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EUROPE
Power Control Intelligent Motion
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Comprehensive, Low-Cost Monitoring of Standby Batteries




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Power Systems Design EUROPE

Power Systems Design

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Summer Heat

It was good to see everyone at the PCIM 2006 Exhibition & Conference. There were close to 300 companies exhibiting and over 500 registered conference attendees.

As summer approaches and Europe heats up we look forward to taking holiday with friends and family. Many of us will drive to holiday and be reaching for our air conditioners and other appliances of convenience that will help make our environment more enjoyable.

In the world of power electronics, that is what we strive for. Better more efficient products that will enhance our lives and better the environment around the globe.

In this issue of Power Systems Design Europe you will find our cover story by LEM explaining their comprehensive, low cost monitoring of standby batteries.

This current LEM technology was based upon the original work done by Nigel Scott and the University of Manchester Institute of Science and Technology, who produced and patented the world's first analysis method to quantify the electrochemical parameters of online standby batteries.

Our regular columns include:

PowerLine: Linear Technology introduces a dual 36V Step-Down LED Driver delivering up to 1.5A/Channel & offers 3000: 1 True Color PWN Dimming.

PowerPlayer: Integrated Power Products-The New Look of Power Semiconductors authored by Christopher Rexer of Fairchild Semiconductor

Marketwatch: Reflections on PCIM Europe 2006, by our popular columnist Chris Ambarian of iSuppli Corporation. Chris attended the conference as well as the show and gives us the details.

As you will see, we have a very nice line up of technical features including:

- Cooling Power Conversion Designs by The Bergquist Company
- Novel Low Leakage Current by IXYS Semiconductor
- Evolution of Power Over the Ethernet by Linear Technology
- Series of Leading Edge 100V MOSFETs by Infineon Technologies AG
- Heel Crack and Lead Free Soldering by Fairchild Semiconductor
- Drive Inverters Simplify Automated Assembly by Siemens Schweiz AG
- Battery Authentication Improves Battery Security by Texas Instruments
- Harmonic and Flicker Testing by Thurlby Thandar Instruments Ltd.

We are committed to serving the technical needs of Europe's power electronics industry and believe that good content comes from you the power engineering professional. If you have good material you wish us to consider for publishing within the pages of the Power Systems Design Franchise, please visit the editorial submission section of our website, www.powersystemsdesign.com, review the requirements and contact us.

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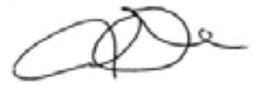
Enjoy your summer!

Cheers!



Jim Graham
Publishing Director
Power Systems Design Franchise

Kathleen McGinty at WindEnergy

WindEnergy–International Trade Fair Hamburg had Kathleen Alana McGinty, Secretary, Department of Environmental Protection in Pennsylvania presenting "The Pennsylvania Model"

Pennsylvania is building the nation's first waste coal-to-diesel fuel plant. It will produce diesel and jet fuels and generate enough electricity to power more than 40,000 homes. An economic stimulus program of $2.3 billion in government capital that is strategically investing in Pennsylvania industries, including $15.6 million in loans and grants for the development of the first windmill blade manufacturing plant in the nation. Solar Power has a main focus based on established Semiconductor Expertise in Pennsylvania. Fairchild for example runs the world first 8 inch Power Semiconductor Fab. in Mountaintop PA since the late 90th. A platform for more technology development including solar power. The state provided capital support for a state-of-the-art biofuels injection facility. Every year the plant will replace 3.2 million gallons of foreign oil in the state's diesel supply with domestically produced bio-fuel. A plan to build new state-of-the-art clean coal fired electric generating facilities. The plan, called EDGE–Energy Deployment for a Growing Economy–is a unique partnership to support Pennsylvania's manufacturing firms Setting energy efficiency standards for the state government fleet, including cutting out the gas-guzzlers and directing fleet managers to purchase smaller and higher fuel-efficient cars and mandating 25 percent of the fleet of SUVs and light trucks be hybrids.

Kathleen was designated a "Global Leader for Tomorrow" by the World Economic Forum in Davos, Switzerland in January 1996. During her tenure in the U.S. Senate, Secretary McGinty worked to promote U.S. leadership in the manufacture of advanced technologies while also serving on U.S. delegations negotiating global environmental treaties. She chaired the White House Council on Environmental Quality and acted as Deputy Assistant to President Bill Clinton.

In 2003, Secretary McGinty became the first woman to head the state Department of Environmental Protection, a 3,000-employee agency with a mission to protect Pennsylvania's air, land and water from pollution and provide for the health and safety of its citizens through a cleaner environment. Secretary McGinty's emphasis is in creating approaches to environmental problems that generate economic growth and encourage advanced technology development in Pennsylvania.

www.governor.state.pa.us

C&D appointed Sales Manager for Germany

Power supply, DC/DC converter and magnetics specialist C&D Technologies has strengthened its sales team with the appointment of Klaus Smieskol. Based from the company's office in Munich, Klaus will have regional sales responsibilities for west and mid-Germany.

Klaus brings considerable industry experience to his new position having spent the last seven years working for Computer Anwendung fuer Management GmbH, where he was responsible for managing several of the company's key accounts. He also has significant experience working on electronic component design-in for both distributors and manufacturers. Klaus holds a degree in electrical engineering (Dipl. Ing.) gained at the highly respected Technical University of Munich (TUM)

Commenting on his new appointment Klaus said: "It is an exciting time to be joining C&D Technologies in Germany. The company has an extensive class-leading standard product range and comprehensive technical capability to support custom solutions. This is coupled with a strong distribution channel to put the company in a great position to further strengthen its already dominant position in the market."

www.cd4power.com

ON Semi Completes 8-Inch Wafer Fab Acquisition

ON Semiconductor announced that its primary operating subsidiary, Semiconductor Components Industries, LLC, has completed the purchase of LSI Logic Corporation's Gresham, Ore., wafer fabrication facility and certain other semiconductor manufacturing equipment for a total price of approximately $105 million, under terms of a definitive agreement executed on April 5, 2006. The Company paid LSI Logic approximately $90 million in proceeds to date, with the balance due within 90 days of closing according to the agreement.

ON Semiconductor has hired substantially all of the LSI manufacturing employees currently working at the Gresham facility. The purchase of the Gresham wafer facility significantly enhances ON Semiconductor's internal manufacturing capabilities. With the completion of the this transaction, the Company has gained the skilled process development engineers, operational expertise and process development know-how to help enable it to develop a larger mix of high volume, low cost, high-performance submicron analog and digital power products down to the 0.18 micron (µ) level, with toolset capabilities down to the 0.13µ level in the future.

www.onsemi.com

New Chairman at SPS/IPC/DRIVES Conference

Prof. Dr. Walter Schumacher, TU Braunschweig takes over the responsibility for the Drives part at SPS/IPC/DRIVES Conference in Nuremberg, 28 - 30 November 2006.

The SPS/IPC/DRIVES Conference is the leading show for electrical automation in Europe. The platform is the dialog between research and development and the end users.

The papers for the conference are selected by experts from science and industry.

Prof. Dr. Walter Schumacher will perform his task together with Prof. Dr.-Ing. habil. Günther Brandenburg, TU Munich. Prof. Dr.-Ing. habil. Günther Brandenburg will hand over all responsibility to Prof. Dr. Walter Schumacher by next year. Prof. Dr. Walter Schumacher is the head of the Institute for control at the Technical University Braunschweig. His focus areas are the mechatronics , the electrical drives and vehicle robotics.

www.mesago.de

Artesyn Shareholders Approve Acquisition by Emerson Electric

Artesyn Technologies announced today that its shareholders have voted to approve the acquisition via merger of Artesyn by Emerson Electric Co. At a special meeting of Artesyn shareholders held today, the merger was approved by more than 99% percent of shares that were voted, and well over the approval requirement of a majority of the outstanding shares eligible to vote.

Under the terms of the merger, each outstanding share of Artesyn common stock will be converted into the right to receive $11.00 in cash. The merger became effective earlier today. After the close of business today, Artesyn will no longer be a public company, and its shares will not trade on Nasdaq.

www.artesyn.com

Digital Power Revolution Still Years Away

Volume shipments of digitally-controlled power supplies are likely to be at least two years away according to latest IMS Research forecasts in The Worldwide Market for Power Supplies–2006.

"Despite significant recent media attention, global revenues for 'full digital' products are not expected to exceed $100 million until at least 2009, whilst penetration for 'hybrid digital' products is forecast to be much greater, though still several years away", commented report author Ash Sharma.

The recently published report estimates the merchant power supply market to have been worth $13.6 billion in 2005 and is forecast to achieve modest growth between 2006 and 2011. Strongest growth is forecast for the AC-DC market driven by strong demand for external adapters and chargers from consumer applications and notebooks as well as continued investment in the IT sector. Weaker growth is forecast for the DC-DC converter market due to intense price erosion, encroachment of discrete solutions and reduced demand from certain key application sectors.

The Worldwide Market for Power Supplies contains latest forecasts for both the AC-DC and DC-DC markets based on 2005 sales data with independent and objective projections for 'digital power', 2005-2011 forecasts for the market by package type, geographic region, power ratings, application sectors and architecture and a number of market share estimates.

www.imsresearch.com

Power Events

- ***EPE-PEMC 2006,*** *Aug 30 - Sep 1, Portoroz, Slovenia, www.ro.feri.uni-mb.si/epe-pemc2006*
- ***MICROSYSTEM,*** *October 5 - 6 , Munich, www.mesago.de*
- ***H2Expo,*** *October 25-26, Hamburg, www.h2expo.com*
- ***ELECTRONICA 2006,*** *Nov. 14 - 17, Munich, www.electronica.de*
- ***SPS/IPC/DRIVES 2006,*** *Nov. 28 - 30, Nuremberg, www.mesago.de*

World's First 212W AC/DC Switcher in a 3x5 Inch Package

XP Power has brought together a series of proven power supply design techniques in a new and innovative way to create the world's smallest 212W, single output AC/DC switcher dubbed the EMA212. Designed for communications applications, the power supply has been developed to meet the needs of networking equipment, voice over IP systems, wireless LANs, servers, storage area networks and post-production broadcast equipment. Designers of these systems demand higher power from AC/DC units in industry-standard 1U formats as processing power and functionality grows within tight space constraints. The EMA212 is the first AC/DC switcher to deliver over 200W across the full universal AC input range from an industry-standard 3 x 5 inch (76.2 x 127mm) footprint. It is 1.34 inches (34.04mm) high and achieves 10.55 Watts per cubic inch power density without compromising performance or functionality.

With efficiency over 90% at full load, the EMA212 needs only 12 CFM airflow for full power operation at up to 50 degrees C ambient and will operate at up to 70 degrees C ambient with de-rating, eliminating the need for a wind tunnel within the mechanical design of the end equipment. The main output is 12 or 48VDC but each power supply also has a 5V, 100mA standby output and a 12V, 1A output for powering a fan. The unit incorporates a fully featured signal set including AC fail/DC OK, active PFC, remote on/off and active current sharing. The following complementary design techniques were combined to achieve the performance of the EMA212.

The size of the input filter was reduced with a 2-stage design using miniature, high permeability cores. Stacked mounting of the cores minimises the printed circuit board area needed and maximises cooling effectiveness. The power factor correction circuit uses a silicon carbide (SiC) diode to gain a further 1% efficiency over a traditional diode and snubber circuit combination, while a stepped-gap inductor, operating in continuous mode, reduces peak switching current and minimises filter requirements. Switching losses are virtually eliminated by using a resonant zero current switching (ZCS) topology for the main converter circuit. Switching occurs at the zero current point from 0 – 100% load. Furthermore, a 100 kHz switching frequency enables the use of small magnetic components without compromising efficiency. Also in the main converter, a ceramic substrate replaces the conventional heat sink, offering additional space savings. The same thermal management technique is used for the output rectifiers. Here, the adoption of synchronous rectification eliminates nearly all switching losses, keeps noise levels low, and minimises both costs and board area. Power factor correction (PFC) is achieved using a once cycle control (OCC) circuit, rather than an average current control mode operating over several cycles. This OCC technique eliminates six passive components, saves PCB space and reduces cost.

Overcurrent, overvoltage and short circuit protection are all built into the EMA212 and the power supply meets all major international specification for safety and EMC performance.

www.xppower.com

Power Player

Integrated Power Products–The New Look of Power Semiconductors

By Christopher L. Rexer, Fairchild Semiconductor

The continued need for the innovative use of electrical power propels our industry. Challenges faced by product developers and power device suppliers include cost reduction, improving efficiency, or adding features and functionality. The consumer demand to provide new product solutions drives our industry for continuous improvement. The trend of combining power devices and drivers in advanced packages as an "integrated power product" is becoming a fundamental element of power management solutions. Integrated power management solutions help system designers provide product solutions with improved performance, shorter product development cycle times, improved manufacturability and higher reliability. Power management system performance improvements have been achieved in part through technological advances of discrete power devices. For example, there has been a tenfold improvement in power MOSFET conduction losses over the past 15 years. The reduction of gate charge and body diode recovery dynamic losses has been addressed through advancements in design and processing techniques. Power semiconductor companies with this technical mastery of discrete power device development are able to provide the power silicon necessary for successful integrated power products.

Similarly, advances in assembly techniques and package design are an important element of integrated power products. The use of thermally efficient materials and multichip bonding techniques are key building blocks. Advanced electrical, thermal and mechanical simulation techniques are employed for validating these designs. Modern manufacturing and test facilities ensure the repeatability and quality of the finished product.

Increasingly creative circuit designers have implemented a number of key topologies improving circuit efficiencies.

Synchronous rectification and inverter driven motor control topologies are such examples. The emerging integrated power products combine the advanced silicon power devices, drivers, and advanced packages to support these topologies in a single integrated product.

As the power management requirements become more stringent due to regulatory requirements, the design of solutions with advanced topologies and discrete components has become increasingly challenging. For example, circuit board parasitics and the interaction of these with the discrete power devices has become a challenging issue for optimized product performance and electromagnetic compatibility (EMC).The dynamic behavior of discrete power devices is fast becoming an integral element of the circuit performance. The characteristics of modern discrete power devices are becoming more manufacturer-specific, making the circuit optimization more difficult. Integrated power product design provides the ability to match power device characteristics with package characteristics for optimal and repeatable performance.

Semiconductor manufacturers are in a position to provide the best solutions for these integrated products. The ability to optimize power chip technology in concert with module packaging elements provides high performance and robust integrated solutions. This integration has been a key investment within Fairchild Semiconductor, and has taken place throughout the industry. These integrated power solutions are developed for key applications.

Motor control solutions for white goods and air conditioning applications as inverter-driven motion are a key area of integrated solutions. A large segment of the Fairchild Smart Power Module (SPM) family of products is designed specifically for these applications. A culmination of expertise in motor control systems, power device design, and advanced package design has been focused on the SPM solutions. The result is an optimized family of products to support requirements ranging from 0.3kW to 3.7kW.

Leveraging the multichip packaging and power device expertise for additional applications, power factor correction SPM products are also available to address the power supply market. The SPM design methodology expertise is available and is being utilized to address additional applications. Examples of these are plasma displays, computing power supplies, automotive ignition systems, protected power switches, and solutions for motor control and power conversion for hybrid electric vehicles. Across several applications, Fairchild currently has 35 SPM products available and more than 40 products in development.

The trend towards integrated power products has gained a foothold in the electrical power industry. As the industry is challenged to provide solutions with shorter design cycles, improved efficiency and expanded features, numerous product choices are becoming available. There are an increasing number of suppliers of integrated power products driving market expansion.

www.fairchildsemi.com

Reflections on PCIM Europe 2006

By Chris Ambarian, Senior Analyst, iSuppli Corporation

It was great to see so many old friends and new faces at PCIM in Nürnberg last month. It was also encouraging to see that so many people were there despite the fact that it's an "Electronica" year. It's without doubt a sign of the health and vibrancy of our little corner of the industry.

So, what did you observe at the show?

The great system-sell

What I observed as a long-time components guy (who had admittedly been away from the show for a few years) is that components are getting harder and harder to find – at least sitting by themselves.

Everywhere one looked, even among many single-component suppliers, one found examples of "solutions." Module suppliers showing the motors that their modules are driving. Maybe even the washing machine that the motor and drive go into. In fact, to me one of the great differentiators at the show was how "complete" the solution (that any given supplier displayed) was.

