATION THROUGH READY-TO-USE, PRE-INTEGRATED COMPONENTS

The available signals provide for interchangeability in most applications, even across CPU platforms (ARM, AMD or Intel). Since the mechanical and thermal interfaces for all Qseven platforms are identical, companies that already use Qseven modules can quickly and easily switch without having to worry about mechanical changes, and ARM variants can easily be evaluated as alternatives. To make it easy to get up and running, congatec provides "application-ready" pre-integrated modules for the most common operating systems. The conga-QMX6 includes a universal bootloader (U-boot) and currently supports Android, Windows Embedded Compact 7.0, Linux, and optionally QNX. The integration of additional (real-time) operating systems can be achieved through partner firms. For newcomers, congatec offers a complete starter kit, conga-QKIT, which includes not only a Qseven module conga-QMX6 with the Freescale i.MX6 ARM Cortex A9 processor and the compatible universal carrier board conga-QEVAL, but also an appropriate power adapter and a complete set of cables. This allows the developer to put a complete system into service in just a few minutes, using Ubuntu-Unix delivered on a MicroSD card. Standard features of the evaluation carrier board include: 5x USB, 1x Gigabit Ethernet, HDMI and LVDS18/24. For connecting to mass storage, the baseboard also contains 1xSATA and 1xSD-card; the module itself has 1x MicroSD and, as an option, a soldered SSD (eMMC) with up to 8GB for robust applications.

Figure 3: Ready in a few minutes: the Qseven ARM starter kit conga-QKIT

In addition, other optional baseboards with different form factors and an extension with a sophisticated charging and power management system are available. The attractive price should help to ensure the rapid spread of the ARM platform into the embedded module market.

SUMMARY AND OUTLOOK

ARM and Qseven go together perfectly to create reliable, pre-integrated platforms in a very short time for mobile and ultramobile systems.

The ARM platform opens the way to the Android operating system with its wide variety of applications so that "trendy" power-saving devices can be developed more quickly. With the "application-ready" integration of ARM modules in the established Qseven standard it is now possible to develop power-saving and user-friendly devices of the highest quality – not just easily, but also cost-effectively and quickly. Broad scalability of the i.MX6 family, long-term availability of at least 10 years, and the "ready-to-use" starter kits from congatec with several baseboard variants and additional options, such as advanced power management, are more good arguments for this future-proof combination.

Author: Zeljko Loncaric, Marketing Engineer, congatec AG
www.congatec.com

Brand X vs Brand Y

MYK DORMER IS A SENIOR RF DESIGN ENGINEER AT RADIOMETRIX LTD
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Not every low power wireless application is range critical, but when you run into one that is, things can get difficult really quickly. You will find that almost every manufacturer is making range claims for their modules, which have very little basis in fact; the very idea of stating that a device can achieve "5km range" without actually saying anything about the data rate, antenna or environment is stark lunacy. Add to this the wide range of disparate solutions available and the various band restrictions on the market, and an 'equation with too many variables to solve' soon appears.

Practically, even when the application is screaming for maximum range, most implementation choices are ultimately driven by other factors:

- Data rate (and therefore the whole baseband path characteristic, including critical S/N performance) is driven by the system interface requirements.
- Choice of frequency band is usually constrained by the regulatory environment of the place where the radio system is to be used.
- Actual choice of module is influenced by price, availability, size, integrated features and sometimes even company internal politics and sourcing policy.

It may seem that I'm suggesting system range is outside the control of the engineer, but there remains one area where considerable latitude remains, and that is in the choice of aerial. There are a bewildering variety of antennae available for the popular ISM/telemetry bands but, despite differences in construction and packaging, their actual quoted characteristics are fairly uniform: all claim omni-directional radiation patterns, an antenna gain of around unity (give or take a few dB) and a return loss of 10dB or better. Unfortunately, this is rarely true. Small UHF aerials are notoriously subject to de-tuning effects from adjacent objects (often including the user's body) or from the presence or absence of a ground plane. Regrettably, quality can also be highly variable.

> *Mapping software is useful, but it's still annoying to arrive on your chosen piece of ruler-straight road to find that it goes up and over a hill, or that your flat open field is actually a pine forest, or is home to an angry bull*

The upshot of this is that the calculated range (from path loss models) and the actual range can end up bearing little relationship to each other. This effect gets worse in the higher frequency bands (868MHz and above) where deviation from a direct line of sight path (due to intervening structures or terrain) can greatly reduce usable range.

So how can you get the best range out of your module? It comes down – as is often the case – to testing. Only real physical results, conducted with the target hardware have any meaning at all.

Before starting range testing, it is necessary to bear a few points in mind:

Decide what you are trying to achieve. If you are attempting to determine the real system range, then use an environment as close to the actual deployment area as possible. If, on the other hand, you are trying to demonstrate the long range capability of the system for 'data sheet' reasons, then that is the last thing to do. Instead, select a totally flat unobstructed range, such as a disused airfield, tract of farmland or a straight section of a major road.

Understand that a series of range trials constitutes a considerable investment in man-hours. If done correctly it is not a "ten minutes in the coffee break" job. It requires considerable work off-site and will take days, or weeks. It also has more in common with a scientific investigation than an engineering project. The results are not always what management, sales or the customer would like.

Be rigorous. There is no point testing with the wrong aerial, a previous version of the wireless hardware or a different data rate or coding scheme. If the tests aren't conducted on representative equipment, the results will mean nothing. If, during comparisons between, for example, different aerials, other factors are also changed (site, elevation, radio hardware), the comparisons will mean nothing.

Beyond these general comments, there are a few pointers which can make a range test somewhat less onerous and a little more likely to yield meaningful results:

Take time to prepare your test system. Make sure it fully represents the eventual customer units in electrical terms. Taking the time to mount test modules or boards in (simple, plastic) cases makes them much easier to handle (as well as keeping off otherwise catastrophic raindrops). Use good quality connectors and fresh, high-capacity batteries. If possible, take a complete spare system. Having to return to the lab with defective equipment will waste days.

Label your equipment and carry plenty of identification. What you are doing looks suspicious and you may well be challenged, or even in extreme cases have contact with the police. (This is doubly important if you are testing alone and have set up the transmitter to operate autonomously: to the uninformed eye it will look like a bomb).

Fit easy-to-read, daylight visible, signalling indicators. A low current LED might show up perfectly in the gloom of the workshop, but be almost invisible on a bright sunny day. Adding an audible indicator (a buzzer or a piezo sounder) as well isn't a bad idea (but provide a way of switching it off, as it can get on your nerves after a few hours).

Provide solid mechanical mounting. Elevation (distance from aerial to ground) has a considerable influence over range, so uncontrolled changes are going to corrupt your results. Use stout mechanical components (it is very annoying to have your transmitter tripod fall over when you are 2km down range and half way through a test).

Survey your test site in advance. Mapping software is useful, but it's still annoying to arrive on your chosen piece of ruler-straight road to find that it goes up and over a hill, or that your flat open field is actually a pine forest, or is home to an angry bull. In fact, make several backup plans to avoid wasted days.

Use the RSSI. Wiring up a voltmeter to the receiver signal strength indicator output is well worth the effort. Calibrate the meter against signal strength in the lab (5dB steps are fine enough) and you have a basic field strength meter. It is also useful for making sure your channel is unoccupied when on site and to detect RF interference from nearby digital hardware.

Be patient and record everything. Especially for longer ranged radios you will spend a lot of time trudging about, peering at blinking LEDs (or driving, but only if you are working with a partner, as attempting to focus on the indicator light and the road at the same time is not always easy. Or safe). Accept that you are going to spend hours on these tests and take good footwear.

Take plenty of sample aerials, and try to get as many results as possible out of each test-run. It takes 30 minutes to walk a mile (and walk back), so you may as well do it with a pocket full of different antennas, swapping them over periodically to determine which aerials give you how much range.

I won't say that testing of this sort is fun. It isn't. It's physically tiring and extremely boring, and any engineer should be able to think of a dozen better uses for their time, but at the end of the exercise you will have real results for real range in a real environment, and that sort of data is priceless.

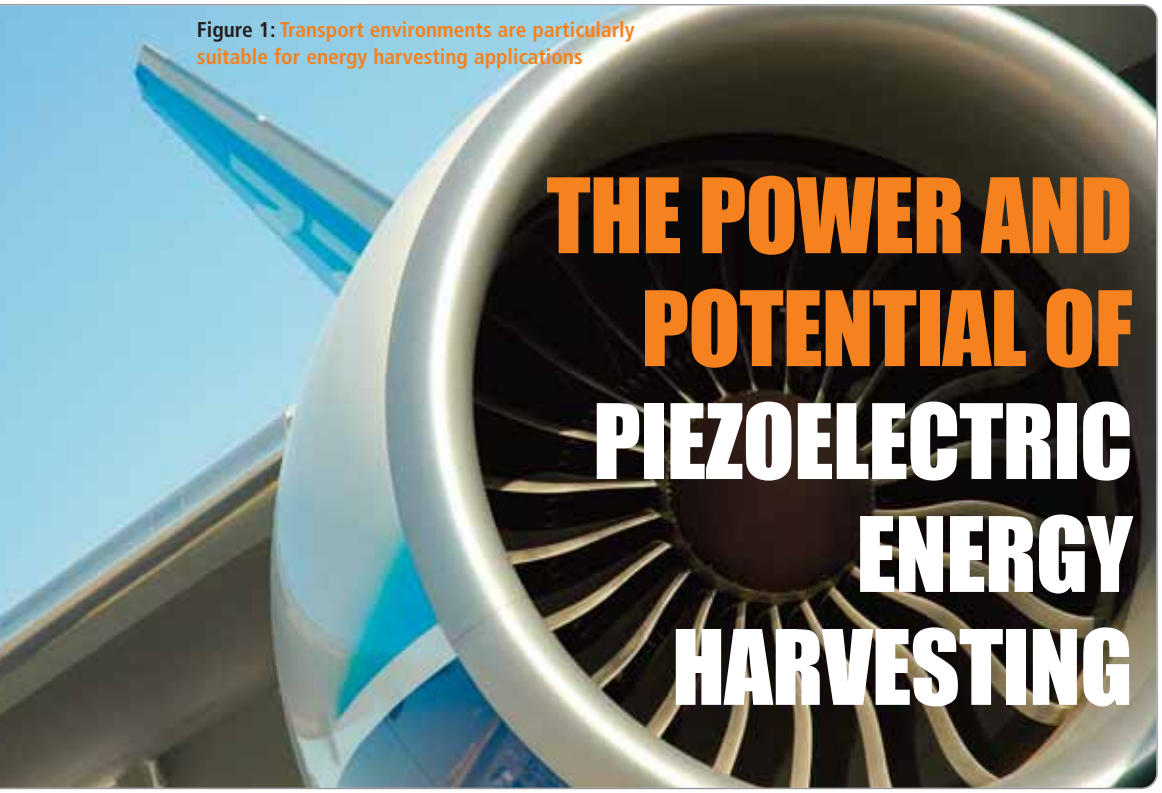


Figure 1: Transport environments are particularly suitable for energy harvesting applications

THE POWER AND POTENTIAL OF PIEZOELECTRIC ENERGY HARVESTING

FRED PIMPAREL, TECHNICAL MANAGER AT MORGAN ADVANCED MATERIALS, GIVES A DETAILED OUTLOOK FOR PIEZOELECTRIC ENERGY HARVESTERS, WHICH ARE GATHERING FORCE IN MANY APPLICATIONS

The process of piezoelectric energy harvesting – converting mechanical energy into electrical – has rapidly gained momentum in recent years for a number of reasons, primarily its energy efficiency and environmental benefits. There has been considerable development in applications utilising piezoelectric innovations, alongside advances in ultra-low-power electronics, meaning energy harvesting is no longer viewed as a potentially unreliable source of energy transfer, capable of only low-power output. While alternative energy harvesting technologies are available, such as thermoelectric or electromagnetic energy, some have a reputation for unreliability as they do not always provide the consistent source of energy needed.

Harvesting Piezoelectric Energy

Piezoelectric energy can be harvested by converting mechanical vibrations into electrical charge, or by placing a material under significant strain through heavy pressure. These techniques generate electricity based on the amount of force used in compressing or deforming a material, as well as the amount and type of deformation on the material's crystal structure and the speed or frequency of compressions or vibrations to the material. The potential for piezoelectric energy harvesting is much greater than alternative energy-harvesting technologies, with the components capable of delivering up to 70% of their charge.

While quartz and ferroelectric crystals such as tourmaline and Rochelle salt are good examples of piezoelectric materials, ceramic lead zirconate titanate – more commonly known as PZT – is the most widely-used piezoelectric material used for energy harvesting. A key advantage of PZT materials is that they can be optimised for specific applications through their suitability to be manufactured in any shape or size. Furthermore, PZT materials are resilient, chemically inert and resistant to high temperatures and atmospheric pressures – all key benefits considering the greatest opportunity for piezoelectric energy harvesting is in industrial applications. PZT products can be deformed repeatedly to generate energy and to power devices, with typical applications being sensors and industrial equipment.

> While alternative energy harvesting technologies are available, some have a reputation for unreliability as they do not always provide the consistent source of energy needed

Generating Power

The piezoelectric effect was discovered by Jacques and Pierre Curie in 1880. The French brothers learned that by subjecting certain crystals to mechanical strain, they became electrically polarised, with the degree of polarisation proportional to the applied strain. The Curies also realised that these same materials deformed when exposed to an electrical field, which is now known as the inverse piezoelectric effect.

But how do piezoelectric ceramic materials generate power through the conversion of mechanical energy into electrical? The smallest of deformations can produce a measurable charge. As a result, a PZT cylinder can generate voltages that are high enough to draw a spark across an electrode gap. The energy created can be stored in a

capacitor and used to power a circuit or another application. However, there are a range of factors which govern the amount of any power generated in this way, including the shape of the PZT transducer, the way in which the transducer has been installed and the nature of the electrical load.

For instance, a PZT disc that is compressed between two metal surfaces will never be able to expand as readily as a long, narrow PZT cylinder, which is only constrained at its flat top and bottom end, resulting in greater potential for the straight parallel sides to expand. Essentially, it is important to allow the material some freedom to expand radially, since energy generation is directly proportional to deformation. If the force that can be applied is limited, then the energy converted can be optimised by ensuring it is applied to a particular area where the material has the freedom to expand.

Another important consideration is the impedance – the measure of opposition to the flow of an alternating current – of the load. When the current is created, it is important to match the electrical impedance of the piezoelectric component to the electronic recovery system, in order to maximise energy transfer to the reservoir capacitor. The charge must be allowed to flow away quickly, otherwise the electrical field generated will tend to dissipate. As a result, applications subjected to a heavy pressure must receive a fast 'impulse' to ensure the charge does not dissipate quickly. Furthermore, the choice and design of the electronic recovery circuit is of equal importance. It is essential to carefully consider components to minimise leakage currents and increase energy transfer efficiency.

The Advantages of Piezoelectric Energy Harvesters

The advantages of piezoelectric energy harvesters are obvious. The process offers some of the highest efficiencies and power outputs by size and cost, and is therefore extremely appealing to those in search of an effective, high-performance solution. The environmental benefit is to replace batteries and other means of charging and their associated replacement costs, as well as focus on saving energy.

Figure 2: Transport environments suitable for energy harvesting applications

Figure 3: Chemical processing plants and other iindustrial environments are suitable for energy harvesting applications

Figure 4: Bimorph devices for vibration-based energy harvesting

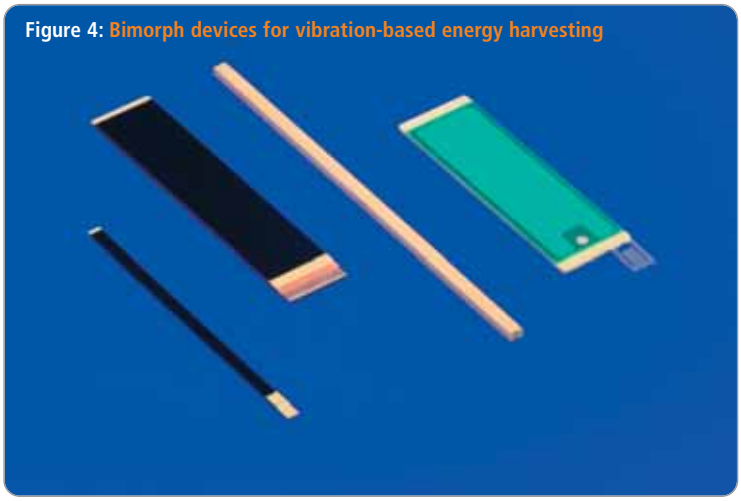


Figure 5: Bimorphs for vibration-based energy harvesting

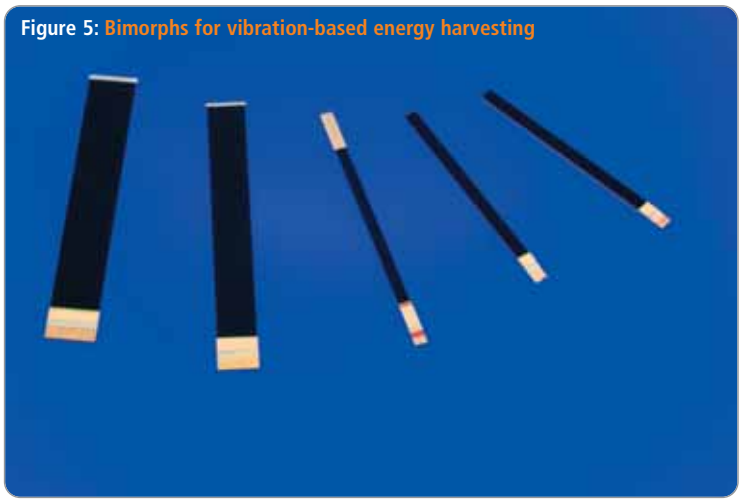
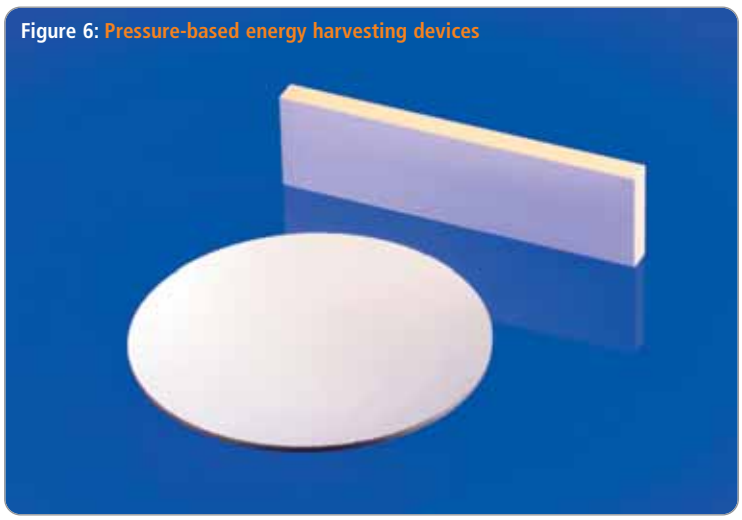


Figure 6: Pressure-based energy harvesting devices



In terms of future market opportunities, research from IDTechEx predicts that the energy harvesting market will grow from £450m in 2012 to more than £950m by 2017. Tests are already under way of piezoelectric energy harvesting in an extensive variety of applications. For instance, modules can be installed on roads or rail networks to react to heavy vehicles passing over them, to generate energy that can be used for powering LED lighting in signs or traffic lights. Industrial applications undoubtedly

Figure 7: Engine vibrations are a good example for energy harvesting

represent the biggest opportunity for piezoelectric energy harvesters, with electrical charge harnessed from engine vibrations being just one key example. Industrial environments, such as oil and gas and manufacturing, will find energy harvesting a cost-effective alternative to expensive wired infrastructure.

