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# ELECTRONICS WORLD

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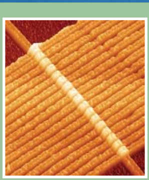

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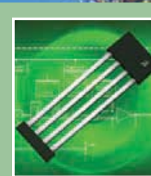

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# EMC GUIDANCE

Electromagnetic Interference (EMI) is widening its reach and EMC is beginning to affect a wider net of designers. Traditionally, EMI used to be primarily a concern for designers of industrial electronics, telecoms, military and computer equipment. Now, we are seeing a growing number of different consumer electronics devices too, where there are many complex and sensitive circuits.

The trend for shrinking of systems continues; analogue and digital circuits are finding themselves in ever closer proximity, which further increases the risk of equipment problems due to EMI. And the 2005 Electromagnetic Compatiblity (EMC) Directive, or 2004/108/EC states that "…Equipment shall be so designed and manufactured, having regard to the state of the art, as to ensure that the electromagnetic disturbance generated does not exceed the level above which radio and telecommunications equipment or other equipment cannot operate as intended".

Designers in the consumer sector are just the latest crowd having to think about EMI/EMC matters too. Even those concerned with LED lighting, as in order to maximise efficiency improvements that the LEDs offer, they must be driven from switching regulators – and where's switching there seems to be EMI.

But, the challenges for all designers remain the same. Unlike every other aspect of system design, there doesn't seem to be a sure-fire method of properly checking EMC on equipment that is being developed before it goes to the test house; EMC is always the last characteristic to be verified. This also means that the cost impact of a failure to meet the EMC requirements could be quite high. In addition, EMC test equipment can be rather expensive and its use can be confusingly complex. Nevertheless, it is desirable to carry out bench tests of the EMC of equipment which is being developed.

Although EMI remains tricky and EMC continues to challenge, in this issue of *Electronics World* we have presented a series of articles that should guide with many aspects of designing with EMI and EMC in mind. Definitions, testing, responsibilities of the designer, responsibilities of the test house, how to interpret results, due diligence and declaration of conformity are just some of the key matters being covered here.

There are also tips, ideas and methodologies as to how to best tackle the blights of EMI and EMC. And as any designer can tell you: "Every little helps."

**Svetlana Josifovska**
**Editor**


Check out Electronics World's new website by clicking on **www.electronicsworld.co.uk**

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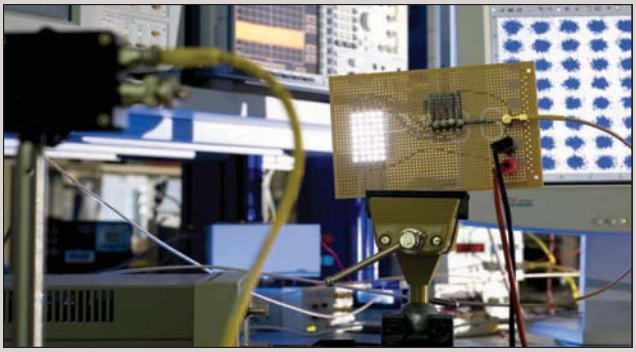
# SIEMENS IN 100MBIT/S VISIBLE LIGHT TRANSMISSION BREAKTHROUGH



*A new generation of LEDs could see visible light replacing radio waves as the transmitting medium for digital content around the house*

Researchers from Siemens have for the first time been able to use visible light to wirelessly transmit digital data at up to 100Mbit/s.

The experiment, which took place in Munich, Germany, saw an array of high-performance, white light-emitting diodes (LEDs) being used as the transmitting device.

Data was transferred across just over one meter. The transmission technique was based on simple variations of the light emitted by the LED. At the other end, a photo sensor that was used as the receiver converted the signals back into electrical pulses to allow the system to decode the information.

The scientists believe that visible light, a medium that has never been unused in the public domain, could one day offer a suitable alternative to radio-based communications. They particularly hope the technology could provide an answer to the expected bottlenecks that are likely to emerge in future home networks serviced by high-throughput fibre optic networks.

"The factor driving this research forward is the ever-increasing demand for bandwidth and flexibility in gigabit home networks, which will be needed for future Internet services," a Siemens statement said.

Although WLAN has enjoyed considerable success as a wireless home networking technology, the fact that it operates in licence-exempt radio frequency bands makes it susceptible to interference from various other sources commonly found in a household, such as microwave ovens, cordless phones or baby monitoring systems.

Using visible light as a data transmission method isn't a new idea, but the concept was deemed impractical using conventional lamps. However, researchers point out that the advent of a new generation of LEDs brings a series of advantages (such as longer operating life, mechanical robustness, low operating voltage and higher energy efficiency) that change this equation.

Omega, a research project involving a consortium of 20 European partners from industry and the scientific community, has been investigating the potential of the technology since January 2008. The group's current main goal is to increase achievable data transfer speeds via white LEDs.

In late 2007, Samsung led a movement looking to standardise visible light technologies. That work is now proceeding at the Institute of Electrical and Electronics Engineers, under the auspices of the IEEE 802.15 Working Group for personal area networks. A first version of the standard is expected to be released by the end of 2010.

# Microsoft cements web commitment with Live Mesh

Microsoft has launched Live Mesh, a new web service which connects different type of devices and applications on line.

Files and folders containing any type of documents, music, photos or video can be accessed via a web browser regardless of the device they reside on. This can be a PC, mobile phone, game console, MP3 player or other.

In addition, Live Mesh will enable sharing of these files online between users.

"This new software-plus-services platform enables PCs and other devices to come alive by making them aware of each other through the Internet," said Amit Mital from Microsoft.

Initially Microsoft is making the service available to Windows XP and Vista users, but will address other platforms, including Apple Macs, in the near future. Users will be given 5GB of personal online storage and unlimited peer-to-peer data for synchronising information between devices.

# Fuel cells tipped to power future Sat Nav gadgets


*The fuel cell-powered prototype is said to deliver three times the "battery" life of a conventional large-screen GPS*

An American start-up has showed a prototype of a GPS handheld device powered by fuel cells at an industry conference held in Atlanta earlier this year.

MTI MicroFuel Cells, a subsidiary of Mechanical Technology, unveiled the new embedded design at the 10th Annual International Small Fuel Cells Conference.

According to the company, its Mobion-powered GPS prototype provides three times more energy than GPS devices powered by four disposable AA batteries. On a model with a large, full-colour screen, the new fuel cell design generates up to 60 hours of continuous power, extending typical usage of these devices from days to weeks, according to the vendor.

The prototype includes a USB interface, which allows it to double up as an independent energy source for a variety of purposes, such as recharging mobile phones, digital cameras, portable media players and other handheld devices.

The GPS gadget can be easily recharged by refilling it with methanol.

"We are exploring the integration of our Mobion platform with GPS devices as part of our strategy to bring micro fuel cell technology to a wide range of portable consumer electronic device market segments," said Peng Lim, president and CEO of Mechanical Technology.

"Our Mobion powered GPS prototype will provide handheld GPS users such as hikers and campers, travellers, boaters, pilots and other sports enthusiasts the peace of mind of much longer usage time and will help them do away with the expense, bulk and environmental unfriendliness of conventional batteries," he added.

Before this can actually happen, though, the start-up will need to secure its first commercial deal to deploy its fuel cell technology with an original equipment manufacturer.

The GPS design is the second prototype MTI MicroFuel Cells has introduced this year. Earlier in February, the company had announced a Mobion-powered camera-grip attachment for digital SLR cameras, claimed to provide twice as much energy as existing battery pack camera-grips of the same size.

The company has also recently entered into a development agreement with an unnamed Japanese manufacturer of digital cameras to evaluate the feasibility of using the fuel cell technology in future products.

# IN BRIEF

**A free-to-view satellite television service from the BBC and ITV is being launched across the UK. Freesat is available to 98% of homes with a satellite dish. Unlike Freeview, Freesat can be received across the country, even in those areas that at the moment can't get access to free digital television. Freesat broadcasts 80 digital TV and radio channels including the main ones, and will rise to 200 by the end of 2008. It will also carry high-definition (HD) programmes.**

**Toshiba Europe launched an online game called 'Get The Disk' to promote the benefits of hard disk drives (HDDs). Over the past few years, high capacity, small form-factor HDDs have revolutionised the consumer electronics sector. Numerous devices including MP3 players, personal media players, compact digital camcorders, set-top boxes and gaming consoles have all used HDDs.**
**"Many people take hard disk drive technology for granted without realising the extent in which it has integrated into our lives," explained Martin Larsson, General Manager of Toshiba Europe. "Most of us have substantial collections of music, video and photos either on portable media players or PCs – none of which would have the capabilities to do so without the trusty HDD."**

**France has further shown its support for electronic nanotechnologies by launching one of the best research tax credits in Europe for the sector's R&D activities, so that 50% of R&D costs can be reimbursed during the first year. Philippe Favre, President of the 'Invest in France' Agency, said: "Microelectronics [in France] illustrates the continuing striving for innovation. R&D costs represent around 15% of turnover and production-line updates, to keep abreast of technological developments, represent an investment of around 20% of turnover."**
**This sector is already thriving in France, with many major firms and R&D centres well established there, including Minalogic in Grenoble (with LETI and STMicroelectronics) and System@tic, the Provence-Alpes-Côte d'Azur.**

- Industry analyst house Gartner says that the worldwide semiconductor market will grow 4.6% this year. The Egham, UK, based firm states that the worldwide semiconductor revenue is forecast to reach $286.5bn in 2008, up on 2007's revenue of $273.9bn.
Global sales of semiconductors were buoyed by healthy PC and mobile phone unit production. Gartner analysts said there have been no signs of a significant slowdown in the markets for digital consumer electronics products and automotive electronics, demand for which could be expected to be affected by cutbacks in discretionary spending by consumers.
Unit production for portable navigation devices has also been forecasted to go up.

- In May, in London, the E3 Academy was launched, an engineering industry initiative to encourage more students to choose engineering-related degree courses as the amount of graduates hits crisis point.
Richard Lambert, CBI Director-General, said: "I'm very pleased to welcome this kind of initiative which shows how businesses and universities can work together to meet the real needs of our economy. However, "the E3 Academy is not the solution but it is a start in the right direction", according to Lambert.
A recent CBI survey recently showed that that more than three quarters of engineering companies expect a shortfall in recruitment this year, leaving companies to seek staff outside the UK.

- Intellect, the UK technology trade association, recently reported that the technology industry is thriving despite the current credit crunch in the UK and that its importance to the local economy is growing.
Sean Finnan, President of Intellect, said: "The health of the UK technology sector is key to the country as a whole. Our industry by itself contributes 10% of UK GDP but its indirect contribution through other industries is much greater. Creating the conditions that make technology companies choose to invest in the UK is an important part of the economic success of the country."

# Memristors move from theory to reality

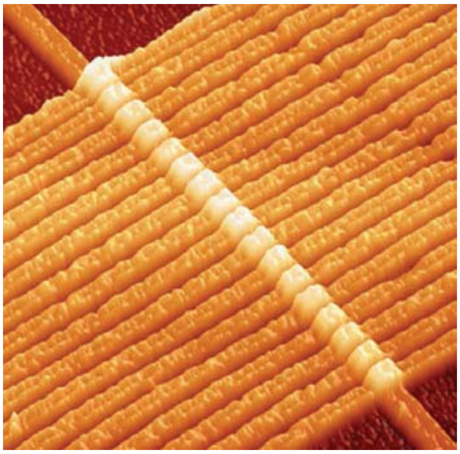


*Image of a circuit with 17 memristors captured by an atomic force microscope [Photo: Stanley Williams]*

The fourth fundamental circuit element in electrical engineering, which had been theorised for nearly four decades, has been proved to exist.

An academic paper published in 1971 by University of California scientist Leon Chua argued that, along with the resistor, capacitor and inductor, there was a fourth fundamental element of a passive circuit. He called it a memory resistor (or "memristor"), adding that it had properties that could not be duplicated by any combination of the other three elements.

Now, HP Labs researchers also based in California have developed a mathematical model and a physical example of such a device, which has the unique property of retaining a history of the information it has acquired. When voltage to the circuit is turned off, a memristor will still remember how much voltage was applied to it and for how long.

"To find something new and yet so fundamental in the mature field of electrical engineering is a big surprise, and one that has significant implications for the future of computer science," said the team's leading researcher and founding director of HP Labs's Information and Quantum Systems Lab, Stanley Williams.

"By providing a mathematical model for the physics of a memristor, HP Labs has made it possible for engineers to develop integrated circuit designs that could dramatically improve the performance and energy efficiency of PCs and data centres," he added.

One possible application could be the development of a new kind of computer memory that would supplement and eventually replace today's commonly used dynamic random access memory (DRAM). Computers using conventional DRAM lack the ability to retain information once they lose power. When power is restored to a DRAM-based computer, a slow, energy-consuming boot-up process is necessary to retrieve data from the magnetic disk.

In contrast, a memristor-based computer would retain its information after losing power and would not require the boot-up process, resulting in the consumption of less power and wasted time.

Another potential application of memristors could be the development of computer systems that remember and associate series of events in a manner similar to the way a human brain recognises patterns.

The researchers believe this could substantially improve today's facial recognition technology, enable security and privacy features that recognise a complex set of biometric features of an authorised person to access personal information, or even allow an appliance to learn from experience.

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| R&S SMG (0.1 – 1 GHz) Sig. Gen. | £1750 |
| Tektronix THS 720A 100MHz 2 Channel Hand-held Oscilloscope | £1250 |
| W&G PFJ 8 Error & Jitter Test Set | £4500 |
| Wayne Kerr AP 6050A Power Supply (60V – 50A) | £1850 |
| Wayne Kerr 3260A+3265A Precision Mag. An. with Bias Unit | £5500 |
| Wayne Kerr 3245 Precision Ind. Analyser | £1750 |
| Various other calibrators in stock. Call for stock / prices | |

# Home Networking 'Super-Standard' Buoyed by Chipmakers

*HomeGrid technology could soon be distributing video content around the home at speeds of nearly 1Gbit/s using existing power, phone or coax wires*

Intel, Infineon Technologies, Texas Instruments and Panasonic have formed an alliance that will work with the International Telecommunication Union (ITU) to create yet another standard for home networking technology.

Four different specifications currently coexist that aim to provide a standardised way of interconnecting a range of digital multimedia devices such as computers, DVD players, TVs, set-top boxes or digital video recorders. Wi-Fi (or IEEE 802.11) is the most commonly used, albeit mainly for whole-house broadband wireless access and printer sharing applications. The three other standards have each been designed to exploit the most common forms of wiring infrastructure already available in homes. These are power lines (standardised as HomePlug A/V), coax lines (Multimedia over Coax Alliance) and telephone lines (HomePNA 3.1, which also supports coax networking).

The HomeGrid Forum, as the new group has been named, insists it won't be competing with any of these industry alliances in particular. On the contrary, it will work towards creating a single MAC and PHY protocol for transporting multimedia across either power, coaxial or phone lines. Backward compatibility with existing specifications will be sought in those cases where practical considerations allow and make commercial sense, the group said.

"HomeGrid will allow consumers to 'plug-and-play' various consumer products without worrying about the interoperability and interface issues that they currently face," said Christian Wolff, senior vice president and general manager of Broadband Access with Infineon Technologies.

The Forum and the ITU-T G.hn working group aim to have a preliminary version of the standard ready before the end of this year, with the final specification not expected before September 2009. Consumer electronics products that successfully pass the certification process will be allowed to sport the HomeGrid logo to indicate compatibility with the standard.

"One of the industry's greatest opportunities is to define a next-generation home networking technology that can run on any wire, in any home, anywhere in the world," said Brendan Traw, chief technology officer of Intel's Digital Home Group.

"The growing number of products being networked in the home means that the technologies need to be compatible. With HomeGrid Forum, manufacturers and service providers will have a standard method to use house wiring to connect their products."

# Silicon chips finally bend to shape, thanks to new research

A team of US researchers has created flexible chips, which can be bent and stretched in two directions. The chips still consist of silicon, which is rigid, however they are being made in a 'sandwich' manner, where multiple materials are being bonded together at different depths.

The way the team has developed these devices is by using a polymer sheet that is bonded to the rigid silicon substrate with adhesive. The circuits are then built using conventional fabrication techniques. Following this, the adhesive is dissolved, allowing the circuits embedded on plastic sheet to be peeled away. After that, the sheet is bonded to pre-strained rubber, creating bendable silicon, which can even wrap around curved surfaces.

Even though the silicon's rigidity and brittleness are still there, the 'sandwiches' of multiple materials are used to form different components and their varied depth has also helped the ability of stretching in two different directions.

"You have to design the thicknesses of those materials in such a way that you put what is called the neutral mechanical plane so that it overlaps with the most brittle material [the silicon]. If you locate your circuits [on this plane], you can bend your overall system to a very tight radius of curvature, but your circuit doesn't experience any strain," said Professor John Rogers of the University of Illinois at Urbana-Champaign's team who created the material.

The researchers have already shown flexible transistors based on the new, bendy, material. The integrated circuits are only one and a half microns thick, which makes them some hundreds times thinner than conventional silicon circuits.

The corresponding paper has been presented in Science.

# REAPING WHAT HAS BEEN SOWN

**BY JOEL BAINERMAN**

The origins of the Israeli semiconductor industry are to be found in the strong microelectronic academic departments in Israel from the early 60s, which created skilled manpower that later emigrated to Silicon Valley, gained important experience and returned to Israel.

This was followed by the establishment of Motorola Israel, Intel and IBM Israel; you could say the three most important milestones in the Israeli semiconductor industry development.

Motorola Israel was established in 1964 and today employs 550 staff. It was the first large multinational company to open facilities in Israel. IBM Israel followed in 1972.

In 1974, Intel began operations in Israel when Dr Dov Frohman, an Israeli electric engineer who worked in Intel as a senior manager for many years, introduced Intel to Israel. Intel's entrance to Israel had many important effects on the local semiconductor industry. In the years that followed many talented young Israeli electronic engineers gained practical experience; young Israelis imitated them and got more motivated to study microelectronics, and other Israeli companies in the field got spill-off of human resources and technology. Equally, there was a rapid increase in demand for products and services of auxiliary industries of the semiconductor industry.

In 1974, Intel established a software design center in Haifa, its first R&D center outside North America. In 1979, the first mathematical processor, 8087, was developed at the Haifa R&D centre. In the wake of this achievement, Intel's CEO Andy Grove decided to establish production plants in Jerusalem and, then, in the mid-90s in Kiryat Gat.

In 1978 National Semiconductor established its first facility in Israel. In the mid 90s Vishay entered Israel. Vishay Israel is engaged in the manufacturing of passive components for the electronic industry. Today, the company has four plants there and some 3,300 employees.

In 1993, Tower Semiconductor established its first foundry in Israel. In 1999, it established a second foundry with mainstream 0.18 micron CMOS processing capability. The fab drew a wide range of local customers, largely fabless communications IC developers that had to go to Taiwan or Singapore for manufacturing support previously.


*Intel's Israel plant*

"THE PRESENCE OF ALL THESE COMPANIES IN ISRAEL HAS ALSO INSTIGATED A FLURRY OF INDIGENOUS FIRMS, PREDOMINANTLY FABLESS START-UPS, WHICH ARE COMING UP WITH WORLD FIRSTS IN TERMS OF TECHNOLOGIES AND PRODUCTS"

In mid-May, Tower Semiconductor acquired Jazz Technologies Inc at an equity value of approximately $40m and took over an undisclosed amount of debt. The deal was a surprise, as Tower was not considered a likely suitor to buy Jazz. Still, Tower and Jazz claim that they offer complementary technologies. The companies bring together Tower's strength in CMOS image sensor, non-volatile memory technologies and RF CMOS with Jazz's expertise in mixed signal, power management and RF.

Tower has also expanded its productions capabilities as Jazz has a fab in Newport Beach and has capacity agreements with various foundries in China. In total, the combined company offers capacity of approximately 750,000 8-inch wafer starts annually.

"The acquisition creates economies of scale, which allows for improved margins and strongly complements our specialty process offering, transforming us into the leading specialty pure-play foundry," said Tower's CEO, Russell Ellwanger.

The presence of all these companies in Israel has also instigated a flurry of indigenous firms, predominantly fabless start-ups, which are coming up with world firsts in terms of technologies and products.


*Amimon chip*

*Wisair's wireless solution*

# Survey of Israeli fabless chip start-ups

## TransChip

Late last year, Samsung paid $70m to acquire TransChip. It was Samsung's first acquisition in more than a decade. After the purchase it turned TransChip into the company's Israeli R&D centre.

Samsung bought TransChip to enhance its competitiveness in CMOS image sensors, which are incorporated into semiconductors used in digital cameras and cameras in mobile phones. Samsung manufactures the sensors.

TransChip is the first company to develop integrated digital camera solutions for capturing, processing and streaming high-quality digital video images with multimedia-enabled mobile devices. The flagship CoderCam product line features high-performance camera-on-a-chip solutions incorporating the latest digital imaging technologies and unique semiconductor design techniques, for achieving TV quality video with a single component. The core real-time capturing, colour processing and streaming compression technologies operate in sync to convert live video feed into highly compressed MPEG-4 in real time.

The single-chip solution offers a significant reduction in cost and power, as well as footprint, compared to competing multi-chip solutions for wireless video capture and compression.

## Siverge Networks

Siverge Networks is collaborating with IBM Microelectronics on the development and production of a convergence processor, codenamed Griffin. According to its CEO Yuval Berger, the chip will be sold to companies such as Alcatel-Lucent, Nokia-Siemens, Ericsson and ZTE.

Siverge has developed a unique engine core, enabling to process very high number of channels/ports/protocols with scalable bandwidth. Siverge will also use IBM development tools and sub-component libraries in the design of the dedicated ASIC chip that is claimed to support a large number of telecom interfaces, various communications speeds and a wide range of networking protocols. Berger believes that, in the next few years, two main needs in the networking space will appear: one is the need for much larger bandwidth and density, driven primary by the extensive use of video of all kinds. In practice, the ability of service providers to tackle this is very limited, since the costs of upgrading the networks are very high. As a result of that, bandwidth extensions are limited and incremental.

The second problem is the need to converge different protocols across the networking generations, while achieving true multiservice capabilities.

The company's chip is set to be the first processor that will solve both of the problems without compromising performance, which will be about 10 times higher than other available chips.

## Wisair

Wisair has developed a chipset solution for high performance wireless communications, based on the UWB (Ultra Wide Band) technology. Ultra Wide Band (UWB) is a technology with incomparable potential in terms of throughput, performance and low-cost implementation.

The uniqueness of UWB is that it transmits across extremely wide bandwidth of several GHz, around a low centre frequency, at very low power levels. This enables the unlicensed reuse of this valuable spectrum. Other indoor wireless technologies transmit across very narrow bandwidths of a few tens of MHz, using significantly higher power levels.

Wisair's UWB chipset enables low cost, low power and high bit-rate communication modules and system solutions for the fast emerging home/office connectivity for video/audio and data applications. This chipset will be installed in a wide variety of appliances such as DVDs, PDAs, TVs, camcorders, digital cameras and more.

Wisair offers a range of Wireless USB reference designs implementing Native Wireless USB and Wire Adapter protocols. These solutions use either USB or SDIO interfaces to enable a range of embedded and aftermarket Wireless USB products.

## Celeno Communications

Celeno Communications is developing components and subsystems for carrier-class WiFi systems and networks. The company's technology enables a new vision in home wireless networking by delivering high definition carrier-class multimedia content throughout the home. Its components provide the boost in throughput, coverage and QoS necessary to deliver multiple HDTV, SDTV, VoIP and data "triple play" services over the home network.

The core technology is based on spatial radio switching combined with adaptive channel coding, dynamic time-space scheduling and multimedia QoS optimisation. The technology targets applications requiring the highest level of system performance (capacity and reach), consistent carrier-class multimedia QoS and tight security protection.

The firm's marketing is focused on the triple-play revolution in home multimedia networking. The company's carrier-class solutions that enable service providers, e.g. telcos, cable and satellite operators, to quickly and simply deploy wireless home networks that can securely deliver multiple streams of high quality SDTV and HDTV video, VoIP and data content throughout the home.

Powered by its system on a chip (SoC) solution, next generation set-top boxes and multimedia home gateways will be able to function as the hub of the converged home network and distribute multiple streams of interference-free HD IPTV signals to multiple television sets. The same wireless network will also support VoIP WiFi handsets and provide connectivity to all 802.11 data devices, including laptops, PDAs and game consoles.

## Ethernity Networks

The company provides off-the-shelf Configurable Network Device (CND) providing superior solution versus off- the-shelf network processors. It has created a new class of Metro Access Flow Processors and offers a family of low cost, high performance Flow Processor/Traffic Manager solutions, optimised for the Metro Access Applications.

Ethernity Network's Flow Access Processor is based on technology that includes field proven wire speed pipeline architecture enabling the support of up to 20Gbps throughput. The platform includes L2/L3 switching, programmable L2 to L7 classification and header processing that supports different types of protocol headers, and comprehensive traffic management. The traffic management function includes MEF policing, rate estimation algorithms, GWRED for improved TCP performance, hierarchical QoS, and Scheduling and Traffic Shaping per logical output queue.

The company recently announced the PON OLT line card on a chip program, an effort designed to help system and semiconductor vendors to come up with a single chip solution for the entire PON OLT line card solution. The ENET architecture enables the support of a full PON OLT line card solution on a single FPGA.

## Asocs

The company recently launched its MP100, the world's first wireless MultiComm processor capable of running up to three wireless air interfaces concurrently.

The MP100 aims to meet two challenges: the ability to work with all communications networks without the need to provide a different processor for each network and the ability to run several applications simultaneously, such as GPS location, a phone call and a WiFi hook-up.

It is claimed that customers using Asocs's single-chip MultiComm processor can reduce the bill of materials (BOM) by up to 50% and reduce power consumption by as much as 70%, whilst supporting wireless standards such as GSM/EDGE/GPRS, WiFi, HD Mobile Digital TV, and GPS. The software reconfigurable ModemX core in the MP100 further enables handheld device manufacturers, OEMs and ODMs to move into the 4G era smoothly by developing software-based Super 3G, LTE and Mobile WiMax products.