Most who know me know that I've long advocated the system- or solution-sell, so this was a welcome sight for the most part. But I also noticed what I call the "shiny objects" trend – which is the addition of a lot of flash, but without a corresponding increase in substance. It's all very nice to show the front of a car or a refrigerator or a conveyor belt – but that also needs to be accompanied by a breadboard and an oscilloscope and some stuff to play with on the computer. In the end, this isn't Las Vegas (i.e., the CES show) – this is a show for engineers, ideally to show us up close

how the latest parts work and what we can do with them, and not to just try to distract us with "shiny objects." In this regard, the exhibitors had mixed marks, and there's some room for improvement.

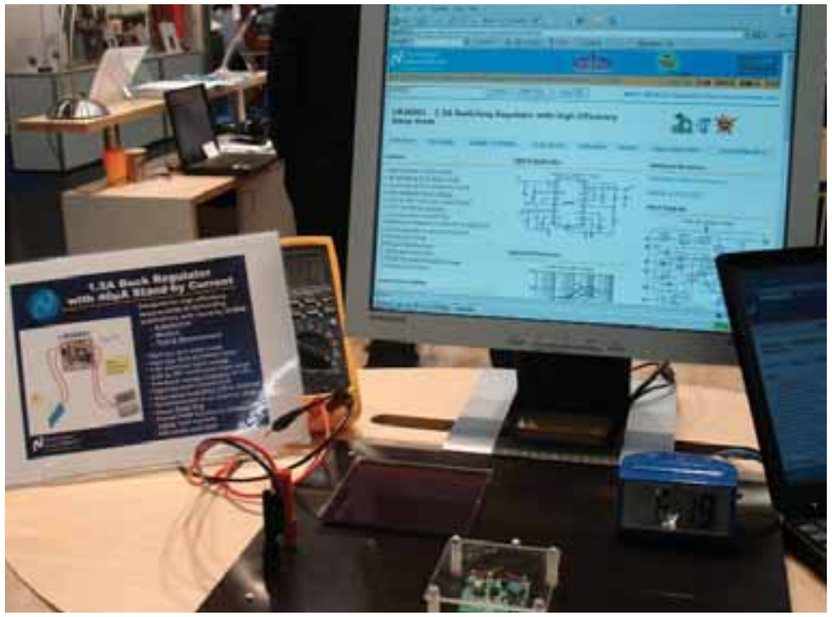
There were however some suppliers who are definitely headed in the right direction. I saw some excellent displays, most typically from those suppliers who make the ever-more-important ICs that control the power devices. In this regard, folks like TI and National really set the pace, with exhibits that nicely balanced their newest parts, plus reference design boards, plus live circuit demonstrations with computer models and information right there on the stand.

But components aren't dinosaurs yet

Though there was a clear trend toward packaging one's line-card all into example end-products, there were still a few good old component folks around too. For them, the focus is still on the products and their performance (and thankfully so in the case of ABB and Semikron, whose end-customers make equipment that would have taken up a lot more space – though it might have been fun to see them try to get a locomotive in there).

This all brings up the ongoing question of what will continue to make sense in the future as a component, and what will be integrated into one chip or one package. This month, TI has announced a 45nm design node using 193nm wet lithography – and they specifically mentioned in their announcement that this technology is designed to leverage their integrated "SmartReflex" power management approach. (It is interesting to note that TI is marketing their solutions for portable electronics with primary emphasis on their power management efficiency!) In any case, this is probably the leading edge example today of power that will be integrated in a full SoC implementation. But these of course won't drive motors.

It can be anticipated that with the next generation of control chips and SOI (silicon on insulator) technology, we will see the economical integration of power up to around 5-10W (of delivered power) on board the main IC chips. In portable applications (i.e., 1-2V), this means more and more of the main loads will be driven from a single chip. At higher system voltages and power levels, you'll see monolithic approaches for battery chargers and POE chips, but you'll still see external discretes driving larger loads for the foreseeable future. This isn't news; what is news will be how much of the control and drive will be able to be brought on board as smaller geometries are applied to power management.



A National Semiconductor display – an example of doing it right, with a breadboard, devices operating, loads, meter, computer, device info. Nice.

Another interesting development in integration was shown at the Mitsubishi booth, where they showed IGBTs with integrated diodes. They have devices with freewheeling diodes for mainstream bridge applications, and they also have 1200V IGBTs with reverse blocking diodes for use in matrix converters. This integration is a clear advantage from a module assembly cost standpoint, and given the relative simplicity of the chip design there shouldn't be much of a silicon cost penalty. What remains to be seen now will be whether there will be any significant performance differentials between these integrated devices and optimized discretes. Their present claims (unverified by me) are that their IGBT performance is equivalent to 3rd-generation planar devices (the market is on 5th generation now), with acceptable performance on the diodes. So if better discrete chips are available, there still may be advantages to those.

Finally, not to forget, it must be recognized that in industrial power applications, a significant portion (sometimes most) of the cost comes from packaging and mechanical design. In this area, there was a healthy amount of innovation on display from both component suppliers (e.g., Mitsubishi, Fuji, and Semikron), as well as from Danish pump maker Grundfos. The guiding principle for all of these exemplary manufacturers is that strong interdisciplinary knowledge in materials and manufacturing engineering can result in a greater impact on cost than silicon improvements can provide.

All in, PCIM Europe showcased a lot of advancements in the world of power, with a decidedly European focus. In the North American shows, the focus of late has been very much on digitalized power conversion; while this was given some treatment at PCIM, the focus was appropriately much stronger on industrial and automotive applications and devices. Even the sessions on hybrid electric vehicles focused on the different requirements of the European market as compared with the Japan and US markets. Given the importance of power semiconductors to the European market, and the specialized and localized focus of the show, I'd say that PCIM Europe is further solidifying its relevance and importance to the European power market.

Christopher Ambarian is a senior analyst with the market research firm iSuppli Corp. El Segundo, Calif.

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www.iSuppli.com

Comprehensive, Low Cost Monitoring of Standby Batteries

LEM current transducers also monitor the world's largest battery

Electronic systems for monitoring, analysis and management of stationary battery systems have, until now, been relatively low-tech and costly.

By Nigel Scott, Technical and Business Development Manager, LEM

This high pricing, forced by low volumes, has made the return on investment times on these systems too long for all except the most critical installations. However, new approaches can now offer better standby management systems, while high volume manufacturing techniques can provide more comprehensive systems at a fraction of the current ownership cost.

Over the last 30 years, the standby battery industry has become dominated by the Valve Regulated Lead-Acid (VRLA) battery, with its cousin the Gel. These sealed cells are used to support a wide variety of critical systems, including uninterruptible power supplies, telecoms and fire & gas safety systems. They must provide power upon mains failure with no discernible break in the supply and are depended upon, not only to support life-critical systems, but trillions of Euros of currency transactions daily. The batteries are held on a small float charge continuously to maintain capacity, and this can have an effect on the various failure modes of the cell, including accelerated plate corrosion, and electrolyte 'dry-out'.

Although based on slightly different chemistries, the characteristics of the VRLA (sometimes called the SLA or sealed lead acid, or AGM, activated glass mat) and the Gel battery have certain similarities, the main one being that they are both much more sensitive to temperature and charging conditions than their predecessor, the liquid electrolyte or 'flooded' cell.

The traditional method of measuring the specific gravity of the electrolyte to estimate the capacity of the individual cell is not possible with VRLA or Gel technology and the only certain method of determining to what extent the battery is capable of supporting its critical load is by autonomy (discharge) testing the battery as a whole.

Most installations have to be shut down during testing to avoid possible damage to their critical loads, and this can be problematical to the services they supply.

To avoid the high cost and disruption these tests entail, non-intrusive electronic methods of continuous monitoring to determine in-service capacity have been developed, and are now widely available. The aim of these systems is to provide enough information about the battery to detect any incipient failures before they happen, hopefully enabling the extension of the service life of the battery as well as preventing catastrophic failure during a power outage.

Today, the battery system parameter most commonly monitored is terminal voltage of each cell or monobloc (a monobloc is two or more cells in the same case), although several manufacturers now monitor cell internal impedance as well, with varying degrees of success. In addition, even the most basic monitoring systems monitor battery discharge current (to facilitate discharge performance monitoring) and ambient temperature.

Continuous battery monitoring is fast becoming generally recognised for its importance in lowering maintenance costs and helping to prevent catastrophic battery failure, particularly in the VRLA/AGM and Gel technologies. What has been lacking is a high quality product at a cost low enough for the average battery user, not just the largest and most sensitive installations.

Now LEM has entered the standby battery monitoring market with an intelligent single SoC (system on chip) solution.

LEM has been actively involved in the battery industry for more than 30 years, as a supplier of isolated, non-intrusive current measuring transducers, current clamps and probes to telecoms, UPS, rail systems and charger manufacturers. For over twenty years, hundreds of thousands of its current measuring devices have been integrated into telecom power equipment racks all over the world and are still being supplied today. LEM current transducers were selected to monitor the world's largest battery, the 40 megawatt Golden Valley project in Alaska. A joint ABB/Saft project, the Golden Valley system operates a 5000 volt DC link, at over 8000 amps.

Now, however, LEM is moving from purely analogue-based transducers into the area of intelligent components and particularly into continuous standby battery monitoring with its Sentinel system. Sentinel is based on an intelligent module, capable of measuring cell and monobloc terminal voltage, internal cell temperature and internal impedance.

LEM's work has already produced several patents in the battery monitoring field, for the advanced analysis of the health of lead acid cells and the non-invasive internal measurement of internal cell temperature.

In the past, the cost of battery monitoring has been as much as 50-70% of the cost of the battery. LEM has worked with OEMs to develop the most comprehensive monitoring system available and to reduce costs to a level affordable by most battery system users. The aim has been to enable all battery users to afford reliable quality monitoring systems.

The current LEM technology is solidly based on the original work done by Nigel Scott and the University of Manchester Institute of Science and Technology, who produced and patented the world's first analysis method to quantify the electrochemical parameters of on-line standby batteries. This work, which won four national and international awards for innovation, is recognised as having changed the thinking in sealed battery analysis from simple impedance or conductance to more complex data set–one that includes cell capacitance. Capacitance was, until recently ignored by the battery monitoring companies as being too difficult to reliably identify for in-circuit cells. Many thought that capacitance could adversely affect the data more easily obtained by measuring 'simple' impedance (AC voltage divided by AC current, giving a single resistance value), or conductance. However, the work begun by Scott/UMIST in multi-frequency analysis and subsequently picked up by several other respected companies and institutions has shown that the identification of capacitance in on-line cells gives data capable of identifying incipient problems much earlier in the failure mode than simple impedance.

Battery monitoring is now recognised as essential in many cases, as is demonstrated by the following example. In a paper given at the Battcon conference in Fort Lauderdale last year, the United Parcel Services Windward data centre presented a case study describing the problems experienced with its standby batteries.

The Windward site has eighteen 600 kVA UPS systems, with a total of 3,750 flooded cells, specified to have a 20 year service life. Despite IEEE maintenance procedures being meticulously carried out quarterly, in year seven the system experienced severe problems on up to 40 per cent of the total cells, which led to the prospect of an unforeseen expenditure of $1.3M in year eight.

After exhaustive teardown tests the conclusions of the engineers were that regular maintenance was not sufficient for early detection of incipient failure. It was concluded that a continuous monitoring system, with trending facilities for individual cell impedance and cell temperature was, for them, essential.

UPS maintenance management believed that only with continuous data could the user hope to: a) predict possible failures before catastrophic problems were encountered and b) have sufficient continuous valid data with which to support a warranty claim.

In this case the battery manufacturers refused the UPS claim, partly for lack of continuous data.

LEM's Sentinel system is composed of interface module kits, a low-cost stand-alone monitor and an 'instant monitor' PCB for integration into OEM equipment. The system is aimed at end users and OEMs and is the first continuous battery monitoring system to be suitable for true integration into other manufacturers' products and systems. As a component manufacturer, LEM's first priority is to sell components, and

Figure 1. LEM's Sentinel stand-alone monitor.

it is therefore happy to provide source code and communications information and drawings where necessary. LEM is the first battery-monitoring provider to offer a components-only solution to the market.

At the end of a discharge and recharge cycle, which is normally something that may only happen once a year or so in stationary batteries, the battery returns to a small maintenance charge, often called a 'float' charge. This charge is normally only about 1 milliamp per ampere-hour of battery and is perhaps only a few hundreds of milliamps. If the cells experience a failure mode, this low current can change by several times its original level and at the same time the internal temperature of the cell can rise or fall significantly.

It has historically been extremely difficult to accurately monitor and trend current at float levels of a few tens to a few hundreds of milliamps, since a discharge of several hundred amps will have to pass through the same transducer. This will cause remanence (hysteresis) in the transducer, and on its return to float levels the zero current point may have 'jumped' several amps, never to return to its original point. This, of course, makes trending impossible.

LEM's believes that, in order to make a real impact, the monitoring of standby battery parameters must be as comprehensive as possible. To that end, in addition to voltage, impedance and discharge performance per cell, LEM already monitors internal cell temperature as standard, a world-first. It is also developing a fluxgate-technology float-charge transducer capable of better than 10mA resolution, with little or no temperature drift, and virtually no remanence after a high current discharge. LEM already has the technology to produce such a transducer and is now working to develop a battery-focussed product to be introduced later this year.

Many failure modes can engender a significant change in float current and this in turn can result in raised cell temperature. Thermal runaway is not a particularly common occurrence, but it can still occur, more so in VRLA than flooded cells, and float current and cell temperature monitoring are good early predictors of this. Although these indicators provide very useful data, virtually no existing systems employ them.

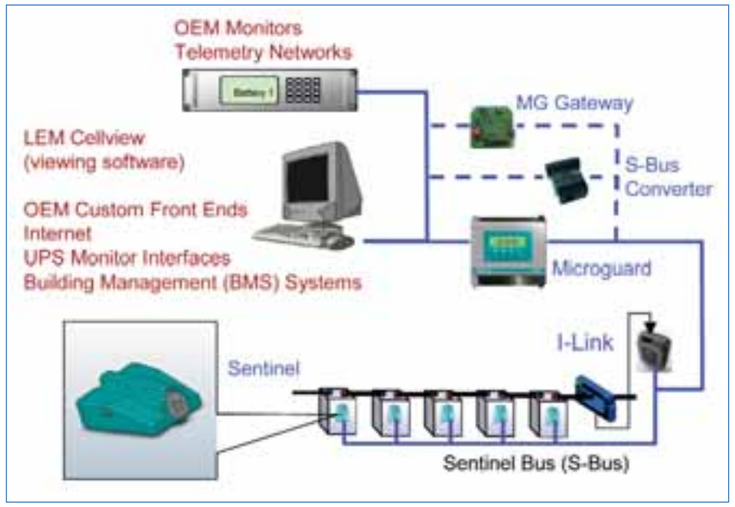

Figure 2. Monitoring of standby battery parameters.

The SoC at the heart of the Sentinel achieves highly-accurate performance. At the LEM component production facility in Geneva, a dedicated design team is concerned solely with the production of Application Specific Integrated Circuits (ASICs). In partnership with a leading high integration chip manufacturer, LEM has designed the SoC to integrate the analogue, digital and control functions of a cell and monobloc in the most efficient and cost-effective way possible. LEM believes that only a single chip solution can give the highest reliability whilst providing a good value for money.

LEM is experienced in manufacturing high-volume components. In Geneva, it manufactures several million components a year for the industrial and automotive markets. One of its recent initiatives reduced the price of a 20 amp Hall-effect current transducer from $40 to $7 in only two iterations and its latest current measurement product is a single chip transducer with built-in Hall-effect sensor, capable of isolated measurement from an adjacent track on a PCB, for less than ?5. LEM's automated manufacturing facility in Geneva can compete with anywhere in the world.

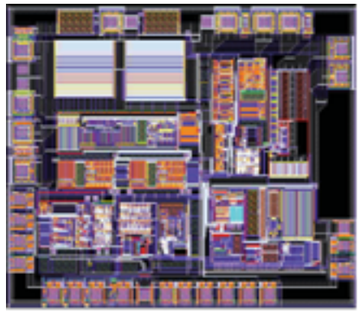

Figure 3.The SoC to integrate the analogue, digital control functions.

