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FOCUS: EU COUNTRIES' ON-GOING BATTLE WITH BATTERIES

PRODUCTS: NEW ESR ANALYSER IS LAUNCHED

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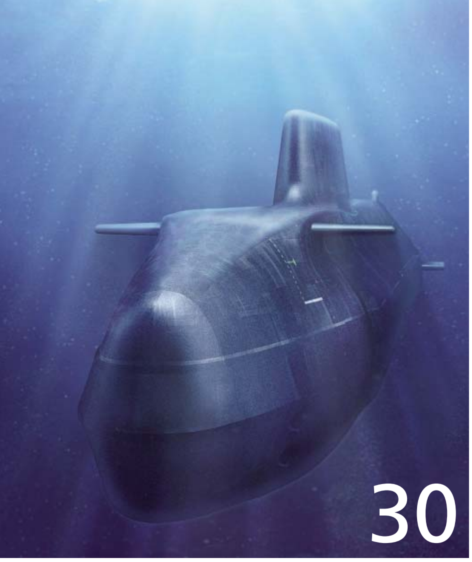

REGULARS

FEATURES

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Technologies Meet Remote Healthcare

Progress in wireless technologies, an increasingly aging population in the western world, the growing incidence of chronic diseases and pressure on the healthcare industry to reduce costs are just some of the trends that are now beginning to cross each other with very interesting and promising results, even.

Young or old, ill or not, we all care about our health and fitness, so new ways of keeping us informed about their state, as well as having access to medical information, assessment and even prescriptions, are always of interest.

Beecham Research, market analyst and consulting firm specializing in M2M connected services, states that part of any solution are the wireless technologies, which can be used for out-of-hospital healthcare and fitness monitoring that includes in-residence and ambulatory monitoring.

But a software firm from Bristol, UK, called Ocean Blue Software, has gone one up and created a system around digital television (with wireless part of the solution) that will help the elderly and infirm to not only gain medical information and help, but also cover the security aspects of their homes, organise their social lives and shopping, as well as offer the customary entertainment expected from television.

Among the medical benefits to be had from Ocean Blue Software's system are automatic alerts, medication intake reminders, ordering repeat prescriptions, as well as being able to send photographs to clinicians for advice via direct links to doctors' surgeries and other medical services.

Ocean Blue Software claims that the system could bring potential healthcare savings to the NHS of up to £5bn each year – making this a very healthy (excuse the pun) saving indeed; never mind the size of the savings to be had in a country such as the US.

So the needs are there (from users and the health services alike) and the technologies that can meet these needs are there too. Let's hope it is only a matter of brief time before we are all kitted out with something similar in our own homes and offices.

Editor
Svetlana Josifovska

TV TECHNOLOGY PROMISES TO BRING MAJOR HEALTHCARE SAVINGS

Bristol-based Ocean Blue Software has launched Nexus TVTM, a television-based software system that will turn a digital television and set-top box into a portal to mind the health, security, social networking as well as entertainment needs of the elderly and infirm in their own homes.

Medical benefits will include automatic alerts, reminding users which medication to take and when. They will be able to order repeat prescriptions by scanning a barcode with the remote control and sending it to their dispensing chemist. It will also be possible to send photographs to clinicians for advice, and there will be direct links to doctors' surgeries and the NHS Direct.

Cameras will be connected to Nexus TV to screen callers, and a local social networking service, based on an interactive message board, will enable people to stay in touch with those around them.

Entertainment services will include Freeview digital TV, talking TV guides and menus, and downloadable audio books. The technology will also support the development of third party software applications, as Apple does with its iPhone, opening the door to additional entertainment, games, education and other services.

Access to local services of all kinds, from taxis to food stores, will be available using a dedicated database, accessed via the television. Shopping for home delivery will be easily accessible too, optionally making use of barcodes scanned with the remote control.

Nexus TVTM promises to be 'Jack of All Trades' for the elderly and infirm in their own homes

"This is about exploiting technology to give the elderly and vulnerable every possible comfort and security where they most want it – in their own homes," said Ken Helps, CEO of Ocean Blue Software. "At the same time, it addresses one of the greatest challenges for the British economy – how to finance support for an ageing population. Nexus TV offers a true win-win solution."

Ocean Blue Software claims that the system could bring potential healthcare savings to the NHS worth up to £5bn each year. Ocean Blue has set up a growing consortium of partners and will start trials of the technology in early 2010.

Ocean Blue is already a part of OpenHub, a consortium aiming to reduce government spending by 50% by 2019, making £100bn available.

New Operating System from Google

Google is planning to launch a new operating system (OS), called Google Chrome OS. Google already has a browser, the Google Chrome, and Android, an operating system for mobile phones.

Initially, the new operating system will be installed in netbooks, but will eventually be migrated on to PCs.

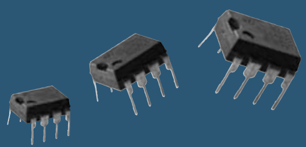
Google claims it has developed the new operating system with "speed, simplicity and security" in mind, but also in a change of focus where operating systems are not just controlling computers but designed to run the Internet as fast as possible.

"We're designing the OS to be fast and lightweight, to start up and get you on to the web in a few seconds," said Linus Upson, engineering director at Google.

The new software is planned for a release later this year on an open source licence. Netbooks running on the Google Chrome OS are expected to go on sale in the second half of next year.

"The user interface is minimal to stay out of your way and most of the user experience takes place on the web," added Upson.

The Google Chrome logo



MEMORY ALLOCATION IN EMBEDDED DEVICES

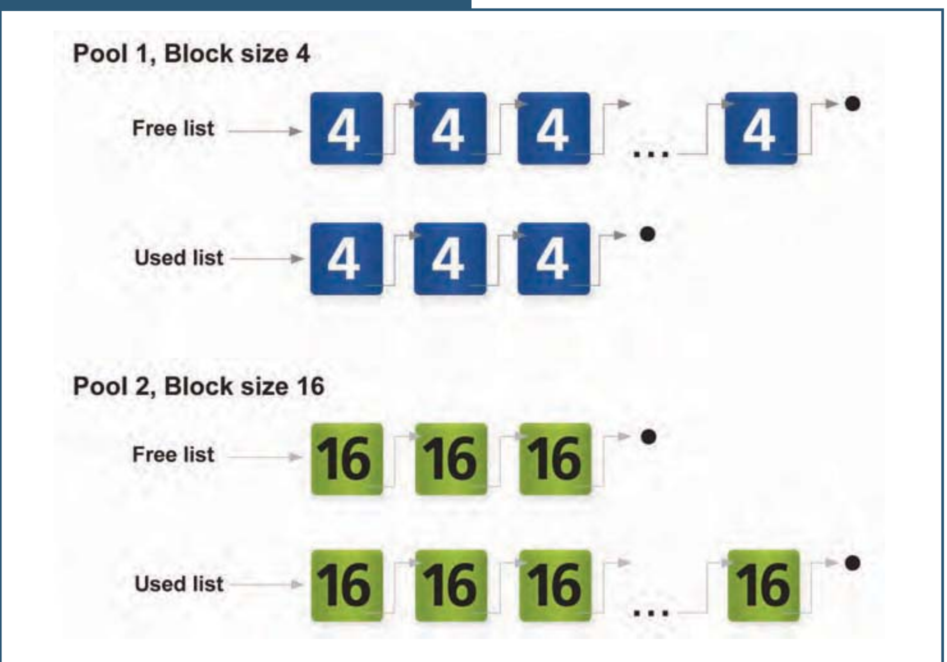
Vicky Larmour from Cambridge Consultants, goes on the ultimate bug hunt in software

APPLICATION DEVELOPERS usually don't have to worry about what's happening in the kernel when they allocate some memory; just keep track of what has been allocated and have a consistent strategy for freeing it.

This article goes one step deeper, to look at how memory allocation can be handled within an embedded kernel.

Issues

Some embedded operating systems provide a variety of memory allocation strategies, so the most appropriate can be selected for a given application. Alternatively, if you are programming for a very tightly constrained device, you might implement your own memory allocator as part of a custom lightweight kernel.



A simple pool allocator showing two pools: one with 4-byte blocks, only three of which are used; and one with 16-byte blocks, only three of which are free

Some issues to consider are:

- **Deterministic results**
  In a real time system a deterministic allocator (guaranteed to return within a fixed time) may be vital even if it is less space-efficient.
- **Fragmentation issues**
  - Will most allocated blocks be the same size?
  - Will there be a lot of allocation and freeing going on, or will the memory mostly be allocated once and remain in use for the lifetime of the application?
- **Speed of allocation and freeing**
  - The time overheads of managing the memory allocation system must usually be taken either at allocation or at freeing. Is one more critical than the other, in your application or system?
- **Space efficiency**
  - Do you have plenty of data space available for memory allocation relative to the needs of the code, or is it imperative to maximize use of the available space?

Strategies

The simplest strategy of all is a 'fixed allocator' which maintains a list or bitmap of free memory blocks, all of one size. When a new memory allocation is requested, a pointer to the first available block is returned; when memory is freed, the block is added back into the free list. This is very simple to implement and provides deterministic results, but is very space-inefficient.

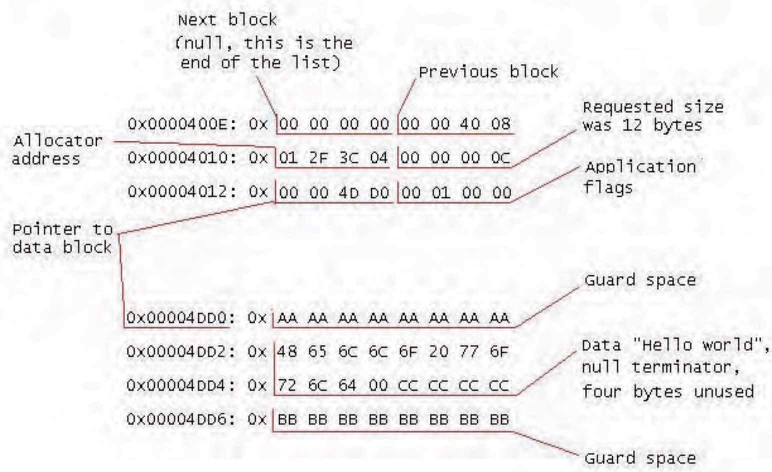
A common strategy in use in embedded systems in a 'pool memory system'. The available memory is divided into pre-defined pools each containing blocks of memory of one size. The pools are defined so that common block sizes are well

represented, for example in an Ethernet driver the Ethernet frame size might be a common size to allocate, so you could have several pools containing blocks of this size. This combines ease of implementation with efficiency, especially when pool sizes are carefully customised to the application. Each pool can essentially be a fixed allocator as above, with some overhead for the request to roll over to the next size pool if the desired size is unavailable.

Many Linux and Linux-like kernels extend the pool concept with 'slab allocation', in which slabs (collections of same-sized blocks of memory) are dynamically created and added to/removed from caches (collections of slabs), as needed. For a lightweight embedded kernel, this is probably overkill, but it does win in terms of flexibility.

Some kernels provide a configurable mixture of fixed and variable allocators; you may find that some modules within your application need to use different allocators with particular characteristics, to best meet their specific requirements.

```
typedef struct T_MEM_BLOCK_tag
{
   struct T_MEM_BLOCK_tag *pNext;     /* pointer to next block in the used/free list */
   struct T_MEM_BLOCK_tag *pPrev;     /* pointer to previous block in the used/free list */
   t_uint32 allocator_address;        /* address of call to malloc() */
   t_uint32 allocated_size;           /* size requested by caller */
   t_uint32 *pData;                   /* data associated with this block */
   t_uint32 app_flags;                /* flags reserved for application memory debug */
}
T_MEM_BLOCK;
```



An example structure declaration for a memory block incorporating some debug features, and a corresponding memory layout where this structure is used

Additional Features for Debug and Development

These features can simplify the debug process considerably, by protecting the integrity of the program memory. Debug features should be configurable so that they can be turned off for release builds.

'Guard space' is some extra bytes wrapped around blocks of allocated memory. Functions that use memory blocks can record their actions here to track the progress of a block through the system. This helps protect against buffer overflow, leaks or double freeing; the memory manager checks the guard space when freeing memory and warns if it is not intact, and leaked blocks can be examined to determine where they were allocated.

The ability to 'dump the contents' of a block (or even an entire pool) is invaluable for debug. If callbacks are provided for applications to be warned of low memory conditions, use them.

Check alternative versions of allocation functions – one might return NULL, which the application must check, and another might simply panic if the request cannot be fulfilled. This latter version should be used for system critical cases where operation cannot continue if the allocation fails.

Some applications benefit from built-in support for chaining blocks of memory together, for example communications protocols where each layer of the stack adds or removes some additional header bytes.

Think About It!

Next time you call malloc(), take a moment to find out what's going on under the hood in your operating system! Are you using the best allocation strategy for your application? Are you making best use of debug features?

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50W single output
dc to dc converter
76.3x38.2x10.2mm, 60g
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The SWITCH MODE is not your friend

Myk Dormer

IN MODERN ELECTRONIC design, the use of DC-DC converters to efficiently step supply-voltages up or down has become commonplace. Offline switch mode designs have replaced the line-frequency transformer linear supplies in the common plug top power supplies, while on-board both module and IC-based buck or boost converters generate stable, high current, logic supplies, with minimum size and heat dissipation.

But there has to be a 'down-side'. For the user of low power wireless modules the ever-present switching regulator or voltage converter is a constant source of anxiety and frequently a serious limitation on radio performance.

At a very simplistic level, the potential difficulties of a switch-mode supply are obvious: it's inherently an oscillating circuit and all AC signals have the potential to cause interference. At the core of any such supply design is a switch device (driven by an alternating waveform) that is handling a significant amount of power. The switch waveform itself, harmonics of it and secondary effects (such as self-resonant ringing in reactive components and mixing in non-linear elements, for example rectifiers), are potential interferers and can affect the radio module by direct radiation, by conduction through power supply rails or ground-plane (loop) effects, or even by magnetic induction.

Equally as obvious, however, is the fact that the environment is full of periodic waveforms, from logic signals to the domestic mains, and untold numbers of radio links continue to provide excellent performance, despite the proximity (in may cases) of DC-DC converter circuitry.

The issue with any design that integrates a switch-mode supply with a sensitive radio element is, therefore, down to identifying the sometimes subtle ways that radio performance can be degraded, and by minimizing or eliminating the possible interference issues. Receivers are inherently more at risk than transmitters (owing to the minuscule signals they handle and the large amounts of circuit gain), but even if they remain apparently functional, transmitters can suffer sufficient interference to become non-compliant with relevant legal regulations.

"AN ON-CHANNEL INTERFERER WILL REDUCE RECEIVER SENSITIVITY AND DEGRADE RANGE, BUT UNLESS A CAREFUL MEASUREMENT IS MADE THIS CAN BE OVERLOOKED IF THE EFFECT IS NOT EXTREME"

Interference to a radio comes in several forms:

1. An unwanted carrier (the switching waveform or harmonics of it) at the RF input frequency, de-sensitizing receivers or adding extra spuri to a transmitter's output spectrum.
2. An interfering signal on a receiver's intermediate frequencies, leaking or conducting into the module.
3. Lower frequency noise can also modulate the sensitive local oscillator circuitry, or mix with wanted signals, to produce unwanted sidebands. These can degrade adjacent channel noise or rejection performance.
4. Audio frequency interference coupling onto the baseband (AF) paths (either receiver AF out, or a transmitter's modulation input) can corrupt the wanted signals, or reduce S/N performance.

These interference effects are not always immediately obvious. An on-channel (either RF input of IF frequency) interferer will reduce receiver sensitivity and, hence, degrade range, but unless a careful measurement is made with proper RF test equipment this can be overlooked if the effect is not extreme.

If the interference causes degradation of a rejection characteristic, the effect will be invisible in initial, single signal, on-the-lab-bench tests and will only become apparent when real interferers are present in the final application, at which point the performance penalty will be obvious to the customer.

With transmitter applications, the situation is even more serious, as a non-compliant spurious output is a legal, regulatory issue, with potentially worse consequences than just embarrassingly poor product performance.

So what can be done to eliminate such problems (beyond eliminating the DC-DC converter from the design altogether, which is frequently not an option)?

- Make as much use of decoupling as possible. Avoid running the wireless device from 'raw' switch-mode output rails: include passive decoupling, or intermediate linear regulators, to ensure the supply is as 'clean' as possible. Be aware of the major current paths to and from the supply (including earth and ground-plane currents) and do not let them pass 'through' the radio.

- Minimise radiated effects: do not locate the switch-mode close to the radio. Within the physical limits of the design, place it as far away as possible. Include shielding to attenuate radiated energy and consider making that shield of a ferrous material to prevent magnetic coupling.
- Keep the power levels low. The less power it handles, the less interference it is generating. Use the DC-DC converter to supply only those elements of the circuitry that actually need it. Run everything else directly from the unswitched supplies. Use low power design methods throughout.
- Make best use of timing. Where possible, time-slice the operation of the DC-DC supply and the radio system; this is especially applicable to systems using short, defined radio communications bursts, where a momentary interruption of user interface or display functions would not be noticed.
- Optimize the switching regulator itself. Topologies are divided between constant frequency designs – where the mark:space of a constant switching frequency varies to achieve regulation; and constant on-time – where the switching waveform on-time is fixed and the frequency is varied with the load.
- Generally, the constant frequency design is to be preferred, as the actual interfering signal is then known, and can (within limits) be placed where it will do least harm. Frequencies in the baseband frequency range of the link should be avoided, as should frequencies approximating to the channel offset and the IF frequencies and, obviously (for high frequency switchers), the channel frequency and subharmonics of it are also forbidden. Some regulator designs allow the switching frequency to be locked to an external source, which then reduces worry over 'drift' of the switching frequency over temperature, or manufacturing spreads.
- Layout techniques should follow good RF practice and all tracks carrying high power alternating waveforms (including the ground returns) need to be short and low impedance (wide). Low ESR decoupling capacitors will be needed, and both low and high frequency decoupling must be provided. Lastly, the power inductor should be chosen for lowest external magnetic field (toroids or closed magnetic circuit 'pot' types are superior to drum or spindle types).
- Be prepared to try several different designs. Effects can be unpredictable and committing to a single approach too early in the design/testing process can be fatal.