> Modules can be installed on roads or rail networks that react to heavy vehicles passing over them to generate energy that can be used to power LED lighting in signs or traffic lights

One of the greatest future challenges for piezoelectric energy harvesting is the ability to convert energy from broadband frequencies, harnessing a number of different sources of vibrations at various frequencies to produce a consistent supply of electric charge. Nevertheless, the opportunities for piezoelectric energy harvesting going forward are considerable – an exciting prospect for those seeking efficient new ways of generating power. ●

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THE LINK TO AN ENERGY-HARVESTING WIRELESS WORLD

MARIAN HÖNSCH, PRODUCT MARKETING – SOFTWARE ARCHITECT AT ENOCEAN GMBH, DISCUSSES A WAY TO EASILY AND SIMPLY INTEGRATE ENERGY-HARVESTING WIRELESS TECHNOLOGY INTO A WIDE RANGE OF APPLICATIONS AND NETWORKS

Energy harvesting has long since made its way into our everyday lives. Energy-autonomous wireless systems are found in all types of buildings, industrial plants and many other sectors. In today's thoroughly-connected world there is an increasing demand to incorporate batteryless devices into networks based on several different communication standards such as WiFi, GSM, Ethernet/IP, BACnet, LON, KNX or DALI. Previously, product manufacturers (OEMs) had to develop individual software solutions, translating energy-harvesting wireless signals into the requested communication protocol. But, there are solutions beginning to emerge that make this process a lot simpler and easier.

Energy Without Batteries

Energy-harvesting wireless technology stems from a simple observation – where sensor data resides, sufficient ambient energy exists to power sensors and radio communications. Harvestable energy sources include motion, indoor light and temperature differentials. These ever-present sources provide sufficient energy to transmit and receive radio signals between wireless switches, sensors, actuators and controllers, sustaining vital communications within an energy management system.

Instead of batteries, miniaturised energy converters generate power for the wireless communicating devices. Via gateways including specifically developed software, energy harvesting wireless devices can be connected to different communication standards and, in most cases, the gateway's software connects radio to one protocol.

By using ready-made middleware this limitation can be removed, resulting in a universal interface between energy-harvesting wireless solutions and any automation application that further processes the wireless information.

The communication protocol is packet-based and the data units can be of three different types: frame, subtelegram or telegram.

A frame is the representation of the encoded data in the physical layer. It includes control and synchronization information for the receiver. A frame is transmitted as a bit-by-bit serial sequence. A subtelegram is the result of a decoding process, in which this control (PRE, SOF, INV and EOF) and synchronization information are removed from the frame. The reverse mechanism for getting a frame from a subtelegram is the encoding process.

The subtelegrams are handled in the data link layer. The ERP protocol is designed to work mostly as a unidirectional protocol without handshaking.

The software converts the bits and bytes of a telegram directly into data values. As a result, sensor data such as humidity or temperature is prepared so that different devices, servers and even cloud services can process it immediately.

OEMs can now integrate energy-harvesting wireless technology easier and faster into a wide range of applications and systems, such as those found in smart homes.

Middleware at the Heart

Middleware is a separate piece of software which functions as a connective link between different systems or applications. It does not contribute to the application itself but enables the application to understand the messages from all components and systems in a network, even when they are based on different standards. This seamless communication is enabled because the different protocols address similar-use cases (e.g. building automation). This eases the combination of several functionalities and applications to a more beneficial technical framework.

However, the main functionalities of the middleware are to automatically take into account all specifications of the protocol stack and specific application profiles (such as those of the EnOcean Alliance – EnOcean Equipment Profiles, EEPs), as well as data encryption mechanisms.

Generally speaking, the software has the following three key tasks:

- Receiving and decoding incoming data communication according to the profile standard;
- Executing device connection, including the teach-in and store device information;
- Encoding outgoing data communication according to the profile standard and sending it onward for further processing.

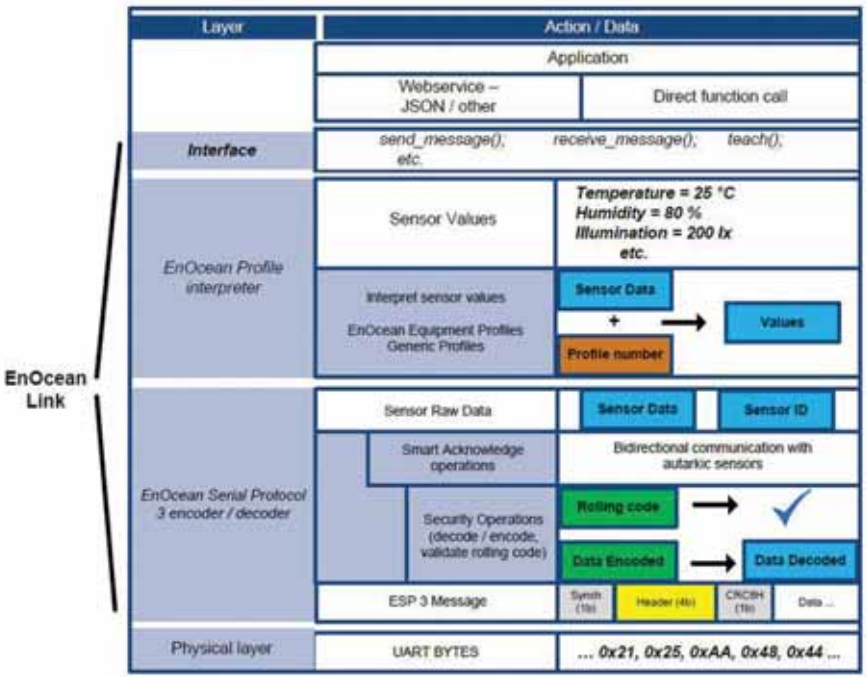


Figure 1: Functionality EnOcean Link middleware – layers, actions and interface overview Bottom-up: The middleware receives sensor information as a UART data stream and recognises the messages. In the next step it handles all security relevant tasks, e.g. data encryption, and extracts the raw sensor data after that. Out of this information the software decodes the raw data into actual values and provides the according application with them as decoded output data for further processing

Interpreting The Protocol Stack

EnOcean Serial Protocol 3.0 (ESP3) describes the serial communication between a host and energy harvesting wireless receivers, such as an EnOcean USB dongle. Hosts are external microcontrollers or PCs that include application-specific software tools.

ESP3 is a point-to-point protocol with a packet data structure. This protocol encapsulates actual user data (payload), command, event or response messages. Every ESP3 packet consists of telegram header, data and optional data. Each of these groups consists of fields with 1 or x bytes. The packet header, for example, is composed of these fields: data length (number of bytes of the data group), optional length (number of bytes of the group optional data) and the packet type (e.g. radio, response, event, command).

EnOcean Link middleware provides several service layers to operate an energy-harvesting wireless sensor network. These service layers are connected together to provide a clear user interface. On the physical layer, EnOcean Link receives the UART (Universal Asynchronous Receiver/Transmitter) data stream from the gateway. This signal can come directly from a gateway or can be provided by a backbone which was optionally tunnelled earlier to forward the encapsulated payload protocol. The ESP3 encoder is located over the physical layer. This layer handles all necessary operations to arrange the telegram data fields into a suitable form for further processing. The most important data fields are payload and sender ID.

The profile interpreter, based on the stored application profiles, interprets the telegram payload into human-readable values such as temperature or humidity. These values are presented as the so-called device channels. The device

ENOCEAN LINK IS CURRENTLY THE FIRST MIDDLEWARE MADE ESPECIALLY FOR ULTRA-LOW POWER AND ENERGY HARVESTING WIRELESS NETWORKS.

It resembles a library, without an internal process running in it and offers services for several layers. By using the software, developers gain control of the execution order of inbound and outbound communication interfaces and data storage.

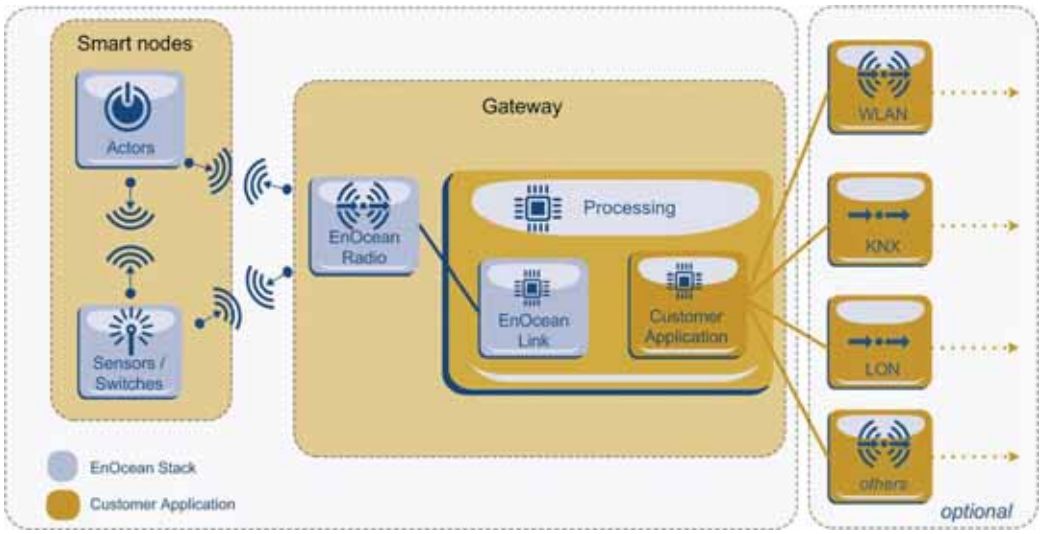


Figure 2: The role of EnOcean Link middleware in a smart-home system

channels are made available to the application through the API interface, which can be called directly from the application's source code or through a tunnelling protocol that encapsulates EnOcean Link.

Including The Application Level

The device channels are the most important part of the middleware's application interface. They present the values which a device provides, in an abstract format. The device profiles that control how the device transmits and codes its values are described in the EnOcean Equipment Profiles. These standardised application protocols are developed by the EnOcean Alliance's Technical Working Group (TWG) and are based on the international wireless radio standard ISO/IEC 14543-3-10. This protocol provides a "Wireless Short-Packet (WSP) protocol optimised for energy harvesting – architecture and lower layer protocols".

The protocol is efficient enough to support energy harvesting products for sensors and switches that do not require wires and batteries. It is the only standard specifically designed to keep the energy consumption of such sensors and switches extremely low – an order of magnitude lower than alternative standards. It achieves this by transmitting multiple, very short transmissions, and by selecting frequencies below 1GHz with robust signal propagation and minimal interference. The standard offers a physical and data-link layer as well as the network layer of the OSI model (Open Systems Interconnection). The application profiles are defined to achieve interoperability between products from different vendors, enabling them to seamlessly communicate with each other in a system.

Generic By Channel Types

For the middleware, the EEPs are mapped to an extended generic profile definition, called device channels. By using device channels, the EEPs are abstracted to a more generic definition. As the device channels are device-independent, this facilitates the handling of the EEPs on the application level. Therefore, OEMs can develop new solutions or integrate EnOcean-based devices/networks into existing applications more easily.

The complete device channel description includes CHANNEL_TYPE and scaling information (engineering minimum, engineering maximum, scale factor) and SUB_FLAG. SUB_FLAG is only in use if one device inserts channels with the same CHANNEL_TYPE. In this case, the SUB_FLAG is used to differentiate between the channels.

The middleware includes three different CHANNEL_TYPE:

- **SIGNAL** – these channels present the physical values, which are measurable values. Signal type device channels are, for example, temperature, humidity and lighting channels.
- **FLAG** – presents values that can only have two states. This includes on/off, up/down and pressed/not-pressed, for example a window contact.
- **ENUM** – Enumerations present values which show states, positions, counters or any other values that are not flags and do not have a physical unit. For example, a room operating panel.

Security On Demand

With the increasing interconnectivity resulting from applications such as smart home, access control machine-to-machine or energy management systems, the issue of data security becomes more important. Activities of garage door openers, occupancy sensors and window contacts represent data about the behaviour of residents and could be misused for unauthorised access to a building.

To meet specific security requirements and prevent replay or eaves-dropping attacks, EnOcean offers enhanced security mechanisms. If these are included, an EnOcean wireless node counts all incoming and outgoing data packets continuously and, thus, ensures the integrity of the telegrams. A 16-bit or 24-bit rolling code (RC) incremented with each telegram is added as a constantly changing (i.e. rolling) security mechanism. Telegram header, telegram data and current rolling code are used to calculate a 24 or 32-bit cypher-based message authentication code (CMAC).

The CMAC is also protected by an AES 128 encryption algorithm. The receiver system can then validate the data packet on the basis of the code. This functionality particularly protects networks against reply attacks. Another

mechanism is the encryption of data packets by the transmitter. The data is encrypted using the AES algorithm with a 128-bit key. This way, eavesdropping attacks are prevented.

If wireless telegrams are encrypted on the air interface, the EnOcean Link middleware decodes them before they are further processed by an external controller. Vice versa, the middleware can encrypt data before it is forwarded to an application. These security functionalities enable OEMs to include data encryption quite easily in their applications, which makes them more attractive and suitable for the needs of critical applications.

Application Examples

OEMs can use the middleware for each gateway application to integrate energy-harvesting wireless devices and systems into a broader network, based on communication protocols such as BACnet, KNX, Z-Wave, ZigBee, Bluetooth low energy or GSM.

In a smart-home application, for example, a gateway can use EnOcean Link to immediately interpret the information from energy-harvesting wireless sensors, including temperature, occupancy and light intensity, and forward this information to a central building control system. Here, the middleware is part of the smart-home box, typically the central unit to control the connected system in a house. The smart-home box holds the applications' intelligence and connects, in most cases, to cloud services via a third party protocol. So, the middleware runs with the OEM-specific smart-home application on the same hardware and provides an interface to the system's energy-harvesting wireless devices. The result is an intelligent home-automation system which can be easily installed, even in retrofit projects, and combines the advantages of batteryless wireless sensor systems with the comfort and security of smart home applications.

Control Over Buildings

Apart from the residential area, the middleware can also be used for a more complex commercial building scenario. In this case, EnOcean Link is implemented on a central device, e.g. a control server, which controls the whole building, holds the automation intelligence and can be physically located outside the building as well. Several gateways in the building record radio telegrams, sometimes from thousands of distributed batteryless wireless sensors and relay receivers, and send back information or command's data when needed. These gateways are connected to the control server by a backbone, which does not have to be based on EnOcean radio or even be wireless. For example, this can be an EnOcean/IP gateway. The middleware, located in the central unit, interprets all telegrams received by the gateways and provides them immediately to the automation system.

Faster Development

The use of middleware saves development resources of OEMs, enabling a quicker time-to-market for energy-harvesting wireless applications. Instead of developing their own software for a particular application, in order to interpret the communication protocol of the energy-harvesting wireless technology, product manufacturers can use finished middleware for this purpose straight away. The same applies to any application that integrates or further processes energy-harvesting wireless technology. As the middleware works independently of the frequency in use, it can be applied worldwide. Even if it was originally developed for Linux-based systems, the software is also portable to other architectural platforms such as OSGi or EEBus. ●

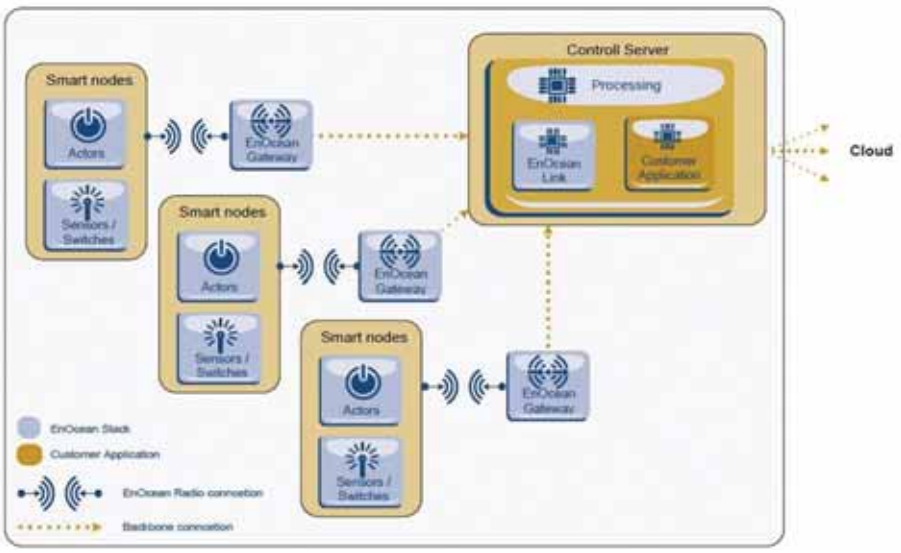


Figure 3: The role of EnOcean Link middleware in a commercial building system

TAKING A LONG-TERM VIEW OF THE SMART METER ROLLOUT

DAVID STROUD, GENERAL MANAGER AT EDMI EUROPE, ANALYSES THE PROS AND CONS OF SMART METERS AND STEPS NEEDED TO MAKE THEIR ROLLOUT A SUCCESS

Smart meters like this one will soon enter everybody's home

The smart emergy meter rollout is in danger of undermining its own success because of the marketing push around the energy-saving benefits it offers.

Let's get one thing straight: a smart meter on its own doesn't result in any energy-saving benefits for the consumer. Instead, the rollout is the start of a journey, not the end result, as it is often portrayed in over-eager advertising. Installing 53 million smart meters in 30 million homes and small businesses across the UK by 2019 is just the first step; the smart meter is an enabler rather than a solution in itself.

Smart Meters – The Answer To All Energy Bill Woes?

The UK has genuinely learned from consumer backlashes experienced elsewhere that early customer engagement is key to success. As such, DECC (Department of Energy and Climate Change) decided to put the consumer at the heart of the smart energy meter rollout.

One advantage of the UK's unique supplier-led rollout is that it provides the energy supplier with the opportunity to educate customers about the energy and money-saving benefits of smart meters, to encourage participation and retain their customers. If the rollout is to succeed, it is imperative it remains consumer focused so that any misconceptions around the potential benefits are avoided; this includes carefully communicating the timescale of these money-saving benefits.

An Oxford Economics report published last year claimed that the smart meter rollout will save households an average £65 a year and that Britain will be almost £14bn better off thanks to the introduction of smart meters to British homes and businesses. It claims that while smart meters will initially cost around £11.5bn to roll out, the benefits could come to £25.3bn. The report estimates that households and businesses will use less energy thanks to the greater control and transparency around energy use offered by smart meters. It also predicts that energy savings will be passed on by energy companies to consumers in the form of bill reductions.

This widely publicised report did a great job at reassuring the public that they could see tangible gains from the rollout. However, many of the benefits highlighted in the report rely on consumers changing their behaviour. This is ultimately where the problem lies when it comes to advertising the rollout.

A consumer-focused approach is almost certainly the right approach; however, this also means that investment is needed to ensure that consumers fully understand how to get the best results from their smart meters.