Consistent with its commitment to high quality, LEM has spent the last 12 months beta testing it's battery monitoring system on various sites in Europe and is now so very confident with the reliability of the products to offer a world-leading five-year warranty.

These advances break new ground in standby battery systems and can change the role of the battery monitor from an expensive addition, the cost of

Figure 4. LEM's automated manufacturing facility in Geneva.

which is perceived to be of value only to the most sensitive installations, to that of an extremely cost-effective integral life management system, essential to maximise the service life of every VRLA battery.

Taken as a whole, these advances can change the role of the battery monitor from an expensive addition, the cost of which is perceived to be of value only to the most sensitive installations, to that of an extremely cost-effective integral life management system, essential to the service life of every VRLA battery.

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Cooling Power Conversion Designs

The PCB has become a significant thermal path

Power density is increasing rapidly, but assiduous thermal management can help designers meet the many system-level demands at the best possible price.

By Nico Bruijnis, European Marketing Manager, The Bergquist Company

With more silicon and more physical channels squeezing onto each circuit board, there is pressure on circuitry such as power supply components to reduce in size while at the same time providing more Watts to drive the additional functions designers want to include.

Power Architectures are evolving

Power architectures are continually evolving to deliver the best achievable characteristics, not only in terms of physical size but also operating efficiency, manufacturability, vendor independence and upgradeability. This process is driven by changes such as the ongoing trend towards low voltage logic in processors, FPGAs and ASSPs on each of the boards.

For instance, the Intermediate Bus Architecture (IBA) emerged to reduce the overall losses incurred as the bulk DC voltage, usually a nominal 48VDC, is stepped down to very low levels such as 2.7VDC or 1.8VDC for low voltage logic. Other groups, such as the Distributed-power Open Standards Alliance (DOSA) and Point of Load Alliance (POLA) prioritise the establishing of standards covering power converter form factors, footprints, feature sets and functionality. The goals include reducing development time and vendor dependence, and enhancing the scalability of power architectures. However, given with the perceived advantages of standardisation, many engineers still prefer to "roll their own" architecture, using off the shelf modules or by bringing up a proprietary power supply design.

Ever smaller form factors

A common trend is toward smaller form factors, particularly for board-mounted circuitry or modules such as non-isolated POLs, which occupy premium real-estate that designers need in order to implement additional system level functions. Although POL efficiency is quite high, typically around 95% or better, the demand for more power from smaller modules means that modern POLs dissipate appreciable quantities of heat. For other modules, such as isolated converters that convert the 48VDC into a primary or intermediate supply–which may be regulated or unregulated–open frame designs now dominate.

Improved magnetics and power semiconductors enable high power density. For example, where the industry standard brick-size form factor used to call for a half-brick-sized isolated converter, quarter-brick, eighth-brick and even sixteenth-brick converters are now capable of supplying upwards of 40A at voltages as low as 1.0V, and at over 90% efficiency.

The drive to miniaturise distributed power modules is actually a mixed bag for the power designer seeking to optimise the thermal performance of the power supply. Even though the available surface area for cooling is reduced, the thermal paths from the devices to the surface of the case are shorter, resulting in lower thermal resistance paths to ambient.

Whether encapsulated in a module, contained in an open-frame converter, or mounted discreetly on the board, it is the semiconductor and magnetic components that produce the most heat. Overheating an electromagnetic device can lead to insulation damage, greater losses, and a reduction in magnetic energy storage capability by hastening the onset of saturation. Consequences include the potential for severe damage to DC-DC circuits. Operating a semiconductor component at an elevated temperature accelerates failure mechanisms that can lead to parametric failure, where the device fails to perform in accordance with the manufacturer's specified parameters. Exceeding the maximum temperature recommended by the manufacturer will likely lead to catastrophic failure of the device.

Maximising heat dissipation

The heat generated within power semiconductors or magnetic components can be conducted efficiently away to the surface of the device package or, for a module, to the housing. The heat can then be removed by convection and radiation, aided by forced air cool-

Figure 1. Bergquist Sil-Pad Applications.

ing, if necessary. A heatsink may also be fitted, enabling higher power output for a given ambient temperature or airflow rate.

Although an off the shelf module may be designed for no-heatsink operation if the rated power is to be below around 30W (subject to conditions including minimum airflow and maximum ambient temperature), vendors of larger modules may offer custom-designed heatsinks that attach conveniently to the module casing or a baseplate. The heatsink may be supplied as part of a complete kit comprising appropriate screws to attach the heatsink, as well as a thermal interface material to ensure efficient coupling of heat from the module case or baseplate into the heatsink. In proprietary power conversion designs, also, a thermal interface material must be inserted to maximise conduction of heat into the heatsink.

When the interface material is supplied as part of a kit, it is often provided as a pre-cut sheet of composite material constructed to have high thermal properties. This may be a mechanically tough fibreglass or kapton carrier, for example, coated on both sides with a high thermal conductivity film. When pre-cut to match the exact shape of the heatsink's mating surface, this is very convenient for the assembler. Such materials can also be packed, stored and transported easily. The Bergquist Sil-Pad range provides an example of these types of material. They are popular with power module OEMs as well as with engineers bringing up proprietary designs, and can be delivered in a number of convenient forms by arrangement. The thermal conductivity of such materials ranges from 0.9W/m-K to 3.0W/m-K.

Phase change materials are the perfect alternative to thermal grease

Another easy-to-use technique for thermally linking a power module to a heatsink is to use a phase change material. This is an easier-to-use alternative to thermal grease, which is not convenient to apply and can result in variability since it is difficult to control the thickness of the applied layer. A phase change material is non-tacky at normal temperatures, and is normally coated onto both sides of a stiffening material such as a polyimide sheet.

Figure 2. Bergquist Sil-Pad pre-cut on tape.

This allows the material to be readily die-cut as well and also facilitates handling in manual or automated assembly. When heated by the normal operation of the power device the phase change material then begins to flow, and wets-out the junction between the casing of the module or device and the heatsink. This creates a low thermal resistance path from the device to the heatsink. The phase-change temperature is typically around 55 °C. Other available options include reinforcing and electrical insulation, if required.

Guidelines published by Bergquist for using phase change materials such as its Hi-Flow series recommend to physically attach the heatsink to the device by using a fastener such as a clip, to ensure a constant mating force over time. Screws may also be used, but an alternative is to use a thermally efficient adhesive tape such as Bond-Ply. This is a pressure-sensitive tape that also provides for the decoupling of bonded materials with mismatched thermal coefficients of expansion.

The PCB has become a significant thermal path

Dissipating heat from power modules or components into the host PCB is also becoming an important cooling opportunity for designers seeking increased power density and outright power handling capability. In fact, some vendors of board-mounted power modules are now positioning low thermal impedance terminations as a significant extra benefit for designers who are configuring power architectures. The host PCB is becoming a significant thermal path for board mounted power modules.

Figure 3. Bergquist T-Clad.

Some module vendors are paying close attention to thermal design inside the module, for example to minimise hot spots and achieve a more homogeneous module temperature. For example, thick copper layers in the module PCB, or an insulated metal substrate (IMS), can efficiently distribute the heat generated by semiconductor and magnetic components to make best use of the module packaging to couple

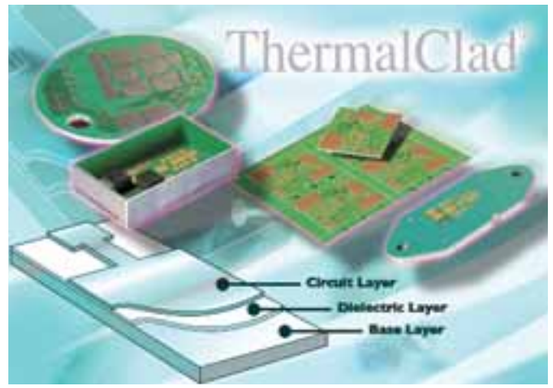

Figure 4. Bergquist T-Clad Applications.

heat into the heatsink and/or surrounding atmosphere, and the host PCB.

As an alternative circuit board technology, an IMS such as Bergquist T-Clad features an aluminium substrate that is insulated from the circuit layer by a thermally enhanced dielectric. The substrate provides a heatsink of high thermal capacity to absorb the heat generated by board-mounted components. IMS can eliminate the costs of additional heatsinks and associated mounting hardware, and also enables surface mount assembly.

Best Practice for Cost-Effective Thermal Performance improvement

It is true that modern power architectures, which aid the distribution of low voltages around the system, have also allowed dissipated heat to be distributed to several physical locations within the system. In addition, improved power semiconductors and magnetic components, as well as enhancements to power design such as increasing switching frequencies, have reduced conduction and switching losses. These factors, too have contributed to progressively higher power outputs in exchange for only incremental increases in cooling airflow, for example.

However, designers are constantly under pressure to increase power density. High-performance components or modules, or complex high-frequency designs, can add to the cost and design time associated with a power conversion solution. Increasing the specification of the cooling fan, to provide greater airflow, also adds to the cost of the delivered product.

When seeking enhanced power output, the first port of call should be to ensure optimum thermal coupling between major heat sources such as converter modules or discrete power semiconductor and magnetic components and the surrounding atmosphere. The use of thermal interface materials to fill air gaps and create low thermal resistance paths away from the active components is the most cost-effective starting point.

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Novel Low Leakage Current

Stable Hiper FREDs

The experimentally demonstration of commercially available platinum doped fast switching, area efficient Hiper Fast Recovery Epi-taxial diodes (FREDs) employing low temperature PECVD oxide, single metal field plate and polymide passivation.

By J.V. Subhas chandra Bose, Holger Ostmann, Peter Ingram, IXYS Semiconductor

The experimental findings are consistent with numerical modelling results and demonstrate that without using guard rings it is possible to get breakdown voltages of 200 to 400V without changing the chip size and active area. The devices showed stable blocking characteristics in High Temperature Reverse Bias (HTRB) and Humidity test with low reverse current.

Numerous techniques have been used during the last 30 years to improve the low leakage current and obtain a stable device with an ideal breakdown voltage of plane junction. It is well known that the blocking voltage of a planar p-n junction is limited by the maximum electric field due to the curvature effect at the main junction. The blocking voltage can be increased by reducing the curvature effect either by using floating field limiting rings (guard rings), metal field plates or a combination of both. It has been shown that the floating ring technique is sensitive to oxide charges and process variations. Optimal field plate designs involve multiple dielectric layers and gap between metal field plates.

Novel 200 to 400V techniques have been investigated which are insensitive to surface charge during processing and after HTRB and humidity test. Its feasibility has been demonstrated for 200V, 300V and 400V devices. A new technique replaces the diffused guard rings and combination of guard rings with metal field plates. To optimise the structure and to analyse the breakdown voltage characteristics ISE TCAD is used. In simulation platinum diffusion is not taken into account.

Device Optimisation: The structure of 200V to 400V devices with the main junction p, metal, channel stopper N+, oxide and polymide as final passivation layer is shown in Figure1. For simulation Interface charge of 1E11 cm-2 is included in this analysis.

Figure 2 show influence of oxide thickness on breakdown voltage. Simulation results clearly indicate an increase in voltage with an increase in oxide thickness till an optimum point is reached. As an example for an oxide thickness of 0.5um for a 300V device,

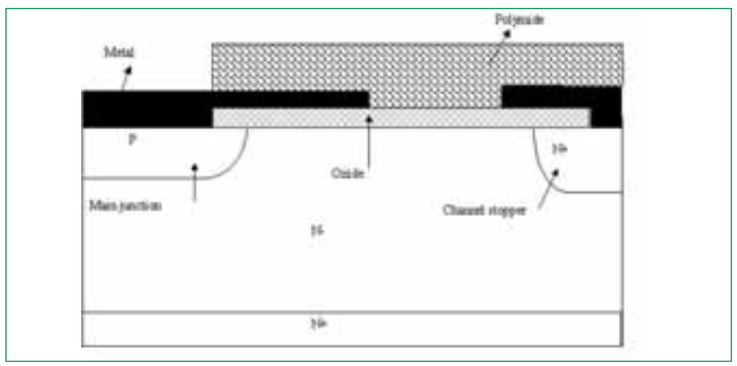

Figure1. 200V, 300V and 400V metal field plate structure.

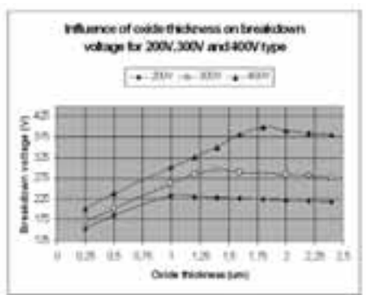

Figure 2. Influence of oxide thickness on breakdown voltage.

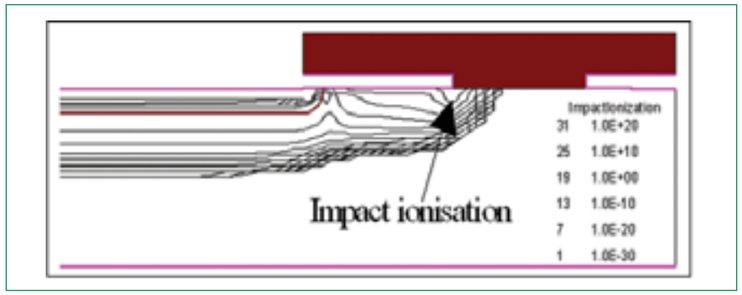

Figure 3a. Impact ionisation contours for oxide thickness 0.5um.

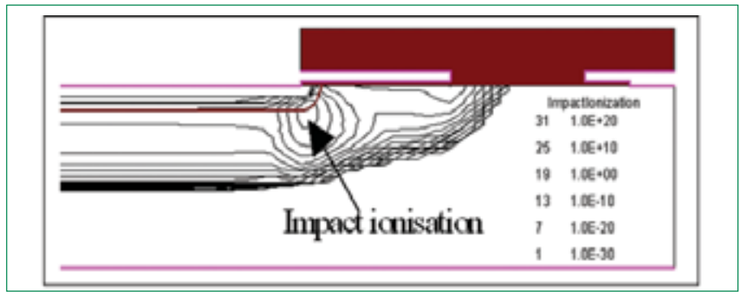

Figure 3b. Impact ionisation contours for oxide thickness 1.4um.b.

premature breakdown voltage (200V) due to impact ionisation will occur at the edge of the field plate as shown in Figure 3(a). With an increase in oxide thickness up to 1.4um the breakdown increases up to 295V and the impact ionisation will occur at the main junction as shown in Figure 3(b).

An oxide thickness of greater than 1.2um has less of an influence on the breakdown voltage. However breakdown voltage slightly decreases due to a reduction in field plate strength. The same is true for 400V as shown in Figure 2. However to get maximum breakdown voltage of 400V an oxide thickness of 1.8um is required.

Experiment: For passivation layer we used Plasma Enhanced Chemical Vapour Deposition (PECVD) oxide at a temperature of 400°C. To obtain a fast switching device we sputtered and diffused heavy metals, platinum, from the front side of the main junction. Table-1 show simulation and practical results after completing the process flow.

Device without heavy metals such as gold or platinum are called rectifier diodes and the device of 300V with chip size 3.3X3.3 mm2 and active area 3X3 mm2 shows a maximum leakage current of 1uA at 25°C and 50uA at 125°C. With platinum diffusion devices are called fast switching diodes or Hiper FREDs and these devices show maximum leakage currents of 1uA at 25°C and 150uA at 125°C. The increase in leakage current from rectifier diode to fast switching diode is due to adding life time killers in the silicon. Furthermore platinum diffused devices show an increase in voltage of 30V due to compensation of platinum into the silicon.

Table-2 gives a detailed comparison of leakage current at different temperatures for 9 mm2 active area 30A device of 200V, 300V and 400V.

30A chip (3.3X3.3 mm2)	Simulation result	Practical result
200V Hiper FRED	230V	255V
300V Hiper FRED	295V	305V
300V Rectifier diode	295V	335V
400V Hiper FRED	400V	440V

Table 1. Comparison of simulation and practical results.

30A chip (3.3X3.3 mm2)	Ir at 25°C	Ir at 125°C	Ir at 150°C
200V Hiper FRED	1uA	100uA	150uA
300V Rectifier diode	1uA	50uA	75uA
300V Hiper FRED	1uA	150uA	250uA
400V Hiper FRED	1uA	200uA	350uA

Table 2. Leakage current at different temperatures for 200V, 300V and 400V 30A chip.