CEO Gilad Garon says his company designed processor for those who want to provide applications – not communications, similar to what happened with the iPhone, where suddenly users were exposed to technology in which it wasn't the communications that was interesting, but rather the technology's uses.

The MP100 was developed by Asocs, in conjunction with Fujitsu Microelectronics, an LSI giant and advanced semiconductor process technologies. Fujitsu process technology coupled with Asocs patented technology, enables flexible interface with all major RF standards to form a complete wireless MultiComm system-on-a-chip.

Initially, the MP100 were produced by using Fujitsu's advanced shuttle service (SiExpress) enabling customers to begin Asocs's evaluation in the shortest possible time.

## Amimon

The company's revolutionary wireless video modem supports delivery of an uncompressed HDTV video stream with video data rates of up to 1.5Gbps, providing video quality that is equivalent to that achieved with a wired interface such as component video.

The technology enables a wireless link connecting flat panel plasma/LCD displays and multimedia projectors to various video sources such as digital set-top boxes and DVD players. Large screen plasma/LCD television displays represent a growing market expected to reach over 40 million units this year, driven by the high quality of these displays and their distinct space-saving designs. The attractiveness of these wall-hanging displays is reduced by the need to run audio and video cables across the room to the A/V sources. A wireless link can solve this problem and facilitate pain-free installation.

The Israeli company's solution is the only one which could provide a universal wireless HDTV link which could interface to all HDTV sources, including those provided through the most common HDTV interfaces: analogue component video and DVI/HDMI. All other wireless solutions do not support these uncompressed HDTV outputs since their bandwidth is a small fraction of that required to deliver the 1.5Gbps video rate, provided at the available decoded outputs of HD devices. ■

*Gary Nevison is chairman of the AFDEC RoHS team, and Customer Support Manager, Legislation and Environmental Affairs at Premier Farnell. As such he is our industry expert who will try and answer any questions that you might have relating to the issues of RoHS, WEEE and REACH. Your questions will be published together with Gary's answers in the following issues of Electronics World.*

# BATTERIES DIRECTIVE – PART 2

The European Union adopted the "Batteries Directive" (91/157/EEC) back in March 1991. This introduced restrictions on the use of mercury in most batteries and encouraged collection and recycling. However, the objectives of this Directive have not been achieved as most portable batteries are still being sent to landfill. As a result, the EU has introduced and adopted a new batteries directive (2006/66/EC) that will come into force on 26 September 2008 and replace the existing Directive. National legislation is also due by this date.

Here, in the second of a two-part look at the new directive, we consider issues such as substance restrictions, labelling requirements, battery removal and the impact the directive may have on future equipment design.

**Substance Restrictions**

The new batteries directive will restrict the use of mercury and cadmium in batteries. The mercury restriction is unchanged from the 1991 Battery Directive but the cadmium restriction is a new addition. The specific allowed levels will be:

– Mercury in batteries except button cells: a maximum of 0.0005% mercury by weight of battery.

– Mercury in button cells: a maximum of 2% mercury by weight of battery.

– Cadmium in batteries: a maximum of 0.002% cadmium by weight of battery but with three exemptions:

– Batteries used in emergency and alarm systems including emergency lighting.

– Batteries used in medical equipment.

– Batteries used in cordless power tools (this exclusion will be reviewed by September 2010 and may be subsequently withdrawn).

It is important to note that there is no restriction on lead in batteries but if present at > 0.004% by weight then the battery must be labelled with the 'Pb' symbol.

As the End-of-Life Vehicle (ELV) Directive pre-dates the new Battery Directive, the ELV substance restrictions should take precedence over those in the Battery Directive. The UK government's interpretation of this is that the concentrations of cadmium and mercury in automotive batteries would, in theory, be permitted to be higher than the Battery Directive's upper limits. However, in practice, lead-acid batteries are nearly always used and do not normally contain these metals.

**Battery Labelling Requirement**

The directive stipulates that batteries must be labelled; this is unless they are physically too small to accommodate a clear label, in which case the battery packaging should be labelled.

Specific labelling requirements are:

– Crossed wheelie bin symbol.

– The capacity of the battery will be (portable and automotive only) required from 26 September 2009 (harmonised rules for this should be available by 26 March 2009).

– "Hg" printed below the wheelie bin symbol if battery contains > 0.0005% mercury.

– "Cd" printed below the wheelie bin symbol if battery contains > 0.002% cadmium.

– "Pb" printed below the wheelie bin symbol if battery contains > 0.004% lead.

In addition to product labelling, there are also requirements to provide information to consumers on the potential effect of substances used in batteries on health and the environment, not disposing of batteries with other waste, details of collection and recycling schemes and an explanation of the symbols printed on the batteries.

Member States are likely to require producers, distributors and retailers to provide this information.

**Requirement for Easy Removal of Batteries from Equipment**

Article 11 of the new directive will affect the design of battery-powered electrical and electronic equipment in that it must be made in such a way as to allow batterier, either for replacement or at end-of-life for disposal, to be 'readily removed'. The term 'readily removed' is not defined; the EC has published brief draft guidance but this is of only limited assistance. Removal may be achieved either by hand or by using tools.

This requirement is clearly intended to ensure that equipment users are able to remove batteries by opening a cover by hand or after removal of a small number of screws. Lengthy dismantling procedures that take considerable time would not be permitted.

However, the boundary between what is and what is not acceptable is not defined and seems to rely on the common sense of equipment designers. The Directive also requires the producer to provide the user with instructions on how to safely remove the battery or batteries.

There are exemptions from this requirement where "for safety, performance, medical or data integrity reasons, continuity of power supply is necessary and requires a permanent connection". Under these circumstances, the battery can be built into the product so that its removal is difficult.

THE TERM 'READILY REMOVED' IS NOT DEFINED; THE EC HAS PUBLISHED BRIEF DRAFT GUIDANCE BUT THIS IS OF ONLY LIMITED ASSISTANCE

**Impact on Batteries and Equipment Design**

Many millions of batteries are used in the EU, with most of them being made in the Far East. The increase in substance restrictions and the requirement for labelling with Hg, Cd or Pb, if present, would imply that analysis might be expected if there is a risk of non-compliance.

The requirement to mark batteries with their capacity could have the effect of encouraging consumers to select higher capacity batteries resulting in a shift in the market. Capacity is not the only important characteristic of a battery, however, so consumers may need educating to understand their requirements.

The requirement for easy battery removal from equipment has, as mentioned earlier, so far not been defined. It could, in many cases, require equipment designs to be changed. Discussions on the definition are continuing but currently its interpretation is not clear.

The new directive does not include any spare parts exemption and, so, alternative types may have to be used to replace NiCd after these are banned. ■

*Please email your questions to:*
***svetlana.josifovska@stjohnpatrick.com***
*marking them as RoHS or WEEE.*

# DON'T WRITE OFF 2008!

**MALCOLM PENN**, CEO OF INDUSTRY ANALYST HOUSE FUTURE HORIZONS, SAYS THE SEMICONDUCTOR INDUSTRY IS IN GOOD SHAPE

Contrary to conventional wisdom, the sky is not yet falling in on the chip industry, despite the current rush to mark down the 2008 forecasts. It's granted that in February the IC unit growth was down 5.9% versus January, offset by a 4.2% growth in average selling prices (ASPs), with the net result a 1.9% value decline. This performance dramatically slowed the industry growth momentum and, if this was to translate into an underlying trend, the net result would be to decimate 2008's growth.

Seasoned industry veterans however, appreciate just how notoriously poor individual monthly numbers are at predicting underlying trends, especially in the notoriously poor seasonally weak first quarter. True to form, March's results saw monthly IC sales soar by 10.8% on a five-week month adjusted basis, driven by a 2.2% decline in units but a 13.3% increase in ASPs.

This resulted in an overall quarterly value decline of 5.9% versus the fourth quarter of 2007, driven by a 5.2% decline in units and a 0.7% decline in ASPs. The corresponding numbers for the first quarter of 2007 were a quarterly decline of 6.9% in value, driven by 0.8% decline in units and a 6.2% decline in ASPs.

The key point here is, not the apparent slowing in IC unit demand but the significant slowing in ASP decline. The fact that ASPs were essentially flat on Q4 is a clear vindication of our belief that the IC ASP trend has finally stopped falling. Hence, we are back to industry basics then: the economy, IC demand, capacity and IC ASP.

The global economy has clearly slowed dramatically from the past heady trends, but the current world outlook is still well in positive territory. Indeed, no economic forecaster is predicting a global world recession. The slowdown in the developed world economies is being offset by the continuing growth in the newly emerging regions, themselves now significant consumers of electronic products, as illustrated by firms such as Nokia and Intel which are growing their revenues the fastest.

Unless the world really does slip into recession, the current economic trends are more than enough to support a strong chip market. This in turn means a steady underlying IC unit demand, with the actual number dictated by any near-term inventory and mix adjustment effects.

Our current forecast for 2008 is a 10% annual growth in units, in line with the industry long-term industry average. This still looks to be a reasonable number and well within the forecast margin of error.

Over-capacity has been the industry Achilles's heel but, here too, the current trends are good, at least from a supply side perspective. CapEx is forecast to be down at least 10% in 2008 versus 2007, a trend that started in the middle of last year. It takes a year for these cutbacks to filter through the supply chain, but given the continued steady demand for units, capacity utilisation rates will only increase in 2008 and 2009.

Supply is already starting to become tight with 300mm utilisation rates at 98% in the first quarter of 2007 and sub-80nm at 95.6%. Given the fourth quarter is the weakest quarter for capacity – it represents Q1's sales, the fact these results were first, high in absolute terms, and secondly, an increase over Q3's results – the strongest quarter for capacity, these being Q4's sales, capacity is already starting to become an issue. It is the mainstream 200mm (160nm and above) market that reflects any remaining weakness, where utilisation rates are still in the mid-80 percent range. Given no one is investing here, natural demand growth will eventually resolve this issue too.

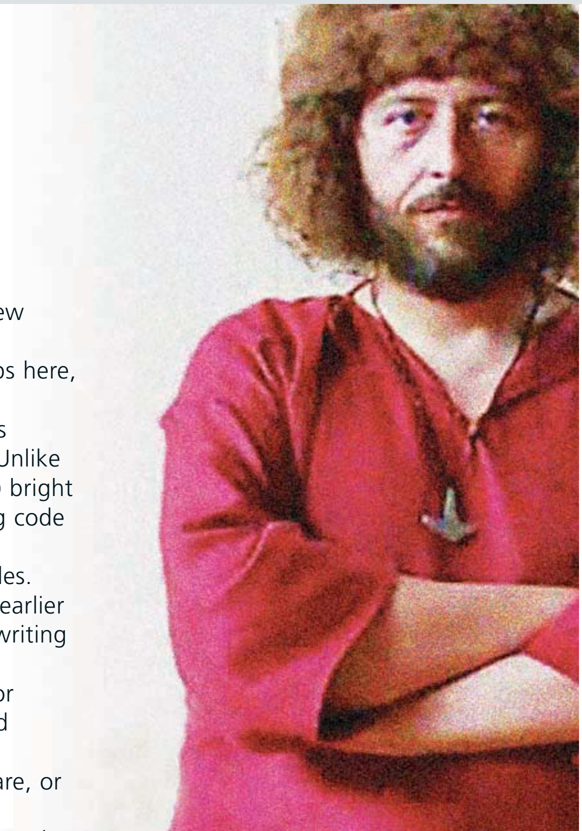
This leaves the final jigsaw piece – IC ASPs. These have been stubbornly refusing to recover since the 2005 crash, but even here the underlying trends are good. They are a complex mix of issues, driven by price declines at an individual device level (the classic industry learning curve trend), new device introductions (selling at a higher device cost than the parts they supersede), supply and demand issues (as with any economic business model) interspersed with price wars, as with memories and MPUs in 2006 and 2007.

You cannot, however, keep on doing more for less (you eventually go bankrupt) and even the strongest competitor cannot sustain a price war forever, which means that an underlying (structural) ASP recovery is inevitable. The only uncertainty is not 'if' but 'when'. It is our belief that the 'when' has now started which, from a yearly growth rate perspective, will be very good news indeed.

It is time, therefore, to get back to basics and stop agonising over the month-on-month numbers. The chip industry has nowhere near run out of steam with the real challenge – as always – of how to deliver new world-class products to market. And if the world were to crash into a global economic recession, the chip market would surely collapse, but from a position of relative structural strength not weakness. ■

**Unless the world really does slip into recession, the current economic trends are more than enough to support a strong chip market**

# EASY, OR DIFFICULT?



by Myk Dormer

Like many engineers, I have frequently been frustrated by the expectations of managers, or rather, those responsible for time scales. Frequently they want to know the exact completion time of an as-yet-undefined task, or they have assumed a prohibitively long period for the completion of a relatively simple task – usually prior to arguing for the cancellation of a valuable project.

But, considering the other side of the fence, it must sometimes seem paradoxical that some tasks take months, while others are finished in apparently a lunch hour.

THERE IS A LOW OF DIMINISHING RETURNS WHEN ATTEMPTING TO OPTIMISE – OR RATHER MINIMISE – A CIRCUIT. THE FIRST PENNY IS EASY TO SAVE. THE LAST ONE WILL TAKE MONTHS

There are coherent reasons for this, which I intend to try to explain:

**• Things which make a job harder:**

- *Unfamiliar territory*: Anything totally new to us, even apparently simple things, can contain pitfalls only apparent after mistakes have been made, and time has been spent making them. That can reach as far as requiring multiple iterations of a PCB design.

Unfamiliarity also matters in the processor: if the software writer knows the chosen CPU, then the work will go much smoother than if a whole new architecture has to be digested. (Transportable high level code helps here, in theory, but rarely in practice.)

- *Software*: The more code that's written fresh, the longer it takes. Unlike circuit design, where a (successful) bright idea can save weeks, when writing code there is no substitute for endless, labourious, write/program/test cycles.

Re-using modules of code from earlier (similar) projects will help, as will writing the code in a high level language, assuming no critical timing loops or signal processing are required. And despite the fact that almost every engineer dabbles in writing software, or has done, a dedicated software professional will do the job better, and faster, than any enthusiast.

- *Financial pressure*. There is a difference between competent design (which has a lowest cost consistent with good practice by default) and an absolute shaved down, bare bones, design. By cutting back everything to a minimum, the opportunity for flaws to manifest increases, and the amount of testing required actually increases.

There is a low of diminishing returns when attempting to optimise – or rather minimise – a circuit. The first penny is easy to save. The last one will take months.

- *"Science"*. If something needs a piece of mathematical understanding, or the invention of something out of the ordinary, it is no surprise that it takes longer. The less admitted aspect of this is that there is no guarantee that a usable solution will ever be found, just a better chance per hour spent.

- *Haste*: Ironically, trying to hurry a job causes errors, which, in turn, cause extra work.

**• Things which make a job easier:**

- *Familiarity*: An engineer working in an area he is used to, at frequencies he is comfortable with, will work much faster than someone working on the edge of their abilities, even though that's much more interesting and exciting for the engineer and looks better on his CV.

- *Space*: The more room on the PCB, the quicker a usable layout can be drafted and the less need for possibly risky bits of layout, so the greater the chance that it will work first time.

- *Specification*: A more complete spec results in less redesign cycles and less wasted effort in misunderstandings. On the other hand, this must be balanced against the gains that can result from a less stringent spec, which gives the engineer more options and requires less complexity.

- *Re-use of design*. A radio that incorporates 80% of an existing, proven design will obviously contain less risk, less work and less effort than a totally new design. But, it won't be entirely without risk, as even an experienced designer can be caught out sometimes.

- *Re-use of parts*. Once the engineer gets to know a PA part, a synth, a micro or similar, the subsequent designs will build on existing experience. Hopefully the same *mistakes* won't be re-used.

- *Use radio modules*. A carrier board using an already proven radio module is (comparatively) very easy to design and test.

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

# A WORLD OF SHIELDING CHOICES FOR CONSUMER ELECTRONICS EQUIPMENT

**DAVID INMAN** TEST SERVICES BUSINESS UNIT MANAGER, AND **BILLY SHEEDY**, ELASTOMERS BUSINESS UNIT MANAGER AT THE CHOMERICS DIVISION OF THE PARKER HANNIFIN CORPORATION GIVE ADVICE TO DESIGNERS IN THE CONSUMER SECTOR OF THE METHODS AND MATERIALS AVAILABLE TO SHIELD AGAINST ELECTROMAGNETIC INTERFERENCE

Electromagnetic Interference (EMI) and shielding against it was primarily a concern and challenge for designers of industrial electronics and telecoms and computer equipment. Now, with the huge growth and diversity in consumer electronics, coupled to the trend for such equipment to contain large amounts of complex, often sensitive, circuitry to support high levels of functionality, designers in the consumer sector need to pay more attention to shielding matters.

Domestic mains-powered equipment such as televisions, DVD players and games consoles typically house analogue and digital circuitry in very close proximity, which heightens the risk of equipment malfunction due to EMI. Sensitive digital electronics components and circuits are susceptible to spurious signals from external sources if not effectively screened. It is also the case that emissions from analogue circuits can affect, not only sensitive components in the same enclosure, but other, separate, pieces of equipment nearby too. Understanding EMI and how to implement counter-measures is an often neglected but very important aspect of consumer electronics equipment design.

Selecting the most appropriate EMI shielding material requires knowledge of both electronic and mechanical engineering. Shear forces, environmental effects, compression set, method of application and pricing are some of the major factors that influencing the choice of shielding material for a given application. For design engineers who do not deal with EMI shielding on a regular basis, getting to grips with the latest materials and their use can be difficult and time consuming unless help and guidance is sought from specialist shielding material manufacturers and EMC/safety testing service providers.

In 2005, the North American consumer and communications electronics comprised 27% of a $375bn total US electronics market. With the availability of rapidly evolving, compelling and affordable personal electronics devices such as MP3 players, gaming consoles, cameras, video equipment, laptop computers, GPS and handheld digital devices, this share of the total available market (TAM) is set to increase rapidly. Furthermore, consumers are replacing their old, cathode ray tube TVs with flat panel LCD and plasma screens at a remarkably fast rate.

### Electronics Designer's Application Needs

In recent years, significant advances by companies such as Parker Chomerics in blending polymers with electrically conductive particles has resulted in the availability of a much wider choice of EMI shielding materials. The choice and diversity of materials means that engineers need not make as many design compromises and can be fairly sure that a material exists to perform the exact function required. At the same time, the choice of materials can be perplexing to designers for whom EMI shielding design and material selection is not an area in which they often work.

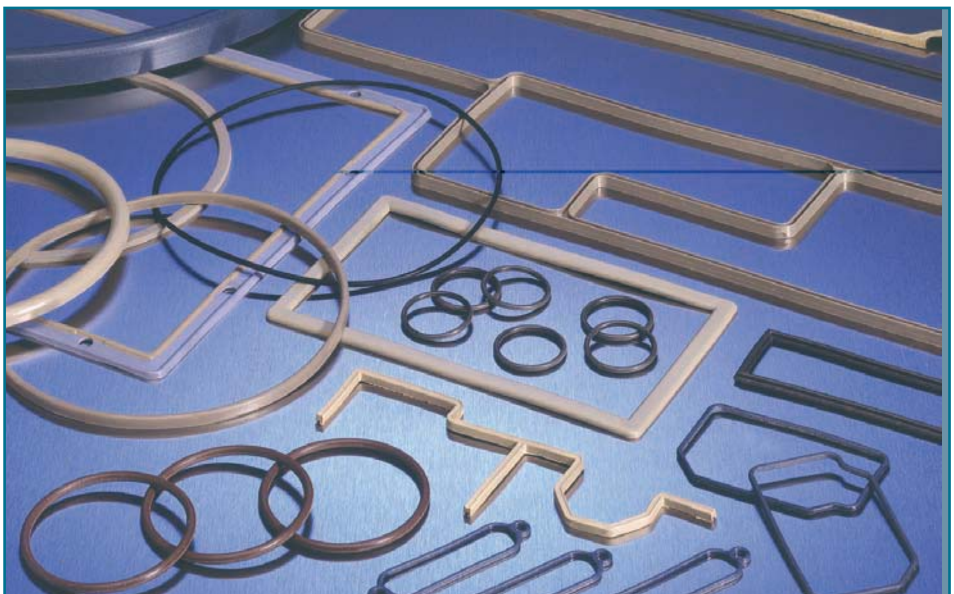


***Figure 1:*** *Moulded elastomer gaskets*

***Figure 2:*** *Soft-Shield 4800 is a conductive Z-axis 'multi-planar' soft foam EMI gasket*

***Figure 3:*** *Fingerstock combines high levels of EMI shielding and low closure forces*

Most consumer electronics applications have several areas that require some form of EMI shielding. Designers need to give thought to several factors when selecting the best material for their application; these include the degree of shielding performance (attenuation) required (measured in dB), mechanical considerations such as assembly closure forces and tolerance build-up, physical aspects (for example the material may be exposed to high shear or compressive forces), environmental factors such as exposure to moisture and humidity, and perhaps resistance to extreme heat, including flames. Consideration should also be given to ease of manufacture and assembly – this is most important for devices produced in high volume.

**Material Choices**

Shielding materials can be broken into several groups:

**a) Moulded and extruded elastomers**

An environmental seal with shielding properties can be achieved by combining an elastomer, usually silicone, with a conductive filler such as nickel/graphite. The even dispersion of the conductive filler within the elastomer ensures uniform physical and electrical performance.

Using this blended material almost any finished shape can be achieved. Processes that may be used include moulding, extrusion and die-cutting. Overmoulding the material onto plastic or metal components is also possible. This provides a one-piece shielded housing that can simplify assembly and reduce inventory.

Although other elastomers are sometimes used, silicone is usually the material of choice due to its ability to compress at low closure forces and its excellent compression set performance across wide temperature ranges. Shielding effectiveness in the region of 80dB from 100MHz to 10GHz can be achieved using these types of materials. Supplied with hollow sections, conductive elastomers require even lower forces in order for them to be compressed and have larger deflection ranges. This makes them ideally suited for use in applications such as door sealing, where it is often difficult or inconvenient to generate high closure forces and where there may be significant tolerance build-ups.

**b) Foam-based gaskets**

A more recent development has seen the emergence of so-called wrapped foam gaskets. These materials are ideal for providing economical shielding in high volume applications. Typical uses include door, faceplate and backplane shielding/sealing. The construction of these materials consists of a conductive nickel-plated nylon material wrapped around and bonded to a soft urethane foam core. Shielding effectiveness of around 95dB between 20MHz and 10GHz can be achieved, and closure forces required are typically less than 0.175N/mm. Such low closure forces make foam-based shielding materials suitable for applications where component flexing is a concern such as in thin-walled plastic enclosures.

Foam core gaskets don't offer the same design flexibility as moulded elastomer parts in terms of the profiles that can be achieved, however they are available in a significant number of popular profiles such as rectangles, P, C and D-shapes, as well as cut parts from sheet. A low-tack pressure-sensitive adhesive on one side can help

***Figure 4:*** *System timings to be considered for MibADC synchronisation signals*

simplify and improve the accuracy and repeatability of assembly.

'Multi-planar' conductive Z-axis foam EMI gaskets are one of the latest innovations in soft foam-based EMI shielding technology. The integration of electrically-conductive fibres into low density foam provides a highly effective yet cost-effective EMI shielding solution. Manufactured in rolls and easily converted into product forms applicable for I/O panels, backplanes, connectors and access panels along with rectangular/square strip gasket seals, this material provides high Z-axis conductivity with extremely short ground paths.

For indoor consumer electronic devices, the choice of EMI gaskets will often come down to either fingerstock or fabric-over-foam. Fingerstock has, until recently, been the gasket of choice – especially in high-end electronics. It is reliable, proven and widely available. However, fabric-over foam is quickly becoming the preferred choice, due to improvements in the plating adhesion, advances in foam formulations and the introduction of flame retardant versions. They are also easier to handle and less prone to damage during assembly and use.

**c) Metal gaskets**

Despite having been on the market for many years, metal gaskets are still important and are used in many applications, especially in rack-mounted equipment where individual circuits may need to be periodically slid in and out.

Beryllium copper fingerstock combines high levels of EMI shielding with 'spring-finger wiping' and low closure forces. The material's high tensile strength and excellent electrical conductivity make it ideal for shielding over a wide frequency range. Strips are available in a wide variety of cross-sections to suit different applications. For low compression grounding contacts, individual fingers with pressure sensitive adhesive (PSA) for convenient peel-and-stick placement can be used. Despite excellent electrical conductivity, other factors such as the dimension and number of slots in fingerstock and contact area in an assembly can negatively affect final shielding performance when installed. Where this is the case, other approaches that perhaps use conductive elastomers may provide a better solution.

For non-dynamic applications that demand good shielding performance but don't need environmental sealing, other metal gaskets such as PCB card cages, connector and panel shields, and knitted wire mesh can be used.

**d) Combination gaskets**

Other types of EMI gaskets are available that use a mix of non-conductive foams or elastomers combined with a mesh or metal gasket. These mixed media gaskets are usually custom made. Other gaskets in this category include silicone sheets with oriented wires and mesh impregnated with neoprene or silicone elastomer. Although these can provide excellent environmental as well as EMI shielding, they need considerable closure forces to do so.

**e) Conductive plastics**

Injection moulded plastics that incorporate EMI shielding provide an elegant, versatile and assembly-friendly solution. They can be used to provide housings for printed circuit board assemblies and allow for value-added details, such as internal compartments and integrated fasteners. With their ability to provide an economic solution for many high volume appliance applications, conductive plastics overcome the need for secondary operations, reduce weight and can cut costs by up to 50% compared to die castings, formed metal, machined extrusions and plated plastic parts.