Switch mode regulators are a necessary part of modern electronic design and with a certain amount of care, good results can be achieved from a design incorporating them with low power wireless hardware.

Be aware, however, that there are pitfalls awaiting the unwary, and as ever: test everything!

Myk Dormer is Senior RF Design Engineer at Radiometrix Ltd ***www.radiometrix.com***

John Cullen, Partner at Neu Mobile, explains why femtocells make a perfect technical and business sense

INSIDE INDOOR BASESTATIONS – THE FUTURE FOR MOBILE?

ACCORDING TO ABI RESEARCH, indoor basestations – known as femtocells – could number 22 million by 2014, with the UK and the rest of Europe among the strongest markets. That might sound a fairly staggering prediction for something that was little known of outside the mobile industry itself, but it starts to make sense when we examine why we need these devices.

Femtocells are small indoor access points that provide dedicated mobile network coverage within an office or home environment. They enable mobile operators to offer an improved service to their customers, while creating new service opportunities for the future.

About the size of a paperback book, these devices differ from traditional outdoor, macro basestations in that the user's broadband line is used to handle the 'backhaul' (the link back to the service provider), instead of microwave or leased lines. They are also low power, with power levels typically below 100mW, and designed to operate within a specific radius, for instance, 50 metres. The vision is that femtocells will ultimately a 'mass market' solution found in almost all homes and businesses.

Why do we need yet another piece of mobile kit? While the mobile operators have done a great job in creating nationwide networks, coverage remains a challenge in many areas. This is particularly true where there are obstructions, such as trees, buildings and even double-glazing (no small issue, considering that over half of all mobile calls are estimated to be made from within buildings).

Research by analyst firm Quocirca found that around one third of SMEs (small and medium enterprises) experience some degree of coverage problems even on GSM. With the introduction of 3G networks, the problem increases, because 3G finds it harder to penetrate these obstacles.

At the same time, we're seeing escalating dependence on mobile phones: for many people these have become the primary means by which they communicate. Furthermore, usage of wireless laptops and PDAs is growing, as is the importance of streamed media services, such as YouTube and iPlayer, to mobile consumers. These new services will only 'fly' if the service providers can ensure service quality and mobile signal coverage is an integral part of that.

A US study from Telephia indicated that over a fifth of customer 'churn' (losing a customer) was as a result of poor mobile coverage. At the same time these services consume large amounts of capacity so operators need to expand their network capacity to ensure that customers receive the service quality that they expect.

Indoor basestations address this dilemma, because they boost mobile coverage and provide additional capacity where it is needed. At the same time, these units are designed to be 'plug and play' so that customers can self-install them in the home or office. This avoids expensive site and installation costs associated with outdoor macrocell basestations that can some times make it commercially unviable to deploy basestations.

Looking ahead, indoor basestations will create new business opportunities for mobile operators. For instance, in the business market, they can be integrated with existing IT environments to become an extension of an IP PBX, or even replace one. In the home, in addition to providing basic connectivity, we envisage a future where femtocells will become an enabler for a whole new range of applications ranging from new messaging applications, such as a virtual message board, to home automation solutions where everything is switched off when everyone leaves the house.

Delivering these services, there will be many different implementations of femtocells, ranging from standalone to models integrated with home gateways or picture frame. Which

"WITH THE AMOUNT OF WEIGHT THAT THE MOBILE INDUSTRY IS PUTTING BEHIND THE INDOOR BASESTATION MARKET, IT SEEMS CLEAR THAT FEMTOCELLS ARE LIKELY TO BECOME VERY FAMILIAR WITHIN THE NEXT FEW YEARS"

implementations succeed and which fail will be dependent on consumer preferences and the underlying business models of the suppliers.

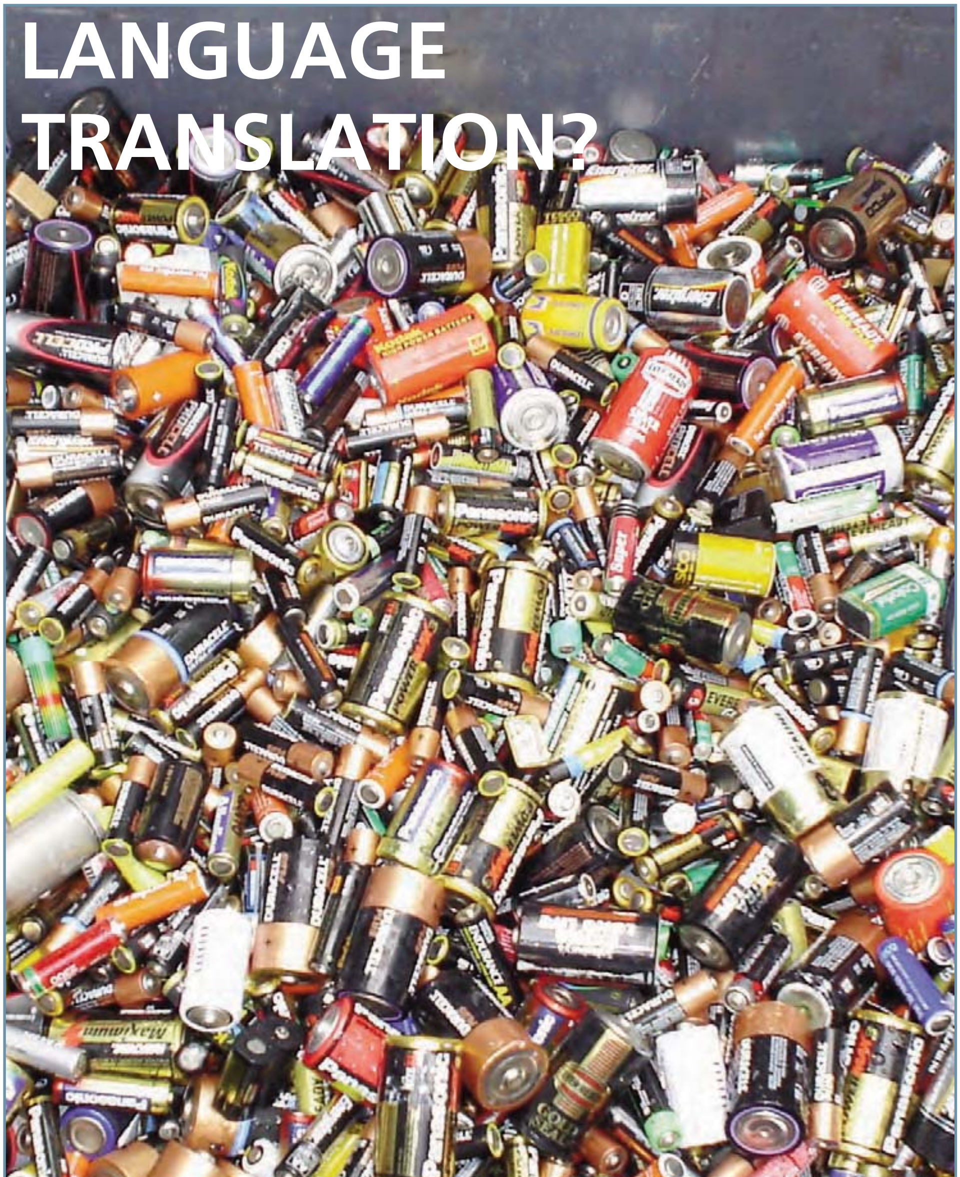
In 2008, US service provider Sprint launched the world's first commercial femtocell service and under the auspices of the Femto Forum, the industry is working towards greater interoperability between an ever-increasing number of vendor equipment.

During 2009, a number of Asian operators have commercially launched femtocells in a number of markets. However, it was only as recently as June that Vodafone announced the first European launch. Given this bold step forward, it is expected over the coming months that other operators will follow their lead.

Although initial deployments are likely to be limited, so operators can assess more accurately the market and the operational costs of femtocells, it is expect that volumes will build up over the next couple of years to the point that femtocells are truly 'mass market'. This will occur as operators' understanding of the technology and business proposition improves and they are able to refine their business case.

One thing is for certain, with the amount of weight that the mobile industry is putting behind the indoor basestation market, not to mention the fact that these devices address some very real issues for users, it seems clear that femtocells are likely to become very familiar within the next few years. ■

A COMMON LANGUAGE LOST IN TRANSLATION?



Assorted alkaline batteries ready for recycling

Vince Armitage, divisional vice-president at Varta Consumer Batteries UK, looks at the current standing of the directive in countries across Europe and how, despite differences in the implementation, nations are facing common problems

THE BATTERIES DIRECTIVE is the latest European environmental legislation to be rolled out across the continent. Despite being a European wide legislation, it seems that the directive is being shaped to suit the internal structure and laws of obligated countries across the EU. While there are differences from member state to member state, one area of commonality is around the experiences and problems that both governments and producers are facing as the directive is implemented in their respective nations.

For the uninitiated, the Batteries Directive was originally transposed into the EU in 1991 to restrict the use of mercury, cadmium and lead in most batteries, whilst also encouraging collection and recycling. However, almost 20 years later, its objectives were not being achieved and portable batteries were still being disposed of in landfill. Therefore, it has been replaced by the new Batteries Directive. The aims of the new legislation include:

- To impose stricter rules on the recovery and recycling of portable batteries.
- To reduce the quantity of hazardous and non-hazardous waste batteries going to landfill and increase the recycling of the materials they contain.
- To demand improvements to the environmental performance of all new batteries.

The directive applies to all batteries placed on the market after 25 September 2008. Its changes required by the directive are far-reaching and include: new labelling and enhanced design requirements; new restrictions on the use of mercury and cadmium in batteries, including a ban on most NiCad-batteries; and challenging, yet achievable, collection and recycling targets. For example, by 2012, some 25% of household portable batteries must be collected; this will increase to 45% by 2016. Recycling targets of collected batteries have also been imposed in accordance with specific battery types.

But to claim the directive is a Europe-wide legislation surely must be a slight contradiction. While the law is meant to straddle all the 27 member states, due to the various internal laws and procedures of the different countries involved, we have ended up with many different 'takes' on the directive, which varies depending on which border is crossed. This lack of uniformity makes the legislation a minefield for producers that operate in many different countries, meaning different rules for different markets but for the same products.

A 'variation on theme legislation' also gives advantages to those countries that have not introduced the legislation as stringently as it should be. This means that some territories will have a head start when it comes to hitting the targets that are laid out in the directive.

But while there is lack of uniformity, when it comes to the legislation and its enforcement, nations have quickly found common ground in the problems and worries that each country is experiencing as part of the implementation. While each country will be different in individual situation and context, the problems experienced can be categorised in three areas: collection, cost and communication.

One Size Doesn't Fit All

The collection schemes will be the heartbeat of the directive and if the nations and producers don't get them right, hitting the targets laid out in the legislation will be nigh on impossible. So, many nations are still debating and deliberating on how the collection scheme system should work best and how to ensure that everyone is aware of it and playing a part. Belgium, however, is one example where the authorities and producers have come together to devise a collection model which is proving fruitful – helping it to already achieve its collection and recycling targets. While it's a success in Belgium, the collection model is one that other nations could find troublesome to replicate – especially due to the high costs.

This is due to a number of factors, including scale. Collections in Belgium are made through a network of 20,000 collection points, which serve 10 million people in total. The collection points in schools and supermarkets are the most successful in terms of weight collected; this is closely followed by collection points in places such as petrol stations, retail outlets and civic amenity sites. But if this model was applied to, say, France, which has a population of 62 million, this would mean the French would have to supply a mammoth 130,000 collection points to handle waste batteries.

To counteract fears around under-achieving collection schemes, we are seeing authorities in a number of countries place demands on producers to ensure maximum returns. Hungary, which has already adopted the directive, has told producers that they will have to partake in a programme of compulsory advertising activity. This means that they are expected to publish a nationwide advert encouraging the collection of batteries – either in newspapers or on TV

"IF THIS MODEL WAS APPLIED TO FRANCE, WHICH HAS A POPULATION OF 62 MILLION, THIS WOULD MEAN THE FRENCH WOULD HAVE TO SUPPLY A MAMMOTH 130,000 COLLECTION POINTS TO HANDLE WASTE BATTERIES"

Recycling batteries is an issue across Europe

"WHILE SOME COUNTRIES MAY LOOK AT THE SUCCESS OF THE BELGIAN COLLECTION SCHEME AND CONCLUDE THAT 'YOU GET WHAT YOU PAY FOR', IT SEEMS THAT MANY OTHER COUNTRIES AREN'T WILLING TO PAY THAT MUCH FOR SUCCESS"

or radio – at least twice a year. This came after producers expressed concern at hitting the higher targets laid out in the directive. Meanwhile, officials in Austria have decreed that producers have to set up at least one collection point in each political district, ensuring access for every consumer.

Steps to increase collection levels have also been taken by authorities in Portugal by making all distributors, not just supermarkets, offer collection points for consumers to discard their spent units. Indeed, it seems that Portuguese authorities are taking a tough stance with producers across the board. When it comes to registration, for example, a zero tolerance attitude has been implemented, meaning that those producers who do not register for compliance will be stopped from placing any product on the market, effectively closing them down overnight. Although once registered, producers can transfer their responsibilities to a compliance scheme, which is subject to a five-year written contract, ensuring long term compliance.

While increasing collection points may mean a rise in collection results, Portuguese producers are also predicting a big rise in costs. As a result, the producers are investigating ways of introducing an 'add-on fee' to all new battery purchases, despite resistance from the Portuguese officials.

You Get What You Pay For?

Indeed, spiralling costs is something that producers are concerned about right across Europe. The cost associated with collection is another reason why the Belgian model, despite its success, will not be used as blueprint by other nations. Its batteries recycling model is one of the most expensive in Europe. While it's envisaged that the average recycling cost across the continent will be 3.9 pence per battery, in Belgium it is currently more than double that at 9.9 pence. With an unpredictable world economy at the moment, factors such as fluctuating oil prices and escalating transportation and manufacturing costs, this price could easily increase.

While some countries may look at the success of the Belgian collection scheme and conclude that 'you get what you pay for', it seems that many other countries aren't willing to pay that much for success.

Perhaps a more appropriate state of affairs would be to say that many countries aren't willing to pay for success by themselves. As previously mentioned, in many territories, producers are considering increasing the price of batteries to recoup the cost of compliance. This is a bone of contention in many EU countries at present, including France and Denmark. While the Batteries Directive states that a 'visible' surcharge to the consumer on the price of a pack of batteries is not allowed, increasing costs may drive producers across Europe into reviewing the true costs of production and recycling. As a result, retailers may then decide to review their own retail prices.

In Denmark, the Danish authorities are considering introducing a surcharge on battery purchases. While it has been decided that battery collections will be undertaken by local authorities as part of already established WEEE collection schemes, the Danish authorities are debating if this should be funded by a 'tax' on all new batteries purchases with funds going to local government to finance publicity and collection points. This has been met with scepticism by the Danish batteries industry with many fearing that the additional funds gathered will just cause confusion, complicating the already efficient, tax payer-funded WEEE collection processes.

No Such Thing as a Free Ride

The topic of producers not paying their way is common to all markets too. As it stands, all obligated companies will have to sign up to a compliance scheme, but, if the producer places less than one tonne of batteries on the market per year, then it will only pay a lower, flat registration fee to the governing body in that country, reporting on an annual basis instead of quarterly.

Waste batteries are sorted at the GP's Darlaston headquarters

Varta batteries

In many countries, it is thought that thresholds are set too high, meaning that only a small number of obligated producers in each market could be liable to pay any compliance scheme membership costs to fund collection.

Known as 'free riders', many governments, including the Cypriot and Finnish, have already voiced their concerns about the impact this could have on the directive. The Finnish government's concerns are based on experiences taken from the WEEE Directive, where a large portion of the obligated companies are not paying to support the directive.

While many producers in the UK are fearful of 'free riders', there is also a fear that increasing prices to combat rising obligation costs will, not only affect sales, it could have a detrimental effect on the success of the Batteries Directive. This is because consumers will look towards cheaper alternatives that will no doubt mean lower quality, Far Eastern imported batteries.

This defeats the purpose of the directive on two fronts. Firstly, those batteries will be poorly constructed, which impairs performance. In today's power-hungry devices, it will mean that users will use more batteries to get the performance they require. This, in turn, will lead to more battery waste.

The second point is that the problem is further compounded due to the materials used to construct the casing of these batteries and the materials used inside. As the casing will not be as strong as those batteries that conform to the more stringent European standards, these could cause even more environmental damage, nullifying the point of the directive.

As these batteries are imported and often sold through markets or discount shops, it will also reduce the impact on the success of the directive. It is fair to assume that many of these retailers will not play an active role in ensuring that their buyers know about the directive and will not ensure dead units are collected and recycled. Without ongoing publicity and education aimed at the consumer, the directive will not succeed, especially in countries where recycling isn't ingrained into the national psyche like it is in countries such as Holland and Germany.

Importance of Education and Publicity

While neither the authorities nor producers would deny the importance of education and publicity around the directive, the question of who is responsible for delivering the publicity is still a point of disagreement in many states.

If questioned, the majority of producers would state they believe it's the authorities in each country that should be leading this part of the directive. But this view is not shared by all European governments. In the UK the government has agreed to include batteries as part of its overall, wider recycling communications, leaving the majority of the consumer education campaign to individual compliance schemes. In Germany, Ireland and a number of other member states, it's the same approach with the price of publicity bore by the producers, not the authorities.

Yet again, this difference between countries ends up confusing producers which operate across borders and costs them more money. It also ultimately affects the effectiveness of the directive as producers will always do the bare minimum that the law expect of them. This means that any publicity undertaken will not be as effective, comprehensive or have the same reach as that offered by a national authority. This would have been more effective if the authorities across all countries agreed to play the same, much bigger part in both the communication strategy and implementation – using their scale and resources to ensure that the populous are aware of the directive and their obligations.

No matter which part of Europe we are in and no matter how the directive is implemented, the final common thread is that producers and authorities need to work together to ensure the directive is a success, but also that it works for every party in the chain.