Reliability: Reliability is defined as the ability of a device to conform to its electrical and visual/mechanical specifications over a specified period of time under specified conditions at a specified confidence level.

Prior to the official release of a new device for mass manufacturing, it must undergo full qualification test. New device qualification most often requires several sets of samples for different reliability tests. The actual reliability of a device cannot be accurately determined with standard visual and electrical measurement techniques. The most important reliability tests for the electrical stability of the chip are High Temperature Reverse Bias (HTRB) and Humidity test.

HTRB: This test check the ability of the samples to withstand a reverse bias while being subjected to the maximum ambient temperature that the parts are rated to withstand.

Humidity: This test checks the ability of the package and chip to resist moisture penetration. The sample is loaded into an environmental chamber. The relative humidity is then increased from 85 to 100 percent and the temperature is also elevated.

HTRB and Humidity test samples are randomly selected from 25 processed wafers. The condition used for HTRB test is 80% of rated voltage at 125 or 150°C. The breakdown voltage and leakage current were measured before starting the test. 200V and 300V devices were assembled into TO-3P package. The test was conducted for up to 1000 hours and readings were taken once every 4h. For 400V devices we have used plastic package with silicone gel and Epoxy as the toping material. 400V device HTRB test was done for up to 168 hours due to a customer request. At present we are running TO-3P package for 1000 hours. Figure 4 clearly shows for all three-voltage classes, leakage currents are below 50uA. Furthermore there is no increase in leakage current between pre and post measurement results.

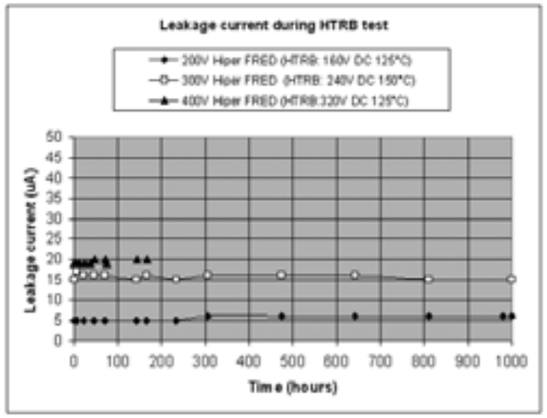

Fig.4. HTRB results of 200V, 300V and 400V device at 80 percent of rated voltage and 125 – 150°C.

The device characteristics are measured before starting the test. The humidity test was conducted at 85°C and at 85% relative humidity for 168 hours. The device characteristics are re measured after cooling down for 2 to 3 hours.

Pre and post measurement results show that there is no increase in leakage current for all 3 types, maximum leakage current 1uA at room temperature and at 150°C for 200V 150uA, for 300V 250uA and for 400V 350uA respectively.

By careful analysis of 30A chips of 200V, 300V and 400V we have designed and fabricated different chip sizes for different current ratings as shown in Table-3. All these Hiper FREDs are commercially available.

It has been demonstrated for the first time that by using simulation analysis and practical results that a single field plate from the main junction is sufficient up to 400V. This technique is less process sensitive and requires less area. Experimental results reveal that the device guarantees low leakage current at 25°C to 150°C conditions plus long term stability of the blocking characteristics even in plastic packages.

Hiper FREDs V	Rating current A	Vf at 25°C V Max	Vf at 150°C V Max	Ir at 25°C uA Max	Ir at 125°C uA Max	Ir at 150°C uA Max	Switching at rated current, 200A/us, 100V,25°C Irm	trr
200	10	1.2	0.9	1	50	75	2.5A	30ns
200	20	1.25	1.0	1	75	100	2.5A	30ns
200	30	1.2	0.9	1	100	150	2.5A	30ns
200	40	1.2	0.9	1	125	175	2.5A	30ns
200	60	1.2	0.9	1	150	200	2.5A	30ns
300	10	1.25	0.95	1	50	150	3A	35ns
300	20	1.3	1.05	1	100	200	3A	35ns
300	30	1.28	0.95	1	150	250	3A	35ns
300	40	1.25	0.95	1	175	300	3A	35ns
300	60	1.28	0.95	1	200	350	3A	35ns
400	20	1.35	1.0	1	150	300	4A	45ns
400	30	1.35	1.0	1	200	350	4A	45ns
400	60	1.35	1.0	1	250	500	4A	45ns

Table 3. Commercially available low leakage current and stable Hiper FREDs.

Evolution of Power Over Ethernet

The four-pair technique has advantage

The IEEE 802.3af standard for Power over Ethernet (PoE) introduced a new facet to Ethernet networking, delivering DC power in tandem with 10/100/1000 Mbps data. PoE brought with it a unique set of problems and new ways of thinking that were unfamiliar to many engineers with experience designing Ethernet equipment.

By Clay Stanford, Design Manager, Power over Ethernet Products and
Todd Nelson, Product Marketing Manager, Mixed Signal Products, Linear Technology Corp.

PoE is now commonly used for VoIP phones, wireless access points and security cameras. As PoE evolves, there is a need for enhancements to the standard to enable emerging pplications.

By way of review, the PoE link allows a Powered Device (PD) to draw up to 12.95W from the Power Sourcing Equipment (PSE). The PoE link or port is controlled by the PSE, which identifies PDs via detection and classification before powering and monitoring the port (I_{CUT}, I_{LIM} and disconnect). Much of the burden of PoE rests on the PSE, which must perform detection and disconnect flawlessly to avoid damaging legacy devices. If the PSE does not adequately perform classification, power delivery and monitoring, intermittent failures and instabilities may result. The PSE cannot control everything; when it applies power, it trusts the PD to follow the standard, turn on without oscillating and avoid drawing more power than requested. Because both types of devices must cooperate, PD and PSE designers should consider issues from the perspective of both devices.

Higher Power for Emerging Applications

13 watts is adequate for basic IP phones, but motorized cameras, multi-radio access points, and devices with large color screens are seriously constrained. The IEEE is currently working a higher power standard, dubbed PoE+ (officially IEEE 802.3at) that will coexist with 802.3af devices available today. The ultimate power levels defined by the new standard have not been established, but as of today, it is likely we will see 30-watt 2-pair systems and 60-watt 4-pair systems. The IEEE 802.3at committee has taken on a daunting task to

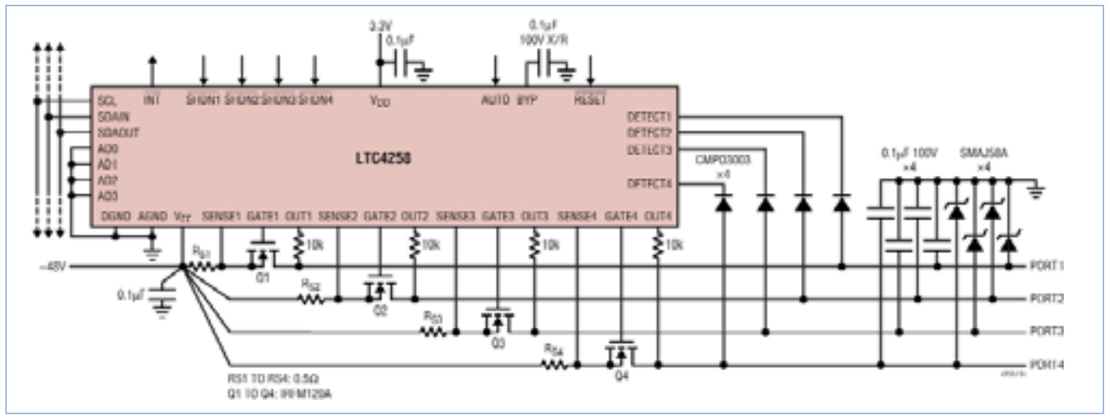

Figure 1a. Basic 802.3af-compliant PSE circuit using LTC4258.

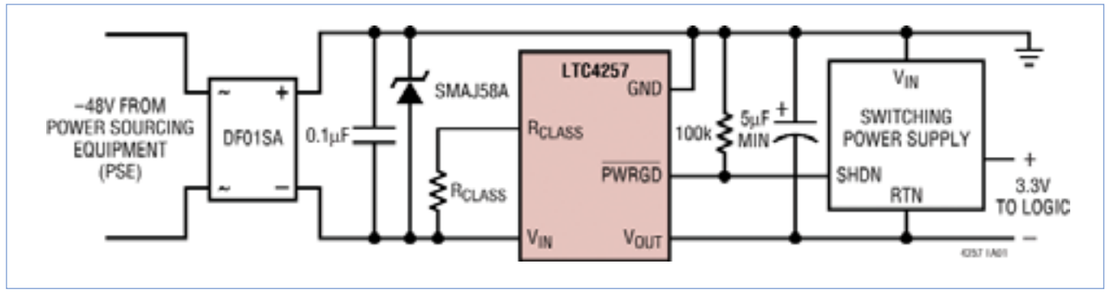

Figure 1b. Basic 802.3af-compliant PD circuit using LTC4257.

define a world standard that will define a safe, higher-power standard that is backward compatible and interoperable with currently deployed 802.3af equipment. Because of the complexities of writing this specification, we are not likely to see a final specification for 1½ to 2 years from now.

Although typical CAT 5 cabling includes four twisted pairs, the 802.3af standard only allows two pairs to carry current at any given time. One option is to allow additional current down the third and fourth pairs, doubling the available power. A second option is to raise the current limit, allowing more power down the same two pairs. Each of these techniques has appeared in proprietary PoE systems. However, each has drawbacks, complicating the choice between them.

Implementing Pre-Standard High Power PSEs

In the interim, some applications require high power and cannot wait for the new standard. There are several ways to do this. The following circuits build on the basic 802.3af-complaint PSE circuit using the LTC4258, shown in Figure 1a, and the basic PD circuit using the LTC4257 shown in Figure 1b. The LTC4259 can be substituted in the PSE circuit if the application requires AC Disconnect; the LTC4267 can be substituted in the PD circuit if the application requires an integrated switching regulator.

The following circuit examples demonstrate several ways that high power operation can be achieved. Note that in some of the following PSE circuits, Channel 4 is used to illustrate the circuit changes, but any channel can be used.

Two-Pair, High Current

The power level can be increased in the PSE simply by changing the value of the sense resistor (R_{S1} – R_{S4} in Figure 2a). R_{Sn} is set to 0.5Ω for 802.3af compliance (375mA I_{CUT}, 425mA I_{LIM}). Cutting the value of RSn to 0.25Ω, for example, doubles all the current limits (750mA ICUT, 850mA ILIM). This doubles the power to the PD when a short cable is used; increased losses in longer cables limit the power delivered to the PD to somewhat less than 2x.

Note that the LTC4258 also uses the sense resistor to detect DC disconnect. Cutting the resistor value to 0.25Ω will double the DC disconnect threshold, rendering it technically non-compliant. Other 802.3af parameters are not affected: detection and classification will remain compliant, and the AC disconnect threshold (LTC4259 only) is not affected by the sense resistor change. Because the raised DC threshold runs a small risk of disconnecting a very low power 802.3af PD, AC disconnect is recommended for interoperability with 802.3af PDs.

Two other components (per channel) need to be modified to handle the extra current. MOSFET Q4 will typically need to be replaced with a larger device to tolerate the higher power during current limit. In this application, IRF530-type devices in D²PAK packaging are adequate. The PoE data magnetics also need to be specified to carry higher current. Several magnetics vendors

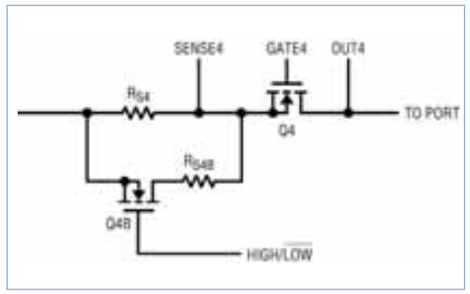

Figure 2a. Dual current High Power/802.3af PSE.

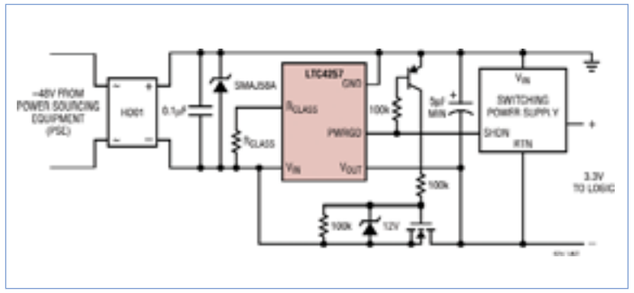

Figure 2b. Two-pair high power PD.

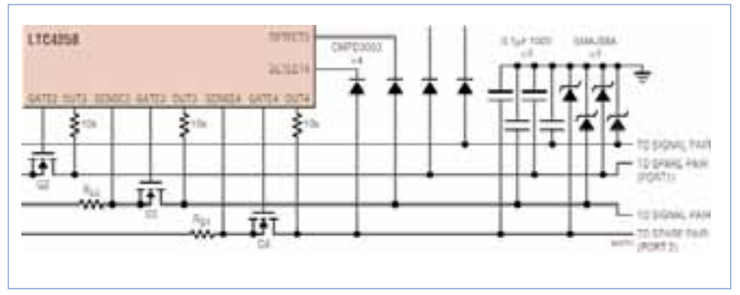

Figure 3a. Four-pair 802.3af Power.

have newly released parts with adequate current capability.

By adding two new components, we can switch between 802.3af-compliant operation and high power. In this case, R_{S4} is set to the original 0.5Ω value and R_{S4B} is chosen so that R_{S4} || R_{S4B} gives the desired higher current level. Setting R_{S4B} to 0.5Ω (the same value as RS4) sets the high power mode to twice the power level of 802.3af.

When Q4B is off, the port operates in 802.3af-compliant mode. Turning on Q4B switches the port to high current mode. This transition can be made at any time: before detection/classification; after detection/classification, but before port power-up; or after power is applied. Note that Q4B can be a low-voltage MOSFET, since only the drain of Q4 sees the high port voltage. Q4B should be selected for very low on-resistance to prevent inaccuracies in the higher current limit. The IRLML2502 is an example of a suitable device in a SOT-23 package.

The PD modification (Figure 2b) is slightly more complicated since the internal MOSFET is pre-configured for 375mA current limit operation. However, adding an external pass device controlled by the PWRGD pin allows high current operation while maintaining full 802.3af detection and classification signatures and inrush current limiting.

Four-pair, Low Current

An alternate technique to increase the power delivered to the PD is to power all four pairs in the CAT-5 cable. Figure 3a shows a four-pair PSE circuit with standard 802.3af power available on each pair. No changes are required to the sense resistor values.

The bigger change is to the four-pair PD circuit (Figure 3b). Two LTC4257

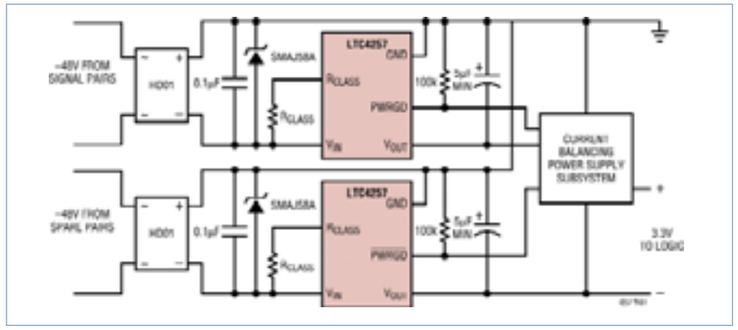

Figure 3b. Four-pair low-current PD.

devices are now required, and the power supply circuitry must be smart enough to limit the current draw from each channel to stay under the 802.3af limits. It can do this by balancing the current drawn from each pair set, or by drawing power from one pair set until it approaches (but does not exceed) the ICUT limit, then beginning to draw from the other set. This circuitry can be fairly complex, and will vary from design to design.

The four-pair technique has the advantage of using all the conductors in the cable, minimizing the total cable resistance and the resulting power lost with long cables. Using standard current levels also comes closest to full 802.3af compliance of any of the high power techniques, since either the signal pairs or the spare pairs used alone will be fully compliant. The primary drawbacks are complexity and expense. The PSE requires two channels of the controller chip per port, halving the effective port density, while the PD requires two controller channels and additional current balancing circuitry to ensure that the current drawn from either pair set does not exceed the maximum level. In addition, four-pair techniques will not work if only the signal pairs have continuity, as in some CAT-3 building installations.