Painting The Bigger Picture

In additionn to understanding the real money-saving benefits, there are a number of other reasons why taking a long term view is important when it comes to the smart meter rollout.

Enabling behaviour change – As mentioned earlier, a smart meter is an enabler, but on its own cannot affect any cost or produce energy savings. It is dependent on behaviour change by the consumer to see results, and unless this is clearly communicated ahead of the rollout then it will inevitably result in disappointment.

A recent report from the European Environment Agency (EEA) *'Achieving Energy Efficiency Through Behaviour Change: What Does It Take?'* states that many factors influence consumer behaviour and practices. These include technological developments, considerations of the general economic situation, age, social norms, belief systems and cultural traits, as well as marketing strategies. Therefore, when developing energy efficiency measures or programmes, a wider variety of factors should be involved from the outset. Consumers need appropriate frames of reference in order to determine if their energy consumption is excessive. Meaningful, clearly communicated and continuous feedback is essential to a long-lasting change in consumer behaviour.

The EEA paper is the first report in a while on the topic of energy

consumption that really seems to understand the different factors that can influence consumer behaviour. This should be a key consideration for the smart meter rollout, to avoid the over-eager advertising described previously.

To achieve sustained reduction in energy consumption, it is important that consumers really understand their energy usage (and with the help from their smart meter) to enable them to make significant changes in their behaviour.

> While the technical specifications for smart meters are pretty comprehensive, to deliver real benefits they need to be paired with other technologies

Data access – although an in-home display (IHD) will really suit some people, it won't be an effective tool for everyone and may well end up unused in many kitchen drawers. So, energy suppliers need to reflect the changing technology used by their customers in the approach to providing smart meter data. Being able to access energy usage information on an iPhone, computer or smart TV may be better received by some people.

Wait for full functionality – while the technical specifications for smart meters are pretty comprehensive, to deliver real benefits they need to be paired with other technologies. These are continuously developing but we are already seeing them in homes, providing options for consumers to engage in energy reduction.

Tool for trust – According to a recent survey, half of consumers do not trust energy suppliers, citing poor value for money and lack of transparency. A third of those who did not trust their supplier said it was because the supplier didn't help customers reduce their bills. Smart meters offer energy suppliers a real opportunity to develop a transparent relationship with customers and rebuild those damaged relationships.

Thinking outside the consumer box – smart meters also have the potential to offer huge benefits to the energy industry. If smart meters are collecting network data too, then they could really help Distribution Network Operators (DNOs) to deal with faults more efficiently and get a better understanding of the impact on their distribution network. It is important to include information of value to network businesses wherever possible.

The smart meter rollout will not have an overwhelming impact overnight and it is important that this is communicated throughout the process. However, smart meters do offer the potential to achieve significant benefits to consumers and businesses alike. The rollout is just the start of the journey but it is an incredibly important journey nonetheless, and if consumers are successfully engaged and educated then smart meters could very well turn out to be the game-changer predicted by their marketing.

Figure 1: Clinicians increasingly use mobile devices

NAVIGATING THE MEDICAL DEVICE MINEFIELD

JEAN-LOUIS EVANS, MANAGING DIRECTOR AT TÜV SÜD PRODUCT SERVICE, A GLOBAL PRODUCT TESTING AND CERTIFICATION ORGANISATION, DISCUSSES THE LATEST REGULATIONS AFFECTING MEDICAL DEVICES AND THEIR DESIGNERS

On 26th September 2012 the European Commission (EC) adopted a package on innovation in health, intended to improve communication on safe, effective and innovative medical devices and in-vitro diagnostic medical devices for the benefit of patients, consumers and healthcare professionals.

A statement in the EC's Citizens' Summary document, which relates to these changes, cites a key issue for this change, as the need for healthcare professionals and other interested parties to have access to essential information on how medical devices have been assessed, as well as what clinical evidence there is to show that they are safe and effective.

The European Union (EU) is proposing updated regulations on a wide range of medical devices. This includes home-use items, such as digital thermometers and blood pressure meters, as well as more complex technologies such as x-ray machines and pacemakers. The aim is to ensure all these products are safe and can be freely and fairly traded throughout the EU.

The EC is, therefore, currently leading a review of the Medical Device Directives, calling for a new regulation to replace Directive 90/385/EEC (active implantable medical devices) and Directive 93/42/EEC (medical devices), as well as a separate regulation to replace Directive 98/79/EC (in-vitro diagnostic medical devices).

New Regulations

The new regulations have become necessary since the EC believes the existing rules, which date back to the 1990s, have not kept pace with the enormous technological and scientific progress of the last 20 years. The final draft of the regulations are now with Member States for their review, and early feedback within the UK community suggests that there will be no requests for major changes.

One reason for the change from directive to regulation is that EU countries can currently interpret and implement medical directives in different ways. This allows EU Member States to adjust the legal text so it can be aligned with the national legislation of that state. However, member states cannot interpret the requirements of a regulation and must accept it into their country's law in its entirety, unchanged.

The EC states that not only are these changes intended to safeguard patients and healthcare professionals, they will also help manufacturers, being clearer rules, easier trading between EU countries and a level playing-field, with penalties for those who don't play by the rules.

The new rules also support patient-oriented innovation and take particular account of the specific needs of the many small and medium-sized manufacturers in the medical device industry.

Impact on the Electronics Industry

Once feedback from the member states is completed, the anticipated date for approval of the regulations by the European Parliament is 2014, and they are expected to come into force in 2017.

In order to ensure that compliance deadlines set by the EC are met, designers and manufacturers of electronic medical devices should take firm action now. Initially, this should

include full assessment of the likely impact of the regulations upon their design and manufacturing processes. Otherwise, if they don't comply with the regulations' new requirements by 2017, their medical devices may not legally remain on sale within the EU.

Device Traceability

In the past it has sometimes proven impossible to trace medical devices back to their supplier. So, in order to improve traceability of medical devices throughout the supply chain, new rules will be introduced. Consequently, manufacturers will have to register their device on the Unique Device Identification (UDI) system. This is a unique number assigned to a medical device, enabling its identification and giving access to relevant information stored within the UDI database. Not only will this deliver full traceability of every individual device on the European market, it is intended to allow easier recall of faulty devices and help in the fight against counterfeit goods.

During the transition period from directive to regulation, manufacturers of medical equipment will also have to register with their country's competent authority, which in the UK is the Medicines & Healthcare products Regulatory Agency (MHRA).

Extended Classes

The regulation also means that importers and distributors of medical devices will now be affected as for the first time they will have to comply with the requirements. For some fully understanding and implementing the legal requirements will be a daunting task; they have never needed to make such arrangements, as until now the onus was placed upon the manufacturer.

Authorised representatives will also be included for the first time. These are legal entities, designated by non-EU manufacturers to represent them in the EU and ensure their compliance with the European Directives. By law, any non-European manufacturer must have an authorised representative based within the EU. However, as authorised representatives are able to work with more than one manufacturer, their access to confidential product files may cause issues for manufacturers, who may be wary of the possibility of confidential information becoming accessible to their competitors and must therefore carefully select the authorised representative they work with.

To keep pace with technological and scientific progress, the new regulations will divide medical devices into four different risk categories and health & safety requirements, including labelling rules. Class I is considered low risk, Class IIa is

medium risk (e.g. tracheal tubes, dental filling material), the medium-risk Class IIb includes items such as x-ray machines, bone plates and screws, while Class III devices are considered high risk (e.g. heart valves, total hip replacements, breast implants).

The class expansion means that some industries will also be included for the first time, such as cosmetic surgery, liposuction and non-corrective contact lenses. This will result in the inclusion of a new set of markets may not be aware of how the requirements affect them, or that may not have the processes already in place to ensure compliance. As such, this could represent an uphill struggle for industries caught within the net of the new regulation for the first time, requiring a significant amount of time and cost to ensure that they are fully up-to-speed and compliant.

Figure 2: Surgeons increasingly rely on electronics systems

Even those manufacturers where the specific requirements for their devices will not change will have to update their quality systems documentation to incorporate references to the new regulation. There are also changes to the approach for the declaration of conformity for individual products. This creates more administration and is not a quick five-minute task, as every document that refers to the current directive must be updated to reflect the new regulation.

Notifed Bodies

As part of the EC's goal of stronger supervision of independent assessment bodies by national authorities, every Notified Body will be de-notified and will have to re-apply. Of the 70-80 that currently exist, it is anticipated that far fewer will be re-notified. Some Notified Bodies may choose not to re-apply for cost reasons, or the competent authority in each country may no longer consider that the Notified Body meets the requirements and will not re-notify them.

If manufacturers have certified products under an obsolete Notified Body, they will be able to transfer that certification to surviving Notified Body under the new regulation. They will even have to do this if their product has been on the market for several years.

However, if the product was certified by an old Notified Body that is no longer recognised, then the new one may decide to conduct a full assessment before transfer. This will inevitably create bottlenecks, with products being taken off the market until they are re-certified, while some may prove unsuitable for re-certification under the new regulation.

Manufacturers therefore need to think carefully about which Notified Body they choose to work with from now on, especially as Notified Bodies will not be re-notified during the transition period of moving form directive to regulation status, giving manufacturers little time to act.

Also, since the EC wants to give more power to assessment bodies to ensure thorough testing and regular checks on manufacturers, the regulations propose that the Notified Body make unannounced factory inspections, in addition to the surveillance audits currently undertaken. At the moment it is unclear who will pay – the manufacturer or the Notified Body – and the process involved. For example, the Notified Body that arrives unannounced may find that the staff they need to meet, in order to access relevant files and other information relating to a product, are unavailable as the visit was not prearranged, which is a waste of time and money.

While the regulations are not yet finalised and the scope unclear, it is likely that Notified Body involvement may be required for some low risk Class I devices (e.g. sticking plasters, corrective glasses). For the first time, these Class I manufacturers will be required to provide technical files for review by a Notified Body, otherwise the product will not be approved and this could result in its removal from the market until that approval is granted. Once again, this means there is a whole new set of manufacturers that may not already have the processes in place to ensure compliance and will have to start from scratch.

The Notified Bodies themselves will also come under greater scrutiny as they will be regularly audited by the relevant authority in their own country, plus one other from another EU Member State alongside a representative of the EC as the lead auditor.

Early Action Needed to Reduce the Impact

With the significant increase in the number of manufacturers be impacted by new requirements for medical device regulation, many of which must comply for the first time and must start the compliance process entirely from scratch, time-to-market delays and product unavailability are inevitable. The equally significant decrease in the number of Notified Bodies, which will need to support these manufacturers, will only heighten the situation.

It is therefore imperative that manufacturers of electronic medical devices take action now to thoroughly understand how they must apply the changes. For those that are prepared, this could turn into a competitive advantage as they will be able to carry on selling after 2017, while their unprepared competitors may have to withdraw products from the market. ●

DESIGN OF FUNCTIONAL ELECTRONIC STIMULATION DEVICE FOR DROP FOOT PATIENTS

DOGAN IBRAHIM, **ALIYE TOSUN** AND **PEMBE YIGITOGLU** FROM THE NEAR EAST UNIVERSITY IN CYPRUS DESCRIBE THE DESIGN OF A MICROCONTROLLER-BASED FUNCTIONAL ELECTRONIC STIMULATION DEVICE FOR DROP FOOT PATIENTS

In general terms, functional electrical stimulation (FES) is defined as the application of electrical pulses to certain nerve points in the body to help accomplish purposeful tasks, such as walking or holding an object, in people where the motor nerve functions have been damaged completely or partially. FES is an electronic device that generates pulses with the correct amplitude, frequency and duration in order to stimulate the damaged nerves externally.

FES is not a new concept or a new device; it was first proposed by Liberson et al in 1961, who applied electrical stimulation to the peroneal nerve of hemiplegic patients suffering from drop foot. In a typical application, external electrodes energized by an electronic device are placed above the peroneal nerve. Pulses generated at certain times cause the tibialis anterior muscle to be contracted during the swing phase of the gait cycle and, as such, help the patient lift the foot, preventing it from dragging on the ground during the swing.

The Drop Foot Medical Condition

Drop foot is a common problem in people suffering stroke, multiple sclerosis (MS), cerebral palsy, or spinal cord injury where some of the motor functions are lost. The condition is due to the loss of communication between the central nervous system and the peroneal nerve which causes lack of activity in the ankle dorsiflexion.

Regular use of a foot-drop stimulator strengthens activation of the motor cortical areas and their residual descending connections. FES can be applied using external, percutaneous or implanted electrodes. In external applications, a pair of self-adhesive electrodes are placed on and near the peroneal nerve in the leg. The actual points of placement are important as they affect the strength and efficiency of the stimulation and patient comfort level.

In the case of percutaneous FES, an electrode is placed under the skin and close to the peroneal nerve with the aid of a needle. Percutaneous FES is more effective than the external FES but its placement requires medically qualified staff. Percutaneous FES is also prone to infection and is difficult to keep in place for long times.

Implanted FES is based on placing the electrodes under the skin permanently by small surgery. In some applications the actual stimulation device may also be implanted under the skin. Although this is suitable for long-term use, it has the disadvantages that as with the percutaneous FES, qualified medical staff is required to implant the device and, as with any type of surgery, there is always the risk of infection. External FES remains the preferred mode of stimulation in the clinical settings.

This article presents the design of a low-cost, programmable, portable high-performance stimulator, designed at the Near East University. The stimulator, called the NEU-Stim, has been designed to correct the drop foot problems using a foot sensor, microcontroller and electrodes. The frequency, duty cycle and amplitude of the output waveform can easily be controlled using switches. Because of its low cost, the device can be used in the

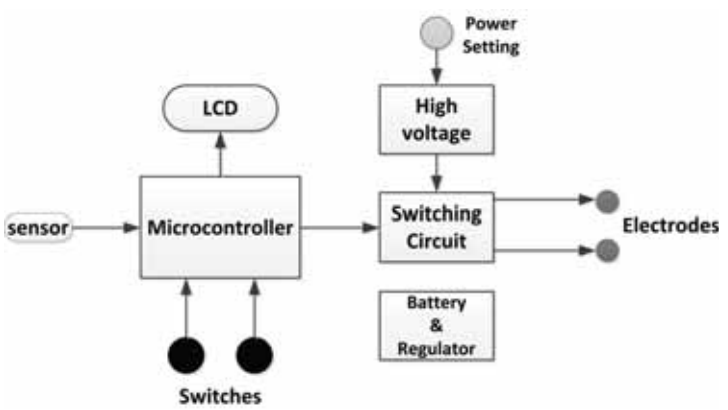


Figure 1: Typical modern FES device

Figure 2: Ness L300 FES device

Figure 3: WalkAide FES device

Figure 4: ODFS Pace FES device

Figure 5: Compex Motion FES device

developing countries. Preliminary results on patients have shown that the device can correct the drop foot and help patients to walk faster.

Parts Of A Modern FES Device

The early FES device by Liberson et al was bulky and hard-wired, requiring dial-based interfaces, and its functions were limited by the technology of the time. It was difficult to modify the design, or fine-tune the settings for specific users.

In general, nearly all modern FES devices today consist of a sensor, a digital controller, a high voltage (or current) generation and switching circuitry, electrodes and battery. In addition, displays and switches are usually provided to make the device user-friendly, such as to change the output amplitude and the frequency and duration settings for specific user requirements. Figure 1 shows the block diagram of a typical, modern FES device.

Sensors

All FES devices require an external sensor to determine when stimulus should be applied. Some commonly used sensor types are Force Sensing Resistor (FSR) sensors, push-button switches, tilt sensors, accelerometers and gyroscopes.

FSR sensors and push-button switches are in-shoe sensors and are fitted to an insole to detect the heel movements. The controller assembly is usually kept in a pocket or is attached to a belt around the body. These sensors are normally connected to the controller with a pair of wires; when the heel rise is detected, the status of the input pin changes at the controller input and this applies stimulation to the peroneal nerve.

FSR sensors are round or rectangular flexible, resistive, devices whose resistance changes with the applied pressure. These sensors are used with a voltage-divider resistor network such that the output voltage is either high or low, depending on whether pressure is applied to the sensor or not.

FSR sensors and push-button switches are simple and low-cost devices, which are desirable qualities in modern FES devices. However, all in-shoe sensors suffer from long-term reliability problems. The repeated application and removal of force on these sensors causes the sensor material to break and the sensor to malfunction, although these problems can be minimised by careful packaging and placement of the sensors. Another disadvantage of in-shoe sensors is the requirement for long wires to connect the sensor assembly to the digital controller. Unless the sensor wires are routed properly such wires may cause user discomfort and difficulty in movement. It is, however, possible to design in-shoe sensors using wireless technology, where heel movements are transmitted to the controller using low-cost, low-power wireless technologies.

Types of Devices

Tilt sensors come in different shapes and sizes; they are small two-state devices that change state when tilted. These sensors are usually based on the movement of liquid (e.g. mercury) to short circuit a pair of contacts when tilted.

Tilt sensors have advantages over in-shoe sensors since they do not suffer from reliability problems when used repeatedly, and they can be miniaturized, which is a desirable property in FES applications. But, like the in-shoe sensors, these devices are not intelligent, since they provide only high/low type output.

Accelerometers are low-cost electronic devices capable of measuring the magnitude and direction of acceleration. These are tiny chips that usually produce output voltages for each direction, proportional to the magnitude of the acceleration experienced by the device. Accelerometers are usually placed on the knee, on the lumbar region, or on the waist.

Accelerometers are intelligent sensors since they can be used to detect the acceleration, as well as the velocity and the movement of the leg in any direction.

Gyroscopes are tiny devices used to measure angular velocity. Some researchers have reported the successful use of gyroscopes as sensors in FES devices. Gyroscopes are usually used with other sensors, such as with FSR sensors and accelerometers.

The Digital Controller

The basic function of the digital controller is to generate pulses of specified duration and frequency, as well as gait detection, user interface control and timing control. The digital controller of all FES devices consists of a microcontroller. There are several factors that influence the choice of a suitable microcontroller, such as power consumption, size of program and data memory, built-in clock, timer and interrupt logic.

Since FES devices are portable and are used in daily activities, long battery life is one of the most important parameters affecting the choice of the microcontroller and interface circuitry. Overall power consumption can be minimized by the choice of low-power components wherever possible. For example, the LCD (if used) can be turned off during normal operation to save power.