While there will be differences from border to border, if the communication is right and the producers feel that the directive has been fairly implemented, then there is no reason why the targets cannot be achieved. ■

Bertrand Klaiber, Strategy Manager, and **Pierre Turpin**, Project Manager, both at the LEM Energy and Automation division, explain how to choose and implement current sensors for designing high-performance and cost-effective power measurement systems

Designing in Current Sensors in Power MEASUREMENT Systems

ELECTRICAL POWER calculation involves current measurement with specific electrical and mechanical characteristics according to the different application areas. While solid core current sensing technology has been able to provide good performance at low cost for a while, some split core sensor technologies have recently made big progress reviving their value for applications involving the retrofitting of power meters into existing equipment. Split core current transformers are not new, but in the past they were bulky and heavy, implementing conventional technologies that presented numerous shortcomings. These transformers either implemented expensive materials, or provided poor performance in terms of accuracy. In this case, inaccuracy refers not to the readings themselves, but to the linearity, the phase shift error of the output current and the sustainability of a reading over time. This article provides an analysis of the traditional current sensing technologies and some innovative ones, highlighting their advantages and drawbacks in different power measurement application areas.

Power Measurement Applications

Electrical power measurement is already at the heart of numerous applications in the industrial sector for power supply management, electricity usage control and condition monitoring.

1) Power supply management is the primary application field as it is essential to any industrial and business activity. It mainly concerns companies related to power generation and distribution, but also industry professionals monitoring their power quality and power factor to control rate tariffs imposed by their utilities, especially when operating low-power-factor loads.

2) Energy sub-metering is gaining importance among facility and plant managers as it allows tracking and allocating energy costs, but also performing advanced analysis of the electricity consumption to improve its efficiency. Power supply sizing and billing is often dependent on the peak consumption and a dynamic management of the overall system enables both cost reduction and failure prevention. Energy sub-metering is required for understanding and managing the main consumers, but also for identifying the energy wastes that are generally caused by defective appliances or inefficient facilities usage (e.g. inappropriate lighting, heating or air conditioning).

3) Condition monitoring requires immediate failure detection and reaction to prevent damage to equipment or interruption of critical processes. Electrical power measurement provides a comprehensive set

Figure 1: A split-core current transformer (1000A)

Figure 2: An 800A ferromagnetic split core current transformer and a 100A ferrite split core current transformer

of information (current, active power, power factor, frequency, etc.) that reflects the motor load behaviour (e.g. conveyer, bearing, pump, cutting tool, etc.). It often provides faster detection of abnormal behaviours than traditional sensors such as temperature, pressure, vibration, etc. An analysis of the evolution in time of these electrical parameters even enables the anticipation of failures which allows for planning effective predictive maintenance.

Power measurement is not only gaining importance in industrial applications, but also for monitoring commercial and residential loads. Energy conservation is a rapidly growing issue across the globe, for both cost and environmental considerations. The key question is how to achieve substantial and sustainable reduction of energy consumption. The most credible solution is to establish an understanding of how users consume their energy and make them responsible for it. Targeting this area remains an industrial concern and is gaining importance for the public sector. Many countries are introducing campaigns and incentive budgets for reducing energy consumption. Taking advantage of such incentives requires organizations to develop accurate measurement capabilities.

Current Sensor Requirements

Engineers designing power monitoring systems should carefully select the required current sensors according to very specific characteristics:

1) Accuracy – In most applications, measurement accuracy directly impacts the efficiency of an overall system. The accuracy of the power calculation is obviously dependant on the accuracy of the current sensors. A class 1 power meter will require current sensors with much better than 1% accuracy, which would generally involve expensive materials and manufacturing processes.

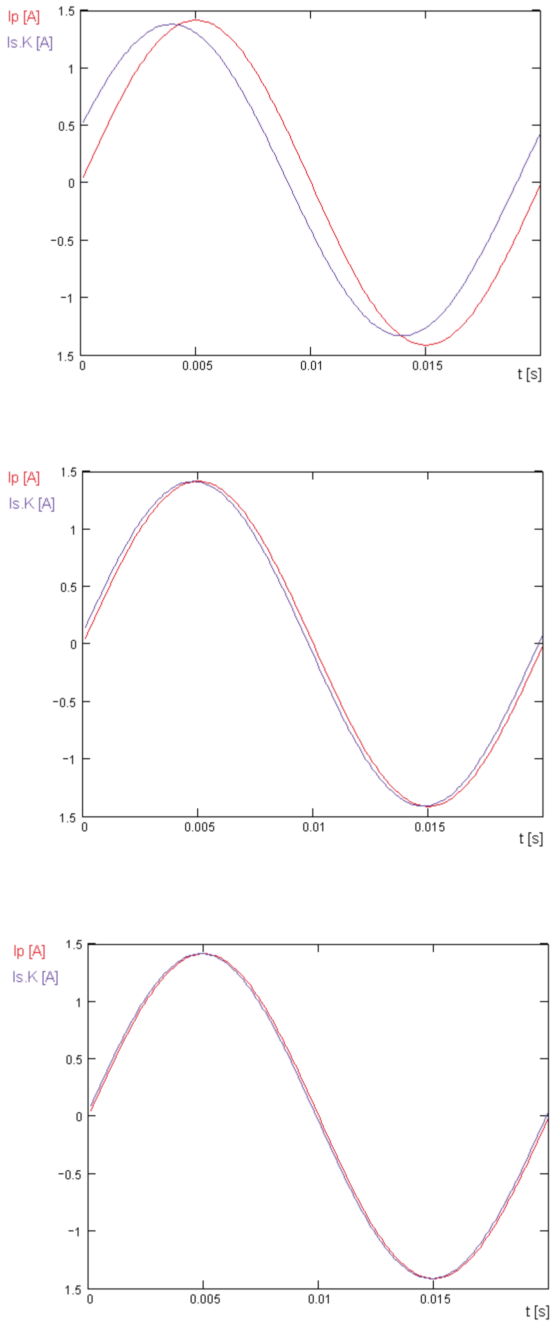
An alternative is to calibrate the power meter for each single sensor it implements. Taking into account the specific characteristics of each sensor allows for use in its most precise operating mode and to mitigate the variations from one sensor to another. As we will see later in this article, this opens the door to new technologies with outstanding performance in terms of linearity, drift and repeatability, compensating for their overall loose reading.

2) Drift – The drift of a sensor is related to the sustainability of a reading over time independently from the initial system calibration. Some variations of its characteristics may be caused by changes in the ambient humidity and temperature, component aging, etc. A low drift level, which means that the sensor has a high immunity to such constraints, is a very important characteristics to build high-performance, stable and reliable power meters.

3) Linearity – The linearity of the sensor refers to the stability of its characteristics within the full operating mode. A high linearity of the analogue sensing part is essential to provide accurate measurement of a wide range of primary currents, especially at low current levels. Several technologies only offer good performance over a limited measuring range, thus limiting the application area to rather high or low currents.

4) Phase shift – The accuracy of the true active power or energy calculation is not only related to the accuracy and linearity of the AC current and voltage sensors in terms of amplitude, but also to the phase shift that may occur between the measurement of these correlated values. The phase shift should of course be as low as possible.

5) Integration – Being self-powered, the current transformers do not require any other wiring than a two-wire output connection to the main power monitor unit. Many of them provide calibrated standard outputs allowing easy integration in the power monitoring system. The typical 1A and 5A or 333mV outputs are compatible with most standard power meters of the market. High accuracy power meters require specific calibration according to each sensor that cannot be interchanged anymore. These may then have low current outputs



Ip = 20% of rated current
F = 50 Hz
Core: FeSi
Air Gap = 25µm (one leg)
Results:
- 5% transfer ratio error
- 20° phase shift

Ip = 20% of rated current
F = 50 Hz
Core: FeNi-80%
Air Gap = 25µm (one leg)
Results:
- 0.15% transfer ratio error
- 3.8° phase shift

Ip = 20% of rated current
F = 50 Hz
Core: Ferrite
Air Gap = 5µm (one leg)
Results:
- 0.004% transfer ratio error
- 1.9° phase shift

Figure 3: *Phase shift behaviour of FeSi, FeNi and high-permeability ferrite in a 5A current transformer*

that are safer than traditional 1A/5A signals when they can be accessed while the system is operated.

Current outputs are also almost insensitive to interferences and should be preferred to voltage outputs when long cables are required to connect the sensors to the power meter.

6) Price – The price of the sensors is important, of course, especially three accurate current sensors are required for 3-phase power measurement. However, the price of the current sensor should not be considered alone, but also the installation and maintenance costs. Although more expensive, reliable and easy to install and replace split core sensors bring real cost reduction to the system as a whole.

Solid Core Current Transformers

Power measurement systems generally implement contactless current sensors rather than shunts, because the latter cause power losses as well as installation and safety issues. Traditional solid core current sensors are based on the principle of a transformer, i.e. primary and secondary windings magnetically linked by a core. The measured current induces a magnetic field in the core which generates a current in the secondary windings proportionate to the primary current divided by the number of turns of the secondary windings. These basic current transformers are designed to measure sinusoidal alternating currents in the typical 50/60Hz range. This well-known technology is very affordable due to the use of common materials and processes.

Solid core current transformers offer a cost-effective and accurate solution for designing power meters dedicated to new equipment and buildings. They are not suitable, however, for the numerous applications involving power monitoring of existing machines and facilities, where it would be necessary to shut down power and disconnect cables before retrofitting the solid core sensors in all the places where they might be used. Installing power metering systems is generally not possible, prohibitively expensive or even dangerous if it requires a service interruption, even for a short while (e.g. stopping a production line, a telecom or data centre power supply, some nuclear plant equipment, etc).

Split Core Current Transformers

Contactless self-powered split core current transformers can simply snap over a conductor, without the need to screw or weld on complex brackets, making installation and maintenance straightforward. They can be installed in electrical control panels (thus avoiding complex wiring) to remotely monitor devices that sometimes operate in inaccessible or harsh environments. The beauty of the split core transformers is that they can be retrofitted into a live installation without disturbing it, which often makes them the unique choice for engineers designing power meters.

But these advantages have a price, making the split core current transformers more

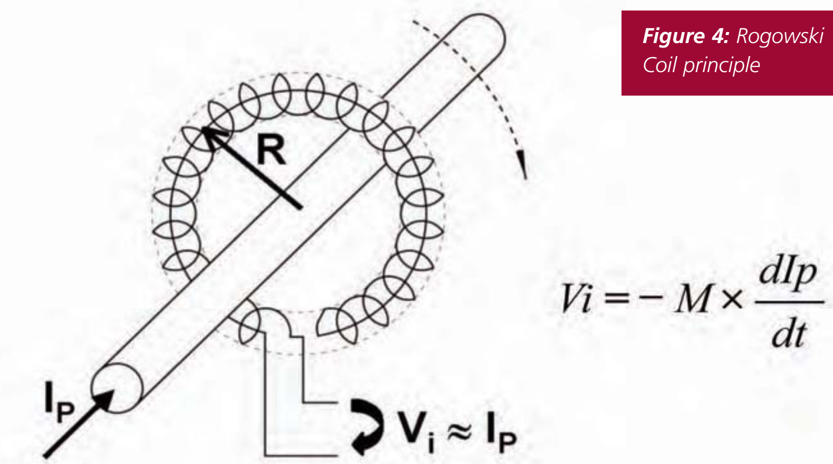


***Figure 4:** Rogowski Coil principle*

***Figure 5:** A Rogowski Coil current sensor from LEM*

expensive and less accurate than the solid core transformers. It is, thus, very important to understand the difference between the various technologies available and make a choice according to specific application constraints.

Split core current transformers are generally based on the same principle described here for the solid core transformers. But in this case the magnetic core is made of two distinct parts that can be separated. Inaccuracy mainly comes from the imperfect contacts between the two parts and the fact that the secondary windings are not uniformly distributed around the magnetic core, but around one of the two parts only. The price and performance of these transformers are linked to the physical and mechanical characteristics of the device. Very flat contact surfaces are required, as well as sufficient pressure between the two parts of the core. The case generally features flexible parts or materials and/or hinges to provide sufficient compression, as well as a reliable opening mechanism.

FeSi Split Core Current Transformers

FeSi has been widely used in split core current transformers, mainly due to its affordable price. The performance offered by this material is quite bad, however, especially due to its poor linearity (especially at low currents) and the large phase shift (see **Figure 1**). This restricts its use to low-cost current transformers for measuring rather high currents, where power monitoring doesn't require high accuracy. Many applications only need a rough estimation of the power consumption, rather for detecting the electricity consumers than for analysing their exact consumption. This may be sufficient in some cases to detect whether a device is consuming electricity or not and to draw operating time profiles, assuming a fixed voltage value rather than using a precise measure. In this case the high phase shift is not a big issue. A typical application is branch current monitoring in panel boards allowing a system to detect when some circuits may come to overload and generate an alarm or balance loads.

Another disadvantage of FeSi current transformers is that they are large and heavy, thus not very appropriate for environments with limited space.

FeNi Split Core Current Transformers

FeNi has been the best material for split-core current transformers for a long time, offering good performance, but at high price. It offers a good alternative to the FeSi material when accuracy and phase shift are important, or when the transformers need to measure small currents.

Apart from the price, FeNi current transformers have some other limitations. As for the bulky FeSi current transformers, they are taking up valuable space within industrial facilities and panel boards. They also suffer from quite bad linearity and drift, mainly due to the air gaps induced by the split core architecture.

Ferrite Split Core Current Transformers

Although ferrite materials have been well-known for years, their poor performance in terms of saturation level and magnetic permeability did not allow their use at frequencies as low as 50/60Hz. However, recent developments have revolutionized the characteristics of ferrite at these frequencies, bringing many advantages to a wide range of power monitoring applications. The new types of ferrite have significantly improved permeability and can be implemented in 50/60Hz current transformers as a substitute for FeSi or FeNi cores, despite the low magnetic saturation level.

Split core current transformers implementing the new types of ferrite can perform accurate measurement of AC signals in an extended frequency range that includes the 50/60Hz application domain. They take advantage of the intrinsic ferrite qualities, providing high accuracy and excellent linearity even at very low current levels. They also feature particularly low phase-shift between input and output currents, which is essential to accurate measurement of true active power or energy. The hard and dense core allows for the minimization of air gaps and is virtually insensitive to ageing and temperature changes in contrast to other materials like FeSi or FeNi.

Last but not least, all the ferrite qualities are available at low cost, which puts the high performance split core current transformers on the market at very attractive price.

With high currents, bigger ferrite cores should be used for measurement, which are unfortunately rare for now due to some fabrication limitations. FeNi transformers or the Rogowski Coil technology described below are actually more appropriate for high currents.

Comparison Between FeSi, FeNi and Ferrite Materials

The high-permeability ferrite material does not give the best results in solid-core current transformers, so let us focus on split core current transformers. The hardness of the solid material (consider ferrite as a ceramic) allows very fine machining, providing air gaps down to a few microns that are stable over many years. Laminated materials such as FeSi or FeNi do not allow air gaps smaller than 20 or 30 microns, and these are more sensitive to ageing and temperature changes. Add the small air gaps to the better linearity of the ferrite at low magnetic excitation (i.e. for low current) and the ferrite offers a better performance than FeNi-80% and a lower cost.

Figures 1, 2 and **3** are extracts from simulations comparing the phase shift behaviour of FeSi, FeNi and high-permeability ferrite in a 5A current transformer.

The phase shift for the ferrite is half that of the FeNi core, so FeNi is definitely out of the competition. The reduced air gap of the ferrite core also allows a better accuracy of transfer ratio (primary turns to secondary turns).

Rogowski Coils

A Rogowski Coil is used to make an open-ended and flexible sensor that easily wraps around the conductor to be measured. It consists of a helical coil of wire with the lead from one end returning through the centre of the coil to the other end, so that both terminals are at the same end of the coil. The length is selected according to the relevant current measuring range to provide optimal transfer characteristics.

This technology provides a very precise detection of the rate of change (derivative) of the primary current that induces a proportionate voltage at the terminals of the coil. An electronic integrator circuit is required to convert that voltage signal into an output signal that is proportional to the primary current. In other words, the Rogowski Coil enables the fabrication of very accurate and linear current sensors, at the price of additional electronics and calibration.

A Rogowski coil has a lower inductance than current transformers and, consequently, a better frequency response because it uses a non-magnetic core material. It is also highly linear, even with high primary currents, because it has no iron core that may saturate. So, this kind of sensor is particularly well adapted to power measurement systems that can be subjected to high or fast-changing currents. For measuring high currents, it has the additional advantages of small size and easy installation, while traditional current transformers are big and heavy.

The performance of such current sensors highly depends on the manufacturing quality of the Rogowski Coil, since equally spaced windings are required to provide high immunity to electromagnetic interference. Another critical characteristic is the closing point that induces a discontinuity in the coil, creating some sensitivity to external conductors as well as to the position of the measured conductor within the loop. The locking or clamping system should ensure a very precise and reproducible position of the coil extremities, as well as a high symmetry while having one of the extremity connected to the output cable.

Some new technologies have recently appeared in this area, with special mechanical and electrical characteristics that allows much better accuracy and immunity to the primary cable positioning. While the error due to primary cable position was typically not better than ±3% in the 50/60Hz frequency domain, it has been reduced to less than ±0.5% on some of the latest Rogowski Coil sensors.

Solid Core Transformer Benefits

Many new installations benefit from solid core transformers, and split core technology is not designed to compete with these. However, existing machines and building equipment have no way to add solid core devices without a costly shut-down of the system. New materials and technologies equip advanced split core current transformers for immediate retrofitting of high-performance and cost-effective condition monitoring, power metering and facility supervision systems.

The fast growing energy efficiency market and the large deployment of power measurement systems dictate the need for high performance but cost-effective split core current transformers.

Split-core current transformers are not new, but conventional technologies used in these transformers presented numerous shortcomings. These transformers either implemented expensive materials (e.g. FeNi), or provided poor performance, especially in terms of linearity and phase-shift (e.g. FeSi). New types of ferrite with dramatically improved magnetic permeability finally achieved to offer both high performance and affordable price. The Rogowski Coil technology has also made big progress recently, allowing small, light and flexible sensors for high currents, but requiring some signal adaptation and calibration to take advantage of the best of its characteristics. The major improvements that have been made in the designs and manufacturing processes have allowed to reduce both the cost and the sensitivity to the Coil positioning around the primary cable, thus overcoming one of the main problems of that technology whose intrinsic qualities were very interesting.