Because of the cost and complexity penalties of the four pair scheme, two-pair high current is the preferred technique at medium power levels. Four-pair systems are most applicable when the PD power rises above the 35W level.

Four Pair, High Current

Combining high current circuitry with four-pair hookup allows more power down the cable than any other technique. Four-pair high current allows as much as 50W to be delivered to the PD over a 100m CAT-5 cable, more if the cable length is kept short. Although this scheme includes the drawbacks of all of the previous schemes, it is the highest power option available.

Beyond 50W, long cables rapidly approach an “impedance matched” situation where the cable dissipates more power than it delivers to the PD. If the length of the cable is kept short, the current level can be further increased, ultimately limited by the RJ45 connector, offset current in the magnetics and the temperature rise in the CAT-5 cable. Extremely high power (>50W) should only be used in systems where the entire solution is specified by the same supplier.

Classification: When to Apply High Power

Notably absent from the above circuits is a method to determine when it is appropriate to apply high power to the line. All of the techniques will successfully power standard 802.3af PDs under normal conditions. The dual-threshold circuits need to have some information from the PD to know when to switch thresholds, and the four-pair schemes need to know when it is appropriate to switch on the second set of conductors. The IEEE 802.3at committee is working to address these issues, but no schemes have yet been finalized. In the interim, ad-hoc solutions are needed to identify high power PDs.

802.3af defines an unused class (Class 4) that looks tailor-made for high power, and both the LTC4258/59 PSE chips and the LTC4257/67 PD chips support Class 4. Unfortunately, a Class 4 PD will be powered with Class 3 current limits if it is plugged into a standard 802.3af PSE, which may cause it to cycle on and off repeatedly if it attempts to draw higher power. Class 4 can be used as a “warning” that a high power PD is connected, but it is advisable to have an additional handshake before higher power is delivered. Ideally, a high power PD should receive some sort of signal from a high-power PSE, acknowledging it is acceptable to operate in a high power mode. If no handshake is received, the PD should give some sort of indication to the user that it is plugged into the wrong kind of PSE.

The best technique to use for pre-standard high power depends on the application. At power levels up to 30W, the two-pair high current techniques provide the lowest cost and complexity, and full 802.3af compliance by using the dual-threshold circuit. If maximum power is required (50W or more), the four-pair high current circuit is the best choice.

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Series of Leading Edge 100V MOSFETs

MOSFETs are key-components of power-converters

The actual introduced 100V Technology has low-resistance and fast-switching devices for most efficient power conversion.

By Dr. Lutz Görgens, Technical Marketing Engineer; Dr. Ralf Siemieniec, Research & Development Engineer, Power Management and Drives business unit, Infineon Technologies AG

A series of 100V MOSFETs is currently introduced by Infineon Technologies. Based on charge balancing, a significant reduction of the MOSFET on-resistance is achieved. In combination with low gate-charge, high switching speed, excellent avalanche ruggedness and improved body-diode characteristics, these devices are best suited for a wide variety of applications. These include highly-efficient AC/DC SMPS and DC/DC converters for telecommunication and server topologies with high power-density, Class-D amplifiers, and motor-control drives.

Today, energy and space saving efforts are the driving forces for the developments in power conversion. These requirements can only be achieved by increasing system-efficiency and power-density.

Power conversion, that requires low-voltage MOSFETs, ranges from AC/DC SMPS to DC/DC-converters, from motor-control to class-D amplification. Furthermore, AC/DC SMPS and DC/DC-converters are taken as an example to highlight MOSFET-requirements. Improvements can be realized on different levels – system-, converter- and device-level. New power-architectures reduce losses on system level. Optimized converter topologies for AC/DC and DC/DC improve efficiency on converter-level. New MOSFET technologies boost efficiency on device level. However, MOSFETs are key-components of power-converters. Better technologies allow more challenging operating conditions for existing topologies, i.e. increase in switching frequency or even enable a change to other topologies. Infineon’s new OptiMOS 2 100V technology provides the fastest switching and lowest on-resistance currently available on the market. Additionally, the high-speed series (HS-series) with ultra-low gate-charge offers a further 33% rise in speed for uncompromised fast switching if needed.

Advanced device concept of OptiMOS 2 MOSFET series

The compensation principle for power MOSFETs was introduced in 1998 in commercially available products with the 600V CoolMOS Technology [1].

The basic principle behind the drastic $R_{ds(on)}$•A reduction compared to conventional power MOSFETs is the compensation of n-drift region donors by acceptors located in p-columns.

For breakdown voltages below 200V, trench field-plate MOSFETs are an excellent alternative. The application of a field-plate clearly improves the device’s performance. The device comprises a deep trench penetrating most of the n-drift region. An insulated deep source electrode, separated from the n-drift region by a thick oxide layer, acts as a field-plate and provides mobile charges required to balance the drift region donors under blocking conditions. The thick field-plate insulation has to withstand the full blocking voltage of the device at the trench bottom. Consequently, oxide thicknesses in the micron range have to be controlled carefully with a special focus on avoiding thinning at the bottom trench corners and preventing generation of stress-induced defects. In contrast to standard MOS structures that exhibit a linearly decreasing electric field with a maximum at the body/drift region pn-junction, the field-plate principle leads to an almost constant field distribution, thereby reducing the necessary drift-region length for a given breakdown voltage. In addition, the drift-region doping can be increased, resulting in a clearly reduced on-state resistance. In fact, $R_{ds(on)}$•A is even reduced below the so-called “Silicon Limit,” which is the on-resistance of an ideal abrupt p^+n-junction at a given breakdown voltage. The reduced drift-region length and increased doping concentration also

significantly improves the performance of the body diode, because a reduced amount of charge is stored in the device. The combination of field-plates and a trench-gate MOSFET results in further improvements of the device characteristics.

Another advantage of the new technology is the availability of a related device optimized towards very-fast switching applications. Although the gate-charge Q_g, compared to the standard device, strongly decreases, the on-resistance $R_{ds(on)}$ rises moderately only. Consequently, the high-speed (HS) device shows an outstanding Figure-Of-Merit (FOM) as shown in Figure1.

Application benefits

The implementation of charge balancing enables the OptiMOS 2 100V technology to be strongly competitive in most application fields. The technology allows for benchmark key parameters, such as $R_{ds(on)}$, Q_g, Q_{gd}, C_{rss}/C_{iss}-ratio and high avalanche ruggedness simultaneously in a single device. The low $R_{ds(on)}$ (12.5mOhm(max) in D-Pak, 5.1mOhm (max) in D^2-Pak) combined with extremely fast-switching capabilities and high avalanche ruggedness makes the OptiMOS 2 100V the right choice for safe, high performance, high power-density applications.

Synchronous rectification

Many applications, as for example power-supplies for servers, notebooks, plasma- or LCD-TV and, in future, for PC's (silverbox), require more efficient power-supplies. Driving forces are the need to save energy and, more important, the tolerable power-losses in the system which should be minimized. The biggest lever to reduce power-losses in a SMPS is to change the secondary-side rectification from a passive system using diodes to an active synchronous rectification (SR) using MOSFETs.

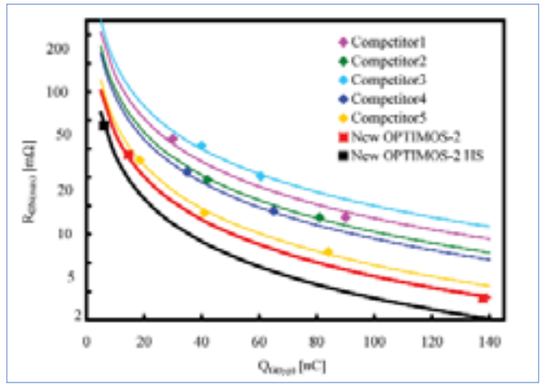

Figure 1. Device performance comparison chart for currently available MOSFET technologies and the new OptiMOS 2 100V technology

For output voltages of 12V-24V, depending on topology, 100V MOSFETs are the right choice for SR. Due to its corresponding conduction losses, the $R_{ds(on)}$ is the key parameter for SR. Other factors are less visible. The cost for the gate-drive scales with the gate-charge Q_g with respect to the on-resistance $R_{ds(on)}$. The figure of merit FOMG ($R_{ds(on)} \cdot Q_g$) is therefore a measure for the effort required to drive the MOSFET. A further risk is the dynamic turn-on. In hard-switching topologies, very large dV/dt-values from drain to source may occur, when the device starts to block. This dV/dt couples to the gate via the capacitive C_{gd}/C_{gs} voltage divider and might dynamically turn-on the device (cp. Figure 2) which is related to the gate-drain charge Qgd:

$$\int_0^{V_{drain,max}-V_{th\,min}} C_{gd}\,dV_{dg} = Q_{gd,crit}$$

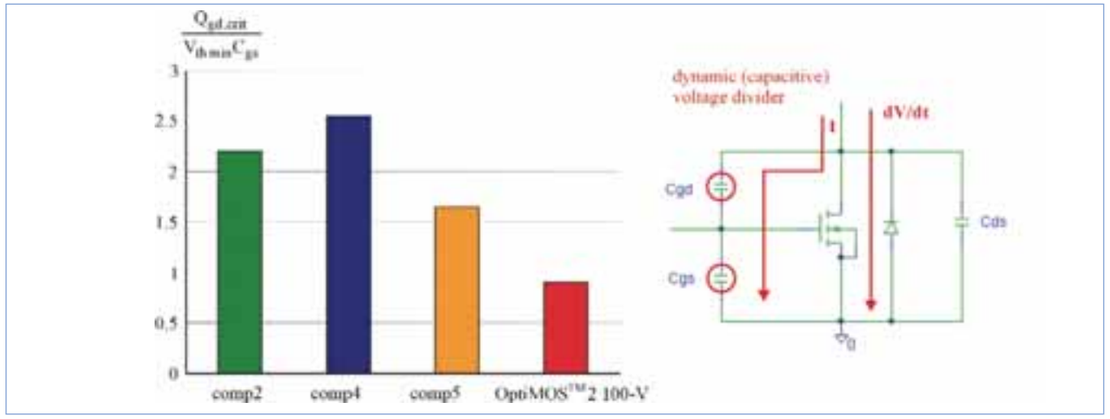

Figure 2. Immunity to dynamic turn-on caused by large dV/dt over device; the new OptiMOS 2 fulfills the stability criteria; competitors indicated as in Figure1.

In worst case this results in a short-circuit situation, a reliable prevention is predicted if:

$$\frac{Q_{gd,crit}}{V_{th\,min}C_{gs}} < 1$$

Primary side switches for DC/DC

The highest demand for efficient power conversion is found in the field of DC/DC power conversion for telecom and server power supplies and similar systems. These converters are required to deliver highest currents using smallest volumes. This can be only achieved by the use of the most advanced components and topologies while operating at switching-frequencies of 250 kHz and above.

For standard 48V wide-range systems, 100V MOSFETs are commonly used as primary-side switches in half- or full-bridge topologies. As switching-frequencies are very large, a low Q_g for a suitably low $R_{ds(on)}$ is required. The FOMG ($R_{ds(on)}$·Q_g) is therefore a reliable measure for MOSFET selection.

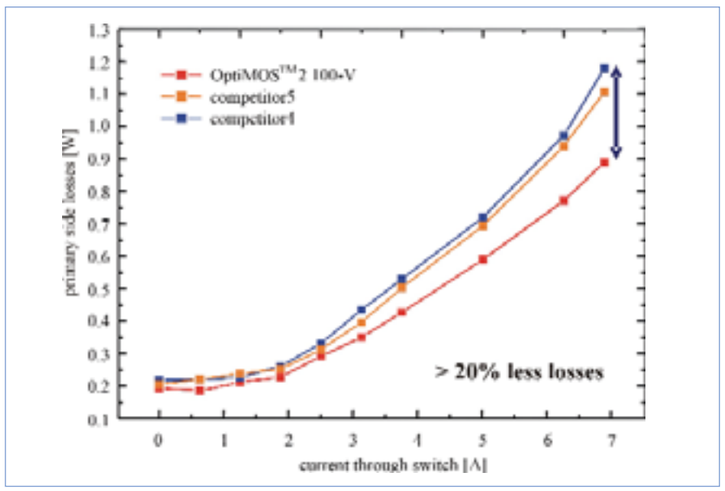

Figure 3. Losses per primary side switch in a DC/DC converter (f_{switch} = 250 kHz, V_{in} = 48 V), comparing fast switching technologies (competitors as in Figure 2) and the new OptiMOS 2 100V technology.

Additionally, the Q_{gd}, as it directly relates to the turn-on and turn-off losses, is of equal importance (cp. Figure 3).

Similar requirements also exist for class-D amplifiers, where the MOSFETs are operated in half- or H- (~full-) bridge topologies. However, the need for very low Q_g and Q_{gd} is of even more importance, as these values not only correlate to efficiency but also directly to sound-quality due to the turn-on and turn-off times.

Conclusion

The field of applications for 100V MOSFETs covers a wide range of requirements. The new OptiMOS 2 100V series is a leading-edge MOSFET technology offering the right properties towards a safe, fast-switching and lowest-resistance single power MOSFET device (cp. Figure 1).

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Heel Crack and Lead Free Soldering

Affecting Power Electronics Packages

Experimental and FEA study for the reliability of Al wire during IR reflow

By Lunwen He, Shaohui Pan, LK.Wang and David Wei.Zhang,
Microelectronic Institute of Fudan University China
By SS.Tey and Tiger Wu, Fairchild Semiconductor

The D-PAK (JEDEC) power device is widely used in mobile electronic products and automotives because of its small footprint, low cost and compatibility with surface mounted technology (SMT). However, the aluminum wires commonly used in this package have small diameter and aluminum wire properties that make them subject to "heel crack," one of the most complicated reliability problems in wire bonding. At the same time, the use of lead in electronic devices is becoming an increasing and serious concern for consumers and the manufacturing industry, many lead-free solders are now being used. But transferring to lead-free solders in reflow can lead to the changes of temperature hierarchy [1].

This article investigates the effects of solder IR reflow on heel crack, both in an experimental and FEA simulation study for the 2-5mil (diameter) aluminum wire. Its aim is to analyze the effect of solder reflow on the reliability of the heel region and to investigate the effect of a different temperature hierarchy to the heel region caused by lead-free solders.

Heel Crack

Heel crack is believed to be caused by the plastic strain at the heel region of the package induced by the wire bonding process and the coefficient of thermal expansion (CTE) mismatches between the leadframe, solder, Al wire, chip and electronic molding compound (EMC).

	1	2	3	4	5	6	7	8	9	10
Low	3.05	3.21	1.26	2.46	2.73	3.45	1.36	2.06	1.57	2.95
High	7.99	11.95	9.27	9.67	8.8	9.08	10.66	20.25	16.32	19.75

Table 1. Resistance between gate to source before reflow (unit: □)

Table 1. Resistance between gate to source before reflow (unit: Ohm)

In our experiment, we use typical D-PAK (JEDEC) packages, each with the same wire bonding and other processes (die attach, molding, etc) parameters. The aluminum wire used in the gate is 5 mil diameter. Table 1 shows the resistance between gate-to-source test results, which are divided into "low" and "high" categories.

Since it is widely used in the surface mount technology, the samples undergo IR reflow under the peak reflow temperature of 220°C. Based on the real condition of the second level package, a three times reflow procedure is chosen. The samples' resistance between gate to source are obtained (Table 2). In the "low" category group, the resistance increases a little, about 0.7Ohm in average. But in the "high" group, eight of the ten samples experience a tremendous increase—40 times larger than the original value in average.

	1	2	3	4	5	6	7	8	9	10
Low Rg	3.42	2.85	1.63	2.5	3.78	4.28	2.3	1.92	2.74	5.9
High Rg	523.15	538.45	9.25	424	430	539.3	9.5	613	504	630.83

Table2. Resistance between gate to source after reflow (unit: Ohm)

As shown in Figure 1, six of the eight bonding-open products used experience the problem of heel crack at the gate pad of chip, causing increased resistance.