Timing of the output pulses uses the built-in microcontroller timers. Usually more than one timer is required to generate

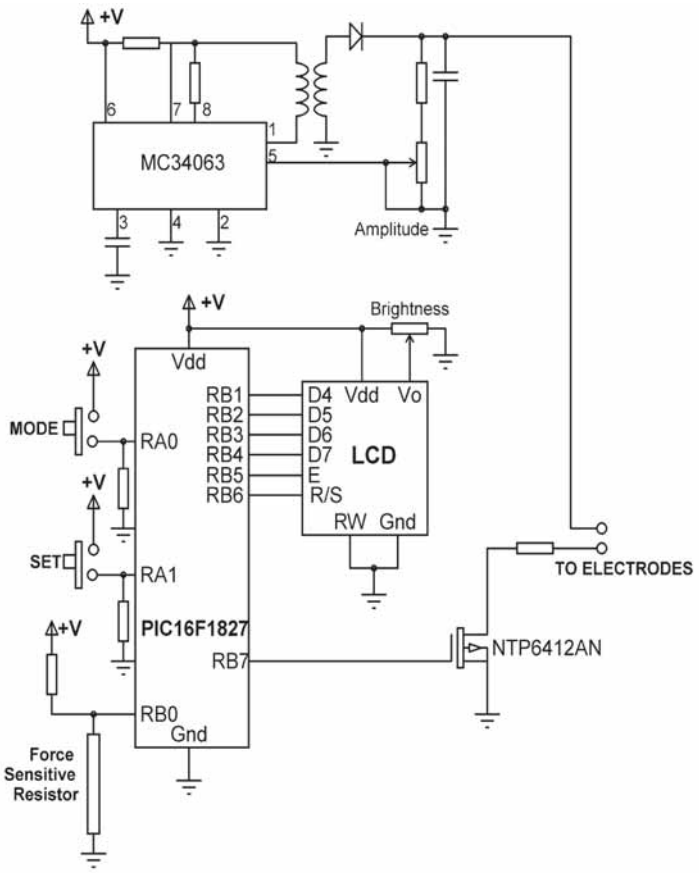


Figure 6: Circuit diagram of the NEU-Stim FES device

pulses with the required frequency and duration. Interrupt capability is also an important factor in the choice of microcontroller since accurate timing is normally handled by the timer interrupt mechanisms.

High Voltage (or Current) and Switching Circuit

In response to the sensor output, the microcontroller is required to generate output waveforms at the correct times. The high voltage and switching circuit increases the amplitude of this voltage to the required levels. This circuit usually consists of a DC/DC converter and a transformer where a low voltage (e.g. +9V) is converted into high voltage (e.g. +80V).

The output of FES devices can be either constant-voltage or constant-current. In a constant-voltage device the pulse amplitude is around 80V and as skin resistance increases the current decreases. Constant-current devices provide around 120mA of current and these devices are less affected by changes in skin resistance.

The output waveform of the FES devices is a pulse with a variable frequency and duration. The pulse shape can be monophasic, consisting of positive pulses only, symmetric or asymmetric biphasic, where the pulses are both positive and negative with no gap between, and symmetric biphasic with inter-pulse intervals. The pulse frequency in most devices ranges between 1-100Hz, and the pulse duration between 50µs-1ms.

Commercial FES Devices

There are many commercially-available FES devices on the market. Here are some of the popular ones.

NESS L300

NESS L300 (Figure 2) is manufactured by Bioness and consists of three parts: leg cuff (1), sensor (2) and wireless control unit (3). The leg cuff contains built-in electrodes and fits just below the knee. The gait sensor is basically an FSR type pressure sensor, attached inside the shoe that transmits on and off signals when the heel is on the ground or in the air. The wireless control unit is a small portable device that can be carried in a pocket, bag or purse. It is used to set the pulse intensity and to configure other stimulation parameters. L300 is a constant-current device providing 0-80mA current with symmetric or asymmetric pulse waveform. The pulse frequency is adjustable between 20-45Hz and the pulse duration can be set between 100-1500µs.

WalkAide

WalkAide (Figure 3) is a single-channel FES device manufactured by Innovative Neurotronics. It can be applied directly to the leg via a cuff which holds the device in place. The beauty of this device is that it is based on accelerometer technology with no sensors, so all the components are built inside and outside the cuff. The device is configured using software called WalkAnalyst which communicates with the WalkAide using Bluetooth wireless technology. WalkAnalyst collects real-time gait data as the patient walks and then configures the WalkAide with the optimum parameters. WalkAide provides maximum current of 200mA and maximum voltage of 121V. Asymmetric biphasic pulses are provided with a frequency range of 16.7-33Hz, and pulse duration of 50-250µs.

ODFS Pace

The ODFS Pace (Figure 4), developed by Odstock Medical Ltd, is a single-channel stimulator having a pair of adhesive electrodes as sensors and a foot switch, which offers data logging and programmable exercise modes. ODFS Pace provides current output to up to 100mA with symmetric and asymmetric biphasic pulse, with a pulse frequency of 0-60Hz and pulse duration of 0-360µs.

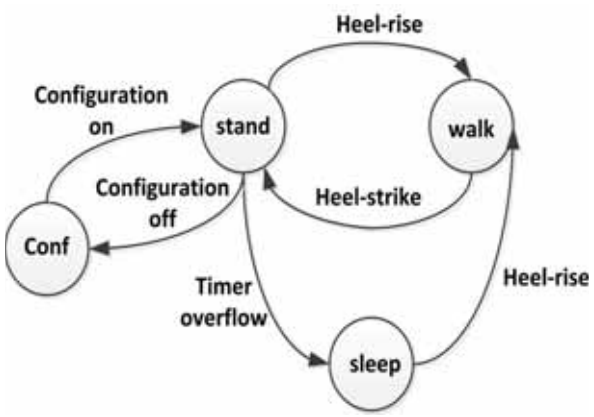


Figure 7: NEU-Stim operational states

Compex Motion

The Compex Motion (Figure 5) is designed to provide stimulus for drop foot patients. The device is configured using a graphical user interface program running on a PC. The stimulation protocol is programmed onto a chip-card which contains all the stimulation parameters, stimulation sequence and data about the sensors connected to the device. One unique feature of Compex Motion is that several units can be cascaded to provide multiple channels. Compex Motion is a current-driven device, providing monophasic or biphasic pulses with a frequency of 0-120mA, pulse frequency of 0-120Hz and pulse duration of 0-16ms.

Designing An FES Device (NEU-Stim)

The main aim of designing the NEU-Stim device has been to produce an FES device that will satisfy the following basic requirements:

- Low cost
- Low power
- Portable
- Battery-operated
- Standalone with no external support, e.g. for configuration etc.

The device is aimed to be used in developing countries where low cost is the main requirement.

The hardware is designed around the very low-power PIC16F1827 microcontroller. This 18-pin microcontroller is classified as a nanoWatt technology chip, having the following basic features:

- Internal 32MHz oscillator
- 7 kbytes program memory
- 384 bytes RAM data memory
- 4 x 8-bit timers
- 1 x 16-bit timer
- Sleep mode for extremely low power consumption.

The circuit diagram of the FES device is simple and is shown in Figure 6. The force-sensitive resistor is connected to interrupt input pin RB0 of the microcontroller through a resistor. Two push-button switches called MODE and SET are connected to port inputs RA0 and RA1 respectively, and are used to configure the operational parameters, such as the frequency, pulse-width and the operation profile.

The LCD, which is used for configuration only and removed during normal operation, is connected to PORT B of the microcontroller. High voltage is obtained using the MC34063 DC/DC converter. The amplitude of the output voltage is adjusted to up to 80V using a potentiometer. RB7 output pin of the microcontroller is used to turn ON and OFF the output voltage through a NTP6412AN high-voltage MOSFET switch. It is possible to remove the configuration switches and the LCD and, for example, connect the device to a PC for configuration. However, one of the requirements was to make the device standalone and low cost.

The software of the NEU-Stim device was developed using the mikroC PRO for PIC language. The software consists of two functionally separate modes: configuration mode and running mode.

```
BEGIN
        Set stimulation OFF
        DO FOREVER
                IF Heel-rise THEN
                        Clear Timer
                        Set Stimulation ON
                ELSE
                        Increment Timer
                        Set Stimulation OFF
                        IF Timer overflow THEN
                                SLEEP
                        ENDIF
                ENDIF
        ENDDO
END
```

Figure 8: PDL description of the software

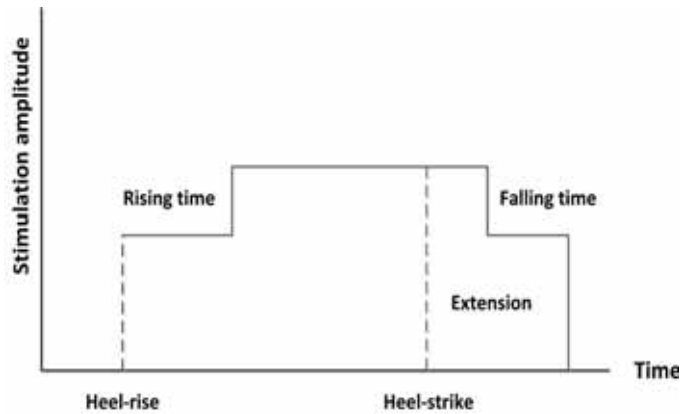


Figure 9: NEU-Stim stimulation envelope

Configuration Mode

Configuration mode enables the user to set the output pulse frequency, pulse duration and the user profile. Two push-button switches, MODE and SET, are used to set these parameters. The configuration mode is entered by pressing the MODE button while turning the power ON. The frequency can be selected between 5-200Hz, the pulse duration between 50-1000µs and, in addition, five user profiles can be selected. During configuration the LCD is connected to the device. The configured parameters are stored in the EEPROM non-volatile memory of the microcontroller. The pulse amplitude is set between 0-80V using a rotary potentiometer.

	Rising time	Falling time	Extension time
Profile 1	0	0	0
Profile 2	2	2	1
Profile 3	2	3	1
Profile 4	3	3	2
Profile 5	4	3	1

Table 1: NEU-Stim profile timings (times in seconds)

Running Mode

Once the device is configured with the required parameters it is ready for use. Although the foot switch has two states, the algorithm is based on four states as shown in Figure 7. The states and the transition between these states are as follows:

- **Stand**: This is the state where the foot sensor is pressed and the stimulator is OFF.
- **Walk**: This state is activated when the heel-rise is detected, i.e. when the foot is lifted off the ground, and as a result the stimulator is activated in this state.
- **Sleep**: This state is reached if an inactivity of pre-specified duration occurrs while in the Stand state. Here, the microcontroller is virtually shut down and operates with an extremely low current. The device automatically returns to the Walk state when heel-rise is detected.
- **Conf**: This is the configuration state which is entered if the MODE switch is pressed while in the Stand state. This state enables the device to be re-configured without having to cycle the power switch.

The operational structure of the software is described in Figure 8 using a PDL type description. If there is no activity for a pre-specified period of time while in the Stand state, the processor is forced into Sleep mode where extremely low power is used. The processor comes out of the Sleep mode automatically when heel-rise is detected.

The required pulse frequency and pulse duration are obtained by using two timers of the microcontroller in interrupt mode. One timer sets the pulse frequency while the other one sets pulse duration.

Stimulation Algorithm

The stimulation algorithm is a simplified version of the stimulation envelope used in the Odstock dropped foot stimulator (ODFSIII), where the envelope consists of time-dependent sections: ramp-up, mid-band, extension and ramp-down. In our application, a rectangular envelope is used with the parameters, as seen in Figure 9.

During heel-rise the stimulation amplitude is reduced for a short time, called the 'rise time'. At heel-strike the normal amplitude time is extended by an amount called the extension time. At the end of this time the stimulation is reduced for a time equal to the falling time, and after this time the stimulation is stopped.

Several experiments carried out on drop foot patients showed that different patients may require different profiles. In NEU-Stim device, five configurable and selectable profiles have been defined with different timing parameters to suit different patients. These profile timings are given in Table 1.

Future Work

The benefits of FES devices to drop foot patients are well known. Although there are many techniques developed for gait detection, in practice the most reliable method is to trigger the electrical stimulation device using a manual push-button switch. Although this method is highly reliable, it has the disadvantage that it requires the patient's continuous and uninterrupted attention to the button press sequences.

Modern devices are all based on microcontrollers, with their size getting smaller all the time. New designs are based on current technology, using intelligent sensors with wireless communication between different parts of the device, and using accelerometers or gyroscopes with Bluetooth communication.

Products like the WalkAide, accelerometer-based FES devices with no external wires or components, are reported to be highly successful. The improvement in walking speed is reported to be 15% after three months of use and 47% after 12 months. The problem with the WalkAide device is its high cost (around $5,000) which many private patients cannot afford.

Similarly, the NESS L300 device has been reported to reduce the rate of falls and help drop foot patients to walk. But at around around $7,000 its cost is again beyond the reach of most patients.

The NEU-Stim device, designed by a team at the Near East University, has been tested successfully with real patients suffering from drop foot. The device can be developed further by adding another in-shoe sensor underneath the metatarsal heads to enable reliable sensing during stair climbing. During stair climbing, normally only the front part of the foot is placed on the step while the heel remains in the air, thus making detection impossible with one sensor only.

The device will also be easier to use if the external wire from the shoe to the controller is removed and replaced with a wireless communication system, such as simple RF or Bluetooth. This will, however, add extra complexity to the design and require a battery and a small transmitter to be added to the shoe instrumentation.

The NEU-Stim device has been approved for clinical use by the Near East University Hospital, and meets the general requirements for safety of medical electrical and electronic equipment. Its benefit is that the processor shuts off and enters the low current sleep-mode when inactivity has been detected while waiting in the heel-strike state. The device then automatically wakes up and stimulation resumes on detection of the heel-rise, thus minimizing conscious user interaction.

The device is currently in the prototype stage and the first commercial units are expected to be manufactured soon, at a manufacturing cost of only $100. ●

CLINICAL TRIALS

Near East University hospital is the largest hospital in the Middle East, covering a 55,000 square-meter closed area with 209 private, single-patient rooms, eight operating theatres, a 30-bed Intensive Care Unit, large laboratories and a cutting-edge diagnostic imaging centre. This is also a teaching medical school of the university.

The clinical drop foot tests have been carried out at the Faculty of Medicine, Department of Physical Medicine & Rehabilitation. The tests involved four patients suffering from stroke and one patient suffering from MS, all having drop foot problems.

The patients had been attending the rehabilitation centre, having physiotheraphy for several years. Part of the theraphy involved these patients to be connected to the NEU-Stim FES device and initial observations indicated that four of them could walk significantly faster and more efficiently than before. One patient with stroke could not benefit from the NEU-Stim FES device because of different anatomical position of the peroneal nerve.

The FES treatment sessions are ongoing, with the same patients receiving the treatment now.

ALTERA AND ARM FPGA-ADAPTIVE PERFORMANCE ANALYSIS IN PRODUCT DEVELOPMENT

Stefano Zammattio, Altera

The goal of development tools is not only to facilitate the debug of complex problems, but also to make development more efficient. Sometimes this has more to do with the convenience and usefulness of standard product features than the availability power features.

One convenience feature available in most professional debuggers is the ability to display memory-mapped SoC peripheral registers as groups of registers with names, bitfields and descriptions equivalent to those found in the peripheral's documentation.

When developing on FPGAs implementation is more complicated. FPGA vendors normally provide a library of FPGA hardware such as encryption/decryption blocks, mathematical algorithm acceleration blocks and peripheral controllers. However, it is up to the hardware developer to decide how many of these blocks are synthesized on the FPGA and where they are located in the processor's memory map, which means that it is not possible for the software debugger to provide peripheral register views for them out of the box. The software developer can generate debugger peripheral description views manually, but manual editing is time consuming and error prone. The solution requires communication between the FPGA synthesis tools and the software debugger. The Altera QSys system configuration tool generates peripheral register description files for complete FPGA designs, and ARM's DS-5 Debugger can automatically import the files and display the FPGA IP registers as if they were part of the hard processor system.

SYSTEM-LEVEL PERFORMANCE ANALYSIS

Today, product developers emphasize debugging performance issues in an effort to gain more functionality out of the same hardware, or to reduce power consumption. Therefore, performance and power analysis tools have become a major area of focus for tools vendors.

One important reason to choose SoC devices (with integrated processor and FPGA fabric) is the ability to use FPGA hardware blocks to accelerate software. For example, FFT decoders or DES decryption algorithms in the FPGA fabric can be used to free up the processor, which can either perform another task or just sleep and save power. For these devices it is essential that tools provide visibility of the relative levels of utilization of the processors and FPGA IP blocks. The designer can then use the information to optimize the system.

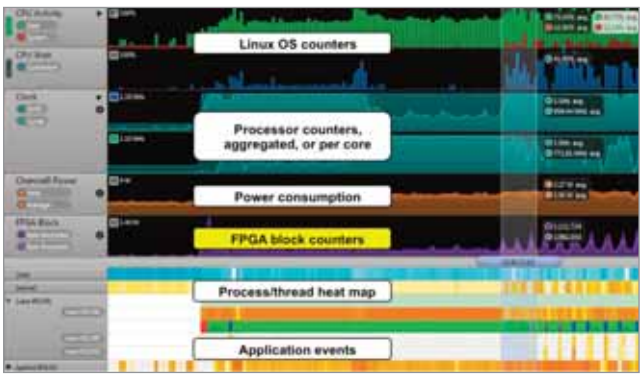
Although instruction trace is used for optimizing software codecs and other performance software, for ARM applications processors running operating systems such as Linux and Android, specific analysis tools such as the ARM DS-5 Streamline performance analyser are used. The ARM DS-5 uses a Linux driver running on the target to sample information at regular intervals and every time that there is a task switch information captured is provided by counters for events such as:

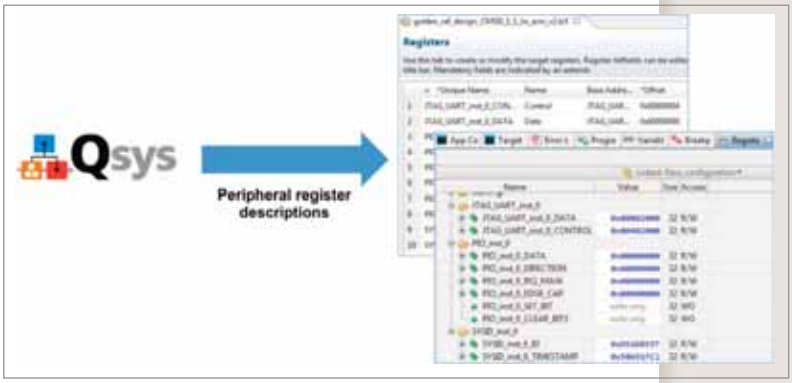
- Operating system events such as processor load.
- Processor events such as branch mis-predictions.
- System events, these counters enable the user to spot system-level bottlenecks.
- Software annotations, used to report events of interest.

When this information is visualized together on a timeline, the interactions between software and hardware are made apparent to the developer.

On hybrid processor and FPGA devices the Streamline analyser can be used to simultaneously optimize hardware and software. The only infrastructure required in the hardware is memory-mapped registers that count the level of utilization of each different IP block. Streamline can then be configured to access those new counters and display their value over time, correlated with CPU activity and other system-level counters.

Users interested in power consumption can extend Streamline with an ARM Energy Probe in order to monitor and visualize voltage and current consumption on a number of power rails on the target. On FPGA targets these power rails would normally be the ones used to power the CPU subsystem, FPGA core and FPGA I/O, but they could also monitor the main power supply of the whole product. Again, by visualizing the dependency of power consumption with software activity and system utilization, and being able to benchmark the energy consumption, developers can optimize the system for power consumption and battery life.





CONCLUSION

The new SoC devices containing ARM applications processors and FPGA fabric open up possibilities for more efficient products. The innovation in the hardware has been matched by innovation in the on-chip debug hardware, FPGA tools and software debug and analysis tools, so that developing on these devices and making the most of their power features is as easy and efficient as software development on fixed ASIC devices.

For more information
http://www.altera.com/soc and www.arm.com/ds5

ADVANCED SURGICAL SYSTEMS HAVE UNIQUE POWER NEEDS

BY **BRUCE HAUG**, SENIOR PRODUCT MARKETING ENGINEER AT LINEAR TECHNOLOGY

Until recently, options for surgery have been limited, and included traditional open surgery with a large incision, or a procedure that uses a lighted tube placed through a small incision, called laparoscopic surgery.