The multiplicity of the technologies responds to the diversity of the needs for an application domain that has evolved a lot recently, to address the diverse systems and infrastructures impacted by cost and environmental considerations. ■

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FLASH TESTING: Getting It Right During Manufacturing

The flash test, also known as High Voltage (HV), Dielectric Strength or HiPot, is one of the more controversial electrical safety tests and has provoked a lot of discussion and debate in recent years. **Stewart Haile**, business manager at electrical safety testing specialists Clare Instruments, looks at new developments in flash testing for electronic product design applications and why it's important

THE VIEW THAT flash testing is essentially a destructive test is often an area of discussion. This originates from the use of flash in type testing where the long time period does provide potential for the degrading of insulation.

However, in terms of production line testing the reduced time period and the 5mA-trip setting significantly reduces this risk and the fact remains that many manufacturers successfully test without witnessing any degrading.

Flash testing is, in fact, not a measurement but a procedure that aims to check that a product is safe when subjected to high voltage and that the user is not exposed to danger.

The test is designed to detect that gaps or clearances between conductive parts and earth are sufficient and that damage in the form of pin-holes/cracks in insulation and other protection devices have not occurred during manufacture or through wear and tear.

The test involves applying a high voltage to the product to check the insulation between the live conductors and all exposed metal surfaces. For Class I equipment the high voltage is applied between conductors and earth, while for Class II equipment the high voltage is applied between the conductors and the outer surface of the product.

The flash test is necessary and designed to ensure the safety of the product. In particular, recent legislation like the LVD (Low Voltage Directive) and issues of product liability have increased the need for manufacturers to demonstrate due diligence.

So what's new? Although there have been few noticeable alterations in the flash testing requirements of most standards in recent years, changes in the technical specification of electrical and electronic products prompted by the EMC directive has required modifications to the flash test. For example, EMC considerations have required the introduction of circuit devices on the supply input to prevent emissions back into the mains (filter circuits including X & Y capacitors etc…).

These devices often take the form of resistive or capacitive or a combination of

Test in progress

PCB testing

the two components. When tested using an AC flash test, these circuits will often prove problematic, as the capacitive part can induce leakage currents in excess of the capacity of the flash tester or demonstrate leakage greater to that required by the electrical safety standard. Situations such as these have led to a substantial increase in the use of DC flash testers, which are unaffected by this capacitive effect.

It's been highlighted that AC flash testing could corrupt sensitive electronic components. Here, solutions include:

- Using a DC flash test. The voltage needs to match the specified peak AC voltage, which is achieved by multiplying the specified AC voltage by 1.414. A discharged facility following application, to ensure that no residual voltage remains, is required.
- A "soft" DC flash test. This involves ramping up to the required voltage. In some instances this test can benefit from ramp down as well. This involves a slow ramp-up from zero to the required value, then holds for a timed period before ramping down to zero and discharging the unit under test.

Flash Testing

The advent of EMC measures has increased the use of suppression devices etc, but this can cause problems for flash testing. While it should be noted that most designers of such components have upgraded their products to meet the specified flash tests, there are possible solutions.

It is important to remember that flash testing, together with earth bond testing (Class I) and insulation resistance measurement, are probably the three core tests for electrical safety testing. In addition, a load leakage test maybe specified also within the electrical safety standard.

Flash testing and insulation testing appear to be, on first examination, very similar. However, there are fundamental differences: flash testing is designed to detect gaps or clearances between conductive parts and earth, pin holes in insulation and other degrading as a result of production processes and/or wear and tear. Insulation resistance testing provides a quantitative measurement of the high quality of insulation.

If a wire was positioned 1/2mm from exposed metal, an insulation test – conducted in dry air – could well provide a pass reading. However, a flash test is more likely to detect this situation as dangerous. Similarly, if insulation is somehow contaminated, a flash test would produce a pass, but an insulation test would highlight a deficiency.

For example, the normal minimum insulation resistance value for Class I appliances is 2MOhm, with a 1500V flash test, the current would be 0.75mA and would not be detected by the 5mA trip, which has to accommodate the capacitate losses that occur.

Obviously a DC flash test with a leakage meter can provide insulation resistance monitoring as the capacitate component is overlooked after the initial in rush of current.

Test Identification and Traceability

The flash test can be regarded as a negative test on the basis that a good product will often not provide a measurable flow of leakage. With the development of modern instrumentation using microprocessor control and data logging software it is now possible to produce fully traceable records of testing undertaken.

Understanding why flash testing is necessary is important but being able to prove that electrical or electronic products comply with the various standards is also vital – particularly if there is a subsequent failure or fault identified. The only effective means of demonstrating that a product has been tested is through proper documentation.

Flash testers, such as the HAL from Clare, automate the testing process on the production line and retain results in an internal memory for later downloading or print-out. Documentation through automated flash testing minimises liability and provides effective proof that a product is safe at the end of the manufacturing process.

What should the test conditions be? Two distinct forms of testing are usually recognised: type testing and production line testing. The former varies according to the relevant product specific standard, but normally for Class I equipment they require between 1000-1500V applied for one minute with a trip level of 100mA. For Class II equipment, voltages are usually higher at between 2500 and 4200V, but with similar timing and trip settings.

Production line flash testing requires special considerations in terms of practicalities such as time and high voltage levels. Here, the need to have faster but equally rigorous tests is recognised by applying 10% over-voltage, but reducing the test time to a few seconds. Thus a type test, with a voltage rating of 1250V, would be carried out at 1375 on the production line with trip levels of 5mA.

One cautionary note is that it is possible to get a seemingly satisfactory result when the equipment is switched off or not properly connected. Obviously there is a need to ensure the equipment under test has the power switch on and the unit under test is properly connected.

HAL tester

Even for experienced operators this can be a stumbling block. In production line situation, such problems are emphasised, because of the greater throughput of products.

Solutions include a simple continuity test, applied on live and neutral, built in to the test programme prior to the flash test and the detection of captive leakage that occurs whenever an AC flash is applied. If no leakage is detected a warning is initiated. Regular fault simulation at the test connection point should also be applied, at each shift change or at each start of a production day is highly recommended.

The test itself is not quantitative, and fail is recorded if a breakdown of insulation or a flash-over between components occurs. Most testers indicate pass or fail via a warning light and/or sound which activates when 5mA of greater leakage occurs.

The best way to maximise productivity is to reduce the time taken to apply all of the safety and functionality tests. By using an integrated test station and enclosure connection to the device under test, only one test sequence is required. As establishing a connection is often the most time consuming part of production line testing, combining up to four or five tests at an integrated test station can significantly reduce time and cost.

Type tests often call for high levels of high voltages to be applied for up to one minute. However, in reality this is not practical in production facilities. This is because at most factories a one minute test would reduce productivity, while the call for a 100mA-trip level can cause a potentially lethal scenario. Lastly, voltage levels and test procedures realistically demand a skilled operator.

Safe Test Areas

Production line flash testing requires special considerations in terms of practicalities such as time and high voltage levels. Effectively designed test instruments mean that the required operator skill level can be reduced and the use of high trip levels can be protected by safe systems with only qualified operators having access.

With the integration of EC electrical safety testing standards in EN50191, specific safety conditions have been specified for all locations where electrical testing is carried out. For example, the use of test enclosures on the production line is advisable to minimise the safe working area around the points where flash tests are to be applied.

In Class II equipment the absence of an earth requires protection via primary and secondary insulation. The first practicality to mention is that flash testing of Class II equipment involves much higher voltage levels, typically between 2500 and 4200V. A common problem, particularly on new equipment, is that you can have failure on the primary insulation that is undetectable by a flash test on the outer surface, which tests the secondary insulation only. In testing regimes BOTH these need to tested.

In order to test the primary protection one needs to find a method of accessing the primary insulation. This is essentially a contradiction in terms, since this connection needs to be inaccessible metal. However, experience shows the following options as feasible:

- Test of the primary insulation prior to final assembly. However, there has to be a check that on assembly no degrading of this protection takes place, e.g.

One of the safest solutions is to test an item housed in an enclosure

screws penetrating the insulation.

- Design the product with an access that can be permanently sealed after testing. This is often an element that product designers fail to anticipate.
- Design test jigs and probes that allow access through the enclosure; ensuring that the integrity of the product on terms of the relevant standard finger tests is maintained.

Testing also needs to be carried out on the secondary protection. Standards generally define the product be wrapped in aluminium foil so that high voltages can be applied to all the outer surfaces.

This test may be practical for laboratory situations but is impractical for production scenarios, both because of complexity in test set-up and time and, also, in that the outer surfaces of the product can easily be marked.

Clare's pioneering use of conductive foam in a special jig to create a nest or envelop around the outer surface of the product enables test voltages to be applied. Although not quoted in standards, this methodology is recommended by standard authorities.

These include some standards which allow the disconnection of such components for safety testing – although this is often impractical for production line testing. Another approach is setting higher trip levels e.g. 10 or 15mA.

The use of this option should always be accompanied by the use of safety precautions such as key locked switches, so that authorisation is gained before carrying out this test.

Ideally, the safest solution in such circumstances is to conduct the test with the item housed in an enclosure with appropriate interlocks. Our experience has shown that these need not be too complicated or expensive and provide maximum operator safety. ■

Designing for STEALTH

Eur Ing **Paul Parkinson**, Senior Systems Architect at the Aerospace & Defence division at Wind River, presents a case study revolving around the design requirements of Thales's state-of-the-art, non-hull penetrating, optronic mast for the United Kingdom Royal Navy's new Astute class submarines

THE ASTUTE nuclear-powered submarines are designed to patrol the world's oceans without being detected by surface ships and other submarines. The Astute deploys a number of technologies to reduce its sonar signature to minimise the probability of detection while submerged. However, submarines are most vulnerable to detection when the submarine commander uses a periscope to assess the situation on the surface. This probability of detection can be reduced by minimising the duration that the periscope is above the surface. However, this conflicts with the need to provide sufficient time for the submarine commander to be able to assess the situation on the surface and make appropriate decisions.

Thales has overcome this problem by using a state-of-the-art, non-hull piercing optronic mast design instead of a conventional optronic design. The new design enables the Sensor Head Unit (SHU) to be extended from the submarine fin and rapidly perform a 360° scan of the surface above, enabling the commander to analyse the image data afterwards and minimising risk of detection. The SHU is a pressure-proof, electro-optical assembly that contains high-performance cameras, optics, environmental sensors and stabilisation mechanisms. It is designed to function in temperatures ranging from -15°C to +60°C and withstand nearby explosion.

Figure 1: *The Astute is transported during construction*
[Courtesy of BAE Systems]

The SHU is used in two configurations on the Astute class submarine. It provides extensive Electronic Surveillance Measures (ESM) through dual redundant High-Definition (HD) colour video operation. The SHU also enables extended capabilities with the two masts providing infrared (IR) and low-light operation respectively, with 3-axis image stabilisation to sub-pixel accuracies, as well as a laser rangefinder.

Inside the submarine hull, the Mast Control Unit (MCU) coordinates overall system activity, controlling a number of other units and communicating with the submarine's tactical, data and combat systems. The MCU controls the mast raising equipment, raising and lowering the SHU out of the submarine fin, as well as the azimuth drive module that rotates the SHU and forms part of the stabilisation system. This requires deterministic, high-standard servo control to compensate for the submarine's movement in the water and a clear image is critical to mission success.

The Role of Software

The optronic mast uses an Ada application developed using AdaCore GNAT running on Wind River's VxWorks real-time operating system (RTOS), providing a reliable system that is essential for this mission-critical application. The application controls the stabilisation system, video and thermal camera control, communication with the in-hull systems and controls all of the mechanisms and motors in the SHU.

The Mast Control Unit (MCU) in the submarine hull uses two processors running VxWorks to raise and lower the SHU out of the submarine fin, and it also controls the azimuth drive module which rotates the SHU and forms part of the stabilisation system. This requires deterministic, high-performance servo control to compensate for the submarine's movement in the water and provide a clear image.

A system like the optronics mast must be robust and highly reliable at all levels. Without it, the submarine is blind.

Development Challenges

Thales's previous optronic mast design had used an Ada application which performed image stabilisation, I/O and control and ran on a quad Digital Signal Processor (DSP) hardware design based on military-grade Texas Instruments (TI) TMS320C40. These specialised devices are ruggedised for use in extreme environmental conditions, such as -30°C operation on a submarine, but also severe shock requirements on military fast jets and helicopters.

For the new design, the Thales Computers V4G4c quad PowerPC 7410 AltiVec COTS board was selected. The quad processor design provided some commonality with the quad DSP architecture previously used, but there were a number of significant architectural differences that presented Thales with some development challenges. These included mapping the software architecture from DSP to the general-purpose processor, and migrating from a scheduler and TI DSP Ada compiler to the VxWorks RTOS and AdaCore GNAT Ada compiler.

The migration from DSP to general-purpose platform is a significant step. However, Thales has standardised on Wind River's platforms for device software and uses a common toolset and software architecture across projects wherever possible. This standardised approach enables it to leverage skills within the engineering organisation across projects.

Figure 2: *Artist rendering of a submerged Astute submarine [Courtesy of BAE Systems]*

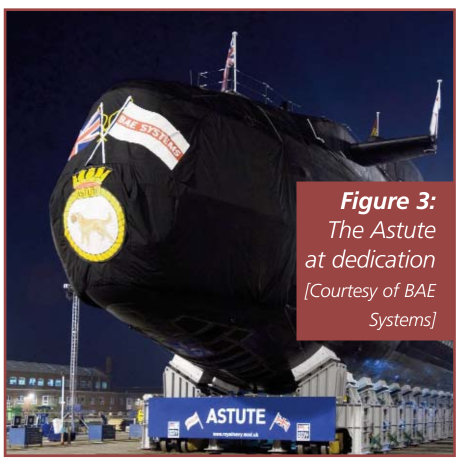

Figure 3: *The Astute at dedication [Courtesy of BAE Systems]*

Jack Cunningham, Head of Discipline (Software) for Thales Optronics explains the rationale behind the migration: "VxWorks has a pedigree that makes it an obvious choice for use in a high-reliability, safety-related environment. Added to this, its support for multiple platforms has allowed Thales to rationalise its use of third party RTOSs and thereby reduce target platform variability from one project to the next. This consistency between projects, through standardisation on VxWorks, results in development cost savings."

The quad 'C40 DSP hardware architecture and quad PowerPC hardware architectures have a number of significant differences, which could have impacted the portability and reuse of the Ada image stabilisation software. Firstly, the 'C40 DSP has six dedicated high-performance communications ports that can be directly connected to other 'C40s, whereas the PowerPC processors are connected via a shared bus and shared memory.

Thales was able to minimise the impact of these architectural differences by simulating the communications ports in software through the

Figure 4: *The launch of the Astute submarine [Courtesy of BAE Systems]*

Figure 5: *The Astute spends very little time on the surface [Courtesy of BAE Systems]*

use of packetized data in shared memory, in conjunction with VxWorks shared memory semaphores to provide atomic access and efficient inter-processor synchronisation.

Secondly, the processor endianism differs on the DSP and PowerPC. This is complicated further when performing transfers between boards over the VMEbus; however, Thales was able to overcome this through configuration of the VxWorks Board Support Package (BSP) to use the appropriate VME addressing modes for data transfers. This hardware simulation and software abstraction at the lower level enabled Thales to reuse their proven image stabilisation algorithms.

Meeting Performance Requirements

Thales also needed to synchronise the four PowerPC processors on system start-up and confirm that the application met its performance requirements. In the development of the earlier DSP-based design, by instrumenting the application to write trace values to the VMEbus, which could be logged with a VMEbus analyser and subsequently analysed. In the PowerPC-based design, Thales was able to embed user events within the application and display these graphically in the Wind River System Viewer, showing their context within overall system operation, whilst providing accurate timing information, without the overhead of generating additional VMEbus traffic.

The system also needed to be configured for standalone deployment. For this Thales was able to link the Ada application with the VxWorks kernel for each of the nodes on a VxWorks True Flash File System (TFFS) on PowerPC board. This enabled the system to start-up automatically from system power-up without external intervention. ■

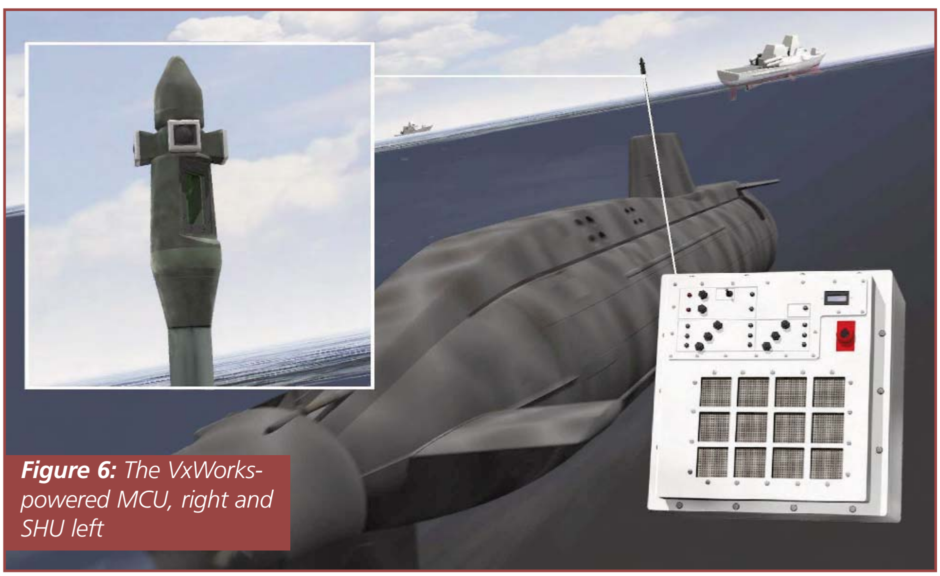

Figure 6: *The VxWorks-powered MCU, right and SHU left*

Figure 7: *An artist dramatization of the Astute [Courtesy of BAE Systems]*

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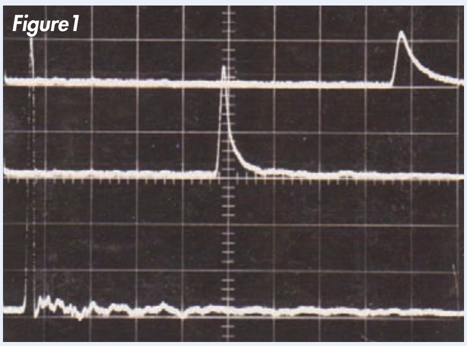
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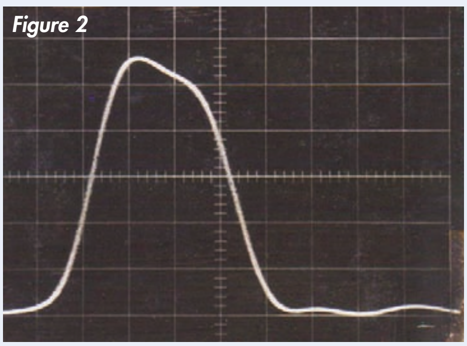
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Returning to Hassell's demand to introduce losses, or imperfections, into the fundamentals of electrodynamics, I would like to apply that to geometry. We know that in practice Euclid was wrong. When actually drawn, the angles in a triangle add up, not to 180 degrees, but to something between 177 degrees and 183 degrees. The angles only add up to 180 degrees with perfect lines. This illustrates the damage caused by wanting to bring in imperfections when addressing fundamental theory like "The Catt Question", where you should consider perfect conductors and dielectrics.