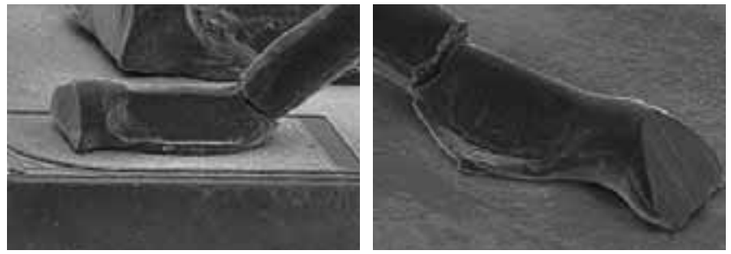

Figure1a/b. SEM shows the heel crack after decapsulation

Heel crack is result of a). plastic strain at the heel region after wire bonding process (Figure.2), and b). stress and plastic strain caused by the CTE mismatches between Al, chip and EMC during the IR reflow. Based on these reasons, the plastic strain induced by a wire bonding process can not be avoided in order to get a reliable bonding [7]. As the peak reflow temperature is larger than Glass transition temperature (Tg) of EMC, which is common at 170°C, the properties of EMC will significantly change below and beyond this point—the CTE is a case in point— and the influence of EMC to the thermal stress and plastic strain distribution should not be ignored.

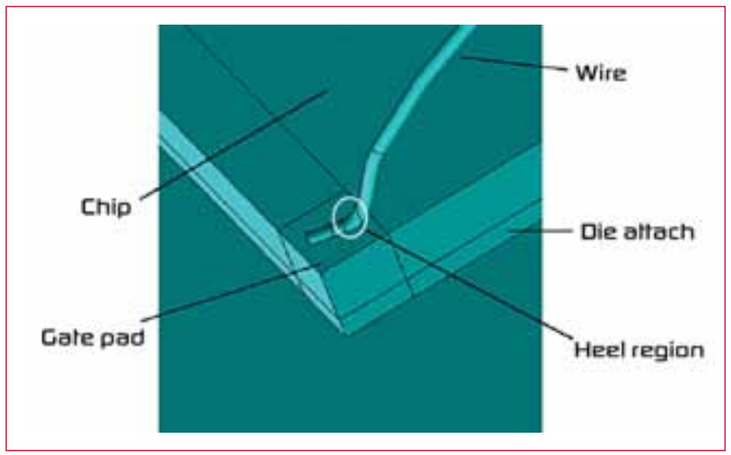

Figure 3. D-PAK FEA model

Our experiment is done at the temperature hierarchy of SnPb eutectic solder reflow. When transferring to lead-free solders, which can bring temperature hierarchy changes especially a peak reflow temperature and wetting time increase[1], the problem will be worse.

3D Finite Element Model

According to the JEDEC standard of D-PAK (Figure 3), the package size used here is about 9.98*6.54*2.3(mm), with 5mil aluminum wire applied as the gate wire. As the heel crack always happens at the gate pad are of the chip, the source wire, which is much larger than 5mil, is ignored.

Additional critical dimensional parameters in the model include the chip: 1.58*1.56*0.2(mm); die attach: 1.58*1.56*0.076(mm); and the leadframe dap: 5.33*3.84*0.51(mm). The wire loop and height are based on real conditions.

When referring to the material properties, it's obvious that the whole process is non-linear and inelastic because of the thermal mechanics. Table 3 shows all material properties [8].

In order to simplify our analysis, the residual stress induced by the first level package process is ignored, and the model is stress free at the reference temperature (300K). Owing to the good temperature uniformity during the IR reflow, it's assumed that the temperatures applied on the model are the same. And, as the heel crack always happens at the chip pad bonding area, the platform is focused on this area.

Figure 2. SEM shows the plastic strain caused by wire bonding

Reflow Effecting Heel Crack

A Von mises stress and plastic strain comparison between the heel region and other area of wire with reflow temperature curve is shown in Figure 4. The stress distribution pattern shows that the stress at the heel region is much larger than other area of the aluminum wire. The largest stress is located at the interface between the wire and the chip gate pad at heel region, which indicates micro crack is more possible to propagate at this point based on J-Integral.

From the stress and strain comparison results, it can be further defined that the heel region is subject to higher stress and plastic strain than other area of the wire, because of the CTE mismatches between leadframe, die attach, Al wire, chip and EMC. The terminations of joints are always predestinated for high stress concentration under stress conditions and plastic strain [7]. And actually during the wire bonding process, some plastic strain can not be avoided at the heel region of the wire, so the fracture load at heel region is much less than in other areas. This can be proved that the broken area is always at the heel when carrying out the bonding pull test, which is used to estimate the wire bonding quality. In other words, the heel region is more subject to fracture during the reflow.

Materials	Modulus (Mpa)	Poisson ratio	CTE(ppm/K)	Yield stress(Mpa)
Lead frame(Cu)	120700	0.3	17.1	
Die attach	1200	0.3	37	16
Chip	131000	0.25	2.8	
Al wire	70500	0.35	25	20.7
EMC	14600	0.35	18(<443K) 55(>443K)	

Table3. Material properties

Table3. Material properties

It's obvious that the von mises stress decreases when the reflow temperature reaches 170°C of Tg, and the plastic strain keep stable during the wetting time. After the wetting time, the stress starts to increase and the plastic strain decreases. This is because when temperature is below Tg, the CTE of EMC is 18ppm/K, which is smaller than that of Al wire. Whereas when the temperature is above Tg, its value changes to 55ppm/K, larger than that of Al wire. This property of EMC leads to the stress and plastic strain variations during wetting time. The material fatigue is mainly governed by the plastic strain and its repeatability, and this can give us a very good understanding of why so many heel crack samples after three times IR reflow occurs.

Besides von mises stress and plastic strain analysis, the shear stress and plastic strain. In fact, the shear stress also plays an important role during the fracture.

Different Reflow Temperature Hierarchy Effect

Owing to the world-wide drive for lead-free, reflow temperature hierarchy should be changed to meet the demand, especially the peak reflow temperature and wetting time. Besides 220°C peak reflow temperature, 240°C and 260°C peak reflow temperatures are applied in the simulation to investigate the influence of lead-free. Figure 5 shows the different reflow temperature comparison, and the results are described in Figures 6 and 7. Not only the peak reflow temperature changes, but also the wetting time changes from 80s of 220°C to 100s of 240°C and 260°C [1].

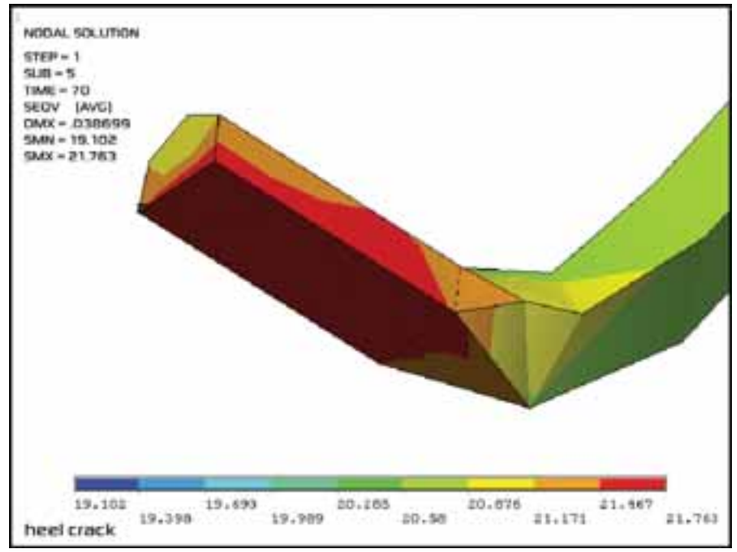

Figure 4. Von mises stress distribution

The results show that both of the stress and plastic strain increase with the peak reflow temperature increasing. In fact, about 20% (0.004) plastic strain variation has been observed when the peak temperature changed from 220°C to 260°C. For many metals subjected to repetitive plastic deformation, a coffin-manson expression for the number of cycles to failure can be applied:

$$N_f = C_1 \varepsilon_{pl}^{-C2}$$

Here, ε_{pl} is the plastic strain in the damaged region, and C_1 and C_2 are constants obtained from stress experiments, N_f describes the life-time. Based on the S.Ramminger's theory [7] in the Al wire life-time model, C_1=16.55 and C_2=1.83, respectively. FIG.10 shows that the life-time decreases 28.4% after the peak reflow temperature shifting from 220°C to 260°C. This means that the peak reflow temperature and wetting time that correspond to lead-free solders have a great influence on the reliability of Al wire.

Upon analyzing the effect of solder IR reflow on the reliability of Al wire, as studied in both an experimental and FEA platform using a D-PAK, we find that the samples with higher resistance between gate to source confront 60% more heel cracks after three times IR reflow. This is caused by the plastic

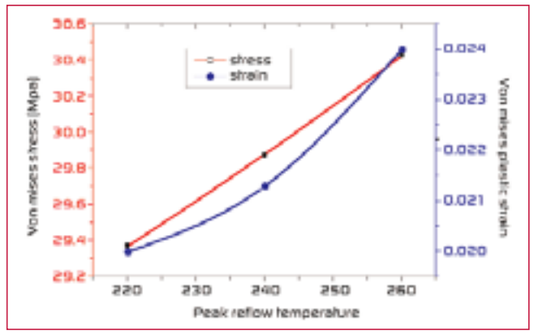

Figure 5. Von mises stresses and plastic strains comparison of different peak reflow temperature at heel region.

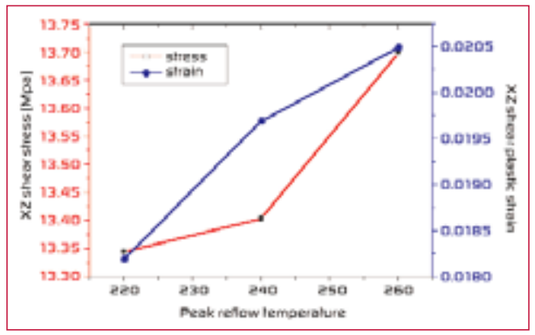

Figure 6.º XZ shear stresses and plastic strains comparison of different peak reflow temperature at heel region.

strain at the heel region induced by the wire bonding process and the CTE mismatches between leadframe, solder, Al wire, chip and EMC. These results indicate that solder IR reflow in the second-level package has a large influence on the heel region of Al wire.

The FEA platform is further extended with respect to fracture mechanics and effects of different reflow temperature hierarchies on the heel region for lead-free solders. We conclude that the max stress and plastic strain located at the interface between the wire and the chip at the heel region, and with the temperature varied from 220°C to 260°C, the plastic strain increases about 20%, which is critical for material fatigue. Based on coffin-manson aluminum wire lift-time models, its life-time would decrease by 28.4%.

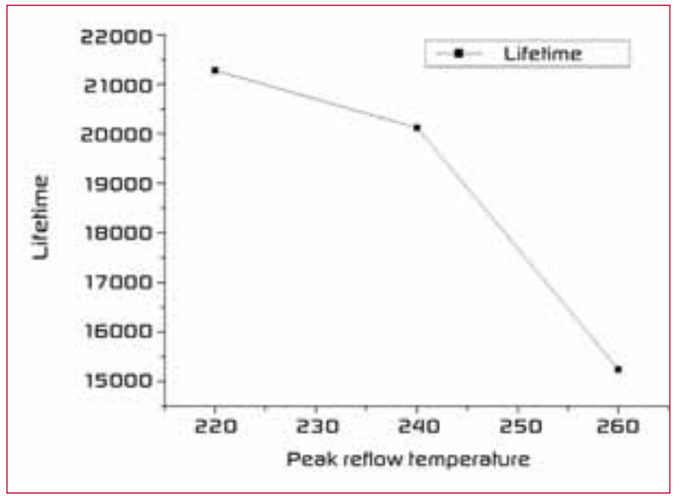

Figure 7. Life-time comparison of different peak reflow temperature

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Drive Inverters Simplify Automated Assembly

Move of large gearbox components are the task

According to VDE regulations, drive inverters not only operate as control element, but may also be used for motor protection. This is why such a device naturally offers itself as complete motor feeder.

By Markus Ingold, Product Manager Standard Drives, Siemens Schweiz AG and Robert Boillat, Paro

The Swiss automation specialist Paro has been building assembly lines for 20 years. Just recently Paro received a contract from an automobile component supplier to supply equipment to move heavy gearbox parts and components from one station to the next - and that as carefully as possible. The ideal solution was a compact drive inverter that has, as complete motor feeder, all of the required protective functions. When compared to a contactor control system, this "entry-level model" is extremely attractive.

Figure 1: It has been seen that there are many advantages if drive inverters instead of direct drives are used for specific belt drive applications. The "Starter" program means that it is child's play to use such drive inverters.

The Swiss company Paro will celebrate its 20th anniversary in 2006. The automation specialist is one of the most well known addresses in Switzerland when it comes to assembly and injection moulding automation. Day-for-day 60 employees in Subingen work to maintain their excellent company image; they produce transfer belts for interlinked systems, injection moulding machine connections and assembly systems.

In addition to the modular standard cells, customers often order very special customized designs from Paro. Such a special solution was designed and constructed in 2005 for an automobile parts supplier in Germany. The application comprised taking gearbox parts from relatively heavy small load carriers (KLT), equipping them and then packing them again at the end. This application was unusual in so much that the high weights had to be precisely moved through relatively short distances. This meant many drives had to be used in the system. In this case, only one solution was possible utilizing frequency converters that operate with extreme precision - whereby the costs for a conventional motor feeder - as is generally used for transfer lines - was not to be significantly exceeded.

Such a drive inverter is called Sinamics G110 manufactured by Siemens. This versatile drive for low power ratings saves space and operates with a voltage-frequency control (V/f). The control technician can decide whether he uses linear or square-law characteristic - or he can parameterize the control characteristics himself.

In order to be able to remove the pressure when bottlenecks occur, ten relatively short transport conveyor belts were planned. One drive inverter powers each of these. In addition, a G110 powers the rotary table in the assembly line. Up until now, Paro never had an application with so many conveyor belts in such a tight space.

It was important that the drive inverters could softly start and stop the belts and control the belt speed. The ramp rounding-off function was precisely what was required. Up until now, the Swiss control engineers had mainly worked with the Siemens Micromaster series of drive inverters and were using the G110 for the first time for this appli-

Figure2: An operator panel can be plugged onto the G110. This can be used to enter, read-out and even save drive inverter parameters. Identical drive inverters can be “cloned” on-site in just seconds

cation. Paro didn't have any problems at all because the parameter names are identical. The drive units are available in three housing sizes; they cover power ratings from 0.12 to 3.0 kW and are connected to single-phase line supplies (200 to 240 V).

Fast commissioning by cloning parameters

The speed can be very easily and manually set. There is a plug-in module that can be used to define all of the parameters. A special feature of this panel proved itself to be extremely helpful when commissioning the interlinked assembly line. For fast series commissioning, the parameters can be saved in this operator panel and then downloaded into the next drive inverter by simply plugging it onto the unit. It goes without saying that we can also read-out diagnostics data.

According to VDE regulations, drive inverters not only operate as control element, but may also be used for motor protection. This is why such a device naturally offers itself as complete motor feeder. The G110 includes both overload as well as short-circuit protection and protective functions such as undervoltage, ground fault, stall protection, thermal motor protection I2t, drive inverter overtemperature and motor overtemperature.

The advantages of the “entry-level model” Sinamics G110:

- *1-ph. 200 to 240 V AC*
- *Power range, 0.12 to 3 kW*
- *Line supply frequency, 50 and 60 Hz (dip switch)*
- *Output frequency, 0 to 650 Hz*
- *Load torque characteristics V/f linear, V/f square-law, parameterizable V/f*
- *3 fixed frequencies can be parameterized*
- *1 skip frequency can be parameterized*
- *Integrated RS 485 interface for the USS bus*
- *Many protective functions*
- *Automatic restart function*
- *Automatic restart after power failure*
- *Parameterizable ramp-up/ramp-down times*
- *Ramp rounding-off*
- *Standards: CE, UL, cUL, c-tick*
- *3 digital / 1 analog input*
- *1 digital output*

This automobile supplier uses four of the described assembly cells with dimensions 2.3 x 2 x 3 m as connecting element between inductively controlled vehicles and the downstream automated assembly line - and that seven days a week. This means that the devices must be appropriately rugged in order to achieve the required number of operating hours in continuous operation. In this case it is also helpful that as a result of its automatic restart, the G110 can automatically start itself again after an operational interruption due to a power failure after the fault has been resolved.