However, even though laparoscopy is a minimally-invasive surgery, it is often limited to very simple procedures due to the instruments required. Thanks to breakthrough technology there is another category of minimally-invasive surgery that incorporates robotic assistance. These surgical systems combine computer and robotic technologies that create a robotic-assisted laparoscopic, thoracoscopic or endoscopic surgery. By providing surgeons with enhanced capabilities, it is possible to treat a broader range of conditions using a minimally-invasive approach with better visualization, precision, dexterity and control than possible through traditional surgical approaches.

Minimising Surgical Damage

Minimally-invasive robotic-assisted surgery has been used in everything from heart surgery to cancer surgery to treat conditions as diverse as prostate cancer, endometrial cancer, morbid obesity and mitral valve regurgitation.

The typical setup is a surgeon's console, a patient cart with interactive robotic arms and a highly magnified 3D-image monitor of the body's interior. New methods of imaging and image-guidance technology provide surgeons with very accurate three-dimensional information about the location of critical subsurface structures and instrument position.

To operate, the surgeon uses controls that work like forceps. As the surgeon manipulates the controls, the system responds to the input in real time, translating his or her hand, wrist and finger movements into precise movements of miniaturized instruments. Figure 1 shows a picture of a robotic surgical system.

This type of system is usually designed using distributed power architecture, and it operates from the AC mains, either 110VAC or 220VAC, which is then converted to isolated 48V DC that charges a bank of 48V batteries. This 48V bus voltage is routed throughout the system to power downstream point-of-load regulators for all the subsystems, including the robotic arms, system electronics, instruments and a high resolution display. The battery pack maintains system operation when a loss of AC mains occurs. However, depending on the state of charge of the batteries, the battery pack voltage can be above, below or equal to the 48V input,

Figure 1: Typical robot-assisted surgical system

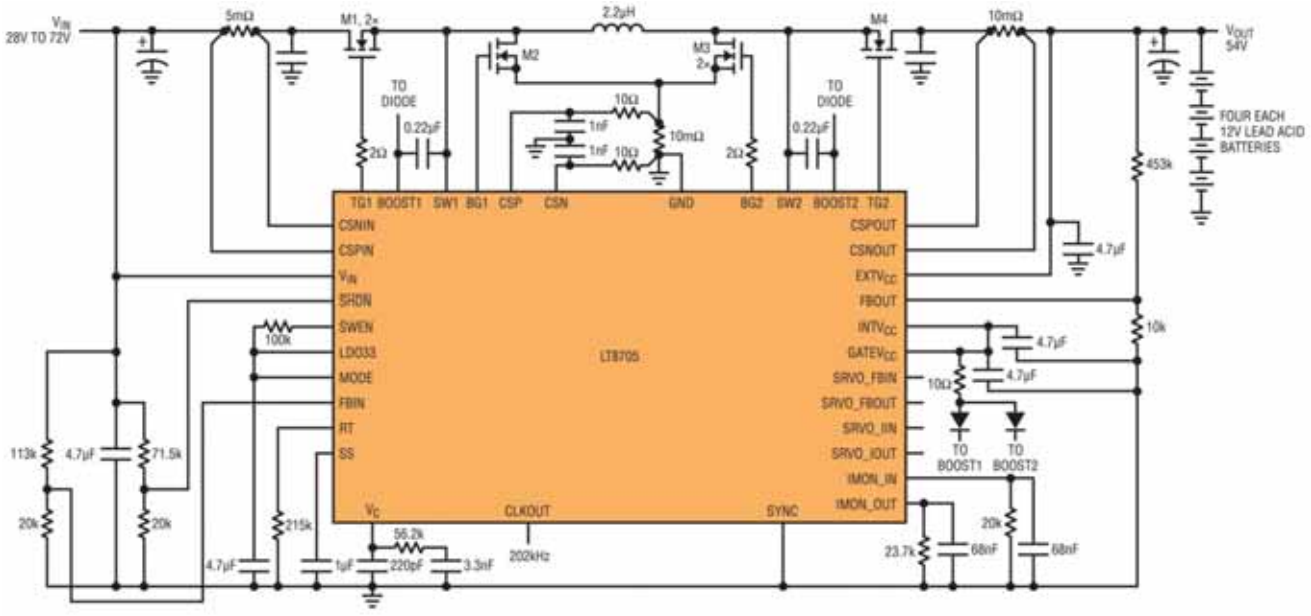


Figure 2: LT8705 battery charger schematic

making it challenging to design a power supply for this application. Fortunately, Linear Technology has recently released the LT8705, an 80V synchronous buck-boost controller that addresses the needs of such a power supply requirement.

A New Approach

The LT8705 is a very high efficiency (up to 98%) synchronous buck-boost DC/DC controller that operates from input voltages above, below or equal to the regulated output voltage. This device has

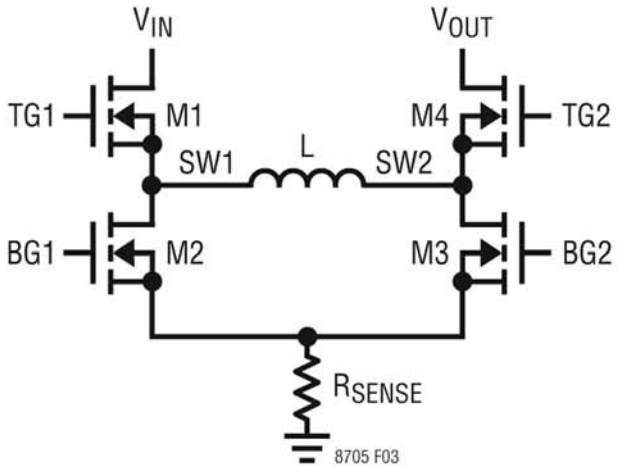


Figure 3: Simplified diagram of the four Mosfet switches driven by the LT8705

four feedback loops to regulate the input current/voltage, along with the output current/voltage. The output current loop provides a regulated output current for a battery charger or as a current source. The LT8705 operates over a wide 2.8V to 80V input voltage range and produces a 1.3V to 80V output, using a single inductor with 4-switch synchronous rectification. Output power up to 250W can be delivered by a single device, and higher output power can be achieved when multiple circuits are configured in parallel.

Additional features include servo pins to indicate which feedback loops are active, a 3.3V/12mA LDO to power external devices, adjustable soft-start, onboard die temperature monitor and an operating junction temperature range of -40°C to 125°C. The LT8705 is available in a 38-pin 5mm x 7mm QFN, and a 38-lead TSSOP package. An LTspice circuit model for the LT8705 is also available and can be used to quickly and easily evaluate all kinds of creative applications.

> By providing surgeons with enhanced capabilities, it is possible to treat a broader range of conditions using a minimally-invasive approach with better visualization, precision, dexterity and control

The LT8705 contains four error amplifiers, enabling it to regulate or limit the output current, input current, input voltage and output voltage. In a typical application the output voltage might be regulated, while the remaining error amplifiers are monitor for excessive input or output current or an input undervoltage condition. In other applications, such as a battery charger, the output current regulator can facilitate constant-current charging until a predetermined voltage is reached where the output voltage control takes over. The schematic in Figure 2 shows an LT8705 circuit that charges a 48V battery and operates from an input voltage that can vary from 36V to 72V. Multiple circuits can be paralleled for higher-power applications. The four external MOSFETs enable this circuit to be used as a synchronous buck/boost converter and are configured as a current source to charge four 12V lead acid batteries in series for this application.

Power Switch Control

Figure 3 shows a simplified diagram of how the four power switches are connected to the inductor, V_{IN}, V_{OUT} and ground.

When V_{IN} is significantly higher than V_{OUT}, the part runs in buck (step-down) mode. In this region, M3 is always off and M4 is always on, unless reverse current is detected while in Burst Mode operation or discontinuous mode. At the start of every cycle, synchronous switch M2 is turned on first and inductor current is sensed by an internal amplifier. A slope compensation ramp is added to the sensed voltage, which is then compared to a reference voltage. After the sensed inductor current falls below the reference, switch M2 is turned off and M1 (synchronous rectifier) is turned on for the remainder of the cycle. Switches M1 and M2 alternate, behaving like a typical synchronous buck regulator.

As V_{IN} and V_{OUT} get close to each other, the duty cycle decreases until the minimum duty cycle of the converter in buck mode is reached and the part moves into the buck-boost region with all four MOSFETs switching.

When V_{OUT} is significantly higher than V_{IN}, the part runs in boost (step-up) mode. In this region M1 is always on and switch M2 is always off. At the start of every cycle, switch M3 is turned on first and the inductor current is sensed by an internal amplifier. After the sensed inductor current rises above the reference voltage, switch M3 is turned off and switch M4 is turned on for the remainder of the cycle. Switches M3 and M4 will alternate, behaving like a typical synchronous boost regulator.

Fault Conditions

The LT8705 activates a fault sequence under certain operating conditions. If any of these conditions occur, such as an overcurrent or overvoltage condition, internal switching and clock output are disabled. At the same time, a timeout sequence commences, where the soft-start function needs to be reinitialize. If the fault persist, like during an overcurrent condition, the soft-start function will not be allowed to restart the converter. After the fault condition has been removed and a predefined timeout period has ended, the converter will restart at a rate dependent upon the capacitor value assigned to the soft-start pin on the LT8705. The timeout period relieves the part and other downstream power components from electrical and thermal stress.

Powering Surgical Systems with Confidence

Robotic surgical systems allow for several types of minimally-evasive major surgeries, which can reduce the hospital stay time, provide a faster return to normal activities and the potential for better clinical outcome. Powering these types of systems with distributive power architecture enables the use of a 48V nominal battery-backed-up bus voltage that powers downstream point-of-load regulators for all subsystems.

Linear Technology's LT8705 synchronous buck-boost DC/DC controller can significantly simplify power supply design with its ability to efficiently charge a battery with a float voltage above, below or equal to the input voltage. ●

3DTV

FAWZI IBRAHIM GOES INTO WHAT IT TAKES TO BROADCAST 3D TELEVISION CONTENT

Three-dimensional (3D) photography, cinema and television have a long history; in fact, stereoscopic 3D versions of these common visual media are almost as old as their 2D counterparts.

Stereoscopic 3D photography was invented as early as 1838, when Wheatstone introduced his stereoscope, a device that directs a different image to the left and right eye simultaneously. In 1849 a more sophisticated version using prisms and mirrors was introduced by Sir Brewster. Anaglyphs using colour filters and polarisation techniques were invented soon after in 1853 and 1891 respectively, and the first glass-less 3D images were introduced in 1903 by F. E. Ives using parallax barriers.

The earliest examples of 3D cinema were available in the early 1900s. Various forms of early 2D television were developed in the 1920s, and by 1929 stereoscopic 3DTV was demonstrated. The first public 3DTV broadcast took place in Los Angeles in 1908 and, since then, effort was placed to develop future 3DTV that provides good quality pictures, which brings us to today's high definition (HD) 3DTV broadcasting.

Depth Cues

The perception of 3D is realised through a number of cues, the most significant of which is the disparity between left and right images viewed by the left and right eyes known as parallax. The other cues are:

- *occlusion* – the overlapping of objects;
- *linear perspective* – by which farther objects appear smaller than closer ones;
- *accommodation* – the focusing of the eye;
- *shades and shadows*; and
- *convergence* of the optical axes of the left and right eyes on a single object.

These cues complement each other, allowing the brain to arrive at an accurate perception of depth. However, depth cues may

Events such as the Eurovision Song Contest, Cirque du Soleil or the Olympics (pictured here) could be further enhanced for the viewer by broadcasting them in 3D

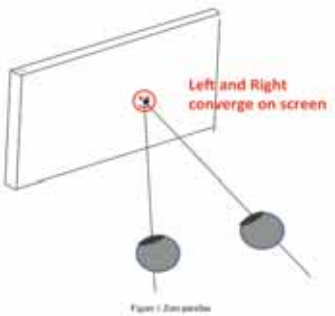


Figure 1: Zero parallax

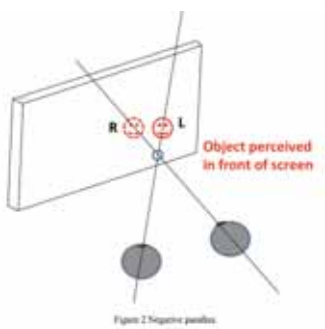


Figure 2: Negative parallax

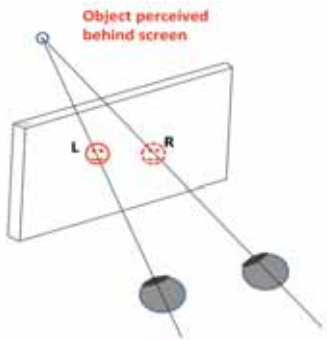


Figure 3: Positive parallax

provide contradictory information, resulting in discomfort in the form of eye fatigue, as the brain attempts to resolve conflicting information.

Parallax

Parallax is the fundamental depth cue used by humans to determine the distance of objects. Humans view a scene through two horizontally-separated eyes. When an observer views a scene, two slightly different views of the scene are projected simultaneously on the retina of each eye, producing what is known as retinal disparities or parallax. It is the retinal disparities that allow the human brain to fuse the two different perspective views into a single, three-dimensional image. As we will discuss later, parallax is what has to be reproduced for 3D video production.

Stereoscopic 3D video is primarily based on the binocular nature of human perception and is relatively easy to realize. Two simultaneous conventional 2D images are produced by a pair of cameras mimicking the two human eyes, which see the environment from two slightly different angles. Then, one of these streams is shown to the left eye and the other one to the right eye. Whether an object appears on the screen, behind or in front of the screen is determined by the type of parallax: zero, negative and positive.

The screen provides the reference distance from the observer. When an object is at that distance, the parallax (i.e. the disparity between the left and right images) is zero. The axes of the left and right eyes converge at a point on the screen as shown in Figure 1. The image is said to have zero parallax.

Objects that are nearer to the viewer have negative parallax (Figure 2). This occurs when the axis of the eyes converge in front of the screen; the image to the left eye is farther right than the image to the right eye. The object appears to be placed in front of the screen, between the viewer and the screen, a space known as 'viewer space'.

HISTORICAL PERSPECTIVE OF TELEVISION:

- First 3D images, Wheatstone, 1838
- First photograph, Daguerre, 1839
- Anaglyph 3D images using red/green filters, 1850s
- Motion captured on film, Muybridge, 1870s
- Motion pictures as entertainment, Edison, 1894
- Mechanical television, 1920s
- The movies add sound, 1927
- Technicolor, 1935
- All-electronic TV, 1930s
- TV in the home, 1940s
- Broadcast colour TV, 1950s
- 3D theatrical movies, 1950s
- Cinerama, Cinemascope wide-screen movies, 1950s
- Holography, 1960s
- Digital photography replaces film, 1990s
- Real-time image processing, 2000s
- HDTV, 2000s
- 3DTV, 2000s

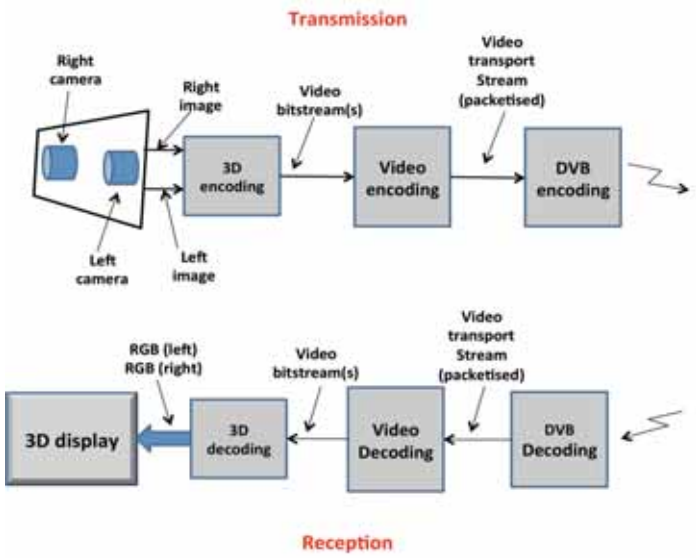


Figure 4: 3D television system

Objects that are farther away have positive parallax in which the object seen by the right eye is farther to the right than when seen by the left eye. Positive parallax causes the object to appear behind the screen (Figure 3). Positive parallax is infinite when the parallax is equal to the distance between the eyes, a distance known as the interocular distance (65mm on average), causing the eyes' axis to remain parallel so that the object will appear to be placed in infinity. Past that point, we have divergent parallax when the parallax is greater than the distance between the eyes, causing the eyes to diverge. This condition does not occur in real life and if it did occur in 3D reproduction would require odd muscle movement, resulting in discomfort.

3D Television System

A simplified block diagram of a stereoscopic 3DTV broadcasting system is illustrated in Figure 4. 3D uses 2D technology and infrastructure and the system starts with a pair of 2D cameras capturing the left and right images of a scene.

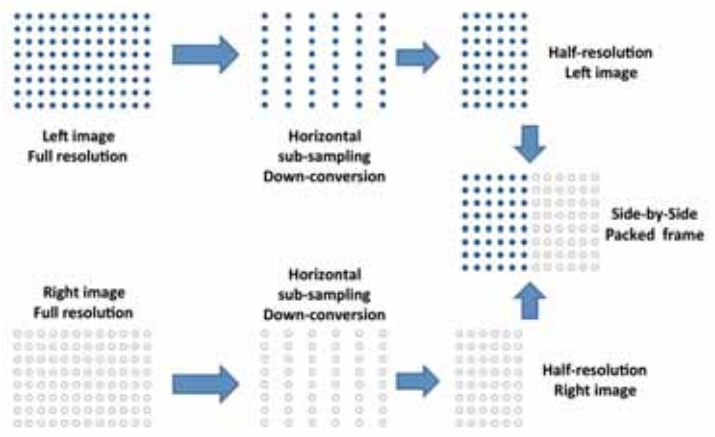


Figure 5: Side-by-side frame-compatible format

Figure 6: BBC 3D 2012 Olympic broadcast as seen on a 2DTV

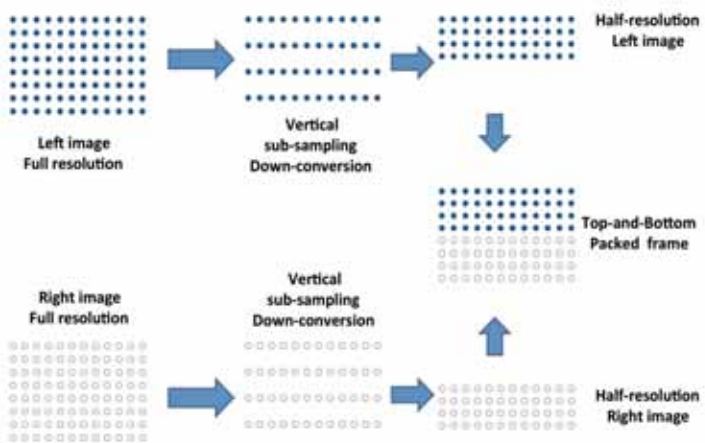


Figure 7: Top-and-bottom frame-compatible format

The left and right images are captured by two displaced cameras placed side by side. The displacement replicates the inter-ocular distance (IOD), the distance between the left and right eyes of humans. Two separate left and right digitised images known as the masters are produced by the twin cameras. These may be processed and broadcast independently, a process known as temporal interleaving, which is extremely wasteful in terms of bandwidth.