Ivor Catt UK

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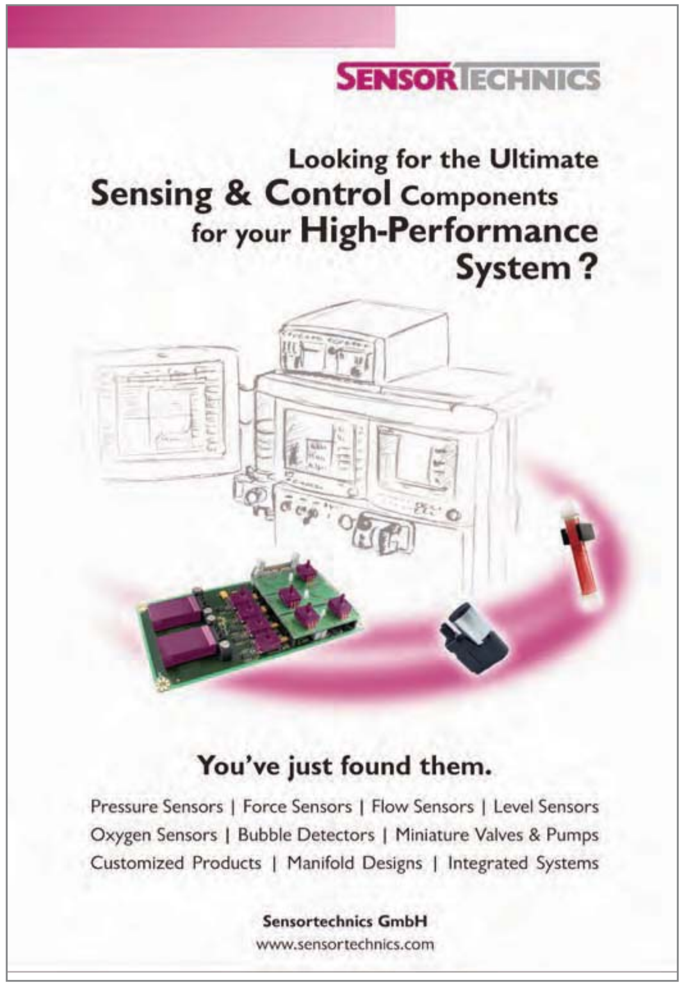
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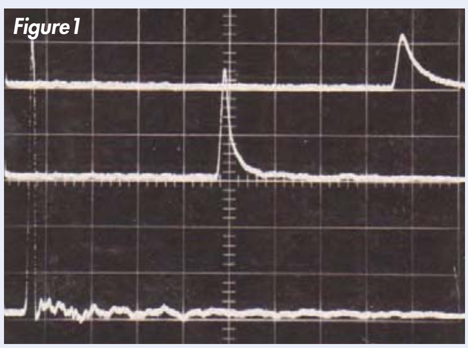

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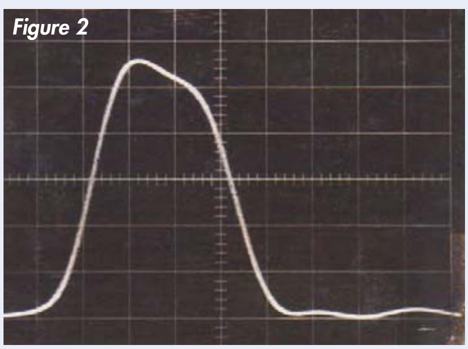

Incidentally, my co-author Malcolm Davidson pointed out 25 years ago that since a capacitor is a transmission line (which statement is taboo), see our Wireless World article in December 1978, the LCLC model of a transmission line models a transmission line in terms of itself, which is ridiculous. There is no high frequency cutoff in a transmission line. Students do not know this, because they still learn the faulty LCLC model.

Returning to Hassell's demand to introduce losses, or imperfections, into the fundamentals of electrodynamics, I would like to apply that to geometry. We know that in practice Euclid was wrong. When actually drawn, the angles in a triangle add up, not to 180 degrees, but to something between 177 degrees and 183 degrees. The angles only add up to 180 degrees with perfect lines. This illustrates the damage caused by wanting to bring in imperfections when addressing fundamental theory like "The Catt Question", where you should consider perfect conductors and dielectrics.

Ian Catt UK

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PLEASE EMAIL YOUR LETTERS TO: svetlana.josifovska@stjohnpatrick.com

Associate Professor **Dr Murat Uzam** from Nigde University in Turkey presents a series of articles on a project that focuses on a microcontroller-based PLC.
This is the eleventh article in the series describing the logical macros AND, NAND, OR, NOR, XOR, XNOR and inv_R

PLC with PIC16F648A Microcontroller – Part 11

THE LOGICAL MACROS AND, NAND, OR, NOR, XOR, XNOR and inv_R are applied to an 8-bit register (R1) with another register (R2) or an 8-bit constant (K).

A logical function performs AND, NAND, OR, NOR, exclusive-OR (XOR), exclusive-NOR (XNOR) logical operations on two registers (or one register plus one constant value) and NOT (invert) logical operation on one register.

As an example, **Figure 1** shows an AND logical function that will retrieve and "AND" two values from sources labelled source A and source B and will store the result in destination C. AND, NAND, OR, NOR, XOR and XNOR logical functions have the form of Figure 1 with two source values and one destination register. In these, the logical function is applied to the two source values and the result is put in the destination register. However, the unary invert (INV) logical function has one source register and one destination register. It inverts all of the bits in the source register and puts the result in the destination register.

Here I'll describe thirteen logical macros for UZAM_PLC, as shown in **Table 1**. In these macros, EN is a Boolean input variable taken into the macro through W, and ENO is a Boolean output variable sent out from the macro through W. Output ENO follows the input EN. This means that when EN=0, ENO is forced to be 0 and when EN=1, ENO is forced to be 1. This is especially useful if we want to carry out more than one operation based on a single input condition.

"IN", "R", "R1" and "R2" refer to 8-bit source variables from where the source values are taken into the related macro, while "OUT" refers to an 8-bit destination variable to which the result of the related macro is stored. "K" represents an 8-bit constant data to be used within the related macro. When EN=1, the macros "R1andR2", "R1nandR2", "R1orR2", "R1norR2", "R1xorR2" and "R1xnorR2" carry out the logical operations AND, NAND, OR, NOR, XOR and XNOR respectively on two 8-bit variables R1 and R2, and they store the result into the 8-bit output variable OUT.

Similarly, when EN=1, the macros "RandK", "RnandK", "RorK", "RnorK", "RxorK" and "RxnorK" carry out the logical operations AND, NAND, OR, NOR, XOR and XNOR respectively on the content of an 8-bit variable R and an 8-bit constant data K, and they store the result into the 8-bit output variable OUT.

Finally, when EN=1, the macro "inv_R" inverts all of the bits in the 8-bit source register IN and puts the result in the 8-bit destination register OUT.

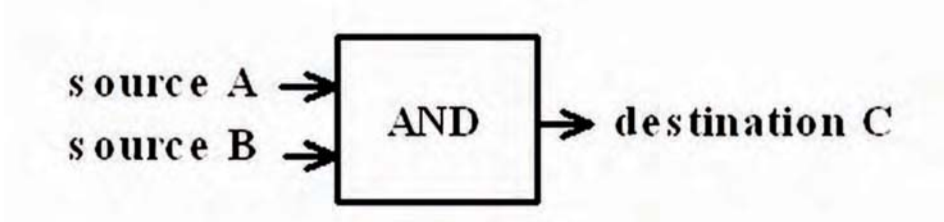


Figure 1: *The AND function*

Logical Macros Example

In this section, we will consider an example program (UZAM_plc_8i8o_ex18.asm) to show the usage of all logical macros. In order to test this example please download the file from http://host.nigde.edu.tr/muzam/ and then open the program UZAM_plc_8i8o_ex18.asm by MPLAB IDE and compile it. After that, by using the PIC programmer software, take the compiled file "UZAM_plc_8i8o_ex18.hex" and with PIC programmer hardware send it to the program memory of PIC16F648A microcontroller within the UZAM_PLC. After loading the "UZAM_plc_8i8o_ ex18.hex", switch the 4PDT in "RUN" and the power switch in "ON" position. Finally, the example program is ready to be tested.

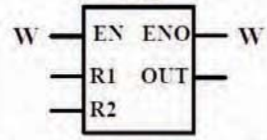
To check the correctness of the program you are referred to the related information for the logical macros provided in Table 1. When studying the example, note that the output register Q0 is made up of the 8 bits: Q0.7, Q0.6…Q0.0 and that Q0.7 is the most significant bit (MSB), while Q0.0 is the least significant bit (LSB). Similarly, note that the input register I0 is made up of the 8 bits: I0.7, I0.6…I0.0 and that I0.7 is the MSB while I0.0 is the LSB. The the example considered here makes use of the previously described macro "load_R", so the file "mv_ld_mcr_def.inc" is included as well.

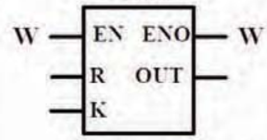
The example program, "UZAM_plc_8i8o_ex18.asm" is shown in **Figure 2**. The ladder diagram of the user program of "UZAM_plc_8i8o_ex18.asm" shown in Figure 2 is depicted in **Figure 3**. This example is more complicated than the ones considered in the previous articles of this series.

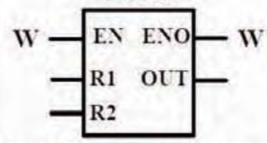
As can be seen from Figure 2, we define and use three additional 8-bit variables: REG1, REG2 and REG3. In the first rung, Q0 is cleared, 8-bit numerical data "F0h" – the mask data – is loaded to 8-bit variable REG1, and 8-bit numerical data "50h" is loaded to 8-bit variable REG2 by using the macro "load_R". This process is carried out once at the first program scan by using the "FRSTSCN" NO contact.

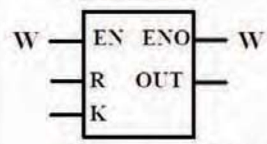
Another condition to carry out the same process is the NO contact of the input I0.0. This means that when this program is run during the normal PLC operation, if we force the input I0.0 to be true, then

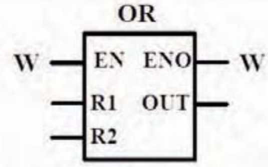
Algorithm	Macro	Symbol

if EN = 1 then
OUT = R1 AND R2;
ENO = 1;
else ENO = 0;
end if;
	R1andR2 macro in1,in2,out
	local L1
	movwf Temp_1
	btfss Temp_1,0
	goto L1
	movfw in1
	andwf in2,W
	movwf out
	movfw Temp_1
	L1
	endm
		AND
		
		R1, R2, OUT (8 bit register)
		EN (through W) = 0 or 1
		EN0 (through W) = 0 or 1

if EN = 1 then
OUT = R AND K;
ENO = 1;
else ENO = 0;
end if;
	RandK macro in1,in2,out
	local L1
	movwf Temp_1
	btfss Temp_1,0
	goto L1
	movlw in2
	andwf in1,W
	movwf out
	movfw Temp_1
	L1
	endm
		AND
		
		R, OUT (8 bit register)
		K (8 bit constant)
		EN (through W) = 0 or 1
		EN0 (through W) = 0 or 1

if EN = 1 then
OUT = R1 NAND R2;
ENO = 1;
else ENO = 0;
end if;
	R1nandR2 macro in1,in2,out
	local L1
	movwf Temp_1
	btfss Temp_1,0
	goto L1
	movfw in1
	andwf in2,W
	movwf out
	comf out,f
	movfw Temp_1
	L1
	endm
		NAND
		
		R1, R2, OUT (8 bit register)
		EN (through W) = 0 or 1
		EN0 (through W) = 0 or 1

if EN = 1 then
OUT = R NAND K;
ENO = 1;
else ENO = 0;
end if;
	RnandK macro in1,in2,out
	local L1
	movwf Temp_1
	btfss Temp_1,0
	goto L1
	movlw in2
	andwf in1,W
	movwf out
	comf out,f
	movfw Temp_1
	L1
	endm
		NAND
		
		R, OUT (8 bit register)
		K (8 bit constant)
		EN (through W) = 0 or 1
		EN0 (through W) = 0 or 1

if EN = 1 then
OUT = R1 OR R2;
ENO = 1;
else ENO = 0;
end if;
	R1orR2 macro in1,in2,out
	local L1
	movwf Temp_1
	btfss Temp_1,0
	goto L1
	movfw in1
	iorwf in2,W
	movwf out
	movfw Temp_1
	L1
	endm
		OR
		
		R1, R2, OUT (8 bit register)
		EN (through W) = 0 or 1
		EN0 (through W) = 0 or 1

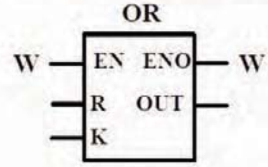
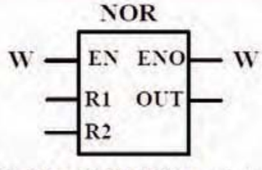
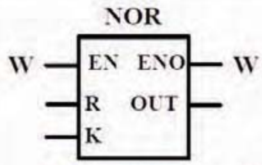
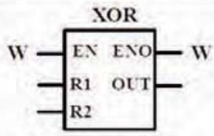
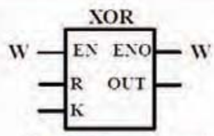
if EN = 1 then
OUT = R OR K;
ENO = 1;
else ENO = 0;
end if;
	RorK macro in1,in2,out
	local L1
	movwf Temp_1
	btfss Temp_1,0
	goto L1
	movlw in2
	iorwf in1,W
	movwf out
	movfw Temp_1
	L1
	endm
		OR
		
		R, OUT (8 bit register)
		K (8 bit constant)
		EN (through W) = 0 or 1
		EN0 (through W) = 0 or 1

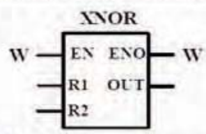
Table 1: *The logical macros together with their algorithms and symbols (continued)*

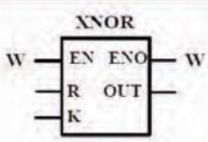
if EN = 1 then
OUT = R1 NOR R2;
ENO = 1;
else ENO = 0;
end if;
	`R1norR2 macro in1,in2,out`
	`local L1`
	`movwf Temp_1`
	`btfss Temp_1,0`
	`goto L1`
	`movfw in1`
	`iorwf in2,W`
	`movwf out`
	`comf out,f`
	`movfw Temp_1`
	`L1`
	`endm`
		
		R1, R2, OUT (8 bit register)
		EN (through W) = 0 or 1
		EN0 (through W) = 0 or 1

if EN = 1 then
OUT = R NOR K;
ENO = 1;
else ENO = 0;
end if;
	`RnorK macro in1,in2,out`
	`local L1`
	`movwf Temp_1`
	`btfss Temp_1,0`
	`goto L1`
	`movlw in2`
	`iorwf in1,W`
	`movwf out`
	`comf out,f`
	`movfw Temp_1`
	`L1`
	`endm`
		
		R, OUT (8 bit register)
		K (8 bit constant)
		EN (through W) = 0 or 1
		EN0 (through W) = 0 or 1

if EN = 1 then
OUT = R1 EXOR R2;
ENO = 1;
else ENO = 0;
end if;
	`R1xorR2 macro in1,in2,out`
	`local L1`
	`movwf Temp_1`
	`btfss Temp_1,0`
	`goto L1`
	`movfw in1`
	`xorwf in2,W`
	`movwf out`
	`movfw Temp_1`
	`L1`
	`endm`
		
		R1, R2, OUT (8 bit register)
		EN (through W) = 0 or 1
		EN0 (through W) = 0 or 1

if EN = 1 then
OUT = R EXOR K;
ENO = 1;
else ENO = 0;
end if;
	`RxorK macro in1,in2,out`
	`local L1`
	`movwf Temp_1`
	`btfss Temp_1,0`
	`goto L1`
	`movlw in2`
	`xorwf in1,W`
	`movwf out`
	`movfw Temp_1`
	`L1`
	`endm`
		
		R, OUT (8 bit register)
		K (8 bit constant)
		EN (through W) = 0 or 1
		EN0 (through W) = 0 or 1

if EN = 1 then
OUT = R1 EXNOR R2;
ENO = 1;
else ENO = 0;
end if;
	`R1xnorR2 macro in1,in2,out`
	`local L1`
	`movwf Temp_1`
	`btfss Temp_1,0`
	`goto L1`
	`movfw in1`
	`xorwf in2,W`
	`movwf out`
	`comf out,f`
	`movfw Temp_1`
	`L1`
	`endm`
		
		R1, R2, OUT (8 bit register)
		EN (through W) = 0 or 1
		EN0 (through W) = 0 or 1

if EN = 1 then
OUT = R EXNOR K;
ENO = 1;
else ENO = 0;
end if;
	`RxnorK macro in1,in2,out`
	`local L1`
	`movwf Temp_1`
	`btfss Temp_1,0`
	`goto L1`
	`movlw in2`
	`xorwf in1,W`
	`movwf out`
	`comf out,f`
	`movfw Temp_1`
	`L1`
	`endm`
		
		R, OUT (8 bit register)
		K (8 bit constant)
		EN (through W) = 0 or 1
		EN0 (through W) = 0 or 1

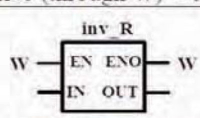
if EN = 1 then
OUT = invert IN;
ENO = 1;
else ENO = 0;
end if;
	`inv_R macro in,out`
	`local L1`
	`movwf Temp_1`
	`btfss Temp_1,0`
	`goto L1`
	`comf in,W`
	`movwf out`
	`movfw Temp_1`
	`L1`
	`endm`
		
		IN, OUT (8 bit register)
		EN (through W) = 0 or 1
		EN0 (through W) = 0 or 1

Table 1: *Continued from the previous page*

the above mentioned process will take place. In the 13 PLC rungs between 2 and 14, a “4 to 16 decoder” is implemented, whose inputs are I0.3, I0.2, I0.1 and I0.0, and whose outputs are M0.0, M0.1... M0.7, M1.0, M1.1...M1.4. Note that only the first 13 combinations are utilised, while the following combinations for inputs (I0.3, I0.2, I0.1, I0.0): 1101, 1110 and 1111 are not implemented. Therefore, for these combinations of the inputs I0.3, I0.2, I0.1 and I0.0, the program will not produce any meaningful output.