Chomerics Premier plastic shielding materials, for example, use a blend of polycarbonate and ABS engineered for stable electrical, mechanical and physical performance. Using a proprietary process the base material is filled with long fibres of nickel-plated carbon; the process ensures dense dispersion, random orientation and full engagement of the fibers to yield optimum shielding performance.

**f) Adhesives, inks and coatings**

These materials are not suited to high volume production unless an automated application process is used to speed throughput and improve repeatability. Conductive adhesives are typically used to bond other conductive materials such as EMI vents, windows, mesh gaskets, or for filling cracks and seams. Conductive coatings and inks can provide EMI shielding, anti-static protection, corona shielding and surface grounding in a wide range of applications. They can be applied to plastic surfaces by painting or for higher volumes, by using conventional spraying equipment.

**g) Conductive windows**

Stainless steel is often used for wire mesh in optical shielded windows, combining high light transmission with high shielding. Lower mesh counts and thinner wire diameter provide higher light transmittance; while higher mesh counts and thicker wire diameter provides better EMI attenuation. Copper may also be used and provides high shielding effectiveness at lower cost that stainless steel.

Plastic using transparent conductive coated films such as indium-tin-oxide (ITO) or multilayer conductive coatings has some significant benefits as it combines high visible light transmission, uniform electrical conductivity and excellent environmental stability. Also, there is no matrix of wires to interfere with the display, which is a major problem of stainless steel and copper meshes described above. However, its level of shielding and consistency of attenuation is not as good as wire mesh.

## Compliance Test Standards

Consumer electronic equipment falls under a wide range of global test standards. The primary markets driving test standards are the US, Canada and Europe (CE Mark). Other market areas can subsequently be reviewed, such as Japan, Taiwan, Australia/New Zealand, etc. For the purpose of this section, major appliances and electric tools are not considered consumer electronics.

Typically, the further along a product is in development, the more extensive, difficult and costly the changes necessary to correct compliance issues. There are two separate critical paths for safety and EMI/EMC certification compliance programs.

For EMI/EMC, the primary test standards for consumer electronics are for information technology equipment (ITE) and audio/video equipment. The Federal Communications Commission (FCC Part 15) and Industry Canada (ICES 003) regulate the radiated and conducted emissions for this type of equipment in the United States and Canada, respectively. In Europe, radiated and conducted emissions are regulated by EN55022 for information technology equipment and EN55013 for sound and television broadcast receivers and associated equipment.

The CE Mark in Europe also regulates the immunity requirements for consumer electronics. Information technology requirements for IT equipment fall within EN55024. Sound and television broadcast receivers and associated equipment falls under the Immunity requirements of EN55020. Both of these "Product Family Standards" provide test levels and methods for immunity tests covering electrostatic discharge (ESD), radiated immunity, conducted transient immunity, conducted surge immunity, conducted RF immunity, magnetic field immunity and voltage fluctuation/dip immunity. There are a number of revisions and amendments to some of these standards.

In Europe, two other test standards exist for the control of power line harmonics and flicker. The standards for power line harmonics EN61000-3-2 (IEC61000-3-2) and flicker EN61000-3-3 IEC61000-3-3) have wide applicability and are also required for CE marking.

For EMI/EMC, the first item on the critical path is to have a test run for radiated and conducted emissions. Once a device meets these requirements, the remaining tests typically fall into place with minor or no issues. These recommendations are for devices and/or systems which already exist. If a device is still in the design phase, it is still best to have a paper review done with regard to the same aspects.

For safety compliance, consumer electronic equipment follows the requirements of UL60950-1 in the United States and CSA22.2 No 60950-1 in Canada for IT equipment. Consumer audio/video equipment follows the requirements of UL6500 in the United States and CSA C22.2 #1 and C22.2 No. 60065 in Canada. In Europe, EN60950-1 (IEC60950-1) is for information technology equipment (ITE), and audio/video equipment follows the requirements of EN60065 for CE Marking to the low voltage directive. In all cases, the standards review both a product's electrical and mechanical safety.

The primary item for safety compliance in the critical path is to have a construction review performed on your design. This should be completed by a qualified safety engineer familiar with the standards and requirements and should centre on the materials used to build the device and the critical safety components. ■

# MEETING MILITARY REQUIREMENTS FOR EMI AND TRANSIENT VOLTAGE SPIKE SUPPRESSION

**DR GLENN SKUTT**, VICE PRESIDENT OF TECHNOLOGY AT VPT INC, THE AMERICAN-BASED SUPPLIER OF DC-DC CONVERTERS, EMI FILTERS AND CUSTOM ENGINEERING SERVICES FOR AVIONICS, MILITARY AND SPACE APPLICATIONS, LOOKS AT THE PROBLEMS EMI POSES TO MILITARY SYSTEMS DESIGNERS


Military and aerospace engineers face several challenges with respect to electromagnetic interference (EMI) and transient voltage compliance. The standards developed by the various military organisations are much more stringent than comparable standards in commercial applications, and test limits and methods often differ.

The purpose of an EMI standard is to prevent problems that can arise when electronic noise from one piece of equipment adversely effects the operation of other equipment. Lack of proper EMI control can result in noise interference, such as unwanted noise in communication and computing equipment, as well as false triggering and faulty readings in sensor circuits.

In addition to noise signals that can cause interference, the normal operation of equipment can result in significant voltage transients that appear on equipment input terminals. These transient voltages are specified by military standards and are tailored to the specific environments encountered by different classes of equipment. For example, land-based equipment can have different requirements from airborne equipment.

One challenge often faced by military systems designers is how to address EMI and transient performance in a timely fashion with equipment that is designed to meet the most stringent requirements imposed by the end customer. But before tackling the problem of EMI, it is important to have a full understanding of what exactly it is.

**Electromagnetic Interference**

Electromagnetic interference (EMI) can be divided into four main classifications: conducted emission; conducted susceptibility; radiated emission; and radiated susceptibility.

Conducted noise is transmitted along the electrical cables that connect the input power bus to the equipment, while radiated interference occurs through the unintended transmission or reception of noise signals. EMI emission standards address noise generated by the equipment, whereas EMI susceptibility standards describe the noise environments

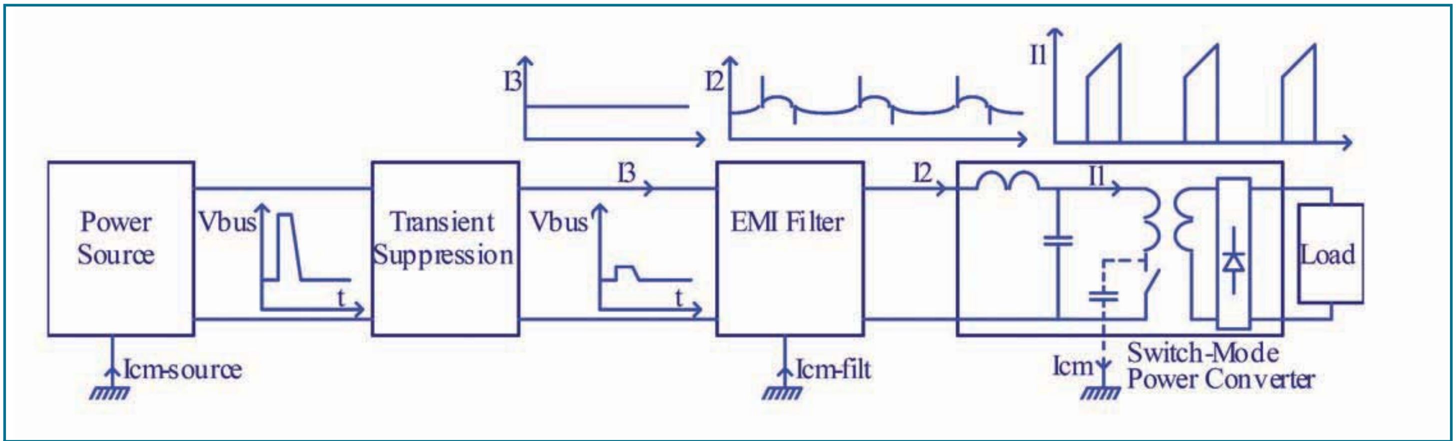



***Figure 1:** Effect of the EMI Filter and Transient Suppression Functions*

that the equipment must tolerate without malfunction.

From a design perspective, conducted emissions are further divided into common-mode and differential-mode noise. Differential-mode conducted noise is a result of currents flowing into one terminal of the converter and out of the other, which is the normal current flow in the circuit. Common-mode current, on the other hand, flows through the chassis ground and returns in the same direction in both the power and return lines. Differential-mode current is generally associated with switching currents in the power converter, whereas the common-mode currents are primarily a result of pulsating voltages in the circuit.

EMI compliance requires the system to meet standards for all of types of conducted and radiated interference. When one considers the function of an EMI filter, however, it is usually with respect to how well the filter prevents the equipment emissions from reaching the main power distribution system. The diagram in **Figure 1** shows a typical SMPS supplied load, along with an external EMI filter and transient suppression circuit. The SMPS switching current, I1, is attenuated by both the built-in and external filters.

The input current of the SMPS, I2, is primarily DC with a specified ripple current component. The ripple component of this current along with the higher frequency spikes are further attenuated by the EMI filter such that the current drawn from the power bus, I3, is essentially DC. While I3 still has a small AC component to it, the filter must be designed to ensure that this AC component is below the level specified in the applicable standard. This attenuation of the switching current to a DC level is a measure of the differential-mode performance of the filter.

The common-mode effectiveness of the EMI filter is determined by the reduction in the generated common-mode current, Icm, that passes through the source, Icm-source. An effective EMI filter must keep the combined common-mode and differential-mode current in the power source leads below specified levels.

**Transient Suppression**

While EMI filtering is used to attenuate the electrical noise that results from the normal operation of electronic equipment, transient voltage suppression addresses the need to survive infrequent or intermittent disturbances that occur on the power distribution bus. Such power disturbances are caused by the switching of large motors, engine starting, load transients, etc.

They are classified as one of three main types: voltage ripple;

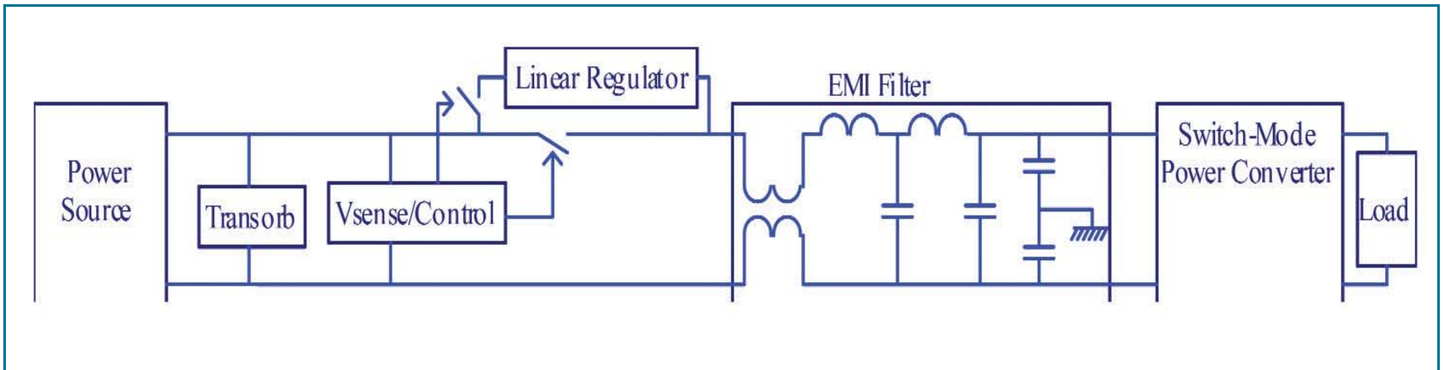



***Figure 2:** Transient Protection and EMI Filter Discrete Solution Block Diagram*

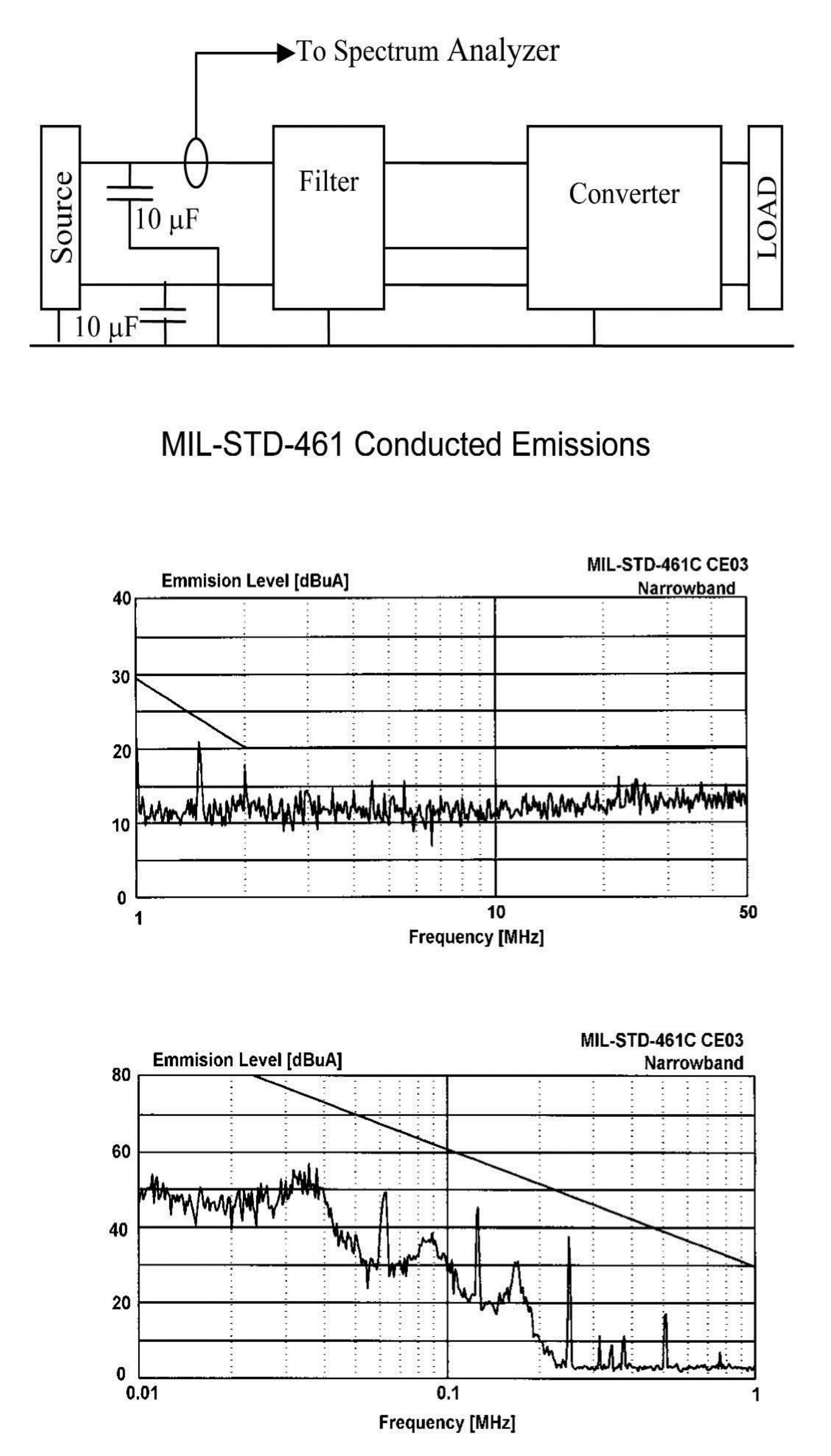



***Figure 3:*** *MIL-STD-461C DV200-2812D With DVMN28 EMI Filter*

voltage surges; and voltage spikes.

Voltage ripple refers to the variation of the input voltage about a nominal DC input voltage. Surges result from load transients on the power distribution bus and generally last on the order of several milliseconds to 100ms. Spikes, on the other hand, are generally caused by the switching of reactive loads, which induces relatively high-frequency, high-voltage oscillations that last for less than 5ms.

The role of a transient suppression circuit is to protect the EMI filter and, in turn, the downstream circuitry from damage due to such transients. The diagram in **Figure 2** shows an input bus voltage, Vbus, with an input surge superimposed on the nominal DC level. The transient suppressor clamps the input voltage to a level that is safe for the EMI filter and downstream converter, shown as Vbus in the diagram above. In this way, the transient suppression function is similar to the EMI filter's susceptibility function: they both protect the load equipment from disturbances that originate on the power distribution bus.

## EMI and Transient Suppression Standards

Both EMI and transient suppression are addressed by a number of standards issued by different organisations around the world. For EMI compliance these include the MIL-STD-461 EMI/EMC standard for the US military, RTCA DO-160D for civilian aircraft, and DEF STAN 59-41 for United Kingdom Ministry of Defence applications. Standards that address transients and bus characteristics include MIL-STD-704, MIL-STD-1275, DO-160, and DEF STAN 61-5.

In light of the many standards that apply to EMI compliance and transient suppression, there is good reason to approach the design of a power system by meeting the strictest of these standards wherever possible. Such a "design once, deploy worldwide" approach maximises the return on development costs and allows for designs that can meet a wider range of end applications. For example, a design that meets MIL-STD-704A specifications for input voltage bus characteristics will usually meet all requirements up to MIL-STD-704E.

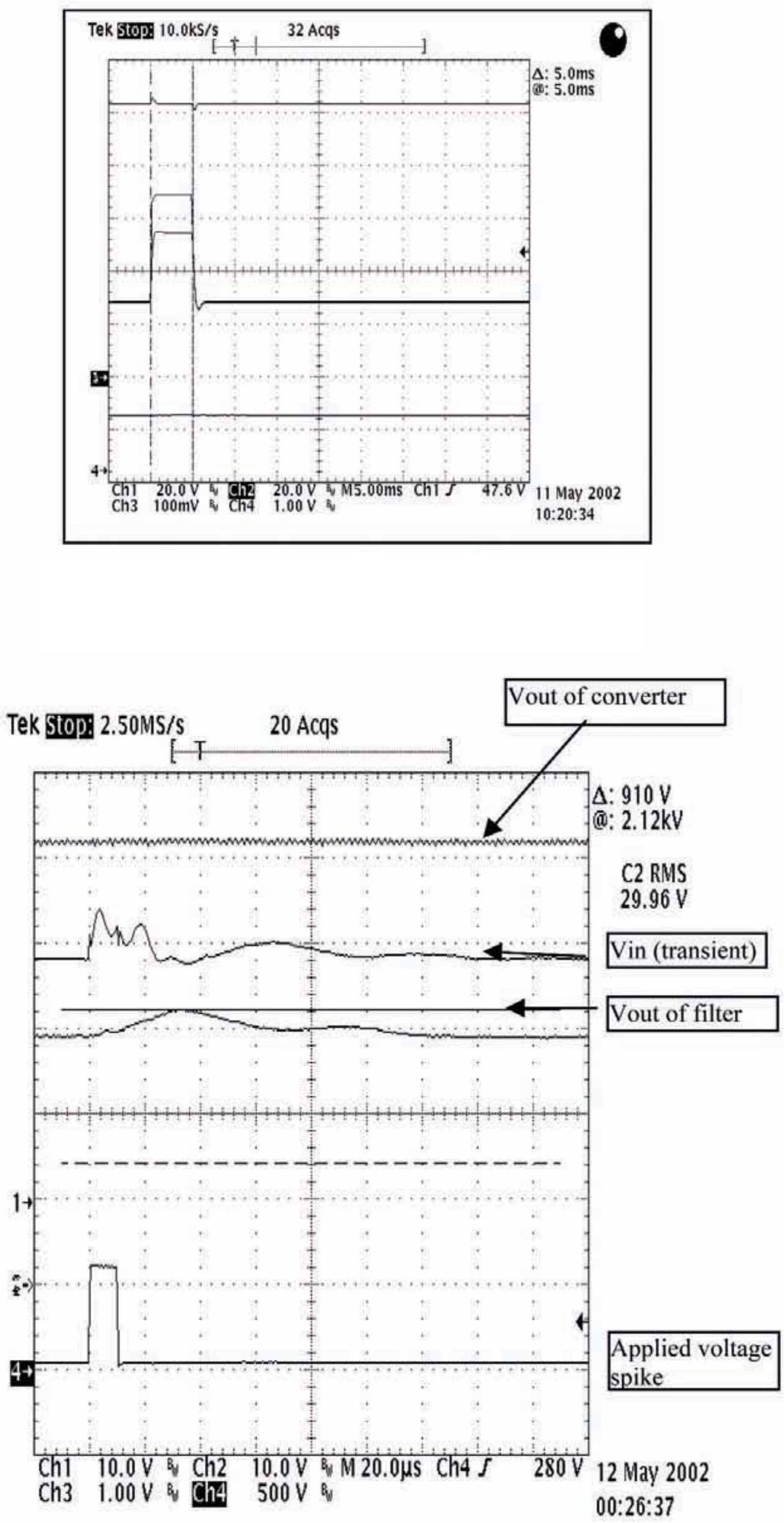



***Figure 4:*** *Transient Performance of a Packaged DVMN28 EMI Filter/Transient Suppression Module with DV200-2812D Converter*

### Discrete EMI/Transient Suppression Systems

The diagram in **Figure 3** shows the basics of a discrete system for transient suppression and EMI filtering. The specific requirements of the different standards must be addressed through the design of each section of the system. The diagram in **Figure 4** shows how the functional blocks of the first diagram can be implemented in a typical power system.

The transient suppression function uses a linear regulation function that is switched into the circuit when the input voltage exceeds a particular value. When the linear regulator is functioning, the output of the transient suppression circuit is clamped at a regulated value and the difference between the input voltage and the clamp voltage is dropped across the series pass element of the linear regulator.

Since the power drawn from the source is assumed constant, the dissipation in the linear regulator can be quite high, and this limits the duration of the input transient that can be blocked by the transient protection module. In order to protect the transient protection module, either the input voltage must be limited in time and amplitude or the load must be shut down.

The specific performance requirements of the transient specification will dictate the size and power ratings of the transient linear regulator. The transorb element shown in the front of the transient protection circuit protects the circuitry from short duration, limited energy spikes. The transorb voltage must be low enough to provide adequate protection from high-voltage spikes, but must not be so low that longer duration overvoltage conditions damage the transorb itself.

The EMI filter is generally composed of several stages of LC filtering, as well as capacitance from each rail to chassis ground. The LC stages provide differential-mode filtering while the input common-mode choke and output common-mode capacitors determine the filter's common-mode filter performance. The transient protection circuitry is placed in front of the EMI filter. In this way the EMI filter components are protected from the input transient spikes and surges and the EMI filter can be designed to filter the specific load requirement.

# TACKLING THE EMI PROBLEM

**KEVIN BROOKS,** PRODUCT MANAGER AT APC HI-REL, ADVANCED POWER COMPONENTS'S SPECIALIST HIGH-RELIABILITY DIVISION AND THE SOLE UK AND IRELAND DISTRIBUTOR OF VPT PRODUCTS, OFFERS ADVICE ON KEY FACTORS TO CONSIDER WHEN DESIGNING EMI AND TRANSIENT SUPPRESSION SOLUTIONS

**1. Where will the design be used?**

When designing a successful EMI and transient suppression system, one of the key considerations from the outset should be the specific needs of the end market that the product will serve. A design for the European market, for example, will probably take a different approach from one intended for the US or Asia.

Whilst most of the EMI and transient standards have similar roots, it is always best to work directly with the specifications for the target market to ensure full compliance. It is also worth noting that the military market is different from the commercial market in that specific performance criteria can vary from project to project. This adds another level of difficulty in that some projects may, for example, require circuitry to operate through particular surge voltages, whereas others will allow equipment to shut down and recover for the same input condition.

Solutions that meet as many of the performance standards as possible result in hardware that can be used in a variety of locations worldwide. The designer must realise, however, that a design that meets the requirements of many different specifications is usually over-designed and, therefore, more expensive, larger and heavier for some applications. As such it is necessary to trade off the overall performance of a system with the specifics of each application and the schedule requirements of the project.

**2. How are EMI and transient voltage tests performed?**

One of the main aims of the various EMI and transient voltage standards is to establish a common technique for the measurement and characterisation of EMI performance, ensuring that EMI characteristics can be reproduced from one test lab to another. However, while test conditions are designed to simulate the actual installation environment, the correlation between results in the test lab and those in the field is often difficult to establish.

A further complication is that not all standards measure the same characteristic in the same way. For example, MIL-STD-461C measures input conducted emissions using a current probe and states the emissions in terms of dBµA, whereas MIL-STD-461E uses an input line impedance stabilisation network (LISN) and measures noise in terms of dBµV.

DEF-STAN 59-41, on the other hand, uses a current probe and specifies the emission levels in terms of dBµA, like 461C, but also uses an input LISN like that used in 461E. For this reason, it is necessary to determine the test method used to state the emission levels.

**3. Are packaged solutions available that meet your needs?**

Meeting the various EMI and transient suppression requirements issued by the different worldwide agencies involves a considerable amount of work and is often accomplished by designing bespoke solutions.

However, packaged filter solutions that are designed to operate with specific power converters can significantly reduce the time and cost required to achieve a compliant system. In addition, the packaged filter solution can be procured as a single unit, thereby reducing parts count and simplifying the qualification process.

The performance of packaged solutions can generally be determined ahead of time and this can increase confidence that a given solution will work for a particular application. The diagrams in **Figures 3** and **4** show the conducted EMI and transient performance of VPT's DVMN EMI filter/transient suppression module (available in the UK and Ireland exclusively through APC Hi-Rel). This type of information is generally available from module vendors for a variety of application conditions. In addition, application notes and application specific information are available to assist in the use of the packaged filter module for specific situations not covered by the standard datasheet. ■

# POWER SUPPLIES AND CONDUCTED EMISSIONS – 10 QUESTIONS ANSWERED

WHAT EMC CONSIDERATIONS SHOULD AN ENGINEER TAKE INTO ACCOUNT WHEN DESIGNING IN A POWER SUPPLY? **STUART NOTTAGE** AND **ROB HUTTON** OF LAMBDA UK GIVE THEIR ADVICE


*Power supplies have their own EMC issues*

**1. How would you best define EMC and how does it apply to power supplies?**

EMC, or electromagnetic compatibility, is the ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances into that environment. Essentially, EMC can be spit into two: emissions and immunity.