In practice, the two images are encoded (3D encoding) to form a bitstream that is compatible with conventional HD infrastructure. This may take the form of a single frame-compatible bitstream or an additional bitstream to carry the depth information. Data compression follows the familiar MPEG-4 (H.264) compression techniques to reduce the bit rate to manageable proportions. This is followed by DVB encoding, which includes channel encoding and modulation before transmission. At the receiving end, the reverse process takes place: DVB decoding, video decoding including data decompression before the 3D content is decoded and the two left and right images re-generated before to be fed into a 3D display.

Where Multiview 3D is employed, more than one pair of cameras is used to capture the image at different positions. Encoding of multiview images takes advantage of the fact that the contents of the images from the cameras are very similar with a high degree of redundancy, resulting in a very efficient data compression.

3D Encoding

The original 3D encoding technique relied on what is known as 'colour shifting' in which the left and right images are colour-coded using a pair of colours such as red/green or red/cyan to produce a single, merged frame as explained earlier. At the receiving end, the two frames are separated using colour glasses. The advantages of this approach are that the frame is compatible with existing HD delivery systems; it can be delivered over any 2D system, it provides full resolution and uses inexpensive glasses. However, it produces the lowest quality 3D image, compared with any of the other systems and, hence, has been shunned by manufacturers.

Instead, 3D broadcaster have opted for a frame packing system in which the two left and right images are squeezed into a single 1920 x 1080 HD frame. However, the resulting video frame is not backward-compatible: legacy HD decoders will display the packed frame composed of left and right images but not separate left and right images.

There are three types of 3D frame encoding techniques available for modern 3D video application:

- Temporal interleaving
- Spatial compression (frame-compatible)
- 2D + Metadata (2D+M) (non-frame-compatible).

Temporal (sequential) interleaving

This technique uses time multiplexing to present sequential left-right images. The images are in full resolution and, therefore, require a doubling of the frame rate and a doubling of the bandwidth, compared with a normal 2D HD signal. Compression can take advantage of the fact that the contents of the left and right images are very similar but this is of limited value and the bandwidth required remains too high for normal commercial applications.

Spatial compression

A basic requirement for a successful 3DTV system is the ability to deliver 3D video on existing HD infrastructure. To achieve this, a single HD frame must be used to carry both left and right video information. This can be achieved by spatial compression.

Pixel sub-sampling is used on each image to cut the number of pixels by half, thus enabling the two images to be squeezed into a single standard 2D HD frame, a format known as frame-compatible. The down side of this process is a 50% loss in picture resolution.

Spatial compression is available in three different formats:

- Horizontal sub-sampling, which takes out alternate columns,

known as side-by-side (SbS) format;
- Vertical sub-sampling, which takes out alternate lines, known as top-and-bottom (TaB) format;
- Diagonal sub-sampling using quincunx filtering, usually referred to as checkerboard format.

In the side-by side frame-compatible arrangement, horizontal sub-sampling is carried out by which alternate horizontal pixels (alternate columns) of the left image are removed, resulting in halving the number of pixels per line as shown in Figure 5. The shortened lines are then placed to occupy the first half of each line of a single HD video frame, as illustrated. The same procedure is carried out for the right image, except this time it occupies the second half of each line of the frame. In this way, the side-by-side frame has the same format as a conventional HD video frame, making it compatible with HD delivery systems.

> The original 3D encoding technique relied on what is known as 'colour shifting' in which the left and right images are colour coded using a pair of colours such as red/green or red/cyan to produce a single, merged frame

The down-conversion of the two images reduces the horizontal resolution of the picture by 50%. Such reduction in resolution may seem drastic, but as far as viewing experience is concerned, the effect is far more limited. This is because the down-conversion is effectively reversed by upscaling the L and R images to full HD before they are displayed. Upscaling is carried out using sophisticated format-conversion techniques, including motion estimation and motion compensation to re-introduce alternate lines.

In the top-and-bottom frame-compatible arrangement, vertical sub-sampling is carried out by which alternate vertical pixels (alternate lines) of the left image are removed resulting in halving the number of rows, as shown in Figure 7. The columns are then placed to occupy the first (top) half of a single HD video frame, as illustrated. The same procedure is carried out for the right image only; this time it occupies the second (bottom) half of the HD frame.

The top-and-bottom method thus has the same format as a conventional HD video frame that is compatible with HD delivery systems. The down-conversion of the two images reduced the vertical resolution of the picture by 50%. Once again, the effect on the viewing experience is limited as a result of up-conversion.

2D-plus-Metadata, 2D+M

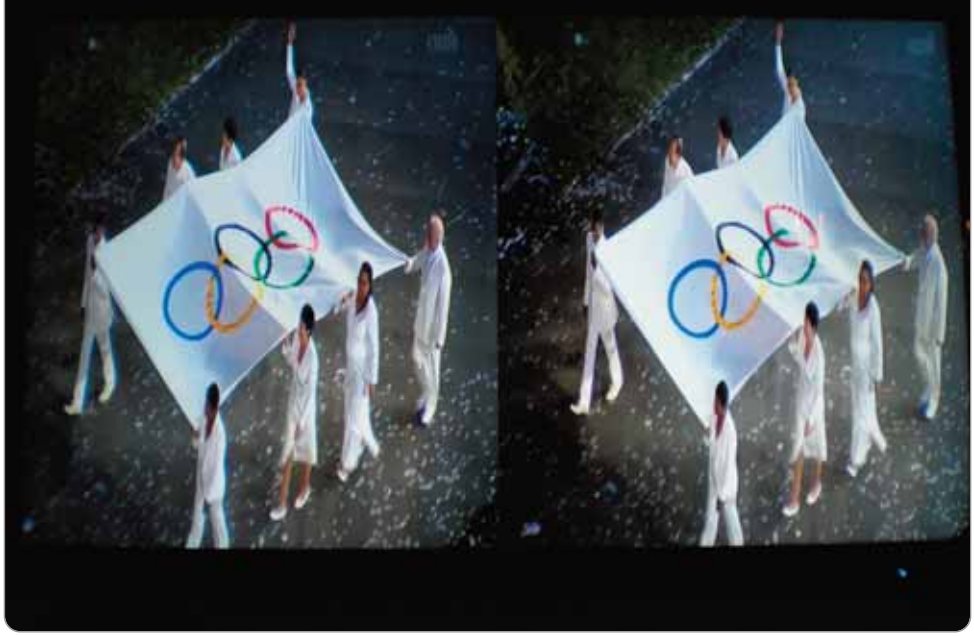
The idea behind this technique is to transmit a 2D left image together with additional depth information (metadata) that allows the reconstruction of a corresponding right 2D image at the receiving end. The metadata is packaged and transmitted as a separate video stream. This approach saves bandwidth compared to the temporal interleaving technique, retains full HD resolution and is consistent with MPEG specification. Furthermore, it is fully compatible with current 2D displays in that a legacy 2D display can receive the 2D image and disregard the metadata to produce a full HD image. The additional information is used to generate one or more virtual views of the 3D scene by means of depth-image-based rendering (DIBR).

2D-plus-M may be presented in three different formats:
- 2D-plus-depth with a 'depth map' as the metadata;
- 2D-plus-DOT, where additional occlusion and transparency information are added to the depth map;
- 2D-plus-D where Delta D is the difference between the left and right images. ●

LEARN MORE:

THE COMPLETE SET OF NOTES IS AVAILABLE ON
www.tvdiagnostics.com
In addition, there's a course on 3DTV. To find out more see http://www.electronicsworld.co.uk/events

The Olympics are a prime example for using 3DTV to enhance the viewing experience



NING YANG, RONGBIAO ZHANG, PEIFENG XU, ZIXUAN XIANG
AND INFORMATION ENGINEERING AT JIANGSU UNIVERSITY IN
MICROFLUIDIC SYSTEM FOR DETERMINING THE RHEUMATOID

Optimised Microfluidic Device for Assessing A Rheumatoid Factor in Patients

Patients who are suspected of having any form of arthritis are frequently assessed for a rheumatoid factor, which helps diagnosis and disease prognosis. As such, a sensitive method for an accurate imunoassay – a procedure for detecting or measuring specific proteins or other substances through their properties as antigens or antibodies – is essential.

We designed a microfluidic system for determining the rheumatoid factor and optimized this process's parameters, including for injecting, mixing, reaction and detection. We also demonstrated its capability to determine the rheumatoid factor with a significantly lower reagent consumption. The agglutination reaction – a clumping of bacteria or red cells when held together by antibodies (agglutinins) – was performed on-chip and the absorbance changes were simultaneously monitored.

Chip Design

The microfluidic chip we designed comprises the following main sections: an y-shaped micro-channel, mixing zone, reacting zone and detecting zone (see Figure 1). The two inlets in the y-shaped micro-channel (a) are used to introduce the latex reagent and rheumatoid factor serum sample. In Figure 1 (b) is the mixing zone, with a distinct rib-shaped channel structure, where the sensitized latex reagent and the serum mix. We found the inner rib-shaped channel allows for high mixing efficiency and low pressure loss of the microfluids.

Figure 1: Photo of the proposed microfluidic chip

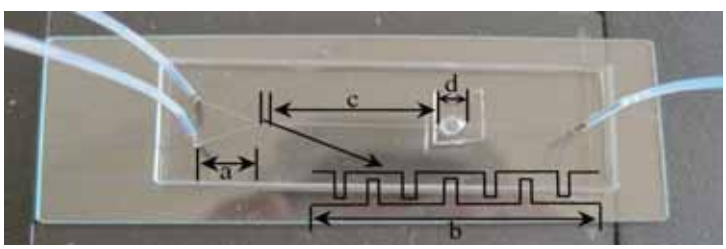


Figure 2: Front view of the microfluidic chip

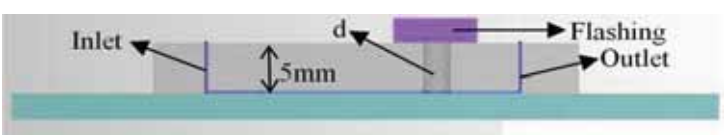
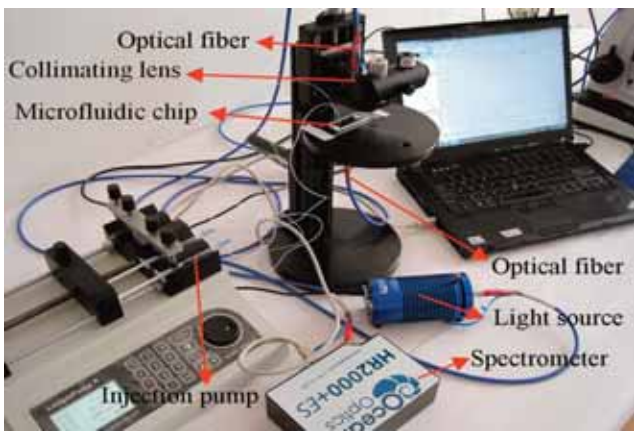


Figure 3: Microfluidic system setup for on-chip immunoassay and absorbance detection



Section (c) is where the reaction between antibodies and antigens proceeds to completion. Secton (d) is the photoelectric detecting zone (see its structure in Figure 2, which is also the front view of the microfluidic chip).

The chip's detection path is 5mm, as the photoelectric detection zone extends the full length of the chip. The diameter of the detection zone is 2mm, the same as the light spot from the collimating lens.

Microfluidic System Setup

The components of the microfluidic system are shown in Figure 3. A two-channel syringe pump (LSP04-1A, Baoding Longer Precision Pump Co Ltd), equipped with two 1ml plastic syringes (Terumo, Terumo Corporation, Tokyo), is used to deliver the latex reagent (Shanghai Jiemen Bio-tech Co) and rheumatoid factor serum sample (collected by the department of preclinical medicine and medical technology from Jiangsu University's attached hospital).

The polydimethylsiloxane microchip is placed in a temperature controller, which keeps the temperature between 25°C and 45°C, ±0.2°C. The microfluidic chip is placed on the transmission test-stand and a light-emitting fibre probe is placed on it. The emitting

AND **JIANJIANG GUO** FROM THE SCHOOL OF ELECTRICAL ZHENJIANG CHINA PRESENT THE DESIGN OF A FACTOR IN ARTHRITIS PATIENTS

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

probe connects with the collimating lens, which lies under the detecting zone of the microfluidic chip.

The detecting fibre and the light-emitting fibre were connected to a spectrometer (Ocean Optics USB2000+ES) and a light source (Ocean Optics HL-2000-HP-FHSA). Absorbance and spectral changes are recorded using the software provided by the manufacturer of the spectrometer, controlled by a portable computer.

Optimising The Parameters

The important parameters for detecting the rheumatoid factor on-chip include injection speed, optical wavelength, optimum reaction temperature and reaction pH. The necessary reaction time of immunoagglutination (the formation of a complex between antigens and antibody immobilised on latex beads, as proposed for the kinetic detection of the rheumatoid factor) is determined by the absorbance of the agglutination process, the parameter used to optimize the injecting speed.

As different wavelengths have different absorption sensitivities with immunoagglutination, we conducted different immunoagglutination experiments on positive serum samples with different titers (the concentration of a solution as determined by titration, a common laboratory method of quantitative chemical analysis) and tested the absorbance. We then selected the absorbing wavelength that is the most sensitive to the intensity change of the immunoagglutination as the detecting optical wavelength.

pH and temperature are the most important factors that affect the results of immunoagglutination. As the amount of fluid in microfluidic systems is on the nano scale, the detection results are vulnerable to external parameters. As such, we need to determine the optimum environmental parameters of the on-chip immunoagglutination.

Determining Reaction Time

In order to analyze the immunoagglutination reaction process between the antibodies and the sensitized latex reagent particles in the serum, we tested the time for the absorbance changes to determine the process. We conducted an immunoagglutination experiment using positive serum that has 60IU/ml (in pharmacology, the International Unit is a unit of measurement for the amount of a substance, based on biological activity or effect. It is abbreviated as IU) of antibody concentration, and collected the changing absorbance data from the immunoagglutination at the 600nm wavelength every 20 seconds. Figure 4 shows these absorbance changes during the immunoagglutination process. The absorbance becomes stable after 120s, so the time the sample needs to enter the detecting section is 120s.

Figure 4: Agglutination process change

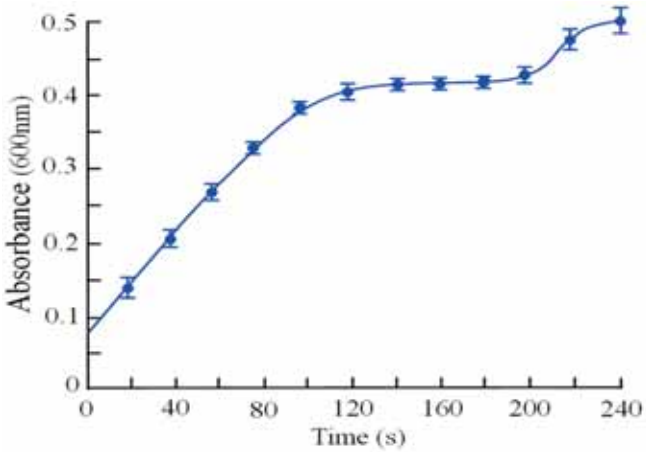


Figure 5: Microfluidic mixing process within the micro-channel

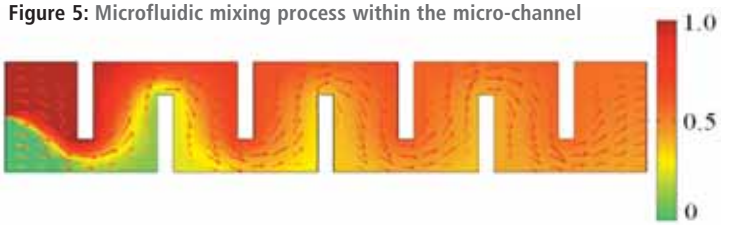


Figure 6: The mixing index of the outlet changes with the injecting speed

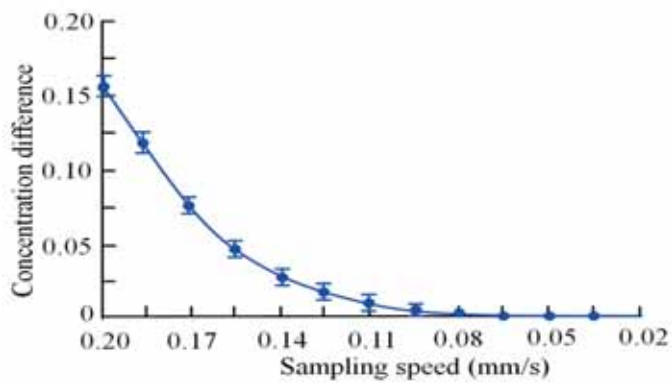
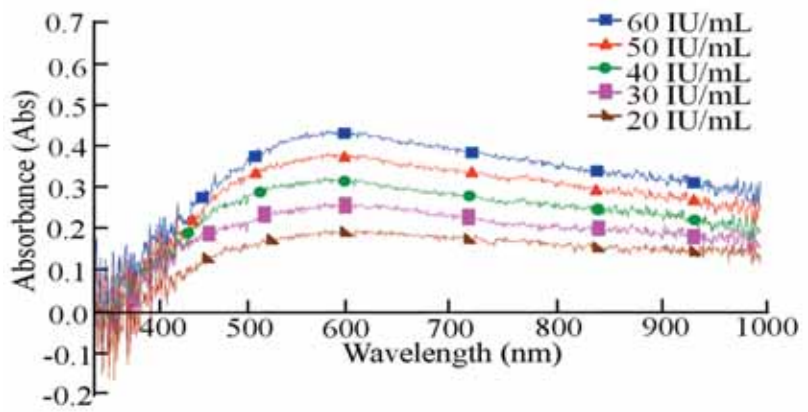


Figure 7: Absorption spectrum of agglutination



The injecting speed has significant influence on both detection efficiency and the effect of the device. Longer reaction time is not recommended for kinetic immunoassays because it could lead to non-specific agglutination and decreased reproducibility. This can be seen in Figure 4, when the reaction time was longer than 180s. Whereas if the injecting speed is too high, it will affect the mixing and reaction processes. In addition, experimental data shows that with a high injecting speed, the injecting time from the mixing zone to the detecting zone is less than 120s, so the immunoagglutination reaction is bound to be incomplete, which significantly distorts the test results.