Figure 3: Thanks to the modular design of the Siemens family of drive inverters, the G series can be just as simply commissioned as for example, the Micromaster series. The “Starter” program supports the control engineer.

The optimum parameter settings can be determined, menu-prompted and graphically supported using the "Starter" software. The parameter settings can then be simply transferred to the device via the RS 232 interface". The parameterizing procedure is significantly simplified by being able to import data from the electronic type plates of the drive components. The "Sizer" program also provides effective support to quickly dimension and design the drive line-ups. The "Sizer" program as engineering software and "Starter" are dedicated Windows-based applications. Functions can be checked and parameters optimized using the integrated test routines.

Figure 4: The G110 drive inverter is the “entry-level model” up to a power rating of 3 kW. However, this model already has parameterizable ramp-up and ramp-down times, an automatic restart function for connecting to rotating motors and many more.

Successful premiere of the “entry-level model”

The Swiss automation company gained some positive experience with the first use of the Sinamics G110 drive inverter - therefore simultaneously underlining its single-supplier strategy. The reason for this decision was that experience had shown that the modular family of drive units offers significant advantages when it comes to engineering, commissioning and after-sales service. Not to mention the reduced logistical costs by decreasing the range to just include specific device types. Every application has to be implemented in its own optimal way. For this application, involving an interlinked assembly solution that isn't often used, the straightforward G110 - the smallest device in the Sinamics family of drive inverters - proved itself to be the first choice; it is small, functional.

www.siemens.de/micromaster

Figure 5: Optimum handling of heavy gearbox parts had made it necessary to use short transfer belts in the equipment. Their synchronization is decisive – and is simple when using the G110 drive inverter.

Battery Authentication Improves Battery Security

Safety is guaranteed throughout the life of the product

The need to power portable devices has opened a huge market for counterfeiters to supply cheap replacement batteries and peripherals. Many of these items may not have the safety and protection circuits required by the OEM.

By Jinrong Qian, Texas Instruments

Driven by integrated functionality and shrinking form factors, the demand for portable devices such as the cellular phone, PDA and DVD player has been growing significantly for the last few years. These portable devices require rechargable batteries and peripherals that will need to be replaced during the "life" of the portable device. Indeed, these counterfeit batteries may violate both mechanical and electrical safety requirements related to short-circuit protection, charge safety and other specifications.

It is usually impossible for consumers to determine the quality of a replacement power device without purchasing it and possibly learning their lesson "the hard way". In addition, this can lead to a potentially dangerous situation for the end-users. Adding simple and effective portable system authentication technology allows the OEMs to ensure customer satisfaction and protects their business. More importantly, safety is guaranteed throughout the life of the product. This article discusses the simple identification (ID) and the more complicated challenge-and-response CRC and SHA-1/HMAC-based battery authentication schemes–battery authentication architectures that meet today's counterfeit battery challenges to protect OEM potential business and ensure the end-user safety and satisfication.

Identification (ID) Based Authentication Scheme

Several schemes are currently used to identify when a battery pack is intended for portable products. The most common is the form-factor, or physical connection. Every cell phone battery pack on the market has a different form-factor. The battery pack's physical size is not even consistent in all the phones manufactured by the same company. While the form-factor identification method affords some protection level for the low-volume runners, high-volume batteries are much more likely to be counterfeited. It would be a cost-saving solution to standardize form-factors and not change them. Many OEMs are moving towards this economic model. However, this design provides opportunities for counterfeiters to replicate the battery pack by measuring its physical dimension.

To improve the battery identification, an electrical identification scheme should be used so that a simple physical counterfeit is no longer enough to replicate the battery. Figure 1 shows the ID authentication functional block diagram. The challenger, or host, sends a command to read the data from the device(responder). The data includes product family code, identification number (ID), and cyclic redundancy check (CRC) value. Each device has a unique ID number. The response data is compared with the data in the host. If the information from the device is valid, then the host enables the system's operation. If not, it may inhibit its operation and provide a system error code and a warning signal to the end-user. The ICs, in this example the bq2022 and bq2023, provide a unique ID for each device. Figure 2 shows the battery pack typical application circuit with the ID chip. The host "communicates" with the chip through a dedicated general purpose I/O to determine if an ID is available and valid. The ID authentication scheme eliminates a significant number of non-OEMs; however, the ID issued by the device is available to anyone with an oscilloscope. It is still possible for the counterfeiters to replicate the ID to the issued command, but it increases the cost to implement a fake ID. Some non-OEMs go after batteries and peripherals for such high-volume products that adding a cheap microcontroller to the system is acceptable. To counter this threat, a more robust authentication scheme must be employed.

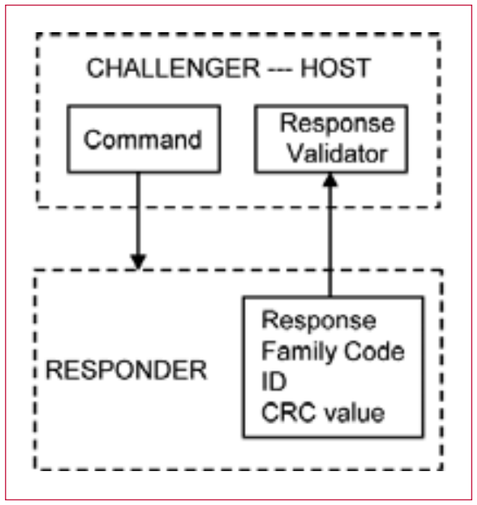

Figure 3. 1 - ID Authentication Functional Block Diagram.

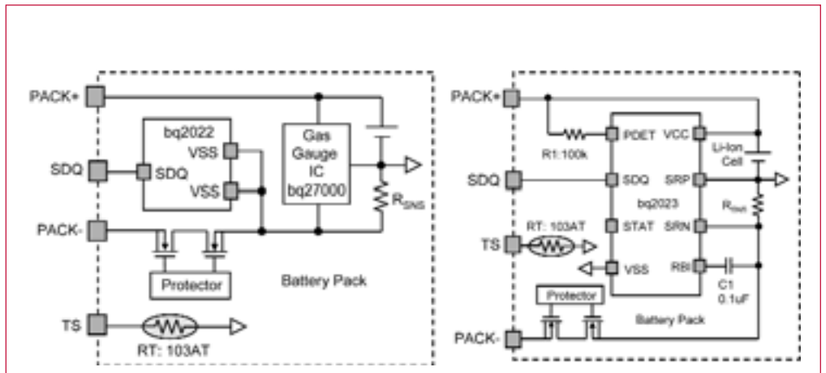

Figure 2. Typical Application Circuit with ID Chip.

Challenge-and-Response Based Authentication Scheme

A straight ID authentication increases the counterfeit complexity to identify the ID and the command and adds cost to the system. If cost is important, a non-original manufacturer will progress to developing a battery or peripheral without this functionality. But for those non-original manufacturers that are willing to add cost to their system to secure a business opportunity, something more robust than an ID authentication is needed.

A more cost-effective and robust approach is based on a challenge-and-response scheme shown in Figure 3. The major components of this scheme are the random challenge and a secret known only to the challenger and responder. In this scheme the host sends a random challenge to the battery pack that contains the identification device, or responder. The challenge consists of random data generated by the host. The secret key is either shared or transmitted securely from one side to another. A shared secret is typically static from responder to responder, minimizing the secure memory requirements on the host. A system that requires each responder to have a different secret would require secure transmission of that secret from the responder to the host. Transmitting the secret securely typically means sending an encrypted version of the secret over a public communication channel. The encrypted secret must be decrypted at the host before it can be used in the authentication calculation.

When the authentication device receives the challenge information, it combines the challenge and a plain-text version of the secret, stored in private memory, and performs the authentication transform to calculate the response. On the other side, the host performs the same transform using the challenge and the plain-text version of the secret it stores. The host compares the value it computes against the response obtained from the identification device. If the calculated data from the authentication device matches the expected answer from the host, then the host authenticates the battery and allows the system to start operation. Otherwise, it may inhibit the system operation and provide a warning signal to the end-users. Why is this scheme more secure than the straight ID based scheme? The single ID authentication scheme has a fixed response to a fixed challenge or command. It is relatively easy for the counterfeiters to find out the fixed challenge and command. However, the challenge and response secure scheme changes the query and response every time. A relatively large and random challenge makes a look up table solution very expensive in terms of memory, which has a direct correlation with the monetary cost, and is difficult to guess. In addition, part of the transform involves a secret shared between the challenger and the responder. Security then resides in the secret, allowing the scheme to use a public authentication transform algorithm.

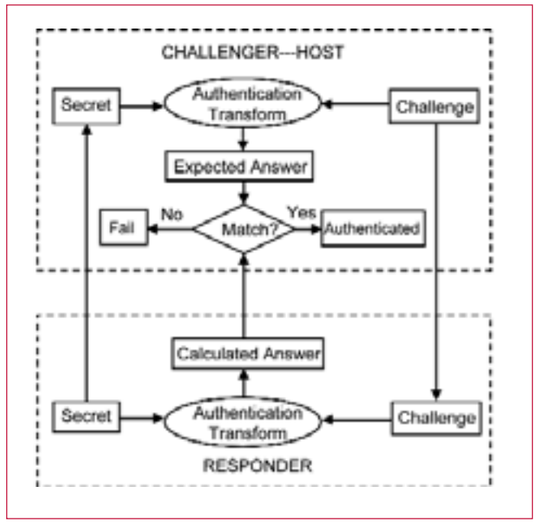

Figure 3. Challenge and Response Based Authentication Scheme.

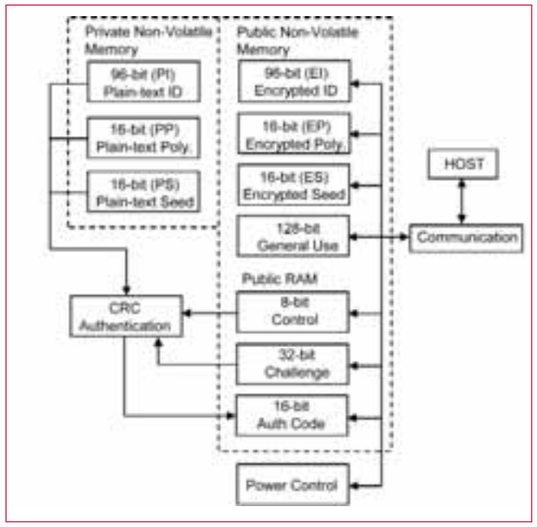

Figure 4. Challenge and Response CRC-Based Authentication Block Diagram.

Public authentication transforms are good because they can be thoroughly and properly evaluated for robustness against attacks to reveal the secret.

Challenge and Response CRC-Based Authentication Implementation

Figure 4 shows the CRC-based authentication implementation diagram based on the concept of challenge and response authentication scheme discussed above. The authentication transform uses CRC to calculate the value to authenticate the battery pack. It combines a 32 bit challenge and a 96 bit secret ID through a CRC with a random polynomial and seed value to generate a 16 bit CRC response. Security is achieved through the use of a 16 bit CRC, a 16 bit CRC seed, a 96 bit device ID, and a 32 bit random challenge. The CRC polynomial, CRC seed, and 96 bit ID are unique from device to device. They are stored as encrypted text in public memory and as plain-text in private memory. Any external device can not access the private memory to look at the plain-text of the CRC polynomial, CRC seed and ID. The host system can decrypt the polynomial, seed and ID values using the secret key that is stored in the end equipment's memory. The encryption method and the secret key used to store the polynomial coefficients and the device ID can be selected by the manufacturer.

To authenticate a battery pack, the host reads the encrypted device ID, polynomial, and seed values from the public memory. It decrypts those values using the secret key and then generates a 32 bit random challenge. The generated random challenge is transmitted to the authentication device, which uses the plain-text version of the polynomial coefficients, seed and device ID, along with the 32 bit random challenge from the host to calculate the authentication CRC value. The host uses the polynomial coefficients, seed and decrypted device ID, along with the 32 bit random challenge that it sent to the authentication device to calculate the authentication CRC value. When the host and the authentication device have completed the calculation, the host reads the authentication CRC value from the authentication device and compares it to its own value. If the values match, the battery pack is authenticated. The host initiates the system start command and it is allowed to communicate with other devices in the battery pack, such as the gas gauge. Otherwise, the host may not initiate the system start-up command and provide a warning signal to the end user.

Figure 5 shows the battery pack typical application circuit with CRC based battery authentication. The authentication chip has an internal regulator powered by the communication line and it can communicate the gas gauge IC. If the authentication fails, the host may not allow charging the battery and provide a warning signal to the user. If the battery pack is authenticated, the host communicates gas gauge bq27000 to get the battery information. CRC based authentication provides a simple and cost-effective solution to authenticate battery packs for end-equipment.

Challenge-and-Response SHA-1 Based Authentication Implementation

A more sophisticated algorithm such as SHA-1/HMAC can be used to achieve a high level of authentication. The SHA-1/HMAC has been used for a number of years to authenticate Internet transactions for Virtual Private Networks, banking and digital certificates. The algorithm used in SHA-1/HMAC is iterative. One-way hash functions can process a message to produce a condensed representation called a "message digest" that determines a message's integrity. Any change to the message results in a different message digest with a very high probability. This property is useful in the generation and verification of a digital signatures and message authentication codes. Figure 6 shows the block diagram of SHA-1/HMAC based authentication. The authentication principle is similar to the CRC based except the algorithm is different. To authenticate a battery pack, the host reads the 128 bits encrypted device ID from the public memory. It decrypts those values using the secret key to achieve the plain-text information with root keys. It then generates a 160 bit random challenge. The generated random challenge is transmitted to the authentication device, which uses the plain-text version of the ID along with the 160 bit random challenge from the host to calculate the authentication digest value.

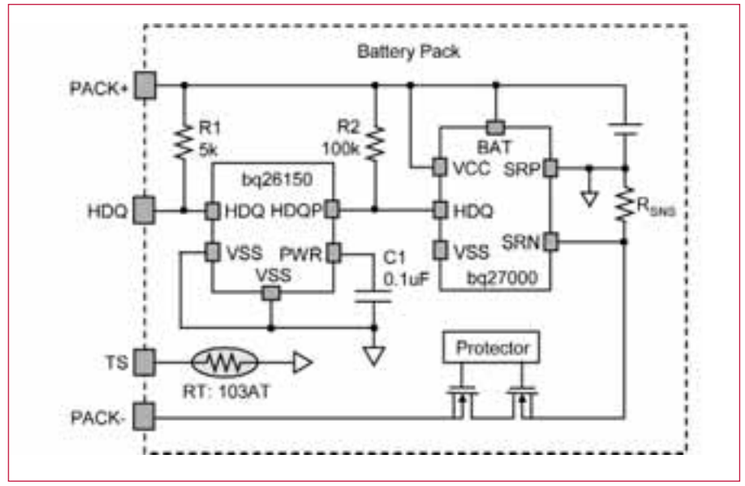

Figure 5. Battery Pack Typical Application Circuit with CRC-Based Authentication Chip.

The host uses the decrypted ID along with the same 160 bit random challenge sent to the authentication device to calculate the authentication digest value. When the host and the authentication device have completed the calculation, the host reads the authentication digest value from the authentication device. It then compares to its own value. If the values match, the battery pack is authenticated. The host initiates system start command. Otherwise, the host may not initiate the system start-up command or provide a warning signal to the end user. Since there is a 160 bit random challenge, it generates 2160 possibilities, which significantly improves the security level. However, the SHA-1/HMAC algorithm requires more memory size, which increases the cost.

The selection of the battery authentication scheme among the simple ID authentication, CRC and SHA-1/HMAC-based authentication is dependent on the security level needed and cost for the applications. The simple ID authentication is cheapest, but it is easy to be replicated though and is desirable for the cost-sensitive applications. The challenge and response CRC and SHA-1/HMAC based authentication is most expensive. However, they have highest security and are good for the high-end portable applications.