Emissions deals with the electromagnetic energy produced by equipment in operation. When these emissions are transmitted through conducting structures (cables, PCB traces, etc) they are considered as conducted emissions. When these emissions are transmitted through open space as electromagnetic waves, they are considered as radiated emissions. These emissions are often called Radio Frequency Interference (RFI).

Where power supplies are concerned, the main source of RFI is the switching devices – generally FETs, the field-effect transistors. The fundamental switching frequency (usually between 50kHz and 300kHz) and harmonics of this cause the predominant conducted emissions and the speed of the switching edges (usually between 200ns to < 1ns) is the dominant source of radiated emissions.

**2. What is the intent of the EMC directive with regard to conducted emissions?**

Directive 2004/108/EC, commonly called "The EMC Directive", is available to download from the Official Journal of the European Commission and came into force on 20th January 2005.

The essential requirements of the EMC directive with regard to conducted emissions state that "…equipment shall be so designed and manufactured, having regard to the state of the art, as to ensure that the electromagnetic disturbance generated does not exceed the level above which radio and telecommunications equipment or other equipment cannot operate as intended".

There is a presumption of conformity that if the requirements of the relevant product standard are met, the essential requirements of the EMC directive are also met. This is not always the case as the test configuration used to claim compliance may not always be chosen (knowingly or unknowingly) to provide the worst case results – this will be covered later.

**3. What standards must be considered for the EMC directive?**

The conducted emissions test standard CISPR16-2-1 specifies the test equipment and the way it is set up, method, frequency range and limits. Specific product standards, where they exist, may specify different methods, frequency ranges and limits, or use part or all of the test standard.

In order to CE-mark a power supply to the EMC directive, the minimum requirements are stipulated in the product standard EN61204-3 – no other standard is required. However, due to the diversity of power supply applications, it is prudent to have considered the requirements of other relevant product standards such as EN55011 and EN55022, as well as the generic standards EN61000-6-3 and EN61000-6-4.

**4. How do you select the correct classification of pass?**

Most conducted emissions standards specify two classes of pass to allow the manufacturer to cover different intended operating environments. Class A is the least stringent and is intended for commercial and light industrial environments (factories, hospitals, office premises, etc). Class B is more stringent, for domestic and residential environments, or for Class A conditions when the domestic mains supply is shared.

The power supply standard IEC/EN61204-3 provides guidance on which classification is required for a particular environment. It is also prudent to consider the guidance given in the product standard for the end application.

**5. What steps must be taken in order to set up the correct test configuration?**

It is the responsibility of the manufacturer to demonstrate that reasonable steps have been taken to ensure that the test configurations producing worst case results have been identified.

Generally most applications can be simulated by two different test configurations:

**a) The power supply and loads mounted on an earthed metallic sheet.**

In tests, Lambda has shown that this configuration produces similar results as with a power supply and loads mounted in an earthed-screened metallic enclosure. This configuration simulates end applications where either a partially or fully metallic enclosure is used.

**b) The power supply and loads free standing with no additional connection to earth.**

This configuration simulates end applications where either a non-metallic enclosure or no enclosure is used.

Experience, with certain power supply topologies, has shown that the emissions can increase over time as the power supply reaches its operating temperature. In some cases, this may take up to one hour, therefore, it may be prudent to allow a warm up time prior to testing in order to simulate worst case results.

**6. What are the responsibilities of the test house and how best to deal with them?**

The test house is responsible for ensuring that the test method is correct and the test equipment is fit for purpose. It is not the responsibility of the test house to ensure that the product under test is configured to produce worst case results. The test house will configure the product as advised by the manufacturer.

This may lead to a test house producing a report that does not show worst case results but shows the product meeting the requirements of the relevant standard/s. This, however, does not necessarily mean the product will meet the essential requirements of the EMC directive when the power supply is used in its intended application.

**7. What are the key elements to understanding reports, results and margin?**

Care must be taken when reviewing EMC reports for conducted emissions that all the necessary information is included:

- Setup information, preferably with a photograph, in enough detail to replicate the test.
- Details of test parameters: IF (input frequency) bandwidth, measurement times, input lines measured.
- Load conditions.
- Line voltage and frequency.
- Dated references to test standards used.

Further information on how to review an EMC test report is available on the Lambda website at: **www.lambda-gb.com.**

It's a fine line between marginal pass and marginal fail – the test standards require that with 80% confidence, 80% of product will pass the limit. This is often called the 80/80 margin. As with all statistical distributions, this has the consequence that some power supplies can have reduced margin or, in certain circumstances, even fail the limit and yet still be compliant with the requirements.

However, most engineers will always insist that 100% of product shipped meets the published specification. When designing power supplies, Lambda stipulates a 3dB minimum margin to meet the conducted emissions limits; this ensures the statistical chance of individual power supplies failing due to manufacturing tolerances is minimal.

**8. Due diligence – what is it, when should it be applied and by whom?**

When power supply products are not CE-marked to the EMC directive, it is the responsibility of the end equipment manufacturer to exercise due diligence. If the PSU product is CE-marked to the EMC directive, it is the responsibility of the organisation that places the product on the market in Europe to exercise due diligence.

For products manufactured inside the European Community (EC) it is the responsibility of the manufacturer to be able to demonstrate due diligence in their testing of the product. For products manufactured outside of the European Community the responsibility lies with the reseller to be able to demonstrate they have exercised due diligence in confirming the test results and reports provided by the manufacturer are correct. And, be warned, it is not due diligence to just accept results and reports from outside of the European Community at face value.

The path to exercising good due diligence is not that easy to follow, however some frequent-use examples are:

- Checking the test report covers relevant standards and contains clear and appropriate information.
- Repeating conducted emissions testing to confirm results detailed in the test report.
- Ensuring that test methods used are appropriate for worst case.
- Visiting the manufacturer and their test facilities/partner.

**9. Declarations of conformity – what are they?**

As stated previously in Question 8, it is the responsibility of either the manufacturer, if located in the European Community (EC), or the reseller, if the manufacturer is outside the EC, to raise and sign a Declaration of Conformity (D of C).

This is a legally binding document and as a minimum should contain:

- The name and address of the manufacturer.
- The name and address of the organisation selling the product in the EC, if the manufacturer is outside it.
- An unambiguous product description.
- A reference to the current EMC directive, correct when the D of C was raised.
- A statement of compliance to the EMC directive.
- A reference to the product standard used for compliance testing. In the case of power supplies this is EN61204-3.
- The identity and signature of the person empowered to bind the manufacturer or his authorised representative (EC based).

Additionally, it is common to find references to the generic EMC standards – EN61000-6-X, other product standards such as EN55011 and EN55022 and individual test standards such as EN61000-3-X and EN61000-4-X. Whilst listing these is not mandatory, care should be taken to ensure that the provisions of all listed standards have been complied with. This information should be available in the test report.

## References:

http://eurlex.europa.eu/LexUriServ/site/en/oj/2004/l_390/l_39020041231en00240037.pdf

Full due diligence would cover other aspects of EMC testing, but for the purpose of this article, only conducted emissions have been considered.

**10. Is there additional support and knowledge available?**

Even after comprehensive testing there is still a risk that applications in the real world can present EMC problems. The additional testing carried out by Lambda based on experience and knowledge of real-life applications can include such tests as: off load, low load, grounded output and effects of temperature. This is in addition to the requirement Lambda seeks for additional margin to minimise this risk. As well as conducted emissions, its support and knowledge also covers other aspects of EMC testing. ■

# INTELLIGENT VEHICLE LIGHT MANAGEMENT

**ADRIAN WONG**, SYSTEMS ENGINEER, AND **SILVESTRO RUSSO**, SYSTEMS APPLICATION ENGINEER, BOTH AT ZETEX SEMICONDUCTORS, EXPLORE THE EMC ISSUES ASSOCIATED WITH HYSTERETIC LED CONTROLLERS, WITH A FURTHER DISCUSSION ON TOPOLOGY, PWM DIMMING AND FREQUENCY SHIFT CONSIDERATIONS

The use of LEDs in a wide range of lighting applications is rapidly increasing. In order to maximise the efficiency improvements that the LEDs offer they must be driven from switching regulators rather than power-hungry linear circuits.

One of the most versatile inductive switching topologies is the hysteretic converter. To ensure these converters are used effectively in a fully EMC-compliant manner their limitations must be understood.

This article explores the EMC issues associated with hysteretic LED controllers. The topology is discussed, along with PWM dimming and frequency shift considerations. The EMC standards to be met and two illumination examples are explained to show how to effectively design an EMC compliant solution for an MR16 replacement lamp and an automotive interior light.

**Hysteretic Converters in High Brightness LED Control**

The hysteretic converter is a switching topology that can be used in buck, boost or buck-boost configurations. Its inherent stability makes it particularly suitable for step-down LED driving applications.

The most important part of the topology, as highlighted in **Figure 1**, is a comparator with a predetermined hysteresis that defines the LED current control. The current in the LED is measured with a resistor and ramps up and down to the limits set by the comparator, with the limits being a trade-off between measurement accuracy/noise immunity and efficiency. Hysteretic converters are, however, always running in continuous mode, which means the inductor never saturates or is completely drained of current. This inherent stability means hysteretic controllers operate over a wide input and output voltage range. They do not require compensation with external components and are not limited to duty cycle ranges as with many PWM topologies.

The key parameters in a self-oscillating hysteretic converter are the frequency of oscillation, the duty cycle and the propagation delay between sensing and switching phase. These affect the accuracy, the power management and the EMI performances of the system. The EMI performance of a hysteretic converter is particularly dependant on the frequency of oscillation that is influenced by many factors, inductor choice being the most important. Since hysteretic converters are self-oscillating, this means the frequency will vary due to input voltage, LED current and the number of LEDs being driven.

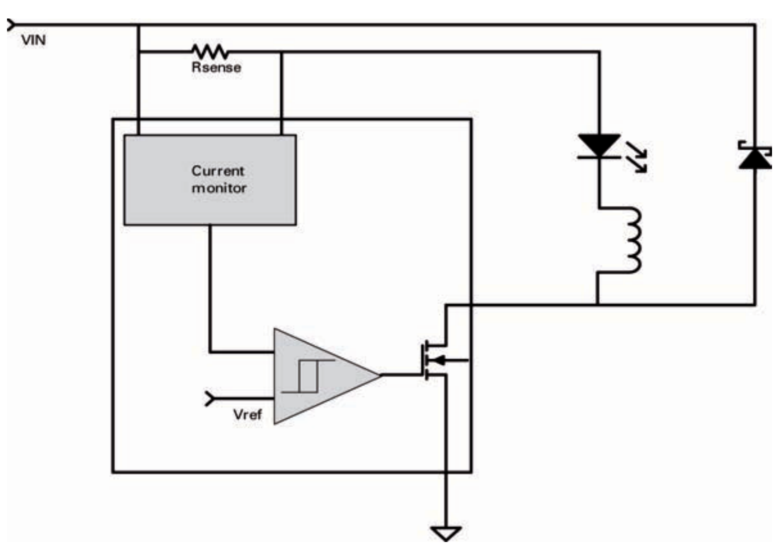



***Figure 1:*** *Hysteretic converter, basic step-down configuration*

**EMC in Hysteretic Converters**

The size, stability and frequency of oscillation of hysteretic converters have a significant impact on the performance of the illumination system. Understanding this fact helps in the selection and usage of the best technique to improve system EMC performance.

The hysteretic converter topology allows a significant reduction in component count compared to other topologies, making system design more compact and shortening tracks between switching element, inductor and load. Shorter PCB tracks mean smaller parasitic inductance and capacitance, resulting in reduced electromagnetic emission and improved

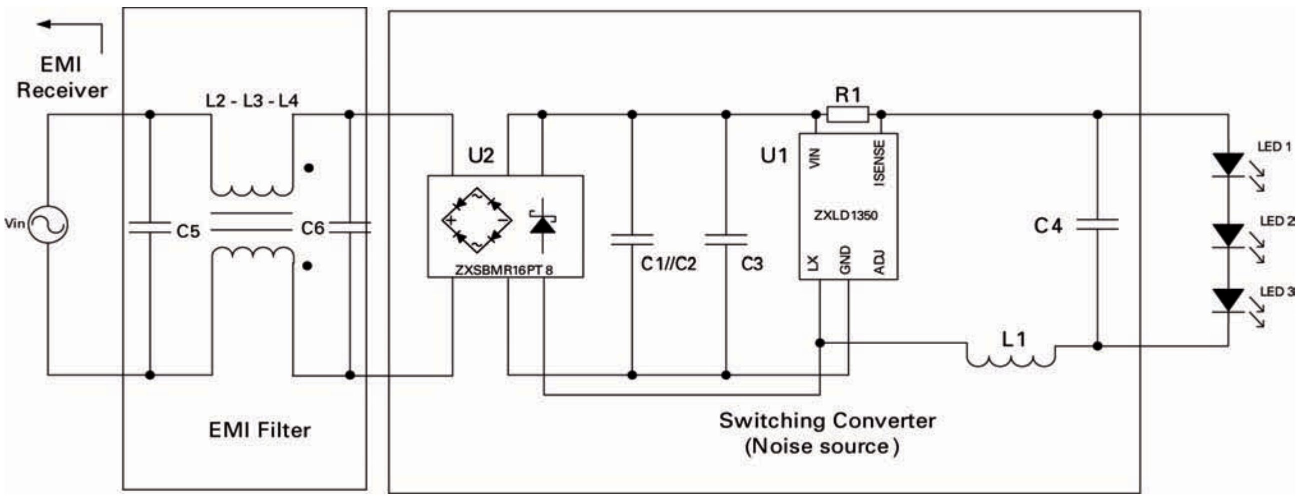



***Figure 2:** System diagram of ZXLD1350 MR16 lamp solution with EMI filter*

immunity. Moreover, the hysteretic converter is inherently stable, which means that it does not require external compensation, which makes it robust and RF immune.

Finally, radiated and conducted emissions are very dependent on the fundamental switching frequency. The peak EMI energy is concentrated at the switching frequency. As the hysteretic converter is a variable frequency technique it is possible to avoid the problems of fixed frequency topologies such as PWM controllers by avoiding persistent energy pulses.

The best techniques to cope with EMI issues in hysteretic converters are the usual improvements in layout design, filtering and shielding. This topic will be covered in the application examples provided here later, with two specific examples that have quite different requirements: general LED lighting and automotive LED lighting.

Among the methods used to reduce EMI impact, the dithering technique has emerged as one of the most promising. The dithering technique consists of sequentially varying and shifting the frequency of the switcher from 10% to 20% of the nominal value, to spread the energy among a wider bandwidth, reducing the likelihood of having a persistent peak of energy at a given frequency (and hence failing to meet the specific EMC requirements). The use of dithering has to be done carefully though to ensure that it does not impact on optical performance.

Hysteretic converters do not allow an exact definition of operating frequency since this depends on a set of parameters rather than an individual one; this suggests that the frequency shift technique is not easily implemented on a hysteretic topology. Nonetheless, some techniques are emerging to limit the spread of the oscillation frequency in order to simplify the filter design. Moreover, hysteretic converters show an inherent advantage when an AC input supply is used, as in the case of MR16 lighting, because the 100Hz input voltage ripple spreads the switching frequency up to ±90% of the nominal value, simplifying the EMI filter design, as will be shown in the application example.

However, care must be taken if low frequency PWM (typically 100Hz to 300Hz) is being used to control brightness. Spreading the frequency among several drivers to reduce EMI could interfere with the PWM dimming signal accuracy and possibly create beating effects, leading eventually to stroboscopic effects in extreme cases or even audible noise.

**EMC Standards and Requirements**

EMC requirements are set to specific international standards and they can be categorised in terms of conducted emissions, ESD susceptibility, radiated emissions and immunity. Generally speaking, the applicable EMC standards for CE marking of general lighting equipment in domestic and residential environments are shown in **Table 1**.

Note that for the US market, the applicable requirements for general lighting are stipulated in FCC part 15 and part 18. For automotive lighting applications, the EMC standards become vehicle manufacturer specific with various test limits and test frequency ranges. **Table 2** presents a *"Generic Automotive Tier 1 Supplier EMC Test Standard"* summary that is essentially derived from consideration of most of the larger vehicle manufacturer EMC standards.

The tests cover the supply of electrical products to a vehicle manufacturer only and do not extend to whole vehicle testing, which remains exclusively the domain of the vehicle manufacturer.

**LED-Based MR16 EMC Solution**

In MR16 lamp applications, the hysteretic converter is preferable to the fixed frequency PWM converter because of the lower component count. Moreover, its lower switching frequency minimises the radiated emissions. Furthermore, an EMI filter along with frequency dithering is adequate to meet EMC emission requirements. The simplicity and ruggedness improves immunity.

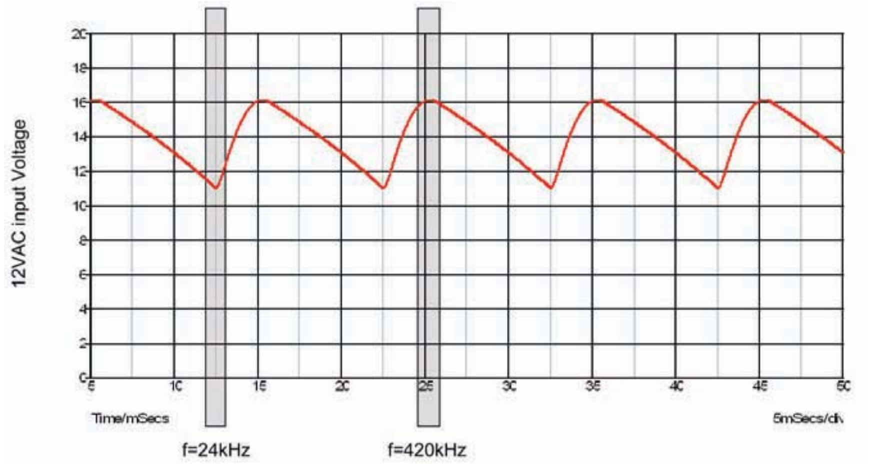



***Figure 3:** Switching frequency variation with 12VAC input voltage*

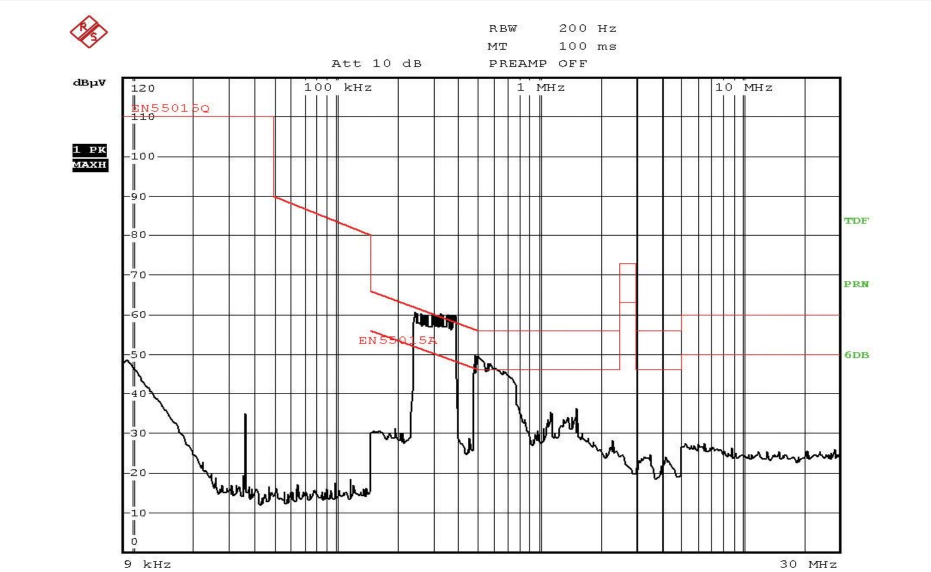



***Figure 4:** Conducted EMI scan*

The basic circuit with the proposed modifications is shown in **Figure 2**. The LED driver is simply implemented using only two semiconductor devices. Full wave rectification is achieved by U2 (ZXSBMR16PT8), which contains a Schottky bridge. U1 (ZXLD1350) is a hysteretic current controller which uses a freewheeling Schottky diode from the combination part U2. The ZXLD1350 controller has an internal switch that greatly reduces both the PCB size and the component count. It also has a proprietary current monitor that significantly simplifies the current sensing circuit for the hysteretic control. Two input energy storage SMD tantalum capacitors, $C_1$ and $C_2$, of total value 300uF have been optimised as the minimum capacitance required to meet efficiency and LED current accuracy. Three 0805 type SMD common-mode chokes in series, $L_2$, $L_3$ and $L_4$, are verified to be the minimum requirement to pass the EMC conducted EMI test (CISPR-25). A screened inductor $L_1$ is selected to minimise the radiated EMI from the switching operation.

Due to input ripple voltage, the switching frequency range in relation to the input variation of 14.5V±2.5V can be found to shift from around 24kHz to 420kHz, as highlighted in **Figure 3**. In this way, the ZXLD1350 offers a ±90% deviation of its nominal switching frequency from a nominal 230kHz, thereby facilitating the frequency dithering.

In addition, an EMI filter is composed of two capacitors, $C_5$ and $C_6$, and three common-mode chokes in series, $L_2$, $L_3$ and $L_4$. The 3dB cutoff frequency $f_C$ is estimated as 200kHz. Hence, the filter can provide a supplementary attenuation of -40dB/decade from 200kHz, which is just below the nominal switching frequency. In other words, it is effective to suppress the higher harmonics.

There are also many critical EMC considerations in the PCB layout as detailed below:

- A star ground connection is employed to avoid the common impedance effect.
- A ground ring is used to protect the ADJ pin against any kind of electromagnetic coupling.
- The sense tracks connecting R1 to ZXLD1350 are as short as possible.
- The decoupling capacitor $C_3$ is placed as close as possible to the Vin pin.
- The freewheeling current path is as short as possible to ensure system precision and efficiency.
- Power and ground tracks have been maximised around critical areas on both sides to create the intrinsic capacitors for high frequency filtering.

The EMC test results in accordance with the general lighting standard EN 55015: 2006 are presented in **Figure 4**. Most importantly, the stand-alone MR16 lamp is operated from a 12Vac source by means of a typical linear step-down magnetic transformer, directly connected to AC mains throughout the compliance verification. However, if an electronic transformer is intended to be used, the system EMC compliance level is unknown at this moment. In which case, the EMI filter may need to be re-designed for optimisation. Also, the ESD test was passed according to IEC 61000-4-2 Level B which requires ±4kV contact discharge and ±8kV air discharge.

**Automotive Interior LED Lighting EMC Solution**

Automotive EMC standards are mainly manufacturer-specific. For example, a typical requirement for an automotive application is that the LED driver should

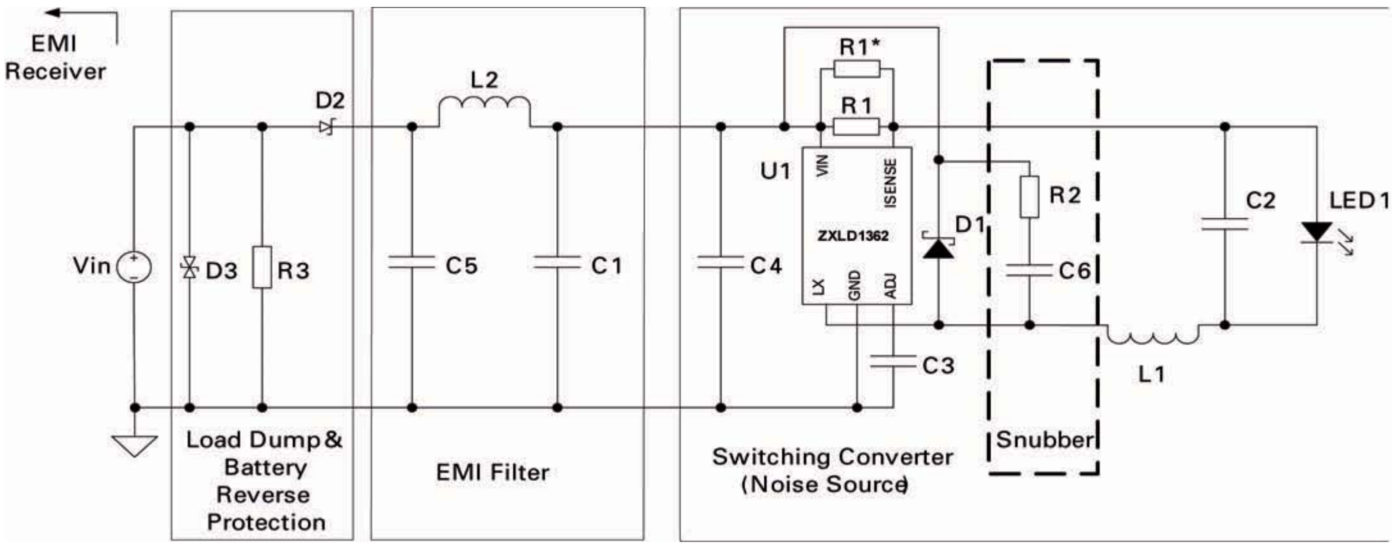



*Figure 5:* *Circuit diagram of 350mA LED driver for car interior lighting*

operate over a wide input range with a transient capability to support both cold cranking and load dump conditions, respectively. Furthermore, ESD tests in automotive LED applications require an air discharge voltage up to ±25kV because automobiles are treated as isolated systems.

A 350mA LED driver circuit for car interior lighting that meets with the essential automotive requirements is shown in **Figure 5**.