Figure 8: Agglutination intensity change with pH

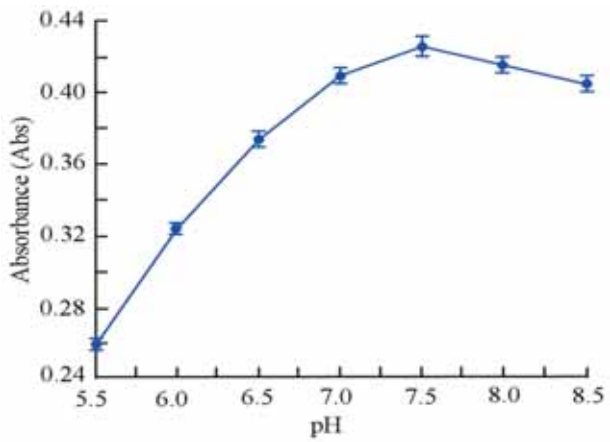
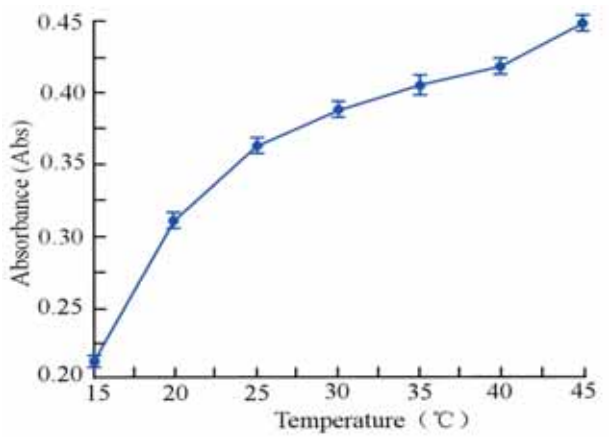


Figure 9: Agglutination intensity change with temperature



Based on the microfluidic chip's structure, the distance from the mixing zone to detection zone is 20mm, while the required time is 120s, therefore, the injecting speed should not exceed 0.167mm/s.

We used the simulation software COMSOL Multiphysics 4.3 to simulate the process of mixing fluids within the inner rib-shaped channel. Figure 5 shows the simulation of the mixing process within the micro-channel when the injecting speed is 0.167mm/s.

The figure shows the 'stretching' and 'folding' of the fluid, which increases the efficiency of mixing and diffusion. Figure 6 shows the results for the mixing index for different injecting speeds. This index is measured by changing the concentration of the fluids and the calculation method is as follows:

$$M = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(C_i - C_0)^2}$$

In the equation M represents the mixing index, n is the number of sections in the micro-channel, C_i represents the volume fraction of the i region and C_o represents the volume fraction when it is completely homogenous. Here we gave C_o a value of 0.5 since it was mixed by two sets of liquids. The mixed index value M changes between 0 and 0.5, with 0 indicating a completely mixed fluid and 0.5 not mixed at all.

It can be seen from Figure 6 that when the speed of the injector is below 0.2mm/s, the concentration index becomes lower, whilst when the sampling speed is 0.08mm/s, the two different liquid concentrations are completely mixed. So, to make the sensitized latex reagents and serum mix fully, we choose 0.08mm/s as the sampling speed for the microfluidic system. As such, the total time of the sensitized latex reagent and serum through the mixing zone and the reaction zone is 250s, which is greater than the security response time of 120s discussed before.

Optimising The Optical Wavelength

We used a rheumatoid factor positive serum with different titers (20IU/ml, 30IU/ml, 40IU/ml, 50IU/ml, 60IU/ml) to react with the sensitized latex reagent; Figure 7 shows the absorption spectrum.

From the figure we can see that the curve of the absorption spectrum increases with the increase of the titer. However, we only need to select a certain wavelength as the detection wavelength. So, we filtered the characteristic absorption

Figure 10: Agglutination intensity change with titers of the rheumatoid factor

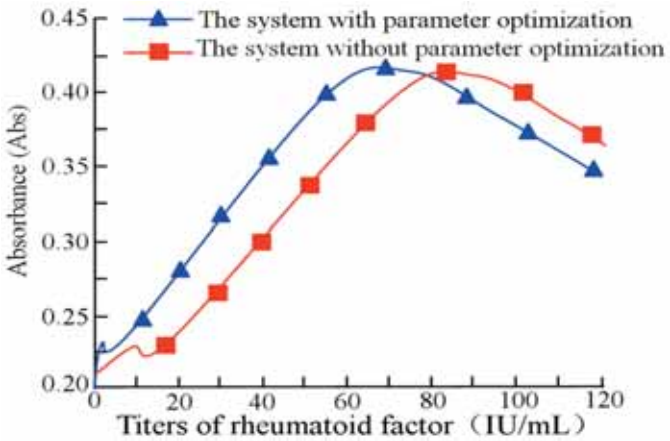
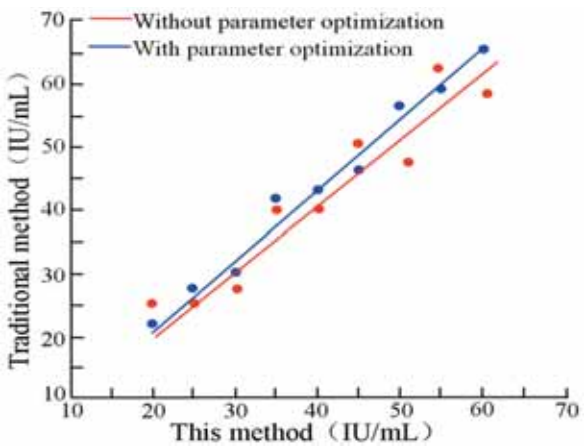


Figure 11: Data distribution and regression analysis



wavelength within the range of 400nm to 1000nm. The goal is to select the wavelength with the maximum change rate as the characteristic wavelength. We found that the change rate of the absorbance would reach the maximum at the wavelength of 580nm, up to 0.08Abs/(IU/ml).

In our experiments, the streams of latex reagent solution and rheumatoid factor serum sample were introduced to the system simultaneously. The carrier buffer delivered both solution streams to the microchip. The pH of the carrier buffer was studied and optimized, since the dispersion of reagents and the buffer can influence the rate of immunoagglutination.

The effect of the carrier-buffer pH on the rate of latex agglutination reaction was studied over the range of pH 5.5-9.0 with 60IU/mL rheumatoid factor serum. The test results of the absorbance at the wavelength 580nm, shown in Figure 8, imply that pH 7.5 was the optimum for this assay, since the highest signal was obtained at this pH value. Performing the assay at near-neutral pH was also advantageous in terms of stability of the tubing in the flow system.

Optimising Temperature

Temperature is one of the factors affecting the immunoagglutination rate, which is very sensitive to small changes; therefore, the effect of varying temperature on the assay reaction was studied. The optimized temperature chosen was regulated for the microfluidic immunoassay by a temperature controller.

We injected sensitized latex reagent with pH 7.5 and the positive serum solution with titers 60IU/mL into the designed microfluidic chip system at the temperatures of 15°C, 20°C, 25°C, 30°C, 35°C, 40°C, 45°C, and then detected the absorbance at the wavelength of 580nm. As shown in Figure 9, it is apparent that the sensitivity of the reaction increases with temperature.

Although at 45°C we observed the highest signal, this high temperature was eliminated in order to avoid protein denaturation – a process in which proteins or nucleic acids lose the tertiary structure and secondary structure which is present in their native state. In addition, we observed that air bubbles were easily generated at this temperature. Generally, performing the reaction at 37°C is a common protocol for most immunoassays, with almost no bubbles and no denaturation of proteins. For this reason, we kept the temperature constant at 37°C during all experiments, with the help of the temperature controller.

Detection Performance

Different titers of rheumatoid factor positive serum and sensitized latex reagent solution were injected into the system via different injection valves. A typical curve for the rheumatoid factor assay, shown in Figure 10, indicates that at rheumatoid factor concentrations higher than 70IU/m, the absorbance signal dramatically decreases. This could be explained by the “hook effect” or post-zone phenomenon, which is attributed to the presence of excess antigens.

A linear response was obtained in the range of 5IU/mL to 70IU/mL. The limit of detection (LOD) was calculated from ten identical assays of the blank sample. Based on a signal-to-noise ratio (S/N) of 3, the detection limit of the detecting system with optimal condition parameters obtained for rheumatoid factor is 5IU/mL. However, for a detecting system without optimized parameters, the detecting limit is 10-20IU/mL.

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

Turning The Page To The Next Chapter On Boundary Scan

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

How many aspects of this fast-paced electronics industry would have been around for over two decades? Not many, but there are a few. One is the boundary scan or JTAG standard (IEEE 1149.1). For something as inconspicuous as boundary scan/JTAG, it has certainly had widespread effects on the industry over the last 20 years. But just as amazing in many ways, boundary scan has become essential to the health of the electronics industry.

Development of the IEEE 1149.1 boundary scan standard began in Europe in 1985 by the Joint Test Action Group (JTAG) and was completed in 1990. The original intent was to provide a non-intrusive test methodology for detecting structural faults like shorts and opens on circuit boards. At the time, manufacturers were finding it increasingly difficult to test boards as access for physical probes was disappearing. Chip-scale-device packages, like ball grid arrays, denied probe access to chip pins by placing them under the silicon die, and test pads on the boards themselves were being squeezed out by increasing board density and new design practices. Multi-layer boards didn't help either; don't even think about placing a probe on a trace on an inner layer.

Industry adoption carried on apace and, now, practically all processors, including DSPs, FPGAs, programmable logic devices (PLD), digital ASICs, Ethernet chips, PCIe endpoints and others feature a JTAG port which conforms to the IEEE 1149.1 boundary scan standard.

Still, this doesn't explain why boundary scan hasn't just survived, but thrived over the years. This is largely down to the ongoing evolution of the original standard, the addition of other standards to the 1149.x boundary-scan family and the inexorable march of technological advancements.

The Boundary-Scan Family

Not long after 1149.1 was ratified, work began on improving it and expanding the family of related standards which took advantage of it as a foundation. Additional uses for boundary scan were found, such as in-system programming. And, because it offered direct access to most processors, JTAG debugging soon emerged.

The IEEE 1149.4 standard tried to incorporate analog test capabilities into the digital 1149.1 framework, but it's been an uphill climb for its adoption. On the other hand, 1149.4 was followed by the 1149.6 standard for advanced digital networks, which extended boundary-scan test to high-speed AC-coupled and/or differential interconnects and has been adopted in a big way by the industry. Most recently, another standard, 1149.7, joined the family. This enhanced version of the original boundary scan standard included new architectures and, if so desired by the designer, reduced the number of chip pins needed to support it. These changes make 1149.7 quite apropos of testing, debugging and validating system-on-a-chip (SoC) devices, multi-die system-in-a-package (SiP) and package-in-package (PiP) chips.

> *The Internal JTAG (IJTAG) standard (IEEE P1687) is heading toward a ratification vote and vendors are already enabling it with tools and deployment methodologies*

Accessing Embedded Instruments

While all of these improvements, enhancements and expansions to the family were happening, engineers were also using boundary scan. And when that happens, it's anyone's guess what the outcome will be. One of the several new applications of boundary scan that emerged was as an access mechanism for embedded instrumentation. Chip and board designers had found that they needed validation, test and debug methods that could operate from the inside out, rather than the older test technologies that relied on outside-in physical probes. Boundary scan gave access to test and measurement instruments or instrumentation functionality that was embedded

– permanently or temporarily – in all sorts of chips. (By the way, embedded instrumentation is akin to built-in self test or BIST, although embedded instrumentation is much more comprehensive than BIST ever was.)

Now, the next step in this boundary-scan saga is upon us. The so-called Internal JTAG (IJTAG) standard (IEEE P1687) is heading toward a ratification vote and vendors are already enabling it with tools and deployment methodologies. As an industry-accepted specification should, IJTAG will standardize the way we work with T&M instruments embedded in chips. To date, that hasn't been the case, but now we're already seeing an ecosystem of tools, support and suppliers growing up around IJTAG.

Staying Power

So why has boundary scan lasted as long as it has? For a start, it did what it set out to do very well, and yet had room for growth. Then, as the industry moved, boundary scan evolved too, taking into account advancements in technology and changes in the industry. Now IJTAG is turning the page on the next chapter, where the exciting possibilities for boundary scan are practically limitless. ●

LEARN MORE

More about the IEEE 1149.1 boundary scan standard and how it's used, through a comprehensive book-length tutorial, can be found at: http://www.asset-intertech.com/Products/Boundary-Scan-Test/e-Book-JTAG-Tutorial

• More about 1149.6 can be found at: http://www.asset-intertech.com/News/White-Papers

• An overview tutorial on IJTAG can be found at: http://www.asset-intertech.com/Products/IJTAG-Test/IJTAG-Test-Software/e-Book-IJTAG-Tutorial

element14 LAUNCHES RASPBERRY PI CAMERA BOARD AND PHOTOGRAPHY COMPETITION

The eagerly anticipated Raspberry Pi camera board is making its debut with element14 enabling pictures and video to be taken with the Raspberry Pi which can be used for security and VoIP projects, as well as image and video capture.

One of a strong pipeline of exclusive Raspberry Pi accessories to be launched this year, the camera board, which retails at $25 is available through Newark element14 and MCM in North America, Farnell element14 in Europe, CPC in the UK and Ireland and element14 in Asia Pacific.

The camera board is a custom designed add-on for the Raspberry Pi which attaches to one of the small sockets on the board's upper surface. This interface uses the dedicated CSi interface, designed especially for interfacing to cameras. The camera board is around 25mm x 20mm x 9mm in size. Key features include 5-megapixel native resolution sensor and 1080p30, 720p60 and 640x480p60/90 video support among others.

At present, element14 is calling all budding photographers to enter its Raspberry Pi photography competition to win a supply of new Raspberry Pi accessories. Anyone owning a Raspberry Pi and camera can enter the competition, which calls for images taken with the device to be submitted in four categories:

- Workshop/den;
- A Pi project;
- People and pets;
- Outdoors.

Finalists will be selected in each category and these will be uploaded to Facebook for a public vote to select an overall winner. The competition will run from 14 May to 14 June 2013.

With over nine million views of the Raspberry Pi group on the element14 Community the success of the micro-computer is clear for everyone to see. To join the conversation, go to http://www.element14.com/raspberrypi. To take part in the Raspberry Pi camera competition and find out more visit http://www.element14.com/picamera.

www.element14.com/raspberrypi

New Technology Delivers Flexible Resolution Oscilloscopes

For the first time in an oscilloscope, Pico Technology has used reconfigurable ADC technology to offer a choice of resolutions from 8 to 16 bits in a single product. Most digital oscilloscopes gain their high sampling rates by interleaving multiple 8-bit ADCs, but despite careful design, the interleaving process introduces errors that always make the dynamic performance worse than the performance of the individual ADC cores.

The new PicoScope 5000 Series scopes have a significantly different architecture in which multiple high-resolution ADCs can be applied to the input channels in series or parallel combinations to boost either the sampling rate or the resolution.

In series mode, the ADCs are interleaved to provide 1GS/s at 8 bits. Interleaving reduces the performance of the ADCs, but the result (60dB SFDR) is still much better than oscilloscopes that interleave 8-bit ADCs. In parallel mode, multiple ADCs are sampled in phase on each channel to increase the resolution and dynamic performance.

www.picotech.com

XJTAG'S FREE BOUNDARY SCAN WORKSHOP IN COVENTRY

XJTAG is running a free boundary scan training workshop at the UK's Manufacturing Technology Centre (MTC) in Coventry on 12 June 2013. The free workshop aims to provide engineers with an introduction to boundary scan and to show how this innovative debug, test and programming process can be used throughout the product life-cycle.

The hands-on workshop will be of interest to engineers in design, development, test and production who will receive a comprehensive introduction to boundary scan. XJTAG's workshop leaders will explain how boundary scan can be used from start to finish, to improve designs and reduce re-spins, and to enhance test coverage, fault diagnosis and production yields on complex BGA-populated circuits. The free workshops will give overview of the IEEE 1149.x standard and demonstrate how to communicate with the JTAG chain and how to interact with JTAG devices such as FPGAs.

www.xjtag.com/workshop.php

PROFESSIONAL BOUNDARY-SCAN TOOLSET IS NOW AVAILABLE TO BUY ONLINE

JTAGLive Studio is a comprehensive package of JTAG/boundary-scan tools that enable designers and manufacturing test engineers alike to develop complete test and programming applications at an unprecedented price level.

On sale now at www.jtaglive.com Studio establishes a new class of PCB test and device-programming toolset that dramatically lowers the cost of entry for test and hardware engineers, while still offering the many traditional benefits of JTAG/boundary-scan alongside newer technologies, like processor-controlled test.

JTAGLive Studio works with or without design netlist data and can be used to test interconnects (from individual nets to an entire board), logic clusters, memories and more. Studio also includes device programming features that support JAM/STAPL and SVF data formats for CPLD and FPGA configuration PROM programming. It can be further used to program flash and serial PROMs. Low-cost options for accessing the debug modes of processor cores allow cut-price access to techniques known variously as Processor Controlled Test and JTAG Emulation Test.

www.jtag.co.uk

APACER LAUNCHES MSATA MINI SSD MODULE OPTIMIZED FOR COMPACTNESS

Consistently devoted to the compactness and lightweight of terminal devices, Apacer rolls out mSATA Mini M4 SSD of Small Form Factor (SFF) to meet the market demands. The product is only 26.8 × 29.85mm in size, and compared with mSATA SSD adopting JEDEC MO-300 standard specification, this latest model has its size reduced by over 1/2.

Featuring ultra-compactness and slimness, it can break through the physical limit of the spatial design and significantly reduce the size and weight of a terminal device. In addition, it also boasts anti-shock, anti-vibration and low-power consumption, thus enabling itself to become the most reliable storage choice for portable devices applied in the military, medical equipment, on-board navigation system, tablet computer and so on.

Apacer's mSATA Mini M4 adopts 52-pin gold finger mSATA connector capable of supporting SATA 3.0Gb/s transmission interface, and uses highly reliable SLC (single-level cell) flash memory essential to guarantee the durability of the product.

www.apacer.com

BUCK REGULATOR POWER SUPPLY IC WITH LOW QUIESCENT CURRENT STANDBY MODE

The new A8580 from Allegro MicroSystems Europe is a buck regulator power-supply IC that offers a high degree of flexibility in input voltage (4 to 40V), switching frequency (250kHz to 2.4MHz) and output current (up to 2.5A).

Designed to provide the power supply requirements of next-generation car audio and infotainment systems, the new AEC Q100 qualified device incorporates all the control and protection circuitry required for a high-current regulator with ±1.0% output voltage accuracy.

A key feature of the A8580 is the use of pulse frequency modulation (PFM) to produce a very low input quiescent current while supplying a "keep alive" voltage supply in standby mode. The IC is guaranteed to draw less than 50µA from a 12V input while supplying 3.3V at 40µA. In addition, to work down to idle-stop battery conditions, the A8580 will operate down to at least 3.6V input with the input voltage falling.

www.allegromicro.com

Charcroft Launches Online Store With Part Builder And Live Help

Charcroft Electronics Ltd, a specialist distributor of passive, emech and interconnect products and a manufacturer of precision, legacy and custom passives, has launched an eBuy store for online purchasing of commercial and BS/CECC-release radial multilayer ceramic capacitors (MLCCs).

Initially offering 1200 individual line items across the VK20, VK21 and VK30 series MLCCs, the online store provides real-time inventory and same-day shipment of ex-stock items ordered before 3.00pm Monday to Friday. Full CECC or BS documentation is included for all release MLCCs at no additional charge.

An online Part Builder enables buyers and engineers to search using a partial part number, or by selecting individual parameters to enable cross-referencing to other manufacturers' devices. Live Help is available via an online chat with a Charcroft technical specialist. The store also includes a My Account option which enables registered users to see the status of current orders and view historical orders.

www.charcroft.com/eBuy

Mouser Offers High-Performance Atmel SAM4S Cortex-M4 Flash MCUs

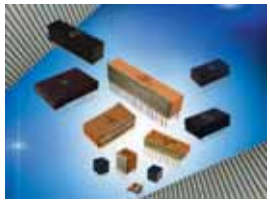
Mouser Electronics is now stocking SAM4S ARM Cortex-M4 Flash microcontrollers (MCUs) from Atmel. SAM4S MCUs boost performance, power efficiency and memory with up to 2MB of Flash and 160kB of SRAM.