This arrangement is made to choose 13 different processes based on the input information given through the input bits I0.3, I0.2, I0.1 and I0.0. **Table 2** shows the truth table based on the input data entered through I0.3, I0.2, I0.1 and I0.0, and the 13 chosen processes. In the 13 PLC rungs between 15 and 27, we define different logical operations according to the decoder output represented by the marker bits M0.0, M0.1...M0.7, M1.0, M1.1...M1.4. In these 13 rungs, the first contacts represent the decoder output and, in the second place, we use a macro “R1andR2” whose inputs are “I0” and “REG1” (having being loaded with “F0h” data throughout the PLC operation) and whose output is REG3. This is solely done in order to “mask” the lower nibble (lower 4 bits) of the input register I0, because we already use the lower nibble as the input bits of the “4 to 16 decoder”. Therefore, the logical operations placed in the third places of these 13 rungs are only applicable to the higher nibble of I0 (REG3). This fact can be seen from Table 2.

As an example let us consider the rung 27. When M1.4 = 1, which implies that input bits are (I0.3, I0.2, I0.1, I0.0) = 1100, the following function is chosen to be done: Q0 = REG3 (I0.7, I0.6, I0.5, I0.4, 0, 0, 0, 0) XNOR 50h. This means that the higher nibble of REG3, which is made up of input bits I0.7, I0.6, I0.5, I0.4 will be subject to XNOR logical function with the

AN OTA-BASED DIFFERENTIAL RELAXATION OSCILLATOR AND ITS APPLICATION AS A VERSATILE ELECTRONIC INTERFACE FOR SENSORS

THIS CIRCUIT CAN operate as a capacitance-to-frequency or inductance-to-frequency converter. It can be used for capacitive/inductive sensor interface. It operates as follows.

When the differential input voltage of the operational transconductance amplifier (OTA) exceeds few millivolts, the output current will be equal to the input auxiliary bias current I_{abc} and will be either outward or inward.

To describe the circuit operation we start by assuming that the output current is outward. With the reference capacitor C_r and the sensor inductor L_s initially fully discharged, the capacitor will act as a short circuit and the inductor will act as an open circuit. Thus, the voltage across the capacitor will be zero and the voltage across the inductor will be $I_{abc}R$. The capacitor will start a charging process heading towards $I_{abc}R_r$ with a time constant = C_rR_r and the inductor will start a discharging process heading towards zero with a time constant = $L_s/(R+R_s)$. Eventually the voltages at the positive and negative inputs of the OTA will be equal. If the voltage at the negative input exceeds the voltage at the positive input by few millivolts, the output current of the OTA will reverse its direction. Thus, the capacitor will start a discharging process, with time constant = C_rR_r, heading towards $-I_{abc}R_r$; the voltage across the inductor will jump to $-I_{abc}R$ and the inductor will start a discharging process with time constant = $L_s/(R+R_s)$ heading towards zero. Eventually the voltages at the positive and negative inputs of the OTA will be equal and both negative.

If the voltage at the negative input exceeds in magnitude at the positive input by few millivolts, the output current of the OTA will reverse its direction. Thus, the capacitor will start a charging process heading towards $I_{abc}R_r$ and the voltage across the inductor will jump to $I_{abc}R$; the inductor will start a discharging process heading towards zero. The cycle will repeat and, except for the first period, the output will be a square wave voltage alternating between $I_{abc}R_L$ and $-I_{abc}R_L$. It is easy to show that the frequency of the output square wave will be inversely proportional to the value of the sensor inductance.

Capacitance-to-Frequency Conversion Case

The same circuit can be used for capacitance-to-frequency conversion. In this case the sensor inductor and the series resistance are replaced by the sensor capacitance. Similar to the inductive sensor case, the circuit operation for a capacitive sensor can be described as follows. With the reference capacitor C_r and the sensor capacitor C_s initially fully discharged, the two capacitors will be short circuit and voltages across them will be zero.

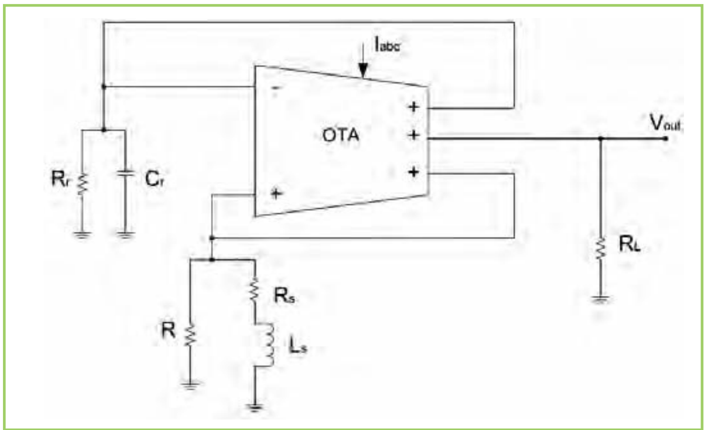


Figure 1: *Proposed circuit for capacitance/inductance-to-frequency converter*

Assuming that the output current of the OTA is outward, the two capacitors will start charging processes heading towards $I_{abc}R_r$ with a time constant = C_rR_r for the reference capacitor, and towards $I_{abc}R_s$ for the sensor capacitor with a time constant = C_sR_s. Obviously one capacitor will charge faster than the other. By proper selection of the components, eventually the voltages at the positive and negative inputs of the OTA will be equal. If the voltage at the negative input exceeds; in magnitude, that at the positive input by few millivolts, the output current of the OTA will reverse its direction. Thus, the capacitors will start discharging processes, with time constant = C_rR_r heading towards $-I_{abc}R_r$ for the reference capacitor, and heading towards $-I_{abc}R_s$ with a time constant = C_sR_s for the sensor capacitance. Eventually the voltages at the positive and negative inputs of the OTA will be equal and both negative.

If the voltage at the negative input exceeds in magnitude at the positive input by few millivolts, the output current of the OTA will reverse its direction. Thus, the capacitors will start charging processes heading towards $I_{abc}R_r$ and $I_{abc}R_s$ with time constants equal to C_rR_r and C_sR_s respectively.

The cycle will repeat and, except for the first period, the output will be a square wave with output voltage alternating between $I_{abc}R_L$ and $-I_{abc}R_L$. It is easy to show that the frequency of the output square wave will be inversely proportional to the value of the sensor capacitance.

In practice the multiple-output OTA is not commercially available. The proposed circuit was, therefore, realized using three AD3080 bipolar OTAs with their inputs connected in parallel and their auxiliary bias currents obtained from the same current source using three current mirrors.

The proposed circuit was tested for different values of capacitance C_s and inductance L_s, and errors not exceeding 3% were obtained for a wide range of capacitance and inductance values.

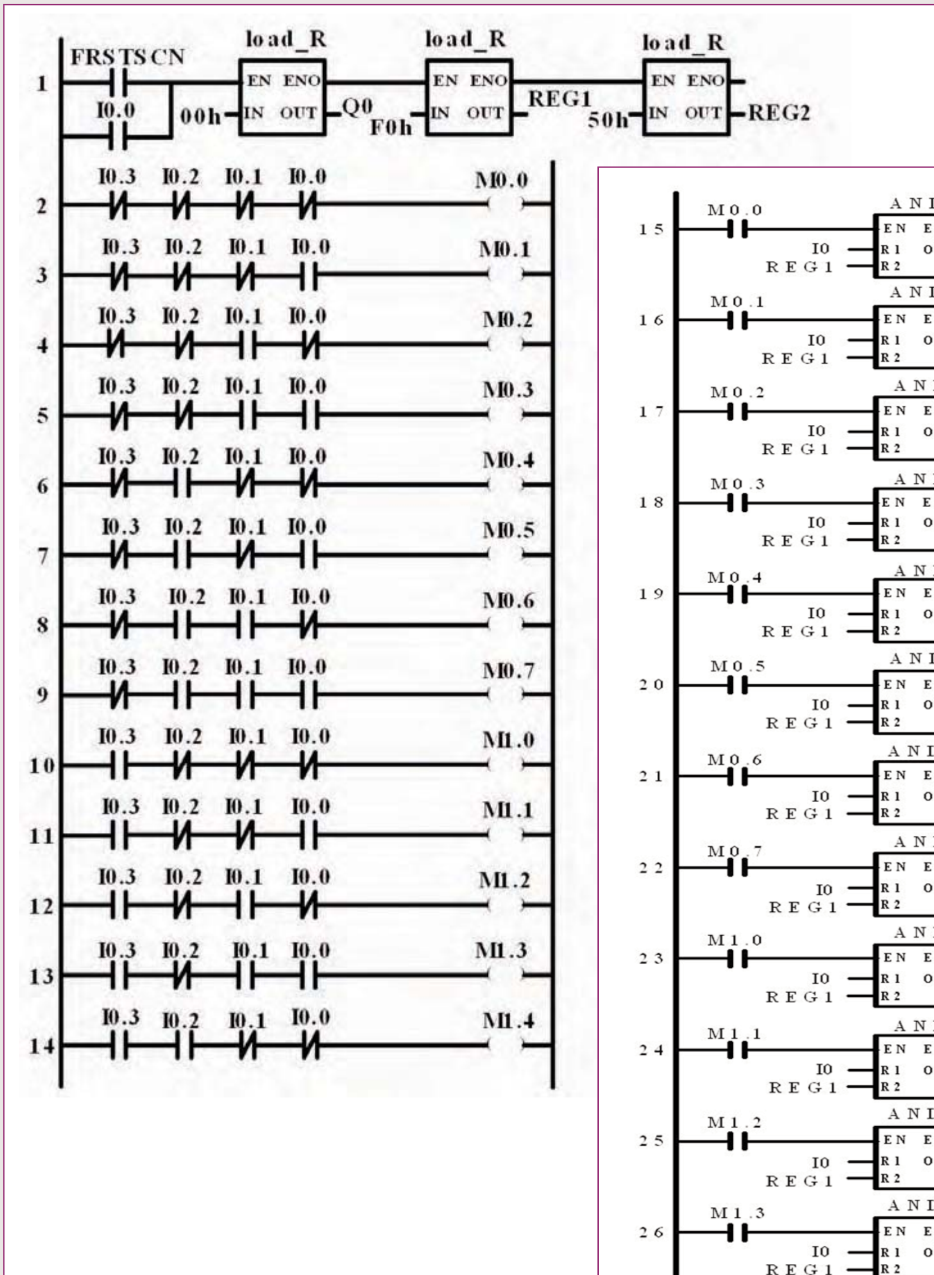
Muhammad Taher Abuelma'atti *and* ***Muhammad Al-Salman***
King Fahd University of Petroleum and Minerals
Saudi Arabia

```
#include <definitions.inc>    ;basic PLC definitions, macros, etc.
#include <cntct_mcr_def.inc>  ;Contact & Relay based macros
#include <mv_ld_mcr_def.inc>  ;move_R, load_R macros
#include <logic_mcr_def.inc>  ;Logic macros applied to registers

#define     REG1  7Ch
#define     REG2  7Dh
#define     REG3  7Eh

------------ user program starts here -----------------------
    ld          FRSTSCN     ;rung 1
    or          I0.0
    load_R      00h,Q0
    load_R      0F0h,REG1
    load_R      50h,REG2

    ld_not      I0.3        ;rung 2
    and_not     I0.2
    and_not     I0.1
    and_not     I0.0
    out         M0.0

    ld_not      I0.3        ;rung 3
    and_not     I0.2
    and_not     I0.1
    and         I0.0
    out         M0.1

    ld_not      I0.3        ;rung 4
    and_not     I0.2
    and         I0.1
    and_not     I0.0
    out         M0.2

    ld_not      I0.3        ;rung 5
    and_not     I0.2
    and         I0.1
    and         I0.0
    out         M0.3

    ld_not      I0.3        ;rung 6
    and         I0.2
    and_not     I0.1
    and_not     I0.0
    out         M0.4

    ld_not      I0.3        ;rung 7
    and         I0.2
    and_not     I0.1
    and         I0.0
    out         M0.5

    ld_not      I0.3        ;rung 8
    and         I0.2
    and         I0.1
    and_not     I0.0
    out         M0.6

    ld_not      I0.3        ;rung 9
    and         I0.2
    and         I0.1
    and         I0.0
    out         M0.7

    ld          I0.3        ;rung 10
    and_not     I0.2
    and_not     I0.1
    and_not     I0.0
    out         M1.0

    ld          I0.3        ;rung 11
    and_not     I0.2
    and_not     I0.1
    and         I0.0
    out         M1.1

    ld          I0.3        ;rung 12
    and_not     I0.2
    and         I0.1
    and_not     I0.0
    out         M1.2

    ld          I0.3        ;rung 13
    and_not     I0.2
    and         I0.1
    and         I0.0
    out         M1.3

    ld          I0.3        ;rung 14
    and         I0.2
    and_not     I0.1
    and_not     I0.0
    out         M1.4

    ld          M0.0        ;rung 15
    R1andR2     I0,REG1,REG3
    inv_R       REG3,Q0

    ld          M0.1        ;rung 16
    R1andR2     I0,REG1,REG3
    R1andR2     REG3,REG2,Q0

    ld          M0.2        ;rung 17
    R1andR2     I0,REG1,REG3
    RandK       REG3,50h,Q0

    ld          M0.3        ;rung 18
    R1andR2     I0,REG1,REG3
    R1nandR2    REG3,REG2,Q0

    ld          M0.4        ;rung 19
    R1andR2     I0,REG1,REG3
    RnandK      REG3,50h,Q0

    ld          M0.5        ;rung 20
    R1andR2     I0,REG1,REG3
    R1orR2      REG3,REG2,Q0

    ld          M0.6        ;rung 21
    R1andR2     I0,REG1,REG3
    RorK        REG3,50h,Q0

    ld          M0.7        ;rung 22
    R1andR2     I0,REG1,REG3
    R1norR2     REG3,REG2,Q0

    ld          M1.0        ;rung 23
    R1andR2     I0,REG1,REG3
    RnorK       REG3,50h,Q0

    ld          M1.1        ;rung 24
    R1andR2     I0,REG1,REG3
    R1xorR2     REG3,REG2,Q0

    ld          M1.2        ;rung 25
    R1andR2     I0,REG1,REG3
    RxorK       REG3,50h,Q0

    ld          M1.3        ;rung 26
    R1andR2     I0,REG1,REG3
    R1xnorR2    REG3,REG2,Q0

    ld          M1.4        ;rung 27
    R1andR2     I0,REG1,REG3
    RxnorK      REG3,50h,Q0
--------------- user program ends here ----
```

Figure 2: *The user program of UZAM_plc_8i8o_ex18.asm*

I0.3	I0.2	I0.1	I0.0	Selected process
0	0	0	0	Q0 = **invert** of REG3(I0.7, I0.6, I0.5, I0.4, 0, 0, 0, 0)
0	0	0	1	Q0 = REG3 (I0.7, I0.6, I0.5, I0.4, 0, 0, 0, 0) **AND** REG2(50h)
0	0	1	0	Q0 = REG3 (I0.7, I0.6, I0.5, I0.4, 0, 0, 0, 0) **AND** 50h
0	0	1	1	Q0 = REG3 (I0.7, I0.6, I0.5, I0.4, 0, 0, 0, 0) **NAND** REG2(50h)
0	1	0	0	Q0 = REG3 (I0.7, I0.6, I0.5, I0.4, 0, 0, 0, 0) **NAND** 50h
0	1	0	1	Q0 = REG3 (I0.7, I0.6, I0.5, I0.4, 0, 0, 0, 0) **OR** REG2(50h)
0	1	1	0	Q0 = REG3 (I0.7, I0.6, I0.5, I0.4, 0, 0, 0, 0) **OR** 50h
0	1	1	1	Q0 = REG3 (I0.7, I0.6, I0.5, I0.4, 0, 0, 0, 0) **NOR** REG2(50h)
1	0	0	0	Q0 = REG3 (I0.7, I0.6, I0.5, I0.4, 0, 0, 0, 0) **NOR** 50h
1	0	0	1	Q0 = REG3 (I0.7, I0.6, I0.5, I0.4, 0, 0, 0, 0) **XOR** REG2(50h)
1	0	1	0	Q0 = REG3 (I0.7, I0.6, I0.5, I0.4, 0, 0, 0, 0) **XOR** 50h
1	0	1	1	Q0 = REG3 (I0.7, I0.6, I0.5, I0.4, 0, 0, 0, 0) **XNOR** REG2(50h)
1	1	0	0	Q0 = REG3 (I0.7, I0.6, I0.5, I0.4, 0, 0, 0, 0) **XNOR** 50h