For this lighting solution a 60V ZXLD1362 based buck converter employing hysteretic current control was used. For load dump protection a transient suppressor diode $D_3$ is added. The EMI filter consists of an inductor $L_2$ and two capacitors $C_1$ and $C_5$ to form a simple filter which attenuates the conducted EMI. A capacitor $C_3$ of 10nF is connected from ADJ pin to ground to filter noise pickup, which may create flickering during the immunity test.

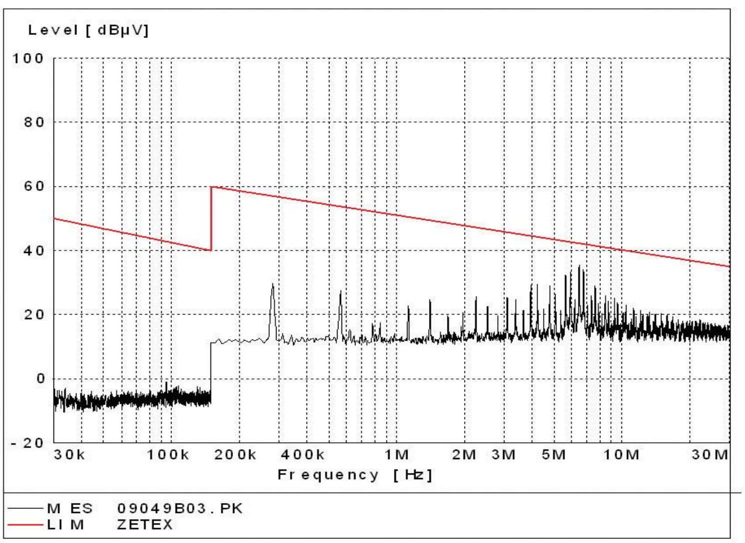



*Figure 6:* *Conducted EMI scan*

An optional RC snubber ($R_2$-$C_6$) could be connected across the diode $D_1$ to control both the spike's transition rate and shape. The capacitor controls the rise time and the resistor the peak voltage. In fact, this was not required to meet the EMC test. Cores of both, the switching inductor $L_1$ and the filter inductor $L_2$, are shielded ferrite-based and closed magnetic field type, in order to provide suppression of radiated emissions as well as immunity to external fields.

The 4th-order low-pass filter, which is formed by $C_5$, $L_2$ and $C_1$, offers more than 60dB attenuation at 300kHz, according to the transfer function analysis.

In this circuit, the switching frequency at $V_{IN}$=12V is about 300kHz. So the filter has been optimised to provide enough attenuation at the fundamental frequency as well as its harmonic frequencies in order to meet the conducted EMI requirement.

Again, there are many critical EMC

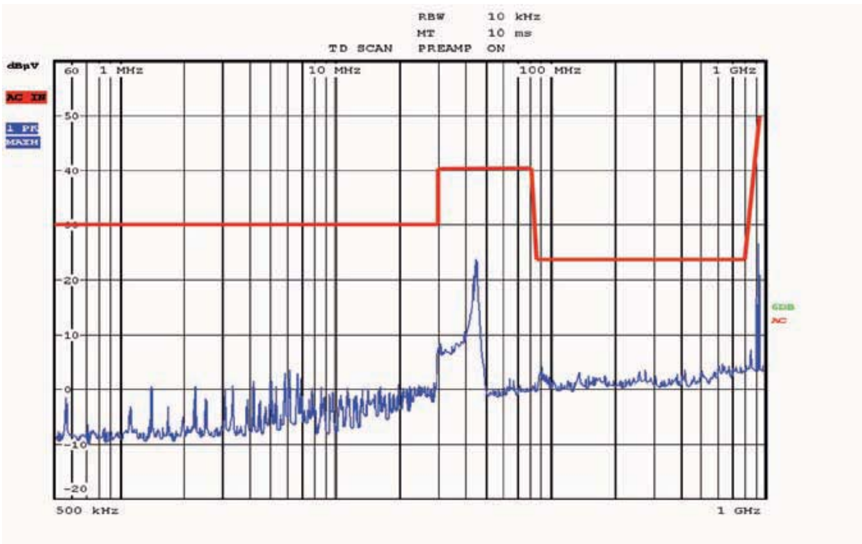



***Figure 7:*** *Operating emission using GTEM*

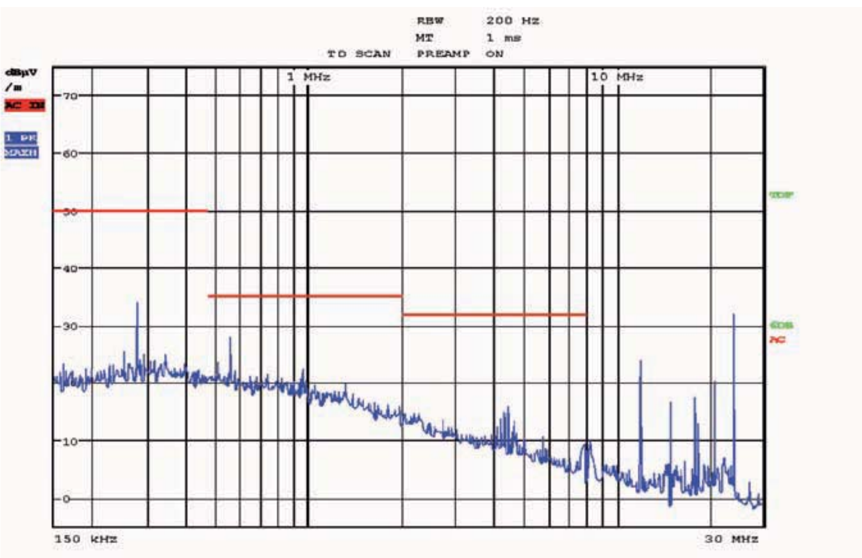



***Figure 8:*** *Operating emission with loop antenna in 1m range*

| Lighting standard | Test(s) covered |
|---|---|
| EN 55015 | Conducted and radiated emissions |
| EN 61547 | Conducted immunity, radiated immunity, EDS, EFT, surge and voltage drip |
| EN 61000-6-3 | Emissions out of scope of EN55015 |
| EN 61000-3-2 | Harmonic current emission (Class C) |
| EN61000-3-3 | Voltage fluctuations and flickers |

***Table 1:*** *General lighting EMC standards*

| Automotive standard | Test(s) covered |
|---|---|
| CISPR-25 | Conducted and radiated emissions |
| ISO 11452-2 & -4 | Radiated immunity |
| ISO 7637-2 | Conducted transient immunity |
| ISO 10605 | Electrostatic discharge |

***Table 2:*** *Automotive test standards*

considerations in the PCB layout as detailed below.

- The capacitor $C_3$ connected from ADJ pin to ground is as short as possible.
- The high di/dt loop ($L_X$-$D_1$-$V_{IN}$-$C_4$) with a fast switching current is made as small as possible to minimise the loop inductance and, thereby, the differential mode noise related L·di/dt effect.
- A simple filter ($C_5$-$L_2$-$C_1$) is placed as close as possible to the input terminals to ensure optimal conducted EMI attenuation.
- The perpendicular configuration of the EMI filter components lowers the capacitive coupling between the inductor and capacitors.
- A V-connection to the filter capacitors $C_1$ and $C_5$ helps prevent self-resonance of these capacitors and a degradation of EMI performance.
- Careful component placement to avoid mutual coupling.
- The EMI filter as a noise bypass was placed in close proximity to the radiation source (the switching regulator).

The EMC test results are shown in **Figures 6**, **7** and **8** respectively, in accordance with the following automotive standards with limits identified by a car manufacturer.

- CISPR-25: Conducted and Radiated Emissions (European and Worldwide Standards)
- ISO11452: Radiated Immunity (North American and Worldwide Standards)
- 95/54/EC: Radiated Emission (European Standards)

It should be noted that the radiated immunity test is correlated from the stripline measurement inside a GTEM cell, while the radiated emission test is correlated from absorber chamber verification using an active loop antenna at a 1m range.

## Efficient Use

Hysteretic converters can be used to efficiently drive LEDs in an EMC friendly manner, by following good EMC practices associated with all switching regulator design and by being aware of the variable frequency nature of the hysteretic topology. The variability of frequency with input voltage can be taken advantage of in some AC applications, such as the MR16 lamp, to create a wide dynamic spread spectrum response that is beyond the expectations of some fixed frequency topologies. Even in the tough automotive EMC environment, successful LED lighting solutions can be created which take full advantage of the converter's simple and stable topology. ■

# MICROCONTROLLER-BASED ENERGY METER

**DOGAN IBRAHIM,** LECTURER AT THE NEAR EAST UNIVERSITY IN CYPRUS, DESCRIBES THE DESIGN OF A MICROCONTROLLER BASED ENERGY METER WITH LCD AND RS232 OUTPUT

An energy meter, also called electricity meter, measures and registers the amount of electrical energy consumed by electricity users. These meters are read at regular intervals and consumers are charged based on the total energy usage in the given period. Early electricity meters used in households and commercial establishments were mechanical devices (see **Figure 1**).

These types of meters were also known as induction-type electricity meters and they are still in use due to their simplicity and low cost. Most domestic meters are single phase with a current rating to up to 60A. In the commercial and small industrial sector we see single phase as well as three phase meters with current ratings up to 60A per phase.

The mechanical meter has a stator consisting of a voltage coil and a current coil. These coils are connected to the incoming mains line and they react electromagnetically as the line voltage and current changes. Both coils act together to turn a rotor with a disk; the rotational speed is proportional to the product of the voltage and the current. Some meters use a gear train to drive the dials, while some more modern meters use non-contact methods such as optical or Hall Effect sensors. Some newer meters are based on the semiconductor technology where pulses are generated with a frequency proportional to the amount of power consumed. For example, it is very common to have meters with 100imp/kWh (impulses per kWh) where 100 pulses are required to register one kWh of energy usage. Stepping motors are then activated with these pulses to display the energy used.


***Figure 1:** Mechanical electricity meter*

With the demand for greater precision and complexity of electricity tariffs, electronic electricity meters are now in common use. Consumers can also purchase plug-in portable electronic meters (see **Figure 2**) to monitor the electricity usage. These devices have LCD displays and they can show the power consumption, energy usage and the total cost of energy used. In addition, some devices can also show the mains voltage, load current, line frequency and power factor.

***Figure 2:** Electric, portable electricity meter*

### Power Measurement

In DC systems, the power (P) can be determined by multiplying the applied voltage (V) and current (I) through the load, i.e. P = VI. For example, if the voltage across the load is 100V and the current through the load is 10A, the power delivered to the load will be 1000W, or 1kW.

The unit of measurement of electrical energy is kilowatt-hour, which is equal to the amount of energy used by a load of one kilowatt over a period of one hour. Thus, in the example above, if the load is operated for two hours the energy consumed will simply be 2kWh.

In AC systems, where the current and voltage are both sine-waves, the instantaneous power delivered to a load is obtained by multiplying the instantaneous values of the voltage and current. As shown in **Figure 3**, when the voltage and current are both in phase (i.e. when the load is purely resistive), the instantaneous power is always positive, since we get a positive result when we multiply two positive or two negative signals together.

Expressed mathematically, let the instantaneous voltage be $v(t) = V_m \sin wt$ and instantaneous current be $i(t) = I_m \sin(wt - \theta)$ Then the instantaneous power is given by:

$$p(t) = v(t)\, i(t) = V_m I_m \sin wt \, \sin(wt - \theta) \quad (1)$$

If T is the period of the voltage or current, the average (or real) power is given by:

$$P = \frac{1}{T}\int_0^T p(t) = \frac{1}{2} V_m I_m \cos\theta \quad (2)$$

Letting the RMS values of voltage and current be and respectively,

$$V_m = \sqrt{2}V_{RMS} \text{ and } I_m = \sqrt{2}I_{RMS} \quad (3)$$

then the average power is given by:

$$P = V_{RMS} I_{RMS} \cos\theta \quad (4)$$

The power given by **Equation 4** is also known as the *real power*, or *active power*, and it has the units of Watts. In addition to the real power we also have the terms *apparent power* (in voltampere, or VA) and *reactive power* (in voltampere reactive), where:

Apparent power = $V_{RMS} I_{RMS}$ (5)

and

Reactive power = $V_{RMS} I_{RMS} \sin\theta$ (6)

Although the real and apparent powers are always positive, the reactive power can have either signs.

For example, in Figure 3, the mains voltage has a peak value of 339V (RMS value of 240V) and the current through the load has a peak value of 14.4A (RMS value of 10A). Multiplying the two RMS values gives the average (real) power in the load as 2400W, which is shown in the figure as a positive value.

When there is a phase difference between the voltage and current, the real power is lowered and is not simply the multiplication of the two RMS values. As shown in Equation 4 the cosine of the phase difference must also be multiplied to get the real power.

The term is also known as the Power Factor (PF) and is very important in AC circuits. For example, if the current lags the voltage by 45° as shown in **Figure 4**, then and the real average power dissipated by the load will be 2400 x 0.7 = 1697W. Similarly, as shown in **Figure 5**, if the phase difference between the voltage and current is 90° then cos90 = 0 and the average power delivered to the load will be zero. In other words, even though there is 240V across the load and 10A current flows through the load, no real power is delivered to the load. It is very important to make sure that the PF is as close to unity as possible in AC power circuits such as in large electric motor circuits.

## The Block Diagram

The block diagram of the energy meter described in this paper is shown in **Figure 6**. The unit consists of the following modules: voltage sensing module, current sensing module, energy meter IC, microcontroller module, LCD module, real-time clock module, RS232 module and the power supply module.

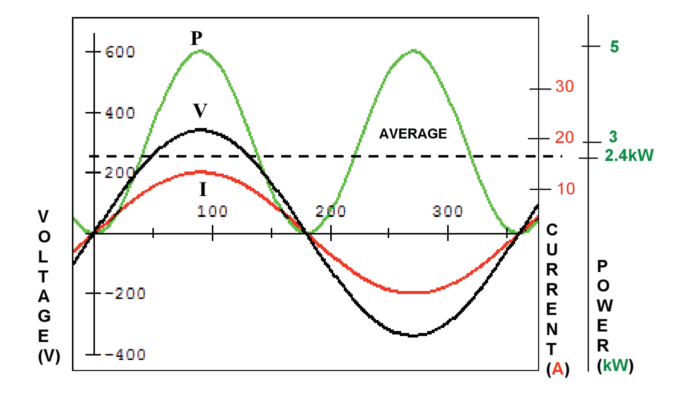



***Figure 3:*** *Power when the load is resistive*

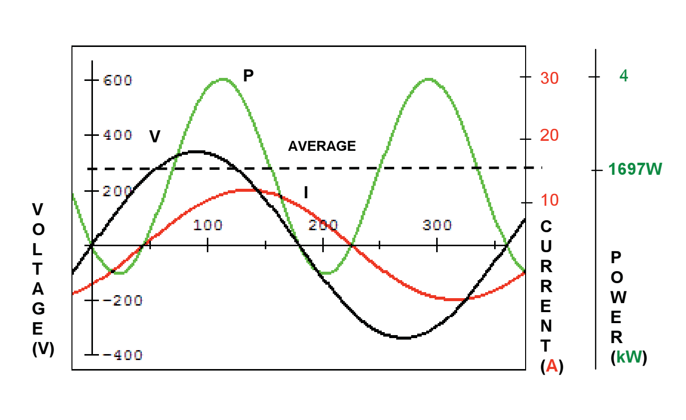



***Figure 4:*** *Current lagging the voltage by 45°*

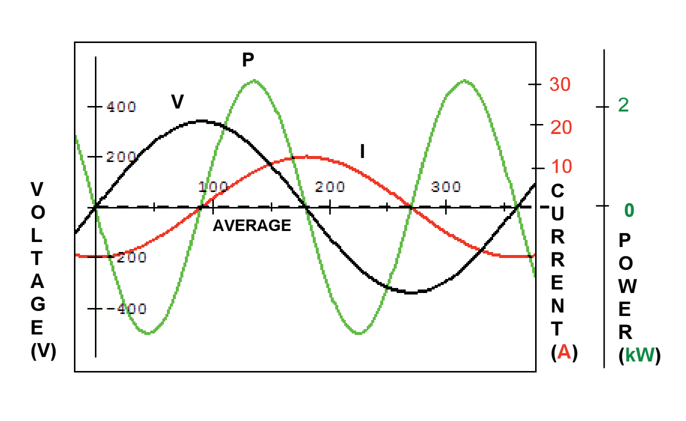



***Figure 5:*** *Current lagging the voltage by 90° and average power delivered to the load is 0W*

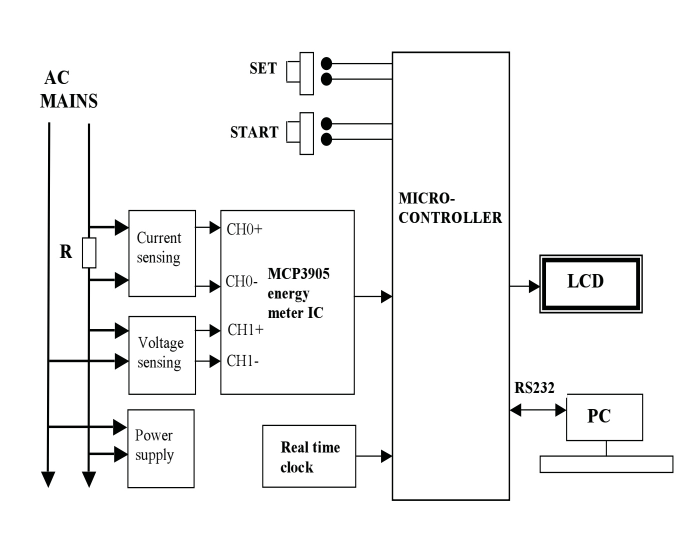



***Figure 6:*** *Block diagram of the energy meter unit*

The mains supply and the load are connected to the unit. The unit calculates the power and energy consumption of the load. The following information is displayed on the LCD and also sent to the RS232 serial port continuously:

– Real-time date and time is updated and displayed every second
– Power dissipation of the load is shown in Wh
– Connection time of the load is shown in hours, minutes and seconds
– Energy usage of the load is shown in kilowatt-hours (kWh)
– Cost of the electricity consumed is shown in chosen units.

The date and time (e.g. 20/02/08 10:00:00) and the unit cost of electricity (e.g. p/kWh) are entered through the RS232 port using a PC or a terminal.

The load current is sensed by a shunt resistor and applied to the CH0 inputs of the energy meter IC. Similarly, the load voltage is reduced to a low value and is applied to the CH1 input. The energy meter multiplies the two inputs to obtain the power dissipated by the load. The output of the energy meter IC is a series of pulses with a frequency directly proportional to the power dissipated by the load. The microcontroller determines the pulse frequency, calculates the load power and then displays the power, energy, load connection time and energy cost on the LCD. Similar data is also sent to the RS232 port for future analysis. A battery operated real-time clock chip maintains the absolute time for the device.

### Circuit Diagram

The circuit diagram of the energy meter device is given in **Figure 7**. The circuit is built around the PIC18F452 microcontroller. Functionally and physically the circuit is in two parts: the *Data Collection* part and the *Data Analysis and Display* part. For the data collection part, the MCP3905/6 evaluation board is used. This board provides easy evaluation of the MCP3905 energy metering IC. A shunt resistor (500µΩ), mains voltage and load are connected to the board as shown in **Figure 8**.

There are several jumpers on the board to choose the amplifier gain, mode of operation, type of output etc. At the output of the board pulses are generated whose frequency is directly proportional to the power dissipated by the load. An opto-coupler is used to isolate the board and to interface the board to external world. MCP3905 is powered from an on-board +5V power supply, designed using a 78L05 type voltage regulator.

The data collection part of Figure 7 shows circuit diagram of the evaluation board as it was configured for this project. The load current is sensed by the shunt resistor, filtered and applied to the CH0 inputs. Similarly, the load voltage is reduced by using a resistive potential divider circuit and is then applied to the CH1 input.

MCP3905 is operated from a 3.579545MHz crystal. G0 and G1 inputs are connected to logic 1 to choose the CH0 amplifier gain as 16. The frequency constant $HF_C$ (see **Equation 8**) was selected by connecting inputs F0 and F1 to logic 1 and F2 to logic 0.

Power for the MCP3905 is obtained by the half-rectifier Zener diode circuit at the lower left corner of the data collection circuit. Here, L1 and L2 are ferrite beads to reduce the ground noise. High voltage capacitors 10nF and 0.47µF divide the line voltage. MOV is a metal oxide varistor used as a transient suppressor.

The diode 1N4004 produces half-wave rectified voltage, which charges the 470µF capacitor, holding an average DC voltage for the LM78L05 regulator. The 1N4744 ensures that the voltage is kept at around 14V at the input. The output of 78L05 regulator is applied to the analogue supply input (AVDD) of the IC. The digital supply input (AVDD) of the IC is further filtered using capacitors and a resistor.

The data analysis and display part consists of the PIC18F452 microcontroller, operated with a crystal of 10MHz, battery-operated PCF8583 real-time clock chip, 4x20 LCD and MAX232-type RS232 voltage level converter chip. PCF8583 is connected to the microcontroller using the $I^2C$ interface. The LCD is connected to PORT B of the microcontroller and MAX232 is connected to the TX and RX pins of the microcontroller. Output pulses from the data collection part are applied to the clock input (T1CKI) of TMR1 of the microcontroller.

### Operation

The operation of the device is as follows: Two push-button switches, named SET and START, are provided. Pressing and holding down the SET button enables the user to enter the current date and time from the PC and this data is stored in the real-time clock chip. In addition, the unit cost of energy is received from the PC and is stored in the EEPROM memory of the microcontroller.

Pressing the START button starts the device to measure and display the power and energy when a load is connected to the device. The energy meter IC multiplies the signals at its CH0 and CH1 inputs to obtain a value proportional to the power consumed by the load. This value is then converted into frequency and is output from the device. Thus, the output frequency is directly proportional to the power consumed by the load.

The energy meter IC provides three outputs. Two of the outputs are very low frequency and can be used to drive stepping motors directly in energy meter applications. The third output ($HF_{OUT}$) is at a much higher frequency and can be used in microcontroller-based energy meter applications.

The microcontroller starts a timer and measures the number of pulses received from the energy meter in a 10-second period. This

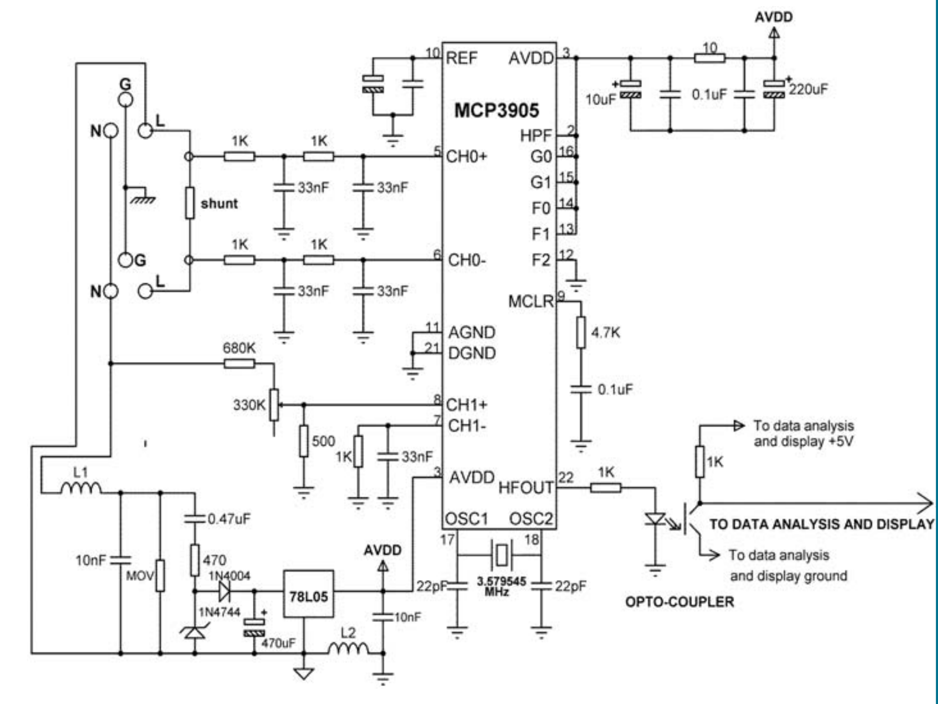



*Figure 7:* *Circuit diagram of the energy metering device, data collection*

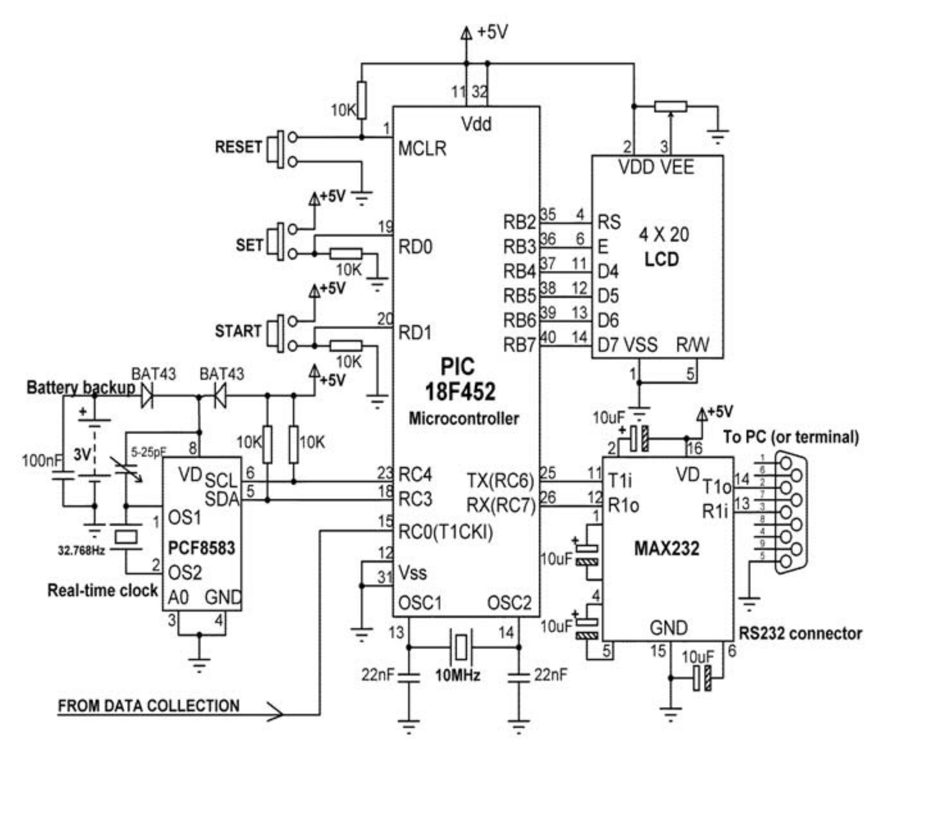



*Figure 7:* *Circuit diagram of the energy metering device, data analysis and display*

value is then converted into power and is displayed on the LCD in Watts. The energy usage is updated every 10 seconds and is displayed in kWh.