Atmel SAM4S devices operate at 120MHz and integrate Atmel's Flash read accelerator and optional cache memory to increase system performance. Atmel SAM4S MCUs also offer a rich peripheral set for connectivity, system control and analog interfacing. The SAM4S series achieves 200µA/MHz in dynamic mode at a low operating frequency and 1µA at 1.8V in back-up mode with the real-time clock (RTC) running. The devices are pin-to-pin and software compatible with SAM3 and SAM3N Cortex-M3 processor-based MCUs, offering a smooth upwards migration path for performance and memory size.

With its broad product line and unsurpassed customer service, Mouser caters to design engineers and buyers by delivering What's Next in advanced technologies.

www.mouser.com/atmelsam4s

25V RATING AND EXTENDED CAPACITANCE RANGE SERIES FROM AVX



AVX Corporation has expanded the voltage and capacitance range of its MIL-PRF-49470-qualified SMPS Series stacked MLC capacitors by adding a 25V capacitor to the original 50-500V offering. The new 25V SMPS capacitor currently features standard MIL-PRF-49470 Level "B" reliability; however, a parallel component with T-Level reliability for space applications is under qualification.

Designed for high-current, high-power and high-temperature applications, AVX's MIL-PRF-49470 SMPS capacitors exhibit very low ESR and ESL and can withstand temperatures ranging from -55°C to +125°C. Primarily used in the input/output filters of high-power and high-voltage power supplies, as well as in bus filters and DC snubbers for high-power inverters, the SMPS Series is also ideal for DC/DC converters, general and switched-mode power supplies, aerospace instrumentation panels and a variety of hybrid power and military applications.

AVX's SMPS Series capacitors are available in six case sizes and with a variety of through-hole and surface-mount lead options.

www.avx.com

AMPHENOL CAT 5E AND CAT 6 MODULAR JACKS NOW AVAILABLE FROM TTI, INC

Amphenol's new Cat 5e and Cat 6 modular jacks for use in applications that require higher standards for data transmission can now be ordered from TTI, Inc. The Cat 5e products work reliably at 1000Mbps (Gigabit Ethernet) speeds while controlling near-end cross-talk. Cat 6 components are ideal for supporting 10 Gigabit Ethernet and are able to operate up to 250MHz.

The new innovative modular jacks are part of Amphenol's broad range of I/O registered jacks (RJ) which offer solutions to meet the increasing demand for faster speeds and greater bandwidth required by telecom and networking markets for VoIP, Ethernet, WLAN, industrial and other applications. Both RJE72 series Cat 5 e and RJE71 series Cat 6 modular jacks are available as single or four port versions benefit from an ultra low profile and feature integrated LEDs.

The latest available technological innovations within each component of Amphenol's RJ connectors ensure that the most stringent market demands are met.

www.ttieurope.com

MINIATURE ULTRA-LOW RDS(ON) DUAL LOAD SWITCH NOW AVAILABLE

Advanced Power Electronics Corp (USA) has announced a miniature, ultra-low on-resistance 6A dual load switch. Comprising two N-channel MOSFETs with associated control circuitry, the APE8990-3 has an RDS(ON) of 20mΩ and controlled turn on functionality.

The MOSFETs operate over an input voltage range of 0.8 to 5.5V and each support a maximum current of 6A. Each load switch is controlled by an ON/OFF input (ON), which is capable of interfacing directly with the low voltage control signals. Additional features include an on-chip 150Ω load resistor for quick output discharge when the switch is turned off. In order to avoid inrush current, the rise time is adjustable using an external ceramic capacitor on the CTx pin.

The device is very useful, suitable for many applications as a load switch for power rail management. As an example, it can be used to turn off power to idle sub-systems, reducing system power consumption and thereby improving battery life in portable applications.

www.a-powerusa.com

Harwin Awards Mouser Electronics for Global Product and Marketing Outreach

Harwin, manufacturer of hi-rel connector and SMT board hardware, has given its Global Product & Marketing Outreach Award to Design Fulfilment Distributor, Mouser Electronics.

Presenting the award, Doug Steele, Global VP for Distribution at Harwin commented: "Mouser has been very successful worldwide in helping Harwin win new design opportunities. A good example is the immediate impact the company has made with our new Gecko family of 1.25mm pitch hi-rel connectors. Mouser's marketing and commitment to inventory has resulted in Harwin winning new designs with new engineers around the globe. We thank them for their efforts on our behalf and look forward to continuing to develop business together."

"It is a great honour to accept this award from Harwin," said Krystal Jackson, Mouser's Vice President of Interconnect. "Harwin, like Mouser, is at the forefront of introducing innovative products on a global level, and we greatly value our partnership with Harwin."

www.harwin.co.uk

CONNECTORS COMBINE LARGE NUMBER OF MATING CYCLES WITH PROTECTION FOR HARSH ENVIRONMENTS

The new Han HMC industrial connector series from Harting combines the capability for more than 10,000 mating cycles with protection against harsh environmental conditions.

The new connector family is designed for use in applications such as the medical, laboratory and test engineering sectors, for example, where equipment may be employed in different locations and can often be connected and disconnected several times a day. Similar situations occur in the automation environment, where the trend to modular and interchangeable machine tools and control systems also requires connectors that can handle a large number of mating cycles.

The complete Han HMC series consists of Han B HMC housings, Han HMC connector inserts with crimp connection in four different versions, Han HMC crimp contacts in two sizes, a range of Han-Modular modules together with the Han HMC crimp contacts, and two different docking frames.

www.harting.com

MOST COST-EFFECTIVE PCI EXPRESS PROTOCOL ANALYZER

Teledyne LeCroy introduced its most cost-effective PCI Express protocol analyzer with interchangeable interposers for probing. The new compact yet feature-packed Summit T24 Protocol Analyzer features a small chassis footprint while maintaining the same data analysis features found in the top-of-the-line Summit T3-16 protocol analyzer. The Summit T24 protocol analyzer supports PCIe data transmission rates up to 5GT/s and data lane widths up to x4 in a single compact unit.

Protocol analyzers are used by system integrators and by driver and firmware developers to understand serial data communication between devices and systems. The protocol analyzer acquires, records, decodes, analyzes and displays complex high-speed serial I/O communication streams, such as PCI Express. The new Summit T24 protocol analyzer provides a solution for system implementers by providing powerful data capture and analysis at low prices.

The Summit T24 also supports upgrade paths from low-cost base units to higher data rates and larger lane size.

teledynelecroy.com/europe

COMPREHENSIVE CATALOGUE FROM KEMTRON

Kemtron, UK-based manufacturer of RFI/EMI shielding solutions, has published a comprehensive new catalogue in response to customer demand.

The 144-page printed catalogue has proved popular with customers who have limited Internet access, or who prefer the convenience of a paper version that they can bookmark, add notes or use as a working reference tool.

Managing director David Wall said: "We have had a fantastic response from customers in countries like Germany, India and Turkey, as well as the UK. They welcome the fact that they can have a printed catalogue when so many suppliers only offer information on the web."

The catalogue provides detailed product overviews, technical specifications, application information and design considerations for Kemtron's range of RFI/EMI shielding solutions, as well as background information on EMC and useful design tools.

www.kemtron.co.uk

Highly Integrated PFC IC for Compact Consumer Products and PCs

Power Integrations introduced a new family of high-efficiency, active-PFC ICs called HiperPFS-2 for offline applications from 100W to 380W. They combine a boost PFC controller, driver, PFC MOSFET, PFC diode and protection circuits in one package, enabling exceptionally compact designs, ideal for small form-factor power supplies as used in mini-tower PCs, all-in-one PCs, game console adapters and TVs.

The HiperPFS-2 controller uses a variable-frequency CCM algorithm providing up to 97% efficiency across the load spectrum from 20% to 100%, and power factor greater than 0.9 at 20% load with 265VAC input for designs over 200W. Including line-connected sense elements, the new device contributes just 60mW to a typical high-power adapter's 300mW no-load budget. Conducted and radiated EMI are minimized due to the integrated soft-recovery diode and short parasitic-inductance loop which results from the highly integrated, compact design.

Other key applications for HiperPFS-2 ICs include telecoms and industrial products such as blowers, motor drives and chargers.

www.powerint.com

CONGATEC PRESENTS ITS FASTEST COM EXPRESS MODULE BASED ON FOURTH GENERATION INTEL CORE PROCESSORS

congatec AG has announced the availability of the conga-TS87, a Type 6 COM Express module featuring fourth generation Intel Core processors.

The COM Express module offers outstanding performance, featuring improved vector processing, more efficient floating-point calculation and amazing graphics, without increase in power consumption. Improvements to the previous architecture have led to efficiency gains that also boost performance. This is particularly evident in the embedded graphics, where the number of integrated graphics units (execution units) has been increased, resulting in higher 3D performance in the range of 28-60% compared to previous generations.

The most exciting new feature is the introduction of Intel Advanced Vector Extensions (Intel AVX) 2.0, which improves performance of floating point instructions. In fourth generation processors, Intel AVX 2.0 helps enable higher performance in applications like signal and image processing for market segments like medical and avionics.

www.congatec.com

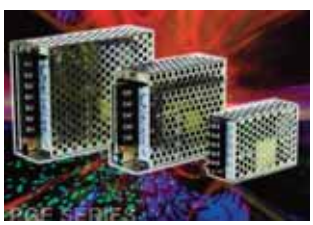
ANTIMICROBIAL SWITCHES HELP FIGHT AGAINST INFECTIONS

Arcolectric – an Elektron Technology connectivity brand – has partnered with BioCote Ltd to offer a range of switches and covers with built in BioCote antimicrobial technology, providing integral protection from a wide range of micro-organisms, including bacteria, mould and fungi.

Recent high profile reports into antibiotic resistance have highlighted the need for robust infection-prevention strategies, helping to eliminate antibiotic resistant organisms before they can cause infection. Arcolectric can incorporate BioCote active silver ion technology into any of its ranges of rocker, push-button and double-pole switches, as well as dust and splash resistant covers. This reduces the presence of bacteria by up to 99.9%, with no decrease in efficacy for the expected lifespan of the component, offering equipment manufacturers a key differentiator for the laboratory, healthcare and food processing sectors.

Switches and controls are often the first contact point for a user when they interact with a product, making these high-traffic areas a key target in the fight against microbial contamination.

connectivity@elektron-technology.com • www.arcolectric.co.uk



25 To 150W Single Output Enclosed Power Supplies With Very Low Standby Power

Powersolve's energy-efficient power supply portfolio is expanded with the introduction of the PGE25-150 Series of enclosed power supplies.

These highly efficient, single-output units feature a no-load power consumption of less than 0.5W, designed to provide high reliability and a long MTBF with every unit undergoing a full load burn-in test.

The PGE family consists of six series, each comprising six models with output voltages of 3.3 to 48V. All models accept a wide, universal AC input and incorporate an LED to indicate power on status.

All models in the PGE family are convection cooled and are protected against short circuit, overload and over voltage. They have an operating temperature range of -20ºC to +70ºC, which is suitable for most applications.

The units are extremely compact ranging in size from 79 x 51 x 28mm for the 25W unit to 179 x 98 x 38mm for the 150W model.

www.powersolve.co.uk

PRODUCTION OF 100% ELECTRIC NISSAN LEAF A "LANDMARK DAY" FOR UK AUTOMOTIVE INDUSTRY

Nissan announced that it will produce its 100%-electric car called LEAF in Sunderland, creating over 2,000 jobs and generating export revenues for the UK economy.

The announcement was greeted with great enthusiasm from the government and local Sunderland authorities.

"The start of UK production of the first massmarket, pure-electric vehicle is a landmark day for the UK automotive industry and represents a bold new step towards zero-emissions motoring," said Rhian Kelly, CBI Director for Business Environment. "This investment in the northeast will help to support more than 2,000 jobs in the UK automotive supply chain. The UK has one of the most diverse and productive automotive industries in the world, attracting more than £6bn inward investment in the last two years and generating around £30bn of annual export revenue for the UK economy."

The CBI is now calling on other car makers to follow suit.

"The much-anticipated automotive industrial strategy must build on this momentum by setting out an ambitious plan to ensure the long-term competitiveness of the UK's car industry, building the strongest possible supply chain and supporting export growth in global markets."

Nissan's announcement comes on the same day the CBI is highlighting the long-term growth potential of the UK automotive industry, outlining key priorities for the UK government and businesses in advance of the automotive sector strategy, including enhancing the UK's capabilities in automotive R&D, strengthening the supply chain and improving the local skills base.

JAN DIDDEN, Audio Expert and Publisher of Linear Audio, UK: It is interesting that this announcement came on the same day Hyundai introduced the first hydrogen car in The Netherlands. Toyota, Daimler and Honda are also working toward hydrogen propulsion.

The one thing hydrogen has going for it as a car energy source is that you can fill 'em up in 3 minutes for a 400-mile range. The extended recharge time for a limited range for electric propulsion naturally leads to hybrids that carry their own charger.

Effectively, what we see here is manufacturers jockeying for pole position, because nobody can predict which technology will ultimately prevail, with some manufacturers straddling several horses at the same time.

A similar situation exists with regards to renewable energy sources: should we erect wind generators on a massive scale, or cover the landscape with solar panels, or extract energy from ocean tides along the coast? Here we also see manufacturers placing their bets on more than one table and groping their way forward.

This is exactly as it should be, and it is technological evolution – and, eventually, the marketplace – at its best.

The smart thing the government can do is to either stand back, or, if it insists on throwing money at something, make sure everyone gets a fighting chance. It is much, much too early to select a winning technology, be it for automobile propulsion or renewable energy.

PROFESSOR DR DOGAN IBRAHIM, Near East University in Nicosia, Cyprus: I hope the investment in zero-emission motoring in the UK becomes a model for the other European car manufacturers. Not only will this investment create several thousand jobs in the UK, it will also help strengthen the economy and the competitiveness of the UK's car manufacturing industry.

HAFIDH MECHERGUI, Associate Professor in Electrical Engineering and Instrumentation, University of Tunisia: To manufacture clean cars is an environmental challenge for the manufacturers rather than a commercial one. The 100%-electric cars produce zero Co2 emissions, and in Europe alone fuel cars create some 20% of the total CO2 emissions at present.

Unfortunately electric cars remain expensive. The greatest stumbling block is the battery because its structure represents the greatest difficulty for these vehicles. Certainly future advancements of technologies could equip these cars with cheaper batteries that offer high energy density.

Despite these difficulties, we don't have a choice: electric cars are a credible alternative for driving in towns. Thus, the electric vehicle constitutes a bet with a promising future and this is why the collaboration between the Japanese Nissan and the UK's automotive industry to produce 100%-electric cars is a significant one.

The initiative will begin to create a market which to date does not really exist. So, to be involved with the electric car is a bet car manufacturers should not avoid.

Equally, this collaboration between Nissan and the UK will help the country establish itself a world leader when it comes to 100%-electric cars, an excellent position to be in.

MAURIZIO DI PAOLO EMILIO, Engineer, University of L'Aquila and EDM Engineering, Italy: These are exciting times to be a part of the automotive industry, even though the demands on the business have never been greater.

Electronic devices have played a vital role in this industry, including telecommunications. In recent times, this has been gaining more attention from car manufacturers.

Going forward, high-tech equipment will become more prevalent, for example, in-vehicle telematics that provide drivers with instant safety, security and communications services. New applications will include vehicle-to-vehicle communications to ensure vehicles keep a safe distance from each other to avoid and eliminate collisions.

> What we see here is manufacturers jockeying for pole position, because nobody can predict which technology will ultimately prevail

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

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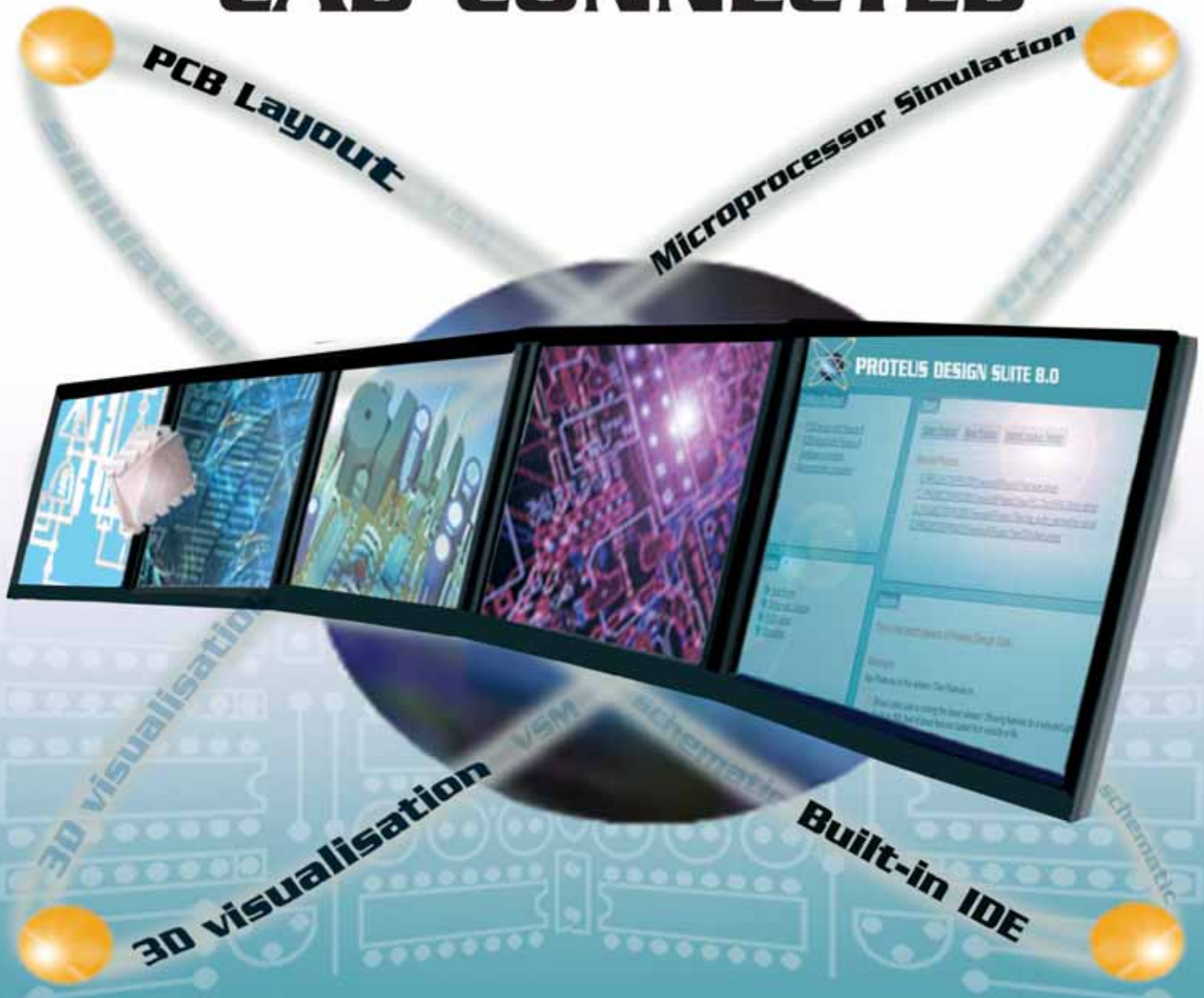

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