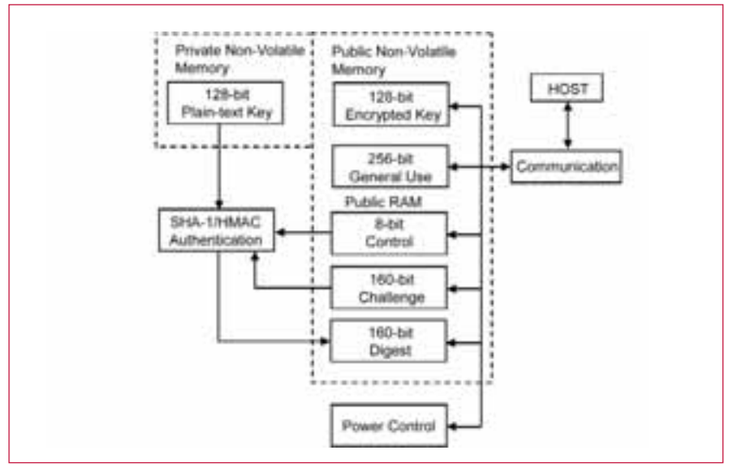

Figure 6. Challenge-and-Response SHA-1/HMAC Based Authentication Block Diagram.

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Harmonic and Flicker Testing

Meeting the requirements of the EN61000-3-2/3

All designers of electrical or electronic equipment which is intended to be connected to the mains supply need to be familiar with the performance requirements of EN61000-3-2 (harmonics) and EN61000-3-3 (flicker and voltage variations) and the test methods required to ensure compliance.

By Malcolm Robinson, Senior Design Engineer, Thurlby Thandar Instruments Ltd.

EN61000-3-2 is the standard that defines permitted harmonic current limits. It categorises equipments into four classes (A, B, C and D) and imposes different harmonic current limits on each class. It also defines cases where no limits apply, but places prohibitions on some control techniques that apply to all equipment within its scope, even if they are not subject to limits. The original standard was released in 1995, but significant revisions were made in 2000, particularly to the treatment of fluctuating harmonics and in the definition of class D.

Figure 1. The HA1600A harmonics flicker and power analyser and the AC1000A low distortion power source from TTi (Thurlby Thandar Instruments.

The standard calls for harmonic levels to be checked using both the average and maximum values over the whole test interval. Any harmonic is allowed to fluctuate up to a maximum of 150% of its limit, provided that its average value is below 100% of the limit. In addition, some trade-off between harmonics is allowed for odd harmonics of orders 21 to 39, based on a value called the partial odd harmonic current (POHC), which is the RMS sum of all the odd harmonics between 21 and 39.

EN61000-4-7 is the standard that defines the requirements for the test equipment for measuring harmonic currents. This standard has also undergone substantial revision: the 1993 version covered both digital and analogue implementations (such as tuned level meters), while the present 2002 version anticipates an implementation based on digital signal processing techniques and extends the measurement complexity.

At the heart of the measurement technique is the discrete Fourier transform, which takes a sequence of samples of a waveform in the time domain and computes the frequency spectrum of the waveform on the assumption that the signal repeats indefinitely. Much of the complexity of the standard lies in the fact that it also covers situations, known as fluctuating harmonics, where this assumption is untrue. The transform is taken across a number of cycles of the mains waveform over a period known as the window length. The present standard calls for a 200 ms window: 10 cycles at 50 Hz or 12 cycles at 60 Hz. The digital system is required to be synchronous, generally involving a phase-locked loop linking the sampling clock to an exact multiple of the mains frequency. Results are required up to the 40th harmonic, and applying the well-known Nyquist criterion means that the sampling rate must be at least 80 points per cycle. The HA1600A instrument shown in Figure1 uses transforms based on the prime factor algorithm at 150 samples per cycle.

The standard demands that the instrument must sample continuously and perform transforms on all the data without any gaps. This imposes a burden of real-time availability on the processor, which is virtually impossible to achieve on a general-purpose computer running a desktop operating system. All compliance-grade instruments will have digital signal processing built in. Incidentally, if a PC is used to carry out the signal processing, then that PC becomes part of the instrument and must be included in the annual calibration cycle.

A major addition to the EN61000-4-7 standard in the 2002 amendment is the need to include spectral components at frequencies which fall between two harmonics (known as inter-harmonics in the standard). If a discrete Fourier transform is conducted over a window of ten mains cycles, it gives spectral amplitudes at ten points between the harmonic 'bins'. Previously, these components were ignored; now they must be added (by an RMS sum of the magnitudes) into the amplitude of the nearest harmonic (with half the amplitude of the mid-point bin added to the harmonics on either side) before comparing that result to the limit.

Systems whose harmonic levels change over a time frame comparable to the window width cause sidebands on the harmonic signals, and these are now included. Other systems may directly generate non-harmonic components, commutator noise from asynchronous motors being one example. A washing machine with an unbalanced spin load may produce such a waveform (it might also produce flicker, although generally the motor current is too small for this). Any such equipment will give different results when tested using the new methods.

Figure 2 shows a typical mains voltage waveform as available at a normal socket outlet. The flat-top distortion is clearly evident, showing the effect on the supply network of harmonic currents caused by large numbers of electronic products taking a sharply peaked current waveform such as that illustrated.

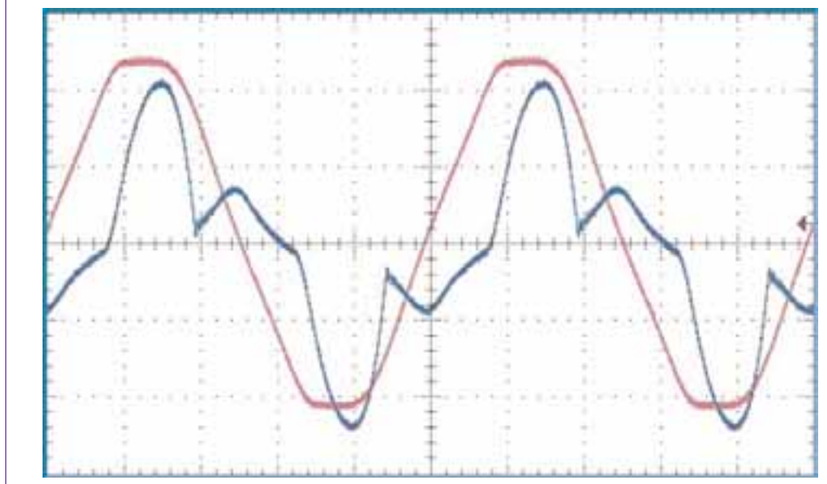


Figure 2. Typical mains voltage waveform showing the effects of harmonic distortion.

EN61000-3-3: flicker and voltage fluctuations

EN61000-3-3 is the standard that defines limits for two related effects: flicker and voltage fluctuations. Both are intended to ensure that equipments do not cause annoyance to neighbouring consumers connected to the same supply network by causing voltage changes across the shared source impedance of the network. The magnitude of these voltage changes depends on the both the network source impedance and on the changes in the current consumed by the unit under test.

Flicker is the impression of changes in the brightness of a lamp as perceived by a human observer. Over the years, surveys have been conducted to establish the threshold of annoyance to the population caused by flicker, leading to the definition of the flicker perception unit. EN61000-4-15 (which has replaced IEC868) describes the complex processing sequence of AGC, demodulation, filtering, squaring and smoothing, and statistical classification by which the real-time voltage waveform is reduced to two simple numbers for the

short- and long-term flicker severity indicators Pst and Plt. As with harmonics, testing to this standard presents a continuous real-time processing burden and requires a DSP in the instrument.

Assessing voltage fluctuations requires an examination of the history of the RMS values of each half cycle over a period of time, categorising an interval as either a steady state or a voltage change, and comparing the magnitude and duration of the changes against the limits.

Supply source and reference impedance

The standard environment for testing requires a perfect sine-wave mains source with a defined source impedance called the reference impedance. This is intended to be representative of the actual characteristics of the supply mains at a domestic socket outlet, and the reference value is derived from survey work carried out many years ago. The voltage change produced by any given current change is directly proportional to the impedance value, so that any error in the magnitude of this impedance translates directly into an error in the measured result. As the permitted overall error is 8%, the impedance must be quite precise. It is also necessary to allow for the resistance of any connecting leads, plugs and sockets.

Some laboratory standard mains generators have provision for simulating the reference impedance using their internal feedback loop, but such methods are subject to the limited bandwidth of that loop, and it is possible for unforeseen interactions to occur.

Many laboratories do not have access to an expensive mains source but, because of waveform distortion and indeterminate source impedance, it is not possible to conduct these measurements by using the public mains supply in conjunction with the normal voltage sensing method. Therefore the HA1600A also implements an alternative current sensing technique that can be used without a laboratory-grade mains supply.

Inrush current

The 2001 amendment to EN61000-3-3 also introduced an explicit requirement to test the voltage fluctuation caused by manual switching events. This imposes a limit on the maximum peak half-cycle RMS inrush current that a unit may take whenever it is switched on. This requirement arises from concerns among supply network operators about the difficulty of reconnecting a network after a supply failure.

These tests have to be conducted by physically actuating the actual switch on the product under test; the use of electronic switches is not permitted. Because of the random phasing of the user's switch action with the mains waveform, a series of tests must be performed to obtain a statistically valid average result. As equipment containing surge-protection measures may take several minutes to cool down between tests, this is a time-consuming requirement.

Because of the nature of modern rectifier circuits, this test needs to be conducted on almost all electronic products.

Complete solution

The HA1600A harmonics flicker and power analyser, combined with the AC1000A low distortion power source (Fig.1), provides a complete solution for the compliance quality measurements described above.

However, in addition to its EMC measurement capabilities, it provides basic power meter measurements, such as RMS and peak current, power, VA and power factor, as well as a visual display of the voltage and current waveforms on-screen, without any of the safety issues involved in using a standard oscilloscope for live mains measurements.

In production testing, a quick check of the waveform can easily show up manufacturing faults such as partially faulty bridge rectifiers or transformers with high magnetising currents in a quick and safe way that allows manufacturers to dispatch their product confident that it is safe.

Another measurement provided is of instantaneous peak inrush current. There are no EMC standards limiting this parameter, but it is a critical aspect determining the life expectancy of switch and relay contacts. Using this measurement, product designers can check that the ratings of the selected switch are not being exceeded.

www.tti-test.com

Compact Split-Core Transducers

LEM has introduced the AHR series of AC and DC current transducers that offer versatile and precise measurement of nominal currents up to 2000A true RMS, extending the existing family that ranges from 100A to 1000A. These split-core transducers combine Hall-effect technology and signal conditioning in a compact case to offer substantial savings in size (more than 50% compared to existing current transformers). They measure only 174 x 86 x 54.1 mm.

Devices in the AHR series have been designed to measure DC signals as well as distorted current waveforms such as variable frequency drive (VFD) outputs. They offer a choice of primary current measurement ranges from 500A to 2000A, a choice of standard output types (4-20mA, 0-5V or 0-10V), a wide power supply range (20 to 50 VDC) and large sensing apertures for non-contact measurement (104 x 40 mm busbar, in addition to a 32 mm ? cable version).

The new transducers provide an absolute accuracy better than 1 percent of the nominal current over a broad range of inputs. This, coupled with a wide bandwidth from DC to 6kHz, an operating range of -40 to +70°C and true RMS computation for non-linear loads or "noisy" environments, makes them an excellent choice for industrial system designers, system integrators and automation distributors looking for accurate and cost-effective AC or DC current transducers. As with all other LEM products, the AHR series products benefit from the company's proven high-quality approach to manufacturing and are backed by a five-year guarantee. Principal applications are expected to be in the monitoring of large SCR or switch-mode rectifiers, backup batteries, main AC power supplies and large AC or DC motors.

www.lem.com

Multiphase Voltage Regulator

Intersil introduced a new family of PWM (pulse width modulation) controllers that control microprocessor core voltage regulation by driving 4-6 synchronous-rectified buck channels in parallel.

The ISL6326/26B/27 family provides the highest-performance VR11 multiphase voltage regulator at the lowest possible BOM cost, "said George Lakkas, senior product marketing manager of Intersil's Computing Power products group. "Our APP and APA technology enable the elimination of several bulk capacitors vs. competitive solutions, representing huge savings in total solution cost. There are numerous OEM/ODM and reference designs in the market using our controllers."

Intersil's ISL6326 and ISL6326B are 4-phase PWM controllers with an 8-bit DAC code for precision dedicated current sense resistance (DCR). The ISL6326B offers an output current pin that enables continuous power monitoring. The ISL6327 is a 6-phase PWM controller with an 8-bit VID (voltage identification) code and differential inductor DCR or resistor current sensing. The ISL6327 also offers an output current pin. The ISL6326 family is optimized for desktop and industrial PCs and the ISL6327 is optimized for Server platforms. Microprocessors require a tightly regulated output voltage position versus load current (droop). The ISL6326/26B/27 sense the output current continuously by utilizing patented techniques to measure the voltage across the dedicated current sense resistor or the DCR of the output inductor. Current sensing provides the needed signals for precision droop, channel-current balancing, and overcurrent protection. A programmable integrated temperature compensation function is implemented to effectively compensate for the temperature coefficient of the current sense element. The current limit function provides the overcurrent protection for the individual phase.

www.intersil.com

POL PWM controller IC

International Rectifier has introduced the IR3624, a 600kHz single-phase synchronous buck PWM controller IC designed for high density, 10A non-isolated point-of-load (POL) regulators. The 600kHz switching frequency enables the use of a reduced footprint inductor and fewer output capacitors, saving board area. For example, when the new IR3624 is used with a pair of IR's small can DirectFET HEXFET MOSFETs, such as the IRF6623 and IRF66636, a complete 10A regulator can be made to fit into 200 square millimeters of board space.

The combination of the IR3624 with two small-can DirectFET MOSFETs allows designers to achieve twice the power density of previous solutions by reducing solution footprint by 45%. For system robustness, the IR3624 features integrated thermal shutdown and programmable over-current limit protection. The IR3624 includes a 0.6V voltage reference, which allows a single POL regulator to support a wide variety of applications from ultra low-voltage DSPs to legacy 5V logic.

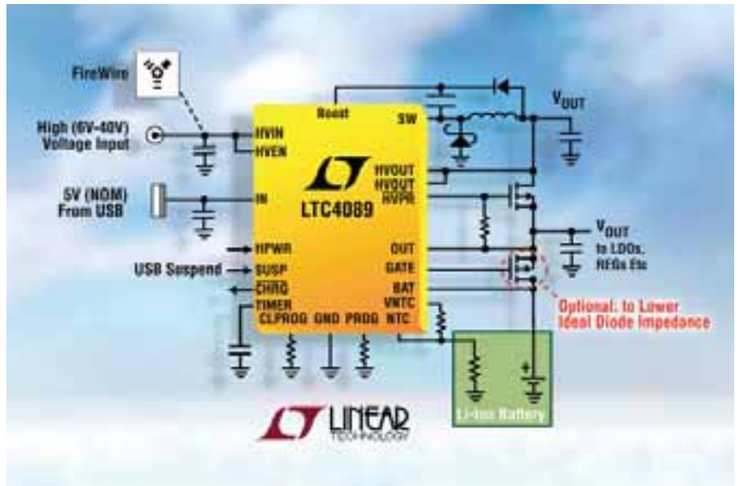
For applications below 5A, even higher density can be achieved by using one SO-8 dual N-channel HEXFET MOSFET such as the IRF8910 to replace the two stand-alone MOSFETs and further shrink the board area to within 150 square millimeters.

To meet the tracking requirements of the latest ASICs and FPGAs during start-up, the IR3624 can start-up with a pre-biased output voltage without discharging the output. This feature simplifies regulator design for both the core and I/O voltages. Under-voltage lockout and programmable soft start features further help to limit in-rush currents and ensure proper power up of the regulator.

The devices are lead-free and are compliant with the Restriction of Hazardous Substances

www.irf.com

USB Power Manager & 36VIN Battery Charger



Linear Technology Corporation introduced the LTC4089 and LTC4089-5, each featuring an autonomous power manager, ideal diode controller and standalone high-voltage switching battery charger for portable USB devices. For high efficiency charging, their switching topology accommodates various inputs, including high voltage power sources up to 36V (40V max) such as 12V AC-DC wall adapters, FireWire ports or automotive batteries. In addition, they accept low-voltage power sources such as 5V wall adapters or USB inputs and single-cell Li-Ion/Li-Polymer batteries. The LTC4089/-5 features PowerPath control that