Let us look at the design of the various modules used in the design. The energy meter IC is at the heart of the design and we shall be looking at this module first.

**Energy Meter IC**

There are many energy metering ICs in the market, such as Analogue Devices's single-phase ADE7751, ADE7753, ADE7757, ADE7759 and poly-phase ADE7752, ADE7754; Microchip's MCP3905, MCP3906, MCP3909 and so on.

The energy meter unit described in this paper is based on the energy metering IC from Microchip, designated the MCP3905. The reason for choosing this particular IC is because an energy metering development kit is available from Microchip that uses this IC, and this kit simplifies the development of energy metering designs. **Figure 9** shows the internal structure of the MCP3905 energy metering IC. MCP3905 is a 24-pin IC. As shown in Figure 9, there are two input channels, one to monitor the current (current channel or CH0) and the other for the voltage (voltage channel or CH1). PGA is an amplifier at the current channel with the gain selectable between 1, 2, 8 and 16.

The load current is measured by monitoring the voltage developed across a very small resistor in series with the load. The maximum differential voltage at the current channel should not exceed ±470mV/GAIN. Similarly, a unity gain amplifier is used at the voltage channel and the maximum input voltage should not exceed ±660mV.

The output signals from both amplifiers are converted to digital values using two independent 16-bit, second order, delta-sigma A/D converters that over-sample the input at approximately 900kHz when the device is operated with the recommended clock frequency of 3.579MHz.

The outputs of the A/D converters are fed to two digital high-pass filters (HPF1) that cancel the system offset on both channels so that the power calculation does not include any circuit or system offset. The signals at the output of the high-pass filters are multiplied to give the instantaneous power. The instantaneous power is low-pass filtered to obtain the instantaneous real power. A digital to frequency converter

(DTF) circuit is used at the output of the device. The DTF accumulates the instantaneous real power information and produces output pulses with a frequency proportional to the average active (real) power.

Three outputs, $F_{OUT0}$, $F_{OUT2}$ and $HF_{OUT}$ are available from the device, selected by pins F2, F1 and F0. $F_{OUT0}$ and $F_{OUT2}$ are very low frequency outputs and are designed to drive electromechanical counters and two-phase stepper motors displaying the real power and the energy consumed one. $HF_{OUT}$ output has a much higher frequency and it can be used during the calibration of the device.

The frequency at the $F_{OUT0}$ and $F_{OUT2}$ outputs are given by:

$$F_{OUT} = \frac{8.06 \times V_0 \times V_1 \times G \times F_C}{(V_{REF})^2} \quad (7)$$

and $HF_{OUT}$ is given by:

$$HF_{OUT} = \frac{8.06 \times V_0 \times V_1 \times G \times HF_C}{(V_{REF})^2} \quad (8)$$

where,

$V_0$ = the RMS differential voltage on channel CH0

$I_0$ = the RMS differential voltage on channel CH1

$G$ = constant PGA gain on channel CH0

$F_0, HF_C$ = clock dependent frequency constant

$V_{REF}$ = constant voltage reference (2.4V)

As can be seen from **Equations 7** and **8**, the output frequencies are directly proportional to the product of voltages across both channels.

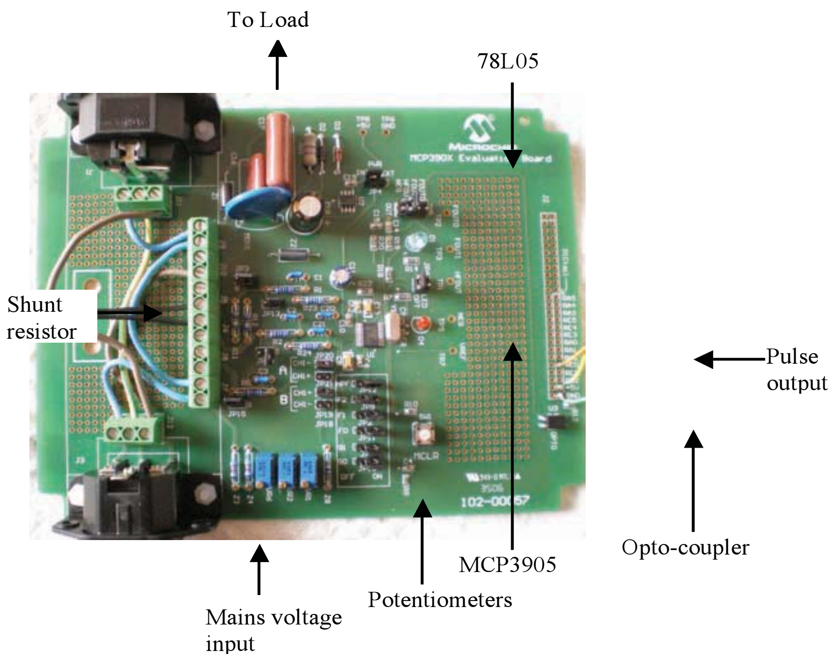



***Figure 8:*** *MCP3905/6 evaluation board*

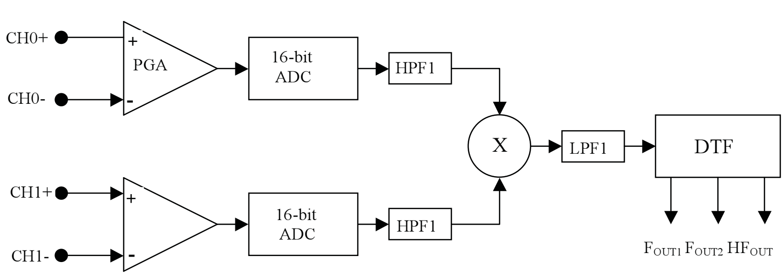



***Figure 9:*** *Internal structure of MCP3905 energy metering IC*

### Voltage Sensing Module

The maximum allowed differential voltage at the voltage channels (CH1) is 660mV. A resistor divider network is used to reduce the mains voltage by a factor of 1:2000 to approximately 100-200mV and then the voltage is applied to the voltage channels of the MCP3905. **Figure 10** shows the circuit diagram of the voltage sensing module.

Here, a potential divider circuit is formed by feeding the mains voltage to a 680K resistor in series with a 330K pot (on the energy meter development kit 3 pots are used for precision adjustment of the voltage) and then a 500Ω resistor is used. The meter can be calibrated by varying the voltage at CH1+ input with the pot. The voltage at the CH1+ input can vary from about 120mV to 176mV. CH1- input is connected to ground though an R-C filter network.

### Current Sensing Module

The load current can be sensed by either using a current transformer, or by passing the current through a small resistor and then measuring the voltage across this resistor. Current transformer offers isolation through transfer of current from the primary to the secondary winding. It can also handle higher currents than a resistor and consume less power. Current transformers are however more expensive and less accurate than resistors.

Another disadvantage of current transformers is that the core can saturate in large current applications making the device highly non-linear and thus causing measurement errors.

In this design a 500μΩ resistor is used. Assuming a maximum load current of 13A, the maximum voltage across this resistor will be 6.5mV. The gain of the PGA amplifier was chosen 16 to give a maximum voltage of 104mV at the current channel of the chip. This value is well below the recommended maximum voltage of 470mV. The signal at the current input of the MCP3905 should be low-pass filtered to remove any anti-aliasing high frequency elements before it is applied to the A/D converter. MCP3905 is operated at a clock frequency of 3.579MHz and at this frequency the sampling rate of the A/D is approximately 900kHz.

Here, the requirement is to design a low-pass filter to eliminate signals around the Nyquist frequency, which will be signals above 450kHz. Usually, a simple R-C circuit is all that is required to remove these high frequency signals at the input; a resistor in value as low as 500μΩ has a built-in series self-inductance of about 5nH. The resistor and inductor in series (see **Figure 11**) act as a high-pass filter in front of our anti-aliasing low-pass filter and, unfortunately, cancel out the action of the low-pass filter. This problem can be solved and the effect of the high-pass filter can be compensated by using a two-stage R-C low-pass filter at the input of the energy meter IC as shown in **Figure 12**. The recommended resistor and capacitor values are 1K and 33nF respectively.

### Microcontroller Module

A PIC18F452 microcontroller is used in the design. This is a high-performance microcontroller from the PIC18F family. It has the following features:
– 32K flash program memory
–1536 byte RAM data memory
– 256 byte EEPROM memory
– 4 Timer modules
– 32 I/O pins
– 8 channel 10-bit A/D converter
– USART and $I^2C$
– Capture/compare/PWM module
– DC to 40MHz clock.

### LCD Module

A standard HD44780 controller compatible 4x20 LCD is used in the design. The LCD is operated in 4-bit mode: pins D4-D7 connected to pins RB4-RB7 of the microcontroller and pins EN and RS are connected to pins RB3 and RB2 of the microcontroller respectively. As shown in **Figure 13**, the LCD displays the absolute time (updated every second), the power, load connection time, total energy used and the total cost of energy.

### Real-Time Clock Module

A PCF8583 type real-time clock chip is used in the design. This chip is $I^2C$ compatible and, once initialised to the current date and time, it can provide the date and time information whenever required. Here, the chip is initialised by the user entering the current date and time from a PC or a serial terminal. Notice that a battery backup is used in the design to keep the clock running when the energy meter is not in use.

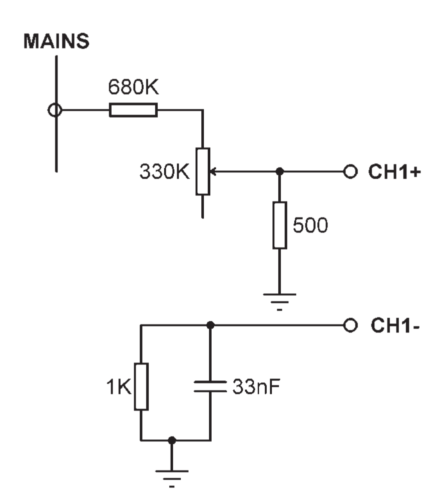



***Figure 10:*** *Voltage sensing module*

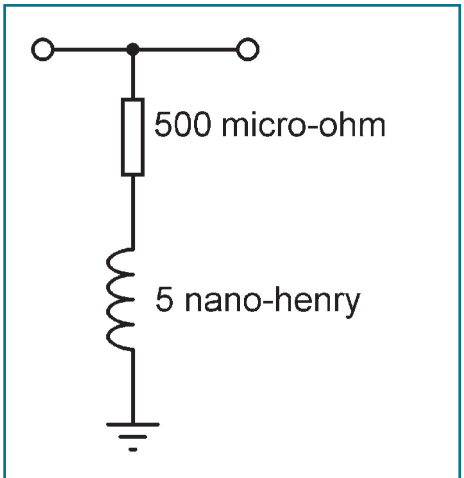



***Figure 11:*** *Shunt resistor with built-in self inductanceenergy metering IC*

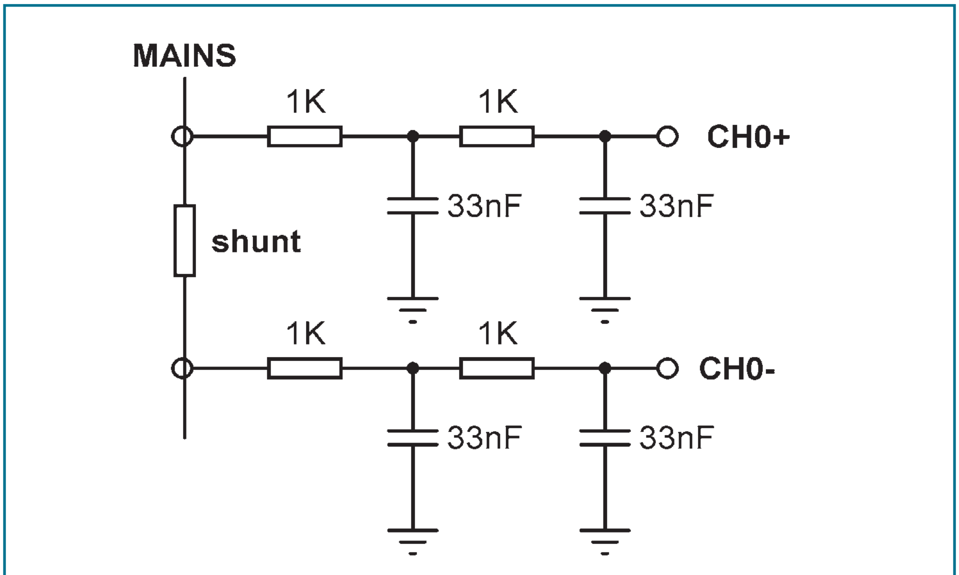



***Figure 12:*** *Low-pass filter used at the input of the energy meter IC*

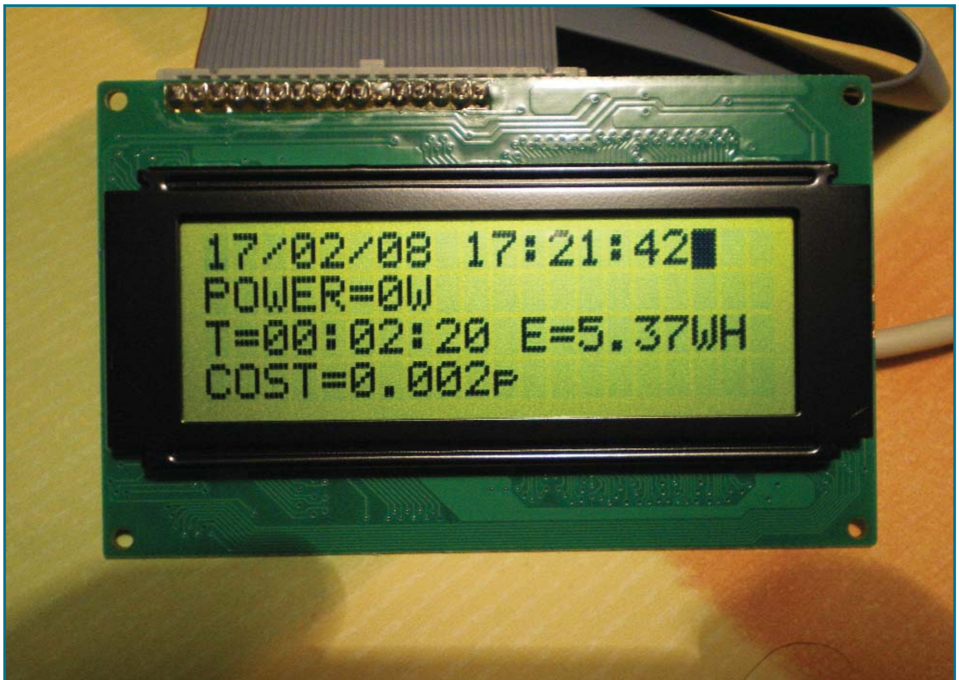



***Figure 13:*** *LCD displays the absolute date and time, load connection time, power dissipated, energy used and the unit cost of energy*

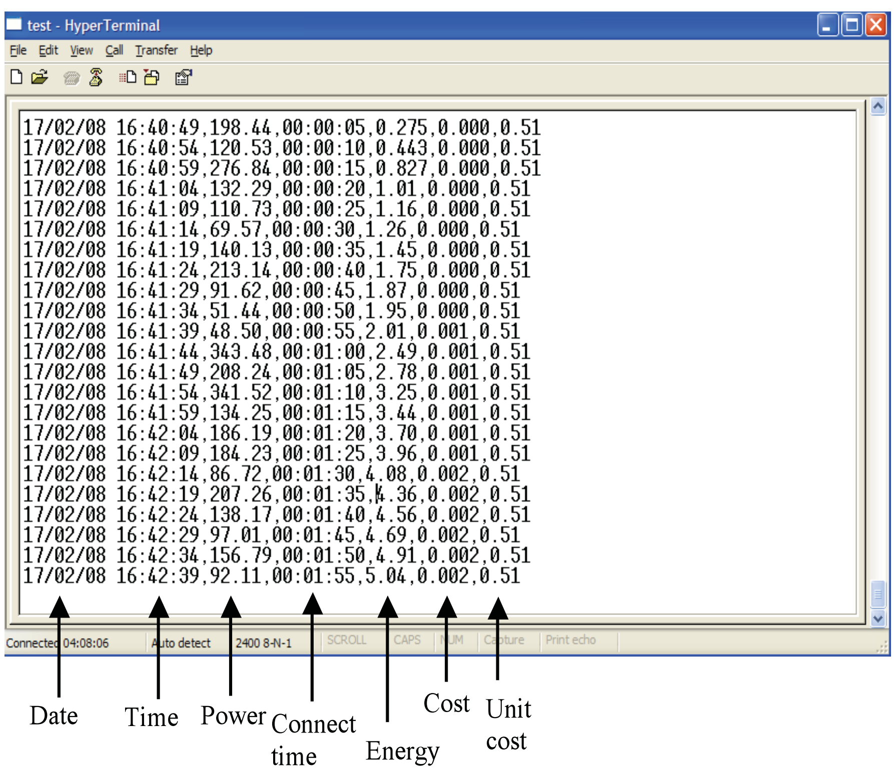



***Figure 14:*** *Screen-shot of the data sent through the RS232 port*

**RS232 Module**

This module provides the communication with a PC or a serial terminal using the RS232 protocol. The protocol parameters were chosen as: 2400 baud, 8 bits, no parity and 1 stop bit. The RS232 module is used to:

– Set the date and time for the real-time clock chip
– Set the unit cost of electricity (p/KWh)
– Receive date, time, power and energy data continuously from the energy meter device.

After a system RESET, pressing and holding the SET button for a minimum of three seconds enables the user to set the real-time clock and the unit cost of energy using a PC or a serial terminal. A typical dialogue is as follows:

**Enter Date & Time:** *20/02/08 10:12:00 <ENTER>*
**Enter Cost (p/kWh):** *9.5 <ENTER>*

The date and time need only be set once because the real-time clock chip is battery-backed. Also, the unit cost of electricity is stored in the EEPROM memory of the microcontroller and need only be entered once, unless it is required to change its value. A screen-shot of the data sent through the RS232 port is shown in **Figure 14**. This data was displayed on a PC using the *HyperTerminal* communications program.

S232 module is connected to the TX and RX pins of the microcontroller via a MAX232 type RS232 level converter chip and a 9-way D-type connector is used for PC interface.

**The Software**

The software has been developed using the mikroC language. This is a powerful and a highly popular PIC microcontroller C programming language developed by mikroElectronika. In addition to their C compiler, the company also offers BASIC and PASCAL compilers for PIC microcontroller. These compilers also support a simulator and an in-circuit debugger.

The operation of the software is described in **Figure 15** in simple program description language (PDL) syntax:

Communication with the RTC chip is by using the built-in $I^2C$ library of the mikroC language. Similarly, LCD control and RS232 communication are handled by using the LCD and the USART libraries respectively.

Interested readers can obtain full copy of the source code by contacting the magazine's editorial offices.

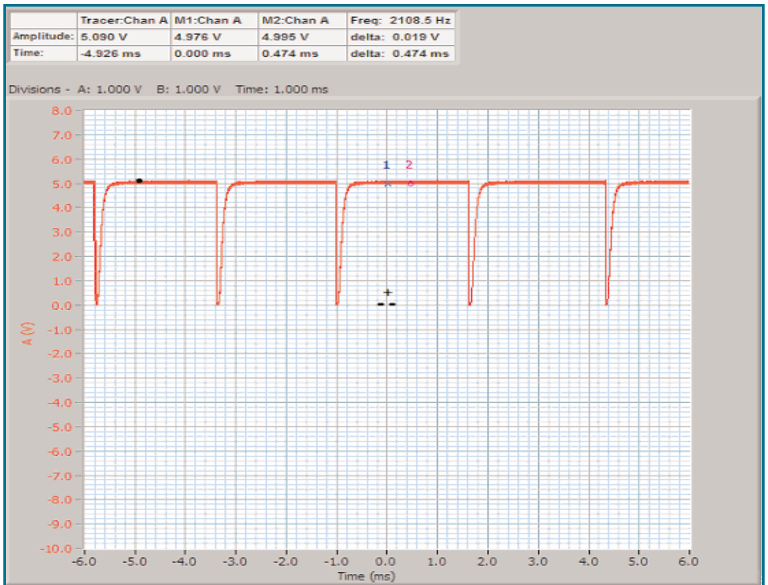



***Figure 16:*** *Output pulses of the data collection unit*

**Calibration and Testing**

The MCP3905 energy metering IC is highly linear and calibration of the device at a given power level should normally be enough. The device can easily be calibrated as follows (assuming that the program code is not modified):

– Connect a frequency counter or a digital oscilloscope to the output of the opto-coupler.

– Connect a 1kW load to the meter.

– Adjust the 330K potentiometer in the Voltage Sensing Module until the output pulses at the opto-coupler has a frequency of 408Hz (in software 408Hz corresponds to 1kW of power dissipation). **Figure 16** shows typical pulses at the output of the opto-coupler circuit.

– An alternative and easier way of calibrating the device is to connect a load of known power and then to adjust the potentiometer until the LCD display shows the correct power dissipated by the load.

**Further Enhancements**

This paper has described the design of a microcontroller-based energy meter device, where the power and energy consumed are displayed on an LCD and are also sent out in an RS232 serial format so that they can be captured and processed by a PC for further analysis.

The device is based on the PIC18F452 microcontroller and MCP3905 energy meter IC, and can be used to measure the energy usage anywhere, together with the absolute date and time information. The energy meter described in this paper can be enhanced in several ways:

– A flash memory card interface (e.g. SD card) can be added to store the power, energy, date and time, and the cost of energy consumed over long periods of time.

– The collected data can easily be analysed on a PC. For example, the data can be imported into Excel and the variation of power or energy usage in a given absolute time interval can be analysed or plotted. Such a graph can provide very useful information when it is required to cut-down energy consumption and save energy.

– The software can be modified to cater for multiple tariffs. For example, different unit electricity costs at different times of the day can easily be added. ■

**Main Program**

```
BEGIN
    Initialise program variables
    Initilise LCD, USART, RTC chip
    DO FOREVER
        Read and display RTC data
        IF SET button pressed
            Read date and time from RS232 port
            Write date and time to RTC chip
            Read unit electricity cost from RS232 port
            Save unit cost in EEPROM memory
        ENDIF
        IF START button pressed
            Load TMR0 for 5 second interrupts
            Clear TMR1
            Enable timer interrupt
        ENDIF
        IF TMR0 interrupt occurred
            Get TMR1 value
            Calculate frequency of pulses
            Calculate and display Power
            Calculate and display connection time
            Calculate and display Energy used
            Calculate and display Energy cost
            Send clock, power, energy, and cost data to RS232 port
        ENDIF
    ENDDO
END
```

**TMR0 Interrupt Service Routine**

```
BEGIN
    Get and save TMR1 value
    IF TMR1 value > 0
        Increment total load connect time
    ENDIF
    Clear TMR1
    Re-load TMR0 for 5 second interrupts
    Re-enable timer interrupt
END
```

***Figure 15:*** *Program operation in simple PDL*

# LOG-DOMAIN, FIRST ORDER, LOW PASS FILTER USING CCII AND CFA

A novel low pass (LP), log-domain filter based on a combination of second-generation current conveyors (CCII) and current feedback amplifier (CFA), current-sources and diodes (besides grounded capacitors) is presented here.

The idea of filtering in log-domain introduced by Adams at 63rd AES conference in May 1979 has brought the area of analogue integrated filters to the attention of researches because of its potential advantages.

The first log-domain filter using log and anti-log techniques, in conjunction with a combination of forward biased diodes and a capacitor to obtain a distortion less first-order LP filter was proposed by Adams.

In log-domain filtering the overall linear transfer function can be implemented by means of highly non-linear circuits. A related concept using companding was introduced by Y. P. Tsividis (*'Companding in Signal Processing'*, Electron Lett, Vol. 26, pp. 1331-1332, 1990). Later Seevinck also addressed the concept of log-domain filtering denoting it by the term current-mode companding (Electron Lett, Vol. 26, pp.2046-2047, 1990).

The log-domain filters offer the following advantages over conventional continuous-time filters: low-voltage operation, superior noise performance, high frequency applications, larger dynamic range and electronic tunability.

Debashis Dutta et al in 2005 proposed a first-order LP filter using four second generation current conveyors (CCII) and as many diodes having the advantage of cascadibility.

In our article here, we are proposing a first-order LP log-domain filter that has the improvement of cascadibility and offers savings in hardware as it employs only two CCII, a single CFA and four diodes. The CCII and CFA combination is more versatile than the employment of conventional operational amplifier (OA) and/or operational transconductance amplifiers (OTAs).