Table 2: *The truth table of the user program of "UZAM_plc_8i8o_ex18.asm"*



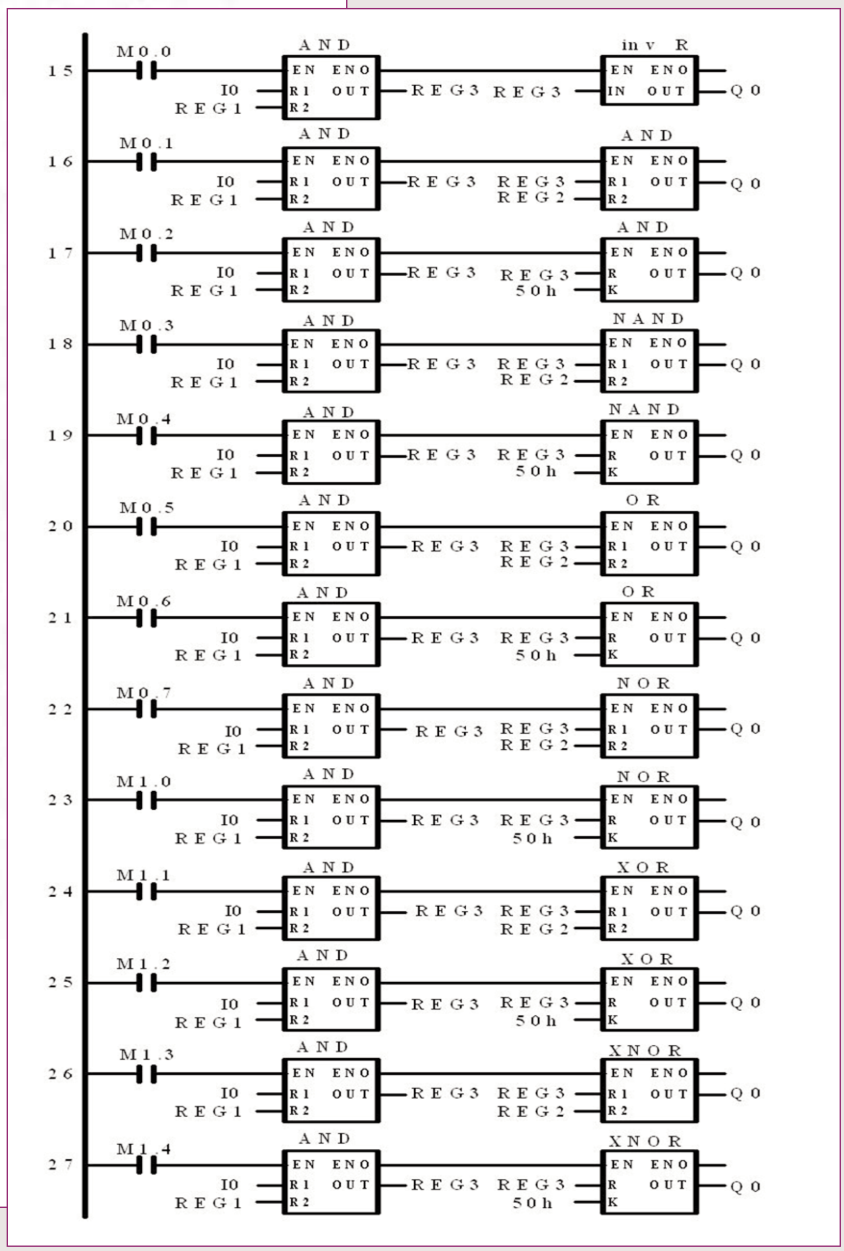


Figure 3: *Ladder diagram for the user program of UZAM_plc_8i8o_ex18.asm*

data "0101" and the result will appear from the output bits Q0.7, Q0.6, Q0.5, Q0.4. When this program is run, the lower nibble of the output Q0 will always be observed to be all zeros, i.e. (Q0.3, Q0.2, Q0.1, Q0.0) = 0000. ■

If you've missed any of the previous articles in this series, you can now order it on line at ***www.electronicsworld.co.uk***

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www.roband.co.uk

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www.iqdfrequencyproducts.com

AN OTA-BASED DIFFERENTIAL RELAXATION OSCILLATOR AND ITS APPLICATION AS A VERSATILE ELECTRONIC INTERFACE FOR SENSORS

THIS CIRCUIT CAN operate as a capacitance-to-frequency or inductance-to-frequency converter. It can be used for capacitive/inductive sensor interface. It operates as follows.

When the differential input voltage of the operational transconductance amplifier (OTA) exceeds few millivolts, the output current will be equal to the input auxiliary bias current I_{abc} and will be either outward or inward.

To describe the circuit operation we start by assuming that the output current is outward. With the reference capacitor C_r and the sensor inductor L_s initially fully discharged, the capacitor will act as a short circuit and the inductor will act as an open circuit. Thus, the voltage across the capacitor will be zero and the voltage across the inductor will be $I_{abc}R$. The capacitor will start a charging process heading towards $I_{abc}R_r$ with a time constant = C_rR_r and the inductor will start a discharging process heading towards zero with a time constant = $L_s/(R+R_s)$. Eventually the voltages at the positive and negative inputs of the OTA will be equal. If the voltage at the negative input exceeds the voltage at the positive input by few millivolts, the output current of the OTA will reverse its direction. Thus, the capacitor will start a discharging process, with time constant = C_rR_r, heading towards $-I_{abc}R_r$; the voltage across the inductor will jump to $-I_{abc}R$ and the inductor will start a discharging process with time constant = $L_s/(R+R_s)$ heading towards zero. Eventually the voltages at the positive and negative inputs of the OTA will be equal and both negative.

If the voltage at the negative input exceeds in magnitude at the positive input by few millivolts, the output current of the OTA will reverse its direction. Thus, the capacitor will start a charging process heading towards $I_{abc}R_r$ and the voltage across the inductor will jump to $I_{abc}R$; the inductor will start a discharging process heading towards zero. The cycle will repeat and, except for the first period, the output will be a square wave voltage alternating between $I_{abc}R_L$ and $-I_{abc}R_L$. It is easy to show that the frequency of the output square wave will be inversely proportional to the value of the sensor inductance.

Capacitance-to-Frequency Conversion Case

The same circuit can be used for capacitance-to-frequency conversion. In this case the sensor inductor and the series resistance are replaced by the sensor capacitance. Similar to the inductive sensor case, the circuit operation for a capacitive sensor can be described as follows. With the reference capacitor C_r and the sensor capacitor C_s initially fully discharged, the two capacitors will be short circuit and voltages across them will be zero.

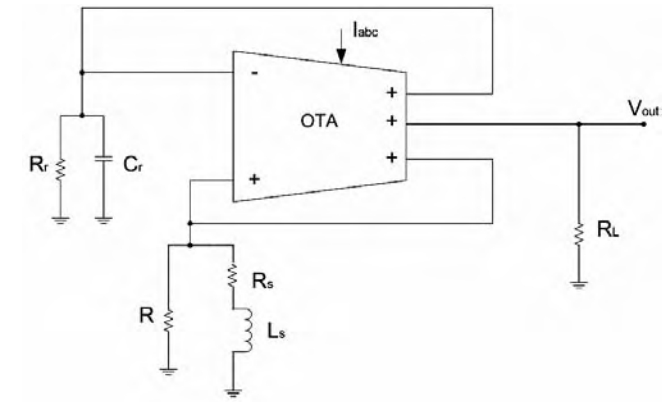

Figure 1: *Proposed circuit for capacitance/inductance-to-frequency converter*

Assuming that the output current of the OTA is outward, the two capacitors will start charging processes heading towards $I_{abc}R_r$ with a time constant = C_rR_r for the reference capacitor, and towards $I_{abc}R_s$ for the sensor capacitor with a time constant = C_sR_s . Obviously one capacitor will charge faster than the other. By proper selection of the components, eventually the voltages at the positive and negative inputs of the OTA will be equal. If the voltage at the negative input exceeds; in magnitude, that at the positive input by few millivolts, the output current of the OTA will reverse its direction. Thus, the capacitors will start discharging processes, with time constant = C_rR_r heading towards $-I_{abc}R_r$ for the reference capacitor, and heading towards $-I_{abc}R_s$ with a time constant = C_sR_s for the sensor capacitance. Eventually the voltages at the positive and negative inputs of the OTA will be equal and both negative.

If the voltage at the negative input exceeds in magnitude at the positive input by few millivolts, the output current of the OTA will reverse its direction. Thus, the capacitors will start charging processes heading towards $I_{abc}R_r$ and $I_{abc}R_s$ with time constants equal to C_rR_r and C_sR_s respectively.

The cycle will repeat and, except for the first period, the output will be a square wave with output voltage alternating between $I_{abc}R_L$ and $-I_{abc}R_L$. It is easy to show that the frequency of the output square wave will be inversely proportional to the value of the sensor capacitance.

In practice the multiple-output OTA is not commercially available. The proposed circuit was, therefore, realized using three AD3080 bipolar OTAs with their inputs connected in parallel and their auxiliary bias currents obtained from the same current source using three current mirrors.

The proposed circuit was tested for different values of capacitance C_s and inductance L_s, and errors not exceeding 3% were obtained for a wide range of capacitance and inductance values.

Muhammad Taher Abuelma'atti *and* ***Muhammad Al-Salman***
King Fahd University of Petroleum and Minerals
Saudi Arabia

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Figure 4a: *Waveform generated by the circuit shown in Figure 1 (Upper: Clock signal), (Lower: DPPM signal)*

Figure 4b: *Waveforms (Upper: Transmitted DPPM signal) (Lower: Sampling pulses for latch circuit at receiver)*

TIP 1: SIMPLE TEMPERATURE MONITORING IN BATTERY MANAGEMENT SYSTEMS

By Tim Regan, Applications Manager, Signal Conditioning Products, Linear Technology Corporation

ENVIRONMENTAL CONCERNS are spurring the development of clean transportation alternatives. Most popular are full electric and hybrid electric motor vehicles, which use stacks of Lithium ion battery cells as the electric power source.

To ensure efficient operation and long battery life, the cells are continually monitored for the available charge, known as the state of charge (SOC). The temperature of the cells is an important factor for the SOC calculation. In addition, the automotive operating environment is a harsh one, with the possibility for many fault conditions. Excessive loading of the battery packs (with a short circuit condition as the worst case) can create a dangerous overheating situation that requires constant attention. Less accurate temperature sensing for fault conditions is often required for safety reasons.

12-bit Accurate Temperature Sensing

The LTC6802 from Linear Technology is a complete battery monitoring system on a chip. The device's primary function is to measure the voltages of up to 12 cells on a single stack and supply a host controller with data for the state of charge calculations in addition to basic safe operating conditions. Any number of these devices can be stacked to provide the complete battery monitoring system for the electric vehicle power source.

The heart of the device is a 12-bit Delta Sigma A-to-D converter. This ADC has a 15-channel multiplexer in front of it. The 15 channels are for twelve cell voltage and three temperature measurements. The temperature channels have one dedicated to measuring the die temperature of the chip itself and two channels for external temp sensors. **Figures 1** and **2** are examples of circuits for measuring temperature with the LTC6802. Figure 1 is an accurate thermistor-based sensor for SOC calculations and Figure 2 shows a very simple diode-based "hot spot" detector.

Accurate Thermistor Pack Sensor

At cold temperatures a Lithium ion cell becomes more resistive and provides less charge between a full (with typical V_{cell} of 4.2V) and an empty (V_{cell} of only 2.5V) condition. At higher operating temperatures the self-discharge current of the cells increases and becomes an important factor for the SOC calculation.

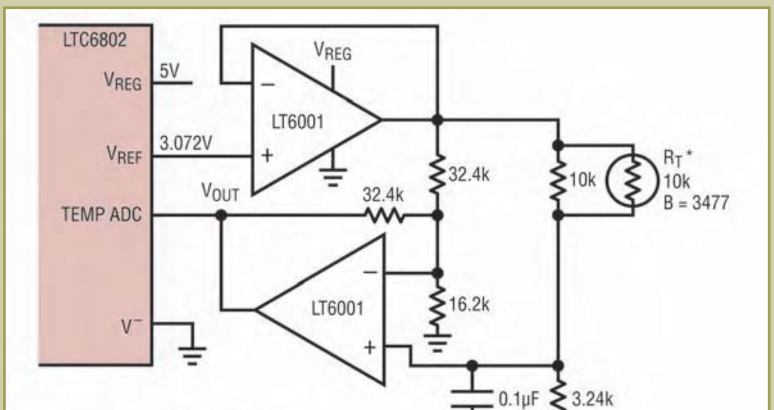
In a typical system the cells are thoroughly characterized for performance over temperature. This information is stored in a lookup table. Together with the cell voltage readings, the pack temperature will retrieve cell characteristics information from the table for the SOC calculation. Attaching a thermistor to a battery pack is an inexpensive yet reasonably accurate way to monitor temperature.

In Figure 1, a Negative Temperature Coefficient (NTC) thermistor is paralleled with a fixed resistor to flatten the change in resistance with temperature. Thermistors are highly nonlinear, exhibiting an exponential change in resistance over temperature

$$R_T = R_o e^{\frac{-B}{T_o}} \bullet e^{\frac{B}{T}}$$

where R_o is the nominal resistance at reference temperature T_o (in degrees Kelvin) and the B-parameter is provided for the particular thermistor. However, in many situations, a simple approximation can be made. For example, an NTC thermistor's resistance changes about -4% per degree C over a limited temperature range.

The LT6001 is a dual 13µA micropower op-amp used to provide bias for the thermistor and to scale and level shift the voltage applied to the LTC6802 temp input to the ADC. The reference voltage (3.072V) and regulator voltage (5V) are included in the LTC6802 device. The output range is set for approximately 0.2V to 4.2V over a temperature range of -20°C to 60°C, the typical operating range of most Lithium cells. The average slope of the output voltage is 50mV/°C giving over 30 ADC counts per degree change in temperature. The precise determination of temperature for the circuit values shown is presented in Figure 1.



$$t(°C) = \frac{3477}{\ln\left[\frac{\frac{22.5k}{V_{OUT}} - 2.5k}{0.085}\right]} - 273$$

Figure 1a: *An accurate thermistor temperature sensor for state of charge calculations*

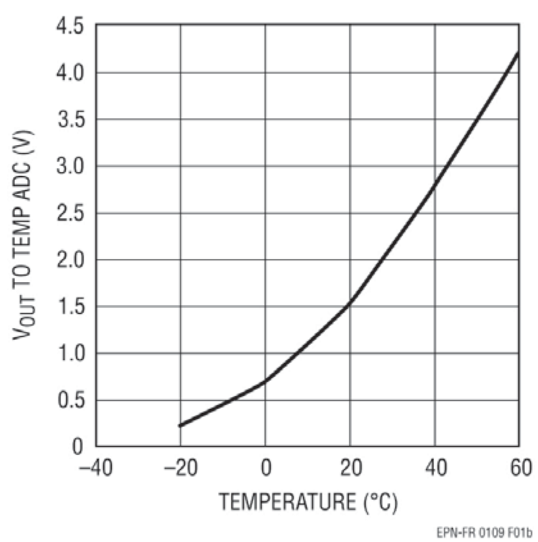


Figure 1b: *ADC input voltage over temperature*

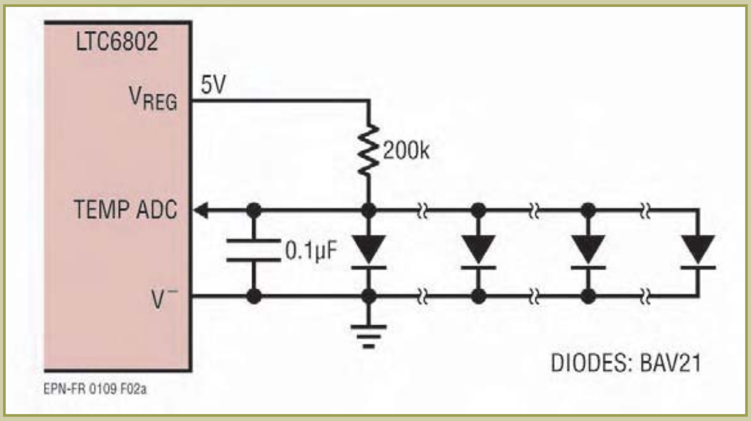


Figure 2a: *A very simple diode array "hot spot" temperature sensor*

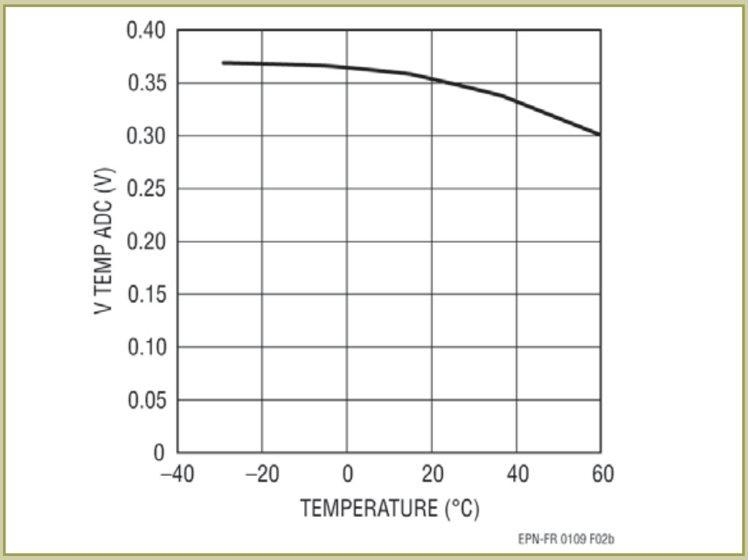


Figure 2b: *ADC input voltage over temperature*

Simple Hot Spot Detector

A string of diodes can be distributed throughout a battery system to create a simple and inexpensive way to create a hot spot warning indication. This is shown in Figure 2. This warning only indicates that there may be a problem with overheating somewhere in the system. The exact location of the problem is not known, but the system could be disabled in the interest of safety until further diagnostics can be run.

Each diode is biased from the same source and will have the conventional -2mV/°C temperature coefficient. The voltage measured across the string will be determined by the hottest diode with the lowest forward voltage drop. Any number of diodes can be used. The built-in ADC has a resolution of 1.5mV per count.

A drop of 150 counts in the ADC code measurement from normal operation would indicate a hot spot with a 75°C rise in temperature. The data shown in Figure 2 is the voltage across the string of diodes with only one subjected to a temperature change. The other three diodes remain at 20°C.