The port relations of CCII and CFA are respectively given by:

$I_z = I_x$, $V_x = V_y$, $I_y = 0$ and $V_z = V_o$

Using the VI characteristics of diode and the port relations of CCII and CFA, the transfer function of the proposed circuit in **Figure 1** can be expressed as:

$$\frac{I_{out}}{I_{in}} = \frac{\omega_o}{s+\omega_o} \quad (1)$$

where $\omega_o$ is the cut-off frequency and is given by:

$$\omega_o = \frac{kI_o}{C} \quad (2)$$

where

$$k = \frac{q}{kT} \quad (3)$$

Thus, from **Equation 2** it is clear that the cut-off frequency $\omega_o$ is electronically tunable through $I_o$, which is preferred in contemporary IC design techniques.

The proposed filter was simulated for the cut-off frequency of 3.18MHz for bias current of $I_O$ = 50μA and C = 100pF. The simulated results shown in **Figure 2** agree well with the theoretical results.

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**Nusrat Parveen**
**India**

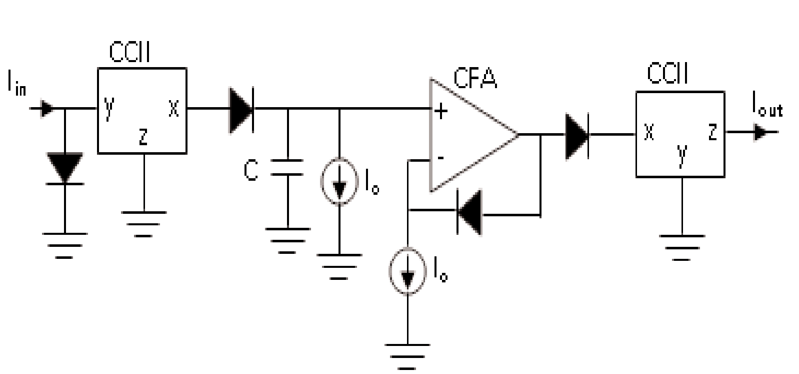



***Figure 1:*** *Log-domain first-order low-pass filter*

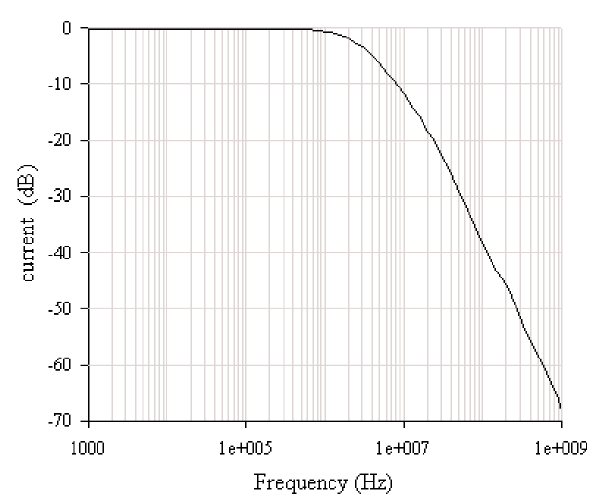



***Figure 2:*** *Simulated response of the proposed LP filter.*

# LED INDICATOR FOR 1V POWER SUPPLIES

It is common practice to use LEDs as indicators for power supplies since they provide a quick visual indicator that regulators are active and capable of supplying current (**Figure 1**):

Using such devices for very low voltage supplies is not possible, however, the threshold to turn on the diode can never be reached – minimum threshold voltages expected for red LED devices is around 1.6-1.8V.

This problem is particularly relevant to 1-1.2V, high current power supplies that are used for example (but not exclusively) for FPGA cores. Given that regulated supplies are usually created from larger unregulated ones, there is scope to use LEDs still to indicate a very low voltage regulator is active and capable of supplying current, by simply adding a reverse (anti-parallel) upside down transistor as shown in **Figure 2** configured as a current driver:

A standard transistor switch would work in the same way but, because of a high current gain ($\beta$) would not draw mA of current from the regulator; this configuration would turn on an LED too easily to indicate that a regulator will supply actual power.

The reverse transistor, with emitter and collector interchanged, is a device with poor current gain (typically $\beta_R$=10 or so), so requiring 2mA to flow into the base to cause 20mA to flow through the LED; current flow through the LED is given approximately by the following equation:

$$i_{LED\_RT} \approx (V_{REG} - 0.7)\beta_R / R_{I\_RT} \quad (1)$$

The only note of caution with this configuration is that the "original" base emitter junction, now being used as a base collector, will break down at voltages around 5V to 6V. This limit from the unregulated source, with the LED voltage subtracted, should not be breached.

If it is required to have the full current flow from a 1V to 1.2V regulator for the LED indicator, without any current gain in the system at all, a simple current mirror can be configured using two transistors shown in **Figure 3** where the approximate current flow is determined by the following equation:

$$i_{LED\_CM} \approx (V_{REG} - 0.7) / R_{I\_CM} \quad (2)$$

Finally, the following circuit has a current flow determined also by the **Equation 2** but provides a more accurate and temperature stable supply for the LED by simply adding one further resistor (see **Figure 4**).

**Andy Pienkowski**
**UK**

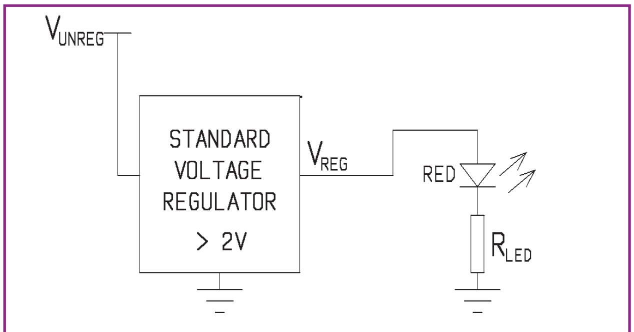



***Figure 1:*** *Standard LED power indicator*

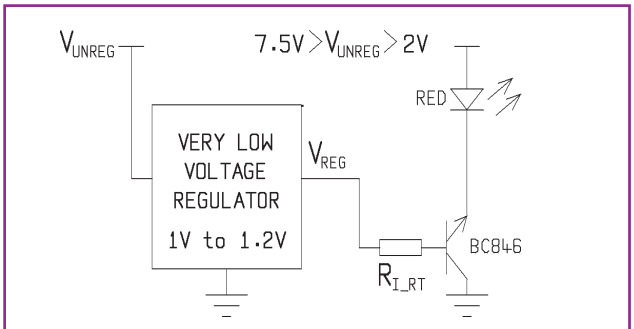



***Figure 2:*** *Low-voltage, red LED power supply indicator using a reverse transistor*

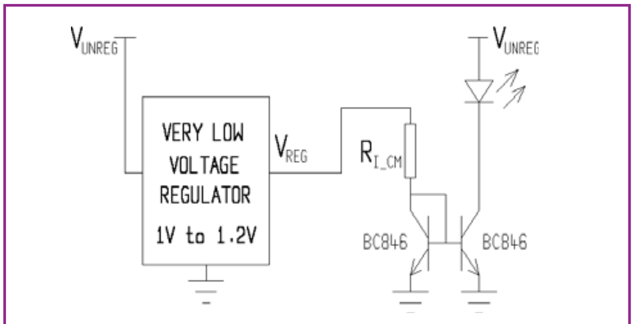



***Figure 3:*** *LED power supply indicator using a current mirror*

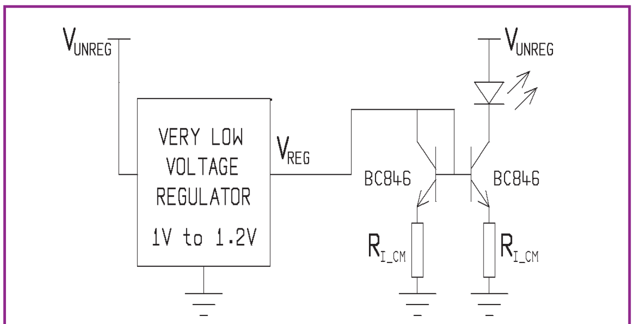



***Figure4:*** *LED power supply indicator using a more accurate and temperature stable current mirror*

# WHY THE OPTICAL RADIATION DIRECTIVE WON'T BE CHANGING YOUR LIFE

**By Chris Williams, UKDL**

Many of the readers of this magazine will be engineers. Quite a few will also be owners or senior managers of companies – this article is aimed at you! The content is based on a workshop held at UKDL, and with kind permission from our colleagues at HPA and HSE, to use the material they presented at the event.

We are accustomed to moaning about the "stupidity" of the laws and regulations coming out from the EU that then control our day-to-day activities. It may surprise you to know that in the UK, some of our regulators and advisory bodies actually seek to stop the implementation of unnecessary regulations, or at least to ensure that they will cause the least inconvenience to us all.

A good example of this is the work that the UK's Health Protection Agency (HPA) and Health and Safety Executive (HSE) is doing in having authorship of the guidelines to employers of their responsibilities under the Optical Radiation Directive, an EU directive.

**WITH THE ADVENT OF NEW HIGHER POWER SOLID STATE LIGHTING SOURCES, PERHAPS IT WOULD BE WISE TO EXAMINE WHAT OUR EXPOSURE TO WAVELENGTH IN THE BLUE REGION IS LIKELY TO BE**

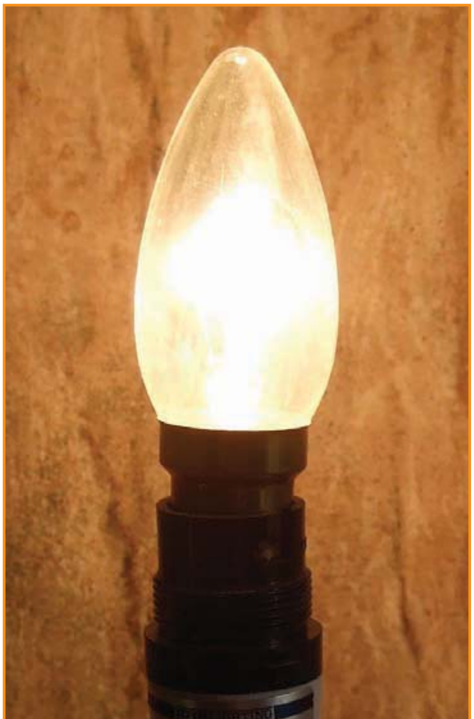
*Artificial lighting at work*

We have several senses – light, sound, touch, smell, etc. The EU requires that employers now take positive steps to ensure that their employees are protected against damage to any of their senses when employed in their workplace. The legislation stemmed from a desire to control workplace hazards to over-exposure to employees – Physical Agents Directive: vibration (white finger), noise (deafness), electromagnetic fields and optical radiation.

This leads to some amusing anomalies. If you are a pop group and have regular gigs at which you play your own loud music, the group owner is now required by law to issue ear defenders to each band member to ensure that the sound levels in their personal space do not exceed legal limits in the workplace. This also applies to orchestras and all other types of activity where sound is created in the workplace.

It doesn't apply to the audience! So, whilst the band or orchestra members may be on stage protected by the latest designer ear defenders, the EU doesn't care about the sound safety of any member of the audience, or any passer-by who may listen in.

Similar legislation was proposed in the Optical Radiation Directive, which was



*Danger at work?*

adopted in April 2006, with full implementation across all EU Members to be complete by April 2010.

However, optical considerations are very different to all other senses. The hazards that employees face in sound, vibration and radiation are all cumulative and may well need control to protect us from excess, but optical radiation either damages or it doesn't. If it were otherwise, the sun would blind us all shortly after birth.

In fact, the most powerful source of optical radiation is not covered by the legislation, which only applies to artificial light sources in the workplace; the light from the sun doesn't count. This does beg several questions: if we become truly green and harvest sunlight for better use for internal illumination of buildings by collecting the sun's rays with (say) a parabolic reflector and directing them in and around an office block or factory, does that still count as natural radiation (outside the regulations) or artificial light (subject to the regulations)?

**Requirements of the Optical Directive**

Employers must now assess the risk of excessive exposure to light radiation from artificial light sources in and around the workplace. If they are not sure, they must measure the light; the allowable exposure is wavelength dependent. This will, probably, result in manufacturers of lighting equipment receiving requests from employers for information and data on those sources.

There are no exemptions in the legislation, which means that lighting and Class 1 lasers are included and there are no requirements to accommodate particularly sensitive people (such as those on photosensitising drugs).

Actually, the requirements of the Optical Directive are already covered by Section 6 of the Health & Safety at Work Act.

We know that is the case – laser hazards and protective measures have been well known for years, and the screening that is necessary in areas where arc or gas welding is taking place.

Implementation of the Optical Directive (in the UK anyway) is intended to be "light touch and fit for purpose". This means no imposition of pre-employment health checks, no imposition on-going health surveillance and assessment only in the event of over-exposure. The maximum radiative doses that are deemed safe are only defined for wavelengths in the range 3µm-180nm, even though the legislation covers wavelengths of 1mm-100nm.

The automatic human response when the eye is exposed to a large amount of optical radiation is to blink and flinch away. This reaction occurs substantially more quickly than the < 0.25s required under the legislation for protection from Class 2 lasers. To not react normally would imply some other impairment, e.g. you are blind drunk, an event that is likely to be covered under existing legislation anyway. It is believed that the main risk is likely to come from optical radiation sources with large blue content where the insensitivity of the eye may not evoke the blink response.

Actually, it is not known if any retinal damage has ever been sustained in the workplace by unregulated equipment, but perhaps with the advent of new higher power Solid State Lighting sources it would be wise to examine what our exposure to wavelength in the blue region is likely to be. The current legislative levels are also based on historic data; there is also a question mark over the validity of the data collected in the 1950s concerning the level of risk of UV light and this work could do with being revisited.

The UK's Health Protection Agency (HPA) is currently drafting non-binding guidelines for SMEs on behalf of the EU Commission. The aim is to ensure that the legislation does not put any further burden on employers above that which already exists. HPA is concerned with reducing risk, not hazards. To implement a policy of 'zero hazard' would render us all incapable of anything. At the moment we have controlled hazardous sources, such as lasers, and trivial light sources, such as lighting, LED on/off indicators, flat panel displays, all of which should be listed as such in the guide.

The grey areas are likely to be profession specific: e.g. do actors and TV staff suffer permanent damage working under high-intensity lighting? Do models have a problem with the flash from the camera and looking into it for hours on end? Do teachers risk damage with regularly looking into the beam of classroom projectors? Is there a knock-on problem for medical technicians working with photodynamic therapy?

In each case, to strictly meet the requirements of the Optical Directive, companies and employers will now need to consider whether they should measure the level of optical radiation that employees would be exposed to in such cases.

For further information on the Directive, please see the official Health and Safety website documents.

Keep blinking – it's good for you!

*Chris Williams is Network Director at the UK Display & Lighting Knowledge Transfer Network (UKDL KTN)*

## REFERENCES:

UK Displays & Lighting KTN
**www.ukdisplaylighting.net**

For further information about the Optical Directive:
**www.hse.gov.uk/radiation/nonionising/optical.htm**

Physical Agents (Optical Radiation) Directive
The Optical Radiation Directive was published in the Official Journal of the European Communities on 27 April 2006 (Ref: L114) under the title of "Directive 2006/25/EC on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (artificial optical radiation)"

Microchip continues to provide innovative products that are smaller, faster, easier-to-use and more reliable. PIC microcontrollers (MCUs) are used in a wide range of everyday products from washing machines, garage door openers and television remotes to industrial, automotive and medical products.
While some designs such as Switch Mode Power Supplies (SMPS) are traditionally implemented using a purely analogue control scheme, these designs can benefit from the configurability and intelligence that can only be realised by adding a microcontroller.
**NOTE:** The Tips 'n' Tricks presented here assume a 3.3V supply. However, the techniques work equally well for other supply voltages with the appropriate modifications.

## TIP 1: IMPLEMENTING A PID FEEDBACK CONTROL IN A PIC12F683-BASED SMPS DESIGN

Simple switching power supplies can be controlled digitally using a Proportional Integral Derivative (PID) algorithm in place of an analogue error amplifier and sensing the voltage using the Analogue-to-Digital Converter (ADC).

The design in **Figure 1** utilises an 8-pin PIC12F683 PIC MCU in a buck topology. The PIC12F683 has the basic building blocks needed to implement this type of power supply: an A/D converter and a CCP module.

The A/D converter is used to sense the output voltage for this particular application. VDD is used as the reference to the A/D converter.

If desired, a more accurate reference could be used. The output voltage is subtracted from the desired value, creating an error value.

This error becomes the input to the PID routine. The PID routine uses the error voltage to determine the appropriate duty cycle for the output drive. The PID constants are weighted so that the main portion of the control is proportional and integral. The differential component is not essential to this system and is not used. Furthermore, the PID constants could be optimised if a particular type of transient response was desired, or if a predictable transient load was to be connected.

Finally, the CCP module is used to create a PWM signal at the chosen frequency with the proper duty cycle.

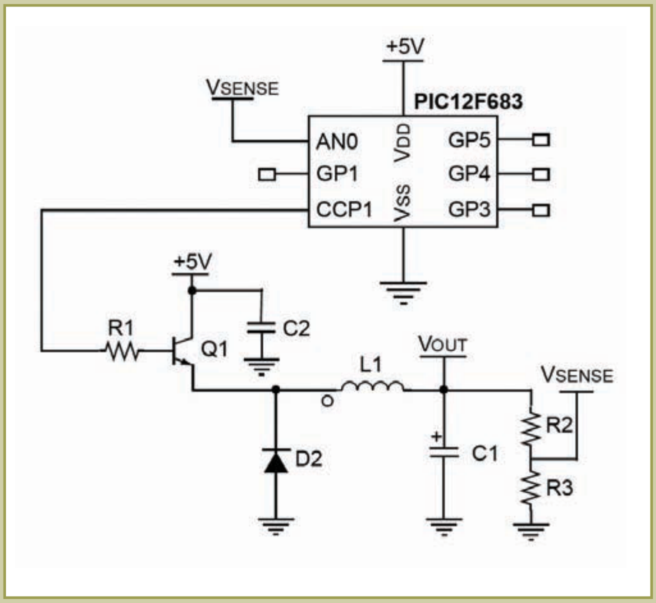



***Figure 1:*** *Simple PID power supply*

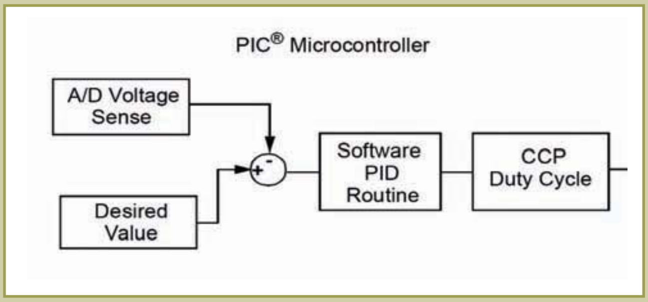



***Figure 2:*** *PID block diagram*

## TIP 2: COMPENSATING SENSORS DIGITALLY

Many sensors and references tend to drift with temperature. For example, the MCP9700 specification states that its typical is ±0.5°C and its max error is ±4°C.

**Figure 3** shows the accuracy of a 100 sample lot of MCP9700 temperature sensors. Despite the fact that the sensor's error is nonlinear, a PIC microcontroller (MCU) can be used to compensate the sensor's reading. Polynomials can be fitted to the average error of the sensor. Each time a temperature reading is received, the PIC MCU can use the measured result and the error compensation polynomials to determine what the true temperature is.

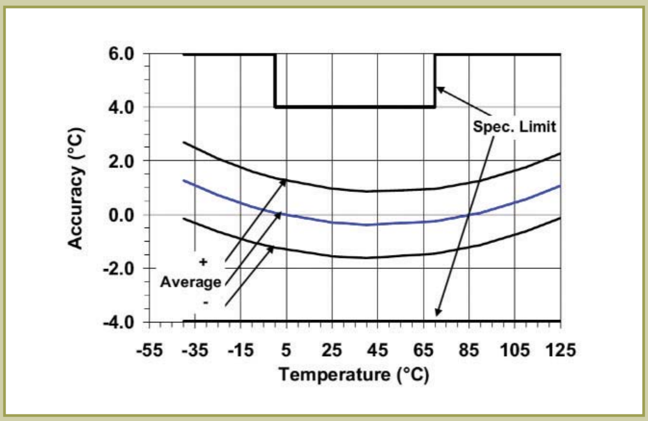



***Figure 3:*** *MCP9700 accuracy*

**Figure 4** shows the average accuracy for the 100 sample lot of MCP9700 temperature sensors after compensation. The average error has been decreased over the full temperature range.

It is also possible to compensate for error from voltage references using this method.

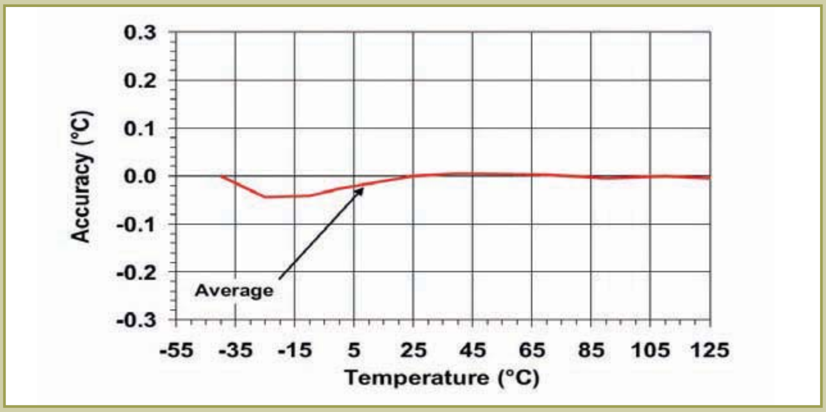



***Figure 4:** MCP9700 average accuracy after compensation*

## TIP 3: USING OUTPUT VOLTAGE MONITORING TO CREATE A SELF-CALIBRATION FUNCTION

A PIC microcontroller can be used to create a switching power supply controlled by a PID loop (as described in **Tip 1**). This type of power supply senses its output voltage digitally, compares that voltage to the desired reference voltage and makes duty cycle changes accordingly. Without calibration, it is sensitive to component tolerances.

The output stage of many power supplies is similar to **Figure 5**. R1 and R2 are used to set the ratio of the voltage that is sensed and compared to the reference.

A simple means of calibrating this type of power supply is as follows:

1. Supply a known reference voltage to the output of the supply.
2. Place the supply in Calibration mode and allow it to sense that reference voltage.

By providing the supply with the output voltage that it is to produce, it can then sense the voltage across the resistor divider and store the sensed value. Regardless of resistor tolerances, the sensed value will always correspond to the proper output value for that particular supply.

Furthermore, this setup could be combined with **Tip 2** to calibrate at several temperatures.

This setup could also be used to create a programmable power supply by changing the supplied reference and the resistor divider for voltage feedback.

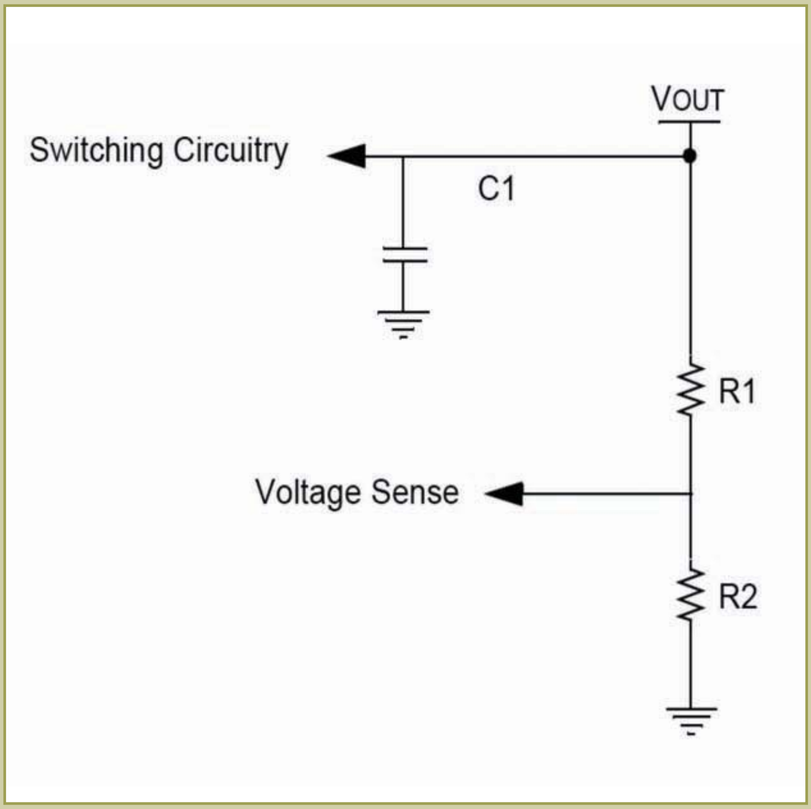



***Figure 5:** Typical power supply output stage*

## TIP: PARALLELING HIGH DENSITY DC/DC μMODULE REGULATORS EASES HIGH CURRENT POWER SUPPLY DESIGN

*By Manjing Xie and Henry Zhang of Linear Technology*

Minimising development time and saving board space are critical for many high performance systems such as network routers, blade servers, cellular base stations and test instruments. The board-mounted point-of-load (POL) DC/DC power supplies in these systems are subject to the same demanding development schedule and solution size. They require fully integrated POL power modules with a built-in inductor, power MOSFET, PWM controller and supporting circuitry.

To reduce thermal stress and achieve high reliability, current sharing is very important when paralleling DC/DC regulator modules. Conceptually, due to the part-to-part variation and output voltage regulation errors, the output voltages of two identical POL supplies can be different even though they are programmed to have the same target value. For example, a 1.5V output POL can have a ±1% error on its output voltage.

When two POL supplies are connected in parallel, the output voltage difference between two modules can be as high as 1.5V x 2% = 30mV. So assuming there is 5mOhm interconnection impedance, the circulation current can be as high as 30mV/5mOhm = 6A. Without current sharing, for a 2-phase, 20A supply with two 10A POLs in parallel, one channel can have 16A current and the other channel only 4A current. The unbalanced phase current can cause serious thermal and reliability issues for the entire system.

A new generation of DC/DC regulators, the LTM4601 family of μModule POLs, has integrated current-mode controllers to provide inherent fast and accurate current sharing capability. The LTM4601 DC/DC μModule regulator is a complete 12A supply. This device is packaged in a 15mm x 15mm x 2.8mm LGA package with an IC form-factor and size. It operates from a wide 4.5V-28V input voltage range.

For high current applications that require PolyPhase POL designs, multiple LTM4601 modules can be easily connected in parallel. **Figure 1** shows how to connect one LTM4601 (with remote sensing) and three LTM4601-1 (without remote sensing) power modules to generate 40A DC/DC step down supply.

Multiple LTM4601 μModules regulators can be paralleled with balanced phase current. Because of the current loop, the internal inductor behaves more like a voltage controlled current source. Current sharing is achieved easily by connecting all the current control signal pins together. In the LTM4601, the COMP pin is both the output of the voltage loop compensation operational amplifier (op-amp) and the reference voltage of the inductor current. Since the transconductance (gm) op-amps are used in the μModule regulator, the COMP pins, which are the output of the op-amps, can be tied together.

**Figure 2** shows the conceptual drawing of multiple gm op-amps in parallel to generate a common current reference voltage $V_{COMP}$. The transconductance error amplifier has a valid input range of 10% of the reference voltage. Even with 1% part-to-part reference voltage variation, error amplifiers are not saturated. In addition, by connecting feedback pin together, only one divider resistor is necessary to set the output voltage.

All of the compensation pins are tied together to achieve current sharing. For modules with phase-locked loop (PLL), each µModule regulator can be synchronised by interleaving clocks to eliminate beat frequency noise at both the input and output terminals.

**Figure 3** shows the measured thermal image of the four LTM4601 modules with 20V input and 1.5V output at 40A load current. The well-balanced temperature indicates that the modules share load current very well.

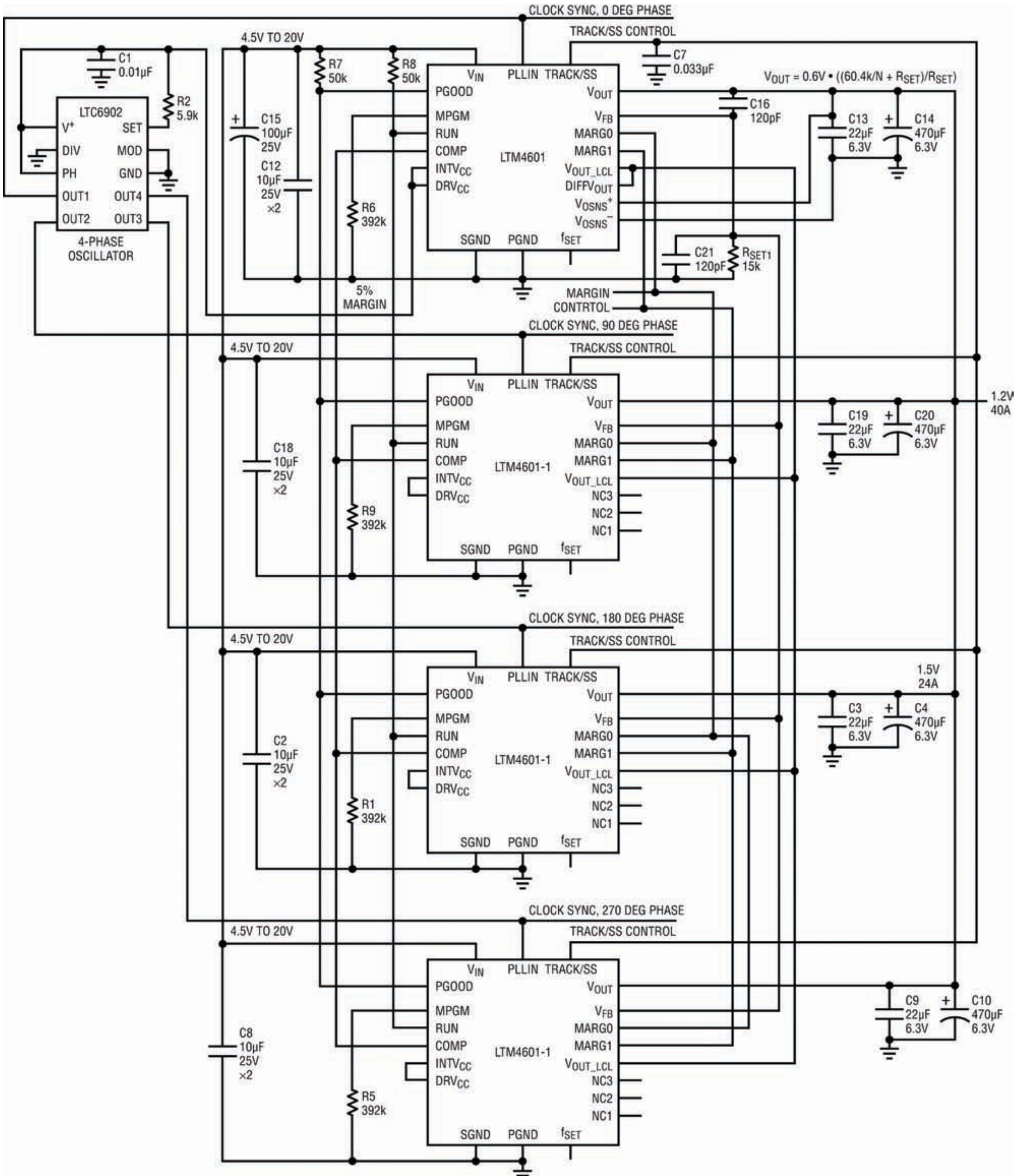



***Figure 1:*** *Connecting four step-down power modules to generate high current*

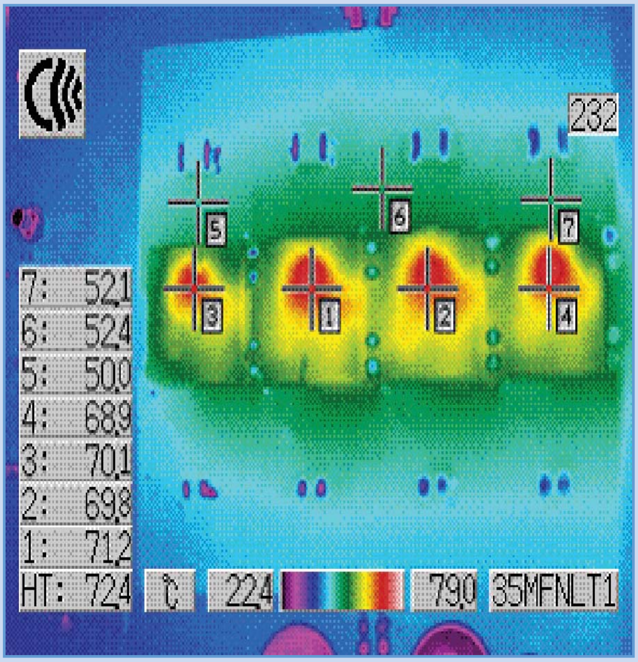



**Figure 2:** *Schematic of paralleled error amplifiers*

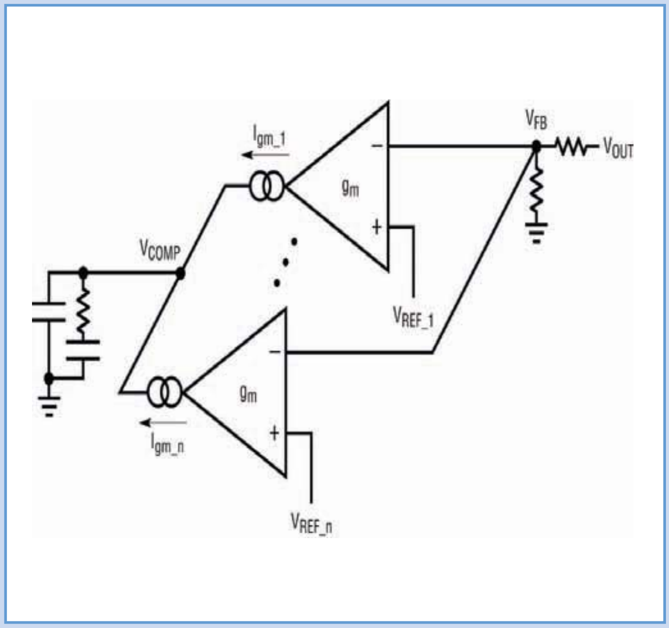



**Figure 3:** *Thermal image of four modules in parallel (Vin = 20V, Vo = 1.5V, Io = 40A)*

# Kontron Debuts Portfolio of AdvancedMC Modules

Kontron debuted a family of AdvancedMC packet processing modules optimised for layer 4 to layer 7 data and security processing, targeting network equipment providers who design 3G/4G BTS, RNC, xGSN and Media Gateways. The Kontron AM42xx series of AdvancedMC Intelligent IO modules are designed with the Cavium Networks OCTEON Plus CN56xx packet processors with 12 64bit MIPS cores with up to 14.4 Billion MIPS64 instructions per second (14.4 GOPS). They are the first to be designed with high-density, high-bandwidth serial IO technology compared with legacy parallel IO technology. What emerges is a much more cost-effective AdvancedMC module design that ensures manufacturers a competitive advantage in taking next-generation equipment to market.

There are two modules available: the AM4204 with 4x 1GbE ports to the front and software configurable interfaces to the fabric side (PCIe, 4x 1GbE or XAUI) and the AM4220 with 2x 10GbE to the front and PCIe to the fabric side.

The introduction of the Kontron AM42xx series of AdvancedMC GbE/10GbE Intelligent IO modules is a major milestone in the Kontron AdvancedTCA 10GbE portfolio. An exciting number of new design opportunities unfold when the Kontron AM42xx AdvancedMCs are, for example, integrated with a Kontron AT8904 AdvancedTCA 10GbE switch.

They provide added functionality such as load balancing for web server, SIP server, SSL offload and content or application-aware processing applications.

**www.kontron.com/advancedmc**

# "NEP-Ready" Integrated AdvancedTCA Media Server Platform


Kontron and Surf Communication Solutions announced the completion of a fully validated AdvancedTCA-AdvancedMC fixed-mobile media server platform. This leads to Network Equipment Providers (NEPs), a compelling commercial-off-the-shelf High Availability (HA) platform ideal for IP-based media processing applications that support today's content delivery subscriber services including IPTV, VoD and Mobile TV.

At the core of the interoperability testing of Surf's SurfRider/AMC AMC DSP module – designed with the TMS320C64x series of Texas Instruments DSPs, including up to 8 DSPs per board such as the TMS320C6412, TMS320TCI6482 and the latest multi-core DSP TMS320TCI6486 – is the Kontron AT840x family of AdvancedTCA Carrier blades. This has enabled Kontron to pre-integrate a new media server platform based on its existing Kontron OM9060 AdvancedTCA Platform, populating it with two redundantly configured AdvancedTCA carrier boards with up to six SurfRider/AMC DSP modules and two Kontron processor AdvancedMC modules used as session controllers.

Media servers are typically deployed in Central Office/Edge networks to process and play out any media over IP, such as voice (in VoIP) or video (in Mobile TV). In the context of IMS (IP Multimedia Subsystems) or NGN (Next Generation Network), media servers perform content and streaming adaptation in real time for a large number of concurrent users.

**www.kontron.com/atca**

# The Only Software with Object-Oriented GUI


Keithley Instruments introduced version 2.0 of its SignalMeister Waveform Creation software, a next-generation RF development tool. SignalMeister 2.0 features a new, "object-oriented", graphical user interface (GUI) and is the only waveform creation software on the market that uses a click-and-drag objects-based approach, allowing RF engineers to intuitively create basic and complex waveforms using graphical objects.

This object-orientated GUI is optimised for MIMO signals and allows users to visually create a dramatically expanded range of test waveforms. SignalMeister 2.0 enables the creation of the entire range of signals in accordance with WiMAX and WLAN wireless connectivity standards and 3GPP and 3GPP2 cellular standards.

SignalMeister is a PC-based, next-generation waveform creation tool that lets engineers create highly complex signals required for today's RF testing needs quickly and flawlessly.

Users download the waveforms they create to Keithley's series 2900 RF Vector Signal Generators. SignalMeister is ideally suited for the testing needs of manufacturers supplying mobile phones, wireless connectivity devices, RF chip sets and components in both production and R&D environments.

**www.keithley.com/signal**

# Keithley Adds WiMAX Testing to its RF Test Instrument Family

Keithley Instruments announced a set of signal creation and analysis tools that extend its RF test capabilities to include WiMAX signal testing. Keithley's new solution is built on a next-generation hardware platform that makes it simple and inexpensive to add support for new signal standards, such as 802.16e mobile WiMAX Wave 2 testing with up to 4x4 MIMO channels, without requiring expensive hardware upgrades or different instrumentation.

In addition, the new instruments support testing to lower frequency bands down to 400MHz, an increasingly important capability for new WiMAX solutions being developed.

Keithley's RF test solutions are based on the firm's 2820 RF Vector Signal Analysers and 2920 RF Vector Signal Generators. Because these test instruments rely on next-generation DSP-based software-defined radio (SDR) architecture, they are capable of making extremely high speed measurements thoroughly and accurately.

The SDR architecture enables Keithley's highly flexible offering with instruments that are easy and less costly to upgrade as new wireless and cellular standards are introduced. In addition, the same Keithley signal analysers or signal generators can be used in an automated production environment or can be moved easily to the bench for standalone test applications.

**www.keithley.com**

# 2-in-1 Multi-Card Connector for µSD and SIM

Yamaichi Electronics now offers a new multi-card or combination card connector. The FRS016T-2000-0 offers two slots offset by 90° and stacked in one casing for microSD flash memory cards as well as SIM chip cards. The SIM card is operated manually and the microSD card via the convenient push/push mechanism.

The small form-factor with an installation height of merely 2.85mm makes the card connector ideal for the tightest spaces in mobile phones and other end devices. This combination is frequently used for SIM module and microSD card applications. As an individual component for these two card types, the FRS016T-2000-0 meets the requirement the best way. At the same time, it reduces the development and space requirement for any conceivable design.

Card slots with a 90° offset stacked above each other allow for a flexible design-in, where the SIM card is inserted into the internal connector in the casing as stipulated, e.g. below the battery pack. The microSD card slot however, is accessed on the casing exterior. This design complies with the Input/Output connector.

The electromechanical component FRS016T-2000-0 is RoHS-compliant and is delivered in tapes-on-reel for automated SMT assembly.

**www.yamaichi.eu**

# 'Build Your Own Cable Assembly' Website

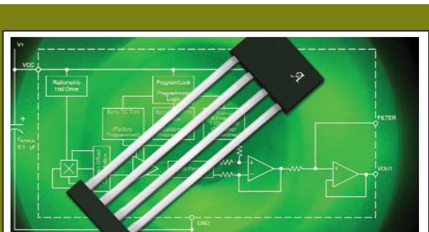
3M has introduced a new website that enables users to build their own cable assemblies. Using the so-called "Find-A-Part" software application and the graphic oriented VCAT (Virtual Cable Assembly Tool) software, users can design an infinite number of possible cable assemblies for their own custom use.

The new, streamlined, website design also makes it much easier to find product features and benefits thanks to a dynamic part configuration and the latest in browse and search technologies. The website allows users to dynamically configure part numbers themselves, eliminating common errors.

Also available on the site are related technical and sales documents and 3D models. Customers can check distributor inventory, submit a request for product sample or request a quote using simple web forms.

**www.3M.com/interconnects**

# Low-Noise, Programmable, Linear Hall-Effect Sensors



New from Allegro MicroSystems Europe is the A1360/1/2 family of programmable linear Hall-Effect Sensor ICs that feature extremely low noise levels and very high bandwidth, making them ideally suited to high-frequency automotive or industrial current sensing applications.

The A1361/2/3 part numbers are ratiometric Hall-Effect sensors, which provide a voltage output that is proportional to the applied magnetic field. Each BiCMOS monolithic circuit integrates a Hall-Effect sensor element, temperature-compensating circuitry to reduce the intrinsic sensitivity drift of the Hall element, a small-signal high-gain amplifier, a clamped low-impedance output stage and a proprietary dynamic offset cancellation technique.

These new devices feature noise levels as low as 8mV peak-to-peak and bandwidth adjustable between 100Hz and 50kHz. They are also the first products to use Allegro's new 1mm thin, 4-lead, single-inline package, which allows for extremely small gaps in the concentrators (C-core style) to improve the signal/noise ratio and sensitivity.

The sensors are extremely stable over temperature variation, with quiescent voltage output and sensitivity maintained to within ±0.025%/degC. They also exhibit precise recoverability after temperature cycling.

The accuracy of these devices is enhanced through the programmability on the output pin of the device. A capacitor to ground on the filter pin of the A136x can be used to tune the device bandwidth over the full range from 50kHz to less than 100Hz.

**www.allegromicro.com**

# New JTAG Module in the Aeroflex 4200 Series ICT

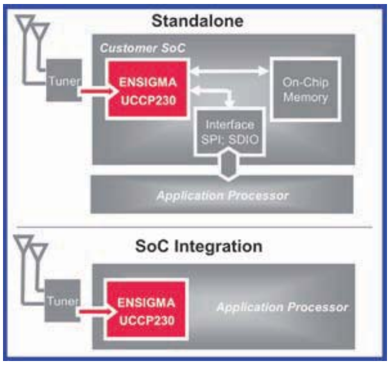
JTAG Technologies has announced the availability of the JT 2147/AGP boundary-scan interface for use with Aeroflex high-performance In-Circuit Testers (ICTs). With the availability of the JT 2147/AGP, both current and previous generation 4200 Series systems can be more easily upgraded with a high-performance JTAG Technologies boundary-scan controller.

The JT 2147/AGP provides an enhanced method for bringing boundary-scan Test Access Port (TAP) signals close to the point of contact within the ICT system. This technique greatly improves signal integrity and simplifies fixture design. A single JT 2147/AGP can be installed on the Aeroflex GPIO custom interface module and provides ground isolation plus a switching matrix to route TAP signals to pins on the test fixture.

Users of integrated JTAG Technologies products benefit from off-line, fixtureless test preparation and the re-use of stand-alone applications at other stages of the product life cycle, such as prototyping and field service. Furthermore, the combination of ICT and boundary-scan draws on the strengths of both technologies and achieves excellent cost-effectiveness through reduced test fixture complexity.

**www.jtag.co.uk**

# Extended Low-Power Receiver IP Platform




Imagination Technologies announced that it has added NorDig-Unified 1.0.3.compliant DVB-T to its licensable receiver IP platform family. With the addition of support for NorDig, the stringent Digital Television platform test specification, ENSIGMA UCCP230 supports the widest range of standards available on a single receiver platform and offers the best balance of functionality, performance and size.

With support for NorDig can deliver a DVB-T solution capable of passing the most rigorous use-case tests, alongside high-Doppler DVB-H. This perfectly complements UCCP230's wide range of terrestrial TV, mobile TV and radio standards. As well as adding wider DVB-T content options to mobile TV devices, the addition of Nordig support to UCCP230's existing ISDB-T full-seg TV capabilities makes it the ideal choice for highly integrated TVs and STBs.

The ENSIGMA UCCP230 multi-standard receiver IP platform requires only the same silicon area as typical single standard solutions. By supporting multiple standards on the same IP platform Imagination's licensing partners are significantly reducing the total cost of ownership for the addition of multi-standard broadcast receiver capabilities on mobile devices, TVs and STBs.

**www.imgtec.com**

# IR Expands Its SupIRBuck Family


International Rectifier (IR) recently expanded its SupIRBuck portfolio of versatile wide-input, single-output, integrated, point-of-load (POL) DC-DC voltage regulators with the introduction of the IR380x family for consumer embedded POL applications up to 14A. Size and feature set are optimised for high performance consumer applications, including set-top boxes, LCD TVs, game consoles, desktop PCs and graphics cards.

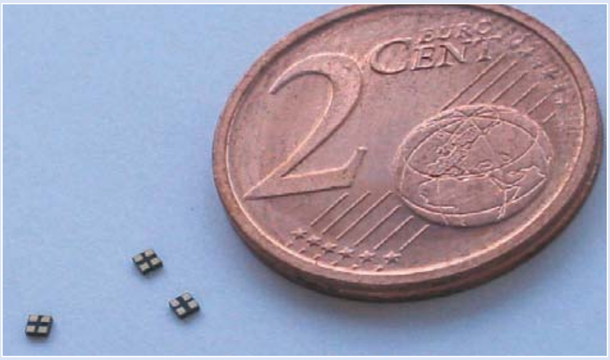
The new application-specific devices integrate IR's high performance control ICs optimised with benchmark HEXFET MOSFETs in a compact 5mm x 6mm power QFN package to enable up to 70% space savings compared to discrete solutions, while maintaining an equivalent overall total solution cost.

The SupIRBuck family of voltage regulators is designed for 4, 7 and 12 Amps of output load current at 600kHz and 6, 9 and 14 Amps at 300kHz respectively. Key features include wide range input of 2.5V to 21V and output range of 0.6V to 12V, pre-bias start-up, a choice of two fixed switching frequencies, hiccup current limit, thermal shutdown and precise output voltage regulation.

The IR380x family's thermally enhanced packages with slim 0.9mm profile, allow mounting on the back-side of the motherboard for additional space saving and enable no-air flow operation without heat sink below 10A.

**www.irf.com**

## Small Footprint Nanopower Magnetic Field Sensors



The new GMR (Giant Magneto Resistive) digital switch is designed to run at low voltages and extremely low currents. The devices are manufactured using patented spintronic GMR technology for miniaturisation, sensitivity, precision and low power.

The output is configured as a magnetic "switch", where the output turns on when the magnetic field is applied and turns off when the magnetic field is removed. The IC is internally duty cycled at approximately 0.1% to conserve power. An integrated latch ensures the output is available at all times.

The IC is available in a new ULLGA leadless package, which measures just 1.1mm x 1.1mm x 0.4mm. The ADL0xx-14E parts are ideal for battery-powered devices such as gas and water meters, portable instruments, or any place where an extremely low power magnetic field sensor is required. The applied magnetic field can be of either polarity, and with applied voltages of 3.6V or less, the part consumes less than 1 microwatt.

The product consists of a 0.6mm x 0.6mm die containing a GMR sensor element, CMOS signal processing circuitry to convert the analogue sensor element output to a digital output, and an oscillator and timing circuit for duty cycling.

**www.rhopointcomponents.com**

## Y-Sol Series for Structured Wiring of Photovoltaic Systems

Yamaichi Electronics has presented the new product series Y-Sol for the complete wiring of PV systems for the first time at the Intersolar 2008 trade show in Munich, Germany. PV module junction boxes for silicon and thin film modules, as well as connector and cables, ensure reliable operation of the systems for their entire life as well as their highest possible efficiency level.

Junction boxes with IP65 protection class are available for both module technologies – silicon modules (monocrystalline and polycrystalline), as well as thin film modules. The junction box comprises, with silicon wafer based modules, one or more voltage-controlled bypass diodes depending on the application. There is one bypass diode at most in the junction box for thin film modules. If one module fails due to shadowing or soiling, for instance, the bypass diodes will ensure that the current is conducted around the affected cell areas.

One feature of the Yamaichi junction box, also called J-Box, is the use of SMD diodes instead of regular radial diodes. SMD diodes have a lower thermal resistance than radial diodes. The thermal resistance of radial diodes is usually about 4K/W, but the Yamaichi one has a thermal resistance of only 1.5K/W.

**www.yamaichi.de**

## High Ripple, Low Inductance Capacitors

AVX Corporation has introduced its FFVS range of medium power capacitors which feature very high frequency operation and the lowest stray inductance of any product on the market. Suitable for applications such as very high frequency ripple (> 100kHz) DC filtering for induction heating, the devices exhibit an inductance of less than 10nH on certain models.

Capacitors of 600V are offered in capacitance values of 22, 90, 140 and 195µF. The 800V devices are rated at 58, 92 and 128µF, and the 900V models at 34, 40, 65 and 90µF. Featuring a dry polypropylene dielectric technology, FFVS capacitors are very reliable with an extended life.

The new FFVS series capacitors are suitable for situations where standard devices are not able to handle the high frequency ripple currents experienced. Typical applications include medical power supplies used in X-Ray and MRI equipment.

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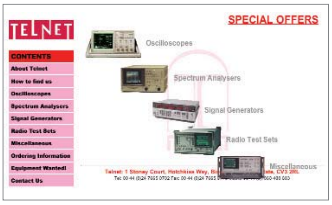

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## AWARDS

# Silver Award for AWS Group Recognises SC21 Leadership Position

AWS Group, one of UK's independent Electronic Manufacturing Solutions (EMS) providers, has been presented with the SBAC's Silver Award for exceeding targets set by the Society in its SC21 (21st Century Supply Chain) change programme.

AWS Group is the first company to be awarded, and has already been acknowledged by the Society of British Aerospace Companies as leading the field of about 350 suppliers signed up to the UK Aerospace market initiative.

SC21 has been designed by the SBAC to accelerate the competitiveness of the UK's aerospace and defence industry by raising the performance of its supply chains. It has three levels: bronze, silver and gold.

AWS's 12 months delivery performance to its sponsor, General Dynamics UK was above 99% and quality was measured at 248 defects per million opportunities (DPMO). The company scored over 500 on its lean manufacturing and business excellence framework performance and the combined assessment means that AWS has been assessed as meriting a silver award. AWS has become the first company under SC21 to achieve this level – a truly significant achievement in under 12 months.

CEO Paul Deehan (left) said: "I believe that successful companies are the ones that drive themselves - those who don't sit back - and in particularly the ones who are pro-active in driving continuous improvement in operations across their own business and down into their own supply chain."

www.awselectronicsgroup.com