Ideas

These are just two ideas for simple temperature monitoring circuits using the convenient inputs of the LTC6802 IC. More accurate sensing can be implemented to take advantage of the same precision ADC used for cell voltage monitoring.

General purpose I/O pins on the LTC6802 can also be used to control an external multiplexer circuit to accommodate individual cell temperature sensors. ■

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www.iqdfrequencyproducts.com

MONITRAN ANNOUNCES "GRIP TIGHT" BODIED VIBRATION SENSORS AND ACCELEROMETERS

Monitran has made its general purpose vibration sensors and accelerometers available as "Grip Tight" (GT) versions. With Grip Tight (patent pending), the fitting or removal of a sensor to/from its GT stud takes mere seconds, yet the mechanical bond, essential for the transfer of energy, is assured.

Unlike a traditional threaded mounting option, there is no need to screw the sensor onto the stud. This is a major plus when using sensors with integral cables, which would otherwise have their cables twisted when tightening the sensor onto the stud. The Grip Tight method also removes, completely, the risk of sheering the stud-to-machine bond; be it screw or adhesive.

A GT-bodied sensor has no hexagonal base, as a spanner is not required for mounting the sensor to its stud. Instead, tightening a grub screw draws the base of the sensor down onto its GT-stud.

Sensors available with the new GT body include Monitran's MTN/1100 family, which have isolated AC outputs and are ideal for vibration analysis, and the MTN/1185 family, which have DC outputs and are ideal for machine protection.

Grip Tight is ideally suited to applications where the vibration sensor is not necessarily going to be a permanent fixture.

www.monitran.com

KONTRON'S NEW RANGE OF MINI INDUSTRIAL SERVERS WITH REDUCED INSTALLATION DEPTH

Kontron's new 1U mini-format industrial server range Kontron KISS 1U Short features a 25% reduced installation depth. Despite their extremely compact format they offer the latest multicore processor performance, two SATA hard disks with optional RAID functionality and two PCI expansion slots for customer-specific expansion options.

The new Kontron small form-factor industrial servers have an installation height of 44mm and are just 350mm in depth, leaving enough space in the back of the rack for installing cables and dock-on devices.

The most important electronic components, such as the embedded motherboard and the RAID controller are engineered and manufactured by Kontron, ensuring optimized system performance and reliability. Thanks to the modularity of Kontron's KISS 1U Short mini-servers, which have long-term availability of at least five years, the system is configurable and scalable according to users' needs. The ready-to-go configurable Kontron KISS servers eliminate the need for many expensive, custom designs efforts, which may also be subject to high minimum order quantities, extensive compatibility testing or special certification efforts. Kontron has completed the testing already to give customers drive, graphics and other I/O options to fit the functionality and price/performance needs of the application.

www.kontron.com/KISS

RECTANGULAR D-SUB SMT CONNECTORS OFFER RUGGEDNESS AND RELIABILITY

Harting has introduced a new series of rectangular D-Sub SMT, which offer a high level of ruggedness and reliability for use with modern production processes, including reflow soldering and vacuum pick-and-place systems.

The design of the connectors has been optimised with a view to reliable processing and a long service life. Key features include the SMT terminals, which have a coplanarity of 0.1mm, the use of black mouldings to simplify camera recognition, and the large, level surface which is ideal for use with common pick-and-place vacuum nozzles.

The open terminal area makes it possible to inspect the soldered connection and also improves heat dissipation. The cast-iron bases, each of which can withstand tensile forces of more than 500N, ensure stableness during mating.

The rectangular D-Sub SMT connectors from Harting are available in both standard and low-profile versions with 9 to 37 contacts and are supplemented with a large selection of screws in M3 or 4-40 UNC sizes. The devices are delivered on reels as standard, although tray packaging is available on request.

Harting connectors and network components are used in mechanical engineering and plant manufacturing, in automation systems, energy generation and distribution, and in electronic and telecommunication markets.

www.Harting.com

HARWIN ADDS HIGH POWER CRIMP CONTACTS TO MIX-TEK DATAMATE CONNECTOR SERIES

Harwin, manufacturer of connectors and interconnect solutions for high-reliability applications, has extended the range of high power contacts available within its Mix-Tek mixed technology Datamate connector series with the introduction of two new crimp style contacts, together with the associated crimp tooling. These contacts will be of particular interest to those users wishing to terminate to cables in sensitive areas where the use of solder joints are not permitted, for example in certain restricted aerospace applications.

The new crimp male power contacts can accommodate cable sizes of between 18 to 20 AWG with current ratings in excess of between 5 and 8 amps achievable, depending on wire size. The new contacts facilitate simple, fast and secure termination to cables, and are fully interchangeable with solder contacts.

Harwin's high-reliability 2mm pitch Mix-Tek Datamate connectors can combine a wide range of different contact styles, including co-axial, signal and power. Contact type and configuration of these connectors is selected by the user to suit his specific requirements. These new male power crimp versions are suitable for aerospace and other applications, where the use of soldering systems may cause unacceptable risks.

www.harwin.co.uk

KJAYA LIGHTWEIGHT, LOW-COST 38999 SERIES III CONNECTOR

Connector manufacturer ITT Interconnect Solutions has designed a hermetically-sealed connector with a lightweight aluminium shell for low-pressure water immersion or fording applications that meets the requirements of MIL-STD-810 Method 512.5 and IP67.

The new KJAYA connector is designed to extend ITT's Mil-DTL-38999 hermetic connector range, which are designed for pressure differentials in excess of 750PSI and operating temperatures of up to 200degC. However, many water immersion applications only require a one atmosphere pressure differential (15PSI) or less and operate at temperatures below 150degC.

Engineered to ITT's most stringent quality standards, the new KJAYA lightweight aluminium shell connector provides hermetic sealing of 0.01 micron cubic feet per hour for pressure differentials of 15PSI, and is 50% lighter overall than standard hermetic connectors in the rest of ITT's Mil-DTL-38999 range.

The KJAYA connector features a special sealant based hermetic design and is water immersion sealed to 10 to -7 cubic cm per second.

Operating temperature range is a wide -55 to +150degC. It is offered in wall and jam nut mounting receptacles in sizes 9 through 25, and its lightweight aluminium shell has copper alloy contacts for reduced electrical resistance.

Devices are available in MIL-DTL-38999 standard insert patterns with either PC tail or poke-home crimp piggyback terminations.

www.ittcannon.com

CURVE-TRACER SOFTWARE FOR SEMICONDUCTOR TESTING

A new version of Yokogawa's curve-tracer software for semiconductor testing has been introduced for the company's GS610 source measure unit.

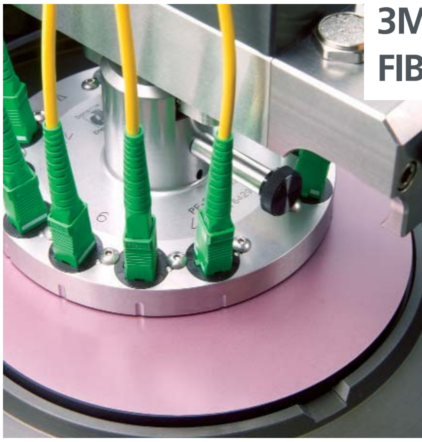
Designed to carry out voltage/current analysis on two-lead or three-lead components including discrete semiconductors, integrated circuits and optoelectronic components, the new PC-based software works in conjunction with the USB-connected GS610 to enable source and sink operations at up to 100V at 0.5A or 12V at 3.2A. A single GS610 is required for two-lead components and two units are needed for three-lead components.

The GS610 is designed for ease of setup and operation, with screens guiding the user through the setup process and the selection of sweep range, graph axes, measurement range and measurement conditions.

Curves can be based on various combinations of current and voltage inputs along with time-stamp references. Sweep shape can be set to ramp (linear or logarithmic), triangular (linear or logarithmic) or rectangular, and the number of sweep points can be 5, 10, 20, 50, 100, 200 or 1000.

In addition to facilities for scaling and averaging, the unit offers a number of analysis features including cursor, zoom, scroll and reference curve designation. File operations include CSV data storage and loading, graphic image storage, panel image storage, and setup storage and recall.

http://tmi.yokogawa.com



3M LAUNCHES LONG-LASTING ABRASIVE FILMS FOR FIBRE OPTIC CONNECTOR POLISHING

Spending more than 6% of its turn over in research and development, 3M has engineered long-lasting Diamond Lapping Films & Lapping Film 865X for final polish of fibre optic connectors.

These easy-to-use products provide an immediate cost per connector and polishing time benefit. In addition, these films allow improved quality and higher yield rate on fibre optic patch cords and pigtails manufacturing without the need for big change in the process.

The 3M Diamond Lapping Films provide a high cut rate and precise finish. They lead to a more consistent and clean finish, important in applications such as fibre optic connectors where surface preparation is essential to product performance.

The films are available in all formats: disc, sheet or roll. The most common disc: 5in/127mm is packed per 25.

These Diamond Lapping Films are colour-coded to assist rapid identification.

The new Lapping Film 865X for final polishing also achieves lower cost per part with a great finish control in multiple uses, providing better value for superior performances.

It produces consistent fibre height and outstanding visual quality, helping finished connectors meet Telecordia GR-326 standards (> -55dB return loss). The polishing film offers upwards of 90% yield for multiple uses, reducing rework.

www.3M.com

PEAK LAUNCHES A NEW ESR ANALYSER – ATLAS ESR+

Buxton-based Peak Electronic Design Limited has launched a new ESR analyser – the Atlas ESR+ (Model ESR70), which offers several features that many hobbyists, technicians and engineers will find invaluable.

The most notable new feature is the inclusion of "Audible Alerts". Every measurement of ESR will be shown on the display as usual, but the unit will also produce a variety of tones depending on the value of ESR.

The ESR measurement range has also been enhanced, now doubled, measuring from 0 to 40 ohms with a resolution as low as 0.01 ohms. This fine resolution is great for assessing large capacitors and can help with the tracing of short circuits and finding the precise area of a PCB that has that invisible wisp of solder.

The original Peak Atlas ESR (ESR60) unit will continue to be manufactured by Peak and is available at a new special price of £75 inc VAT, while the new Peak Atlas ESR+ (ESR70) is available for £89 inc VAT. Peak charges just £2 for delivery in the UK.

Existing users of Atlas ESR (ESR60) can send get a hardware and software upgrade to the ESR70 features for £55 inc VAT.

www.peakelec.co.uk

RF AND SIGNAL CONTACTS HIGH RELIABILITY CONNECTORS

Originally commissioned for a petroleum company designing exploration equipment and described in a recent application note, the 38999 connector from leading hi-rel connector company, ITT Interconnect Solutions, delivers a consistently reliable interconnect for both RF and signal contacts. Designed according to the most stringent military requirements, defined by the MIL-DTL-38999 standard, the connectors are able to withstand extreme temperatures, high-levels of shock and vibration, corrosive agents as well as sand and dust.

ITT's 38999 connector meets MIL-DTL-38999 requirements Series I, II, III but also offers a variety of features that cater to many different industrial and commercial needs, such as blind mate, rear release snap-in crimp contacts and a choice of bayonet coupling or threaded coupling to facilitate quick and easy connect. Supporting up to 128 contacts, the connector features a low profile and low weight, has superior EMI shielding and is 100% scoop proof. Corrosion resistant shells of aluminum alloy with cadmium over nickel plating are able to withstand a 500-hour salt spry exposure.

Applications include avionics, military and commercial aircraft, satellites and industrial equipment. Special and custom capabilities can also be catered for and space grade connectors are available.

www.ittcannon.com

NO 'NASTY SHOCKS' WITH A REEPOL FLOOR!

When a static dissipative flooring solution was required for a large electronics factory in the UK, industrial flooring systems manufacturer Reepol was able to deliver the ideal floor for this very specialised environment.

Implementing its vast experience, Reepol provided its Reeflor EL300 AS Static Dissipative Floor for installation at the site. Developed for use in areas where a build up of static electricity may lead to damage of sensitive electrical equipment or even explosion of dust or solvents, Reeflor EL300 AS has been extensively favoured by many of the UK's leading electronics companies as it has been specifically produced, and extensively proven, to meet the very exacting requirements of the electronics industry.

Available in a choice of colours and formulated for ease of application, Reeflor EL300 AS provides a seamless finish, good chemical resistance and excellent resistance to heavy traffic. The efficient drying time enables foot traffic within 2 days at 100°C, helping to ensure that premises can be fully operational again at the earliest possible opportunity.

Paul McGarry of Reepol remarked, "Reeflor EL300 AS has been successfully installed within many locations where a static dissipative floor is a prerequisite. Its outstanding performance and reliability is testimony to the rigorous levels of research and development that we endorse across our range of industrial flooring products".

For details on Reepol's static dissipative flooring systems and for further information on its range of industrial flooring products, please contact Reepol on 01952 588575, or visit

www.reepol.com

NEW KEITHLEY MICROSITE OFFERS ACCESS TO INFORMATIVE PHOTOVOLTAIC MEASUREMENTS SEMINAR

Keithley Instruments has created an application-specific microsite for those responsible for characterizing solar and photovoltaic devices. "Simplify Your Solar CellTesting with Keithley's Precision Measurement Solutions" describes Keithley's high accuracy solutions for solar cell I-V and C-V characterization, which allow high speed testing without the hassles of integrating separate instruments or writing complicated programs. It also describes key solar cell parameters and measurement techniques.

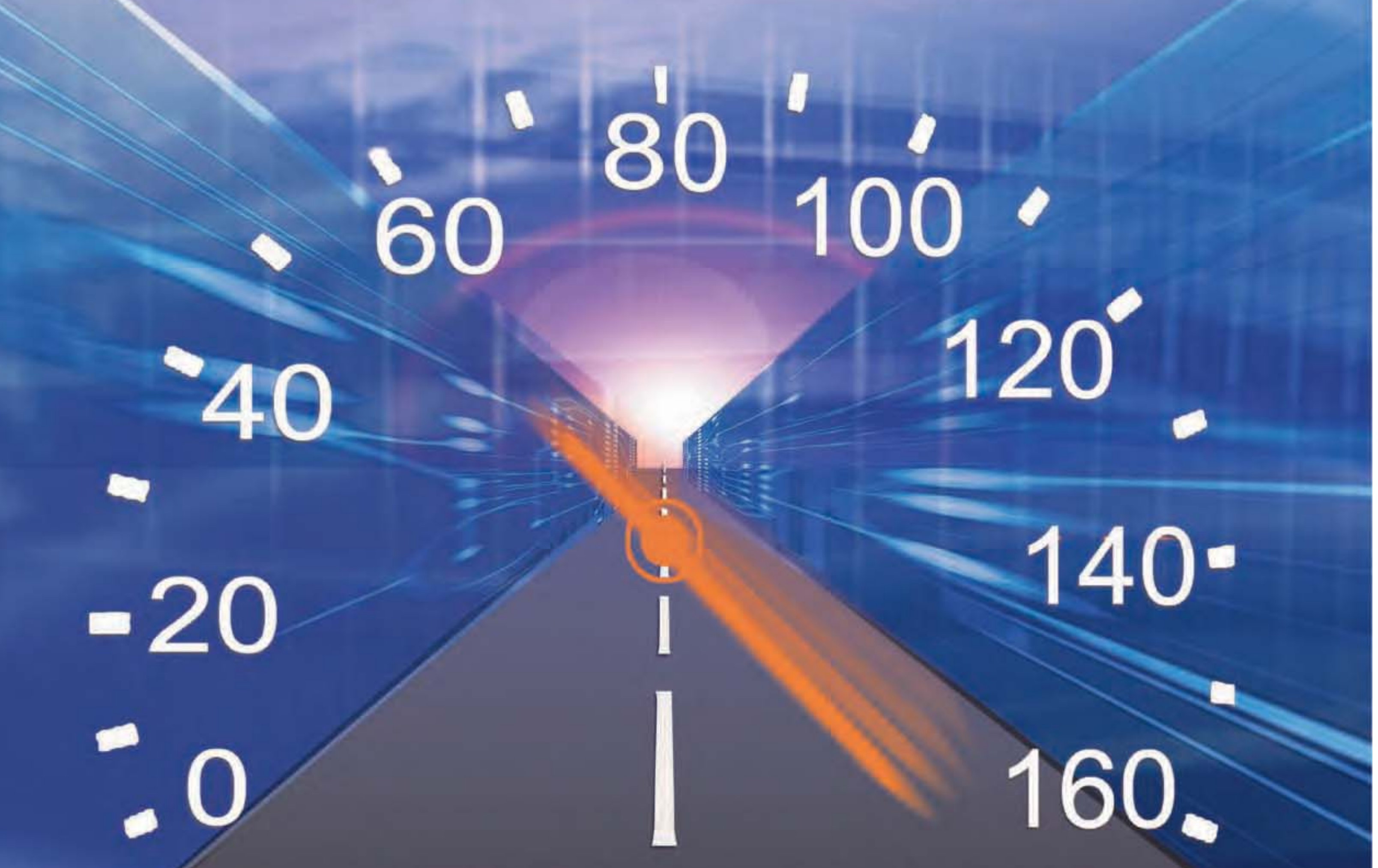
To visit this microsite, go to www.keithley.com/solar_cell.

The microsite offers access to a pre-recorded seminar titled "Photovoltaic Measurements: Testing the Electrical Properties of Today's Solar Cells". An online demonstration provides a high-level overview of how Keithley's ACS Basic Edition systems can be applied to solar cell characterization. Other Keithley solutions profiled include the Model 4200-SCS Semiconductor Characterization System, Model 2602A System SourceMeter Instrument and Model 2440 or Model 2425 SourceMeter Instruments. Microsite visitors can also request Keithley's solar cell test information kit.

Keithley Instruments offers customers around the world a variety of flexible solutions for current-voltage (I V), capacitance-voltage (C-V), and pulsed I-V measurements and analysis. Products range from benchtop instruments to turn-key systems and are used in applications as diverse as materials analysis, device characterization, wafer level reliability and process control monitoring.

Keithley works closely with semiconductor customers worldwide through its network of field service centers and application engineers with specific expertise in the area of semiconductor technology.

For more information on Keithley or any of its test solutions, visit www.keithley.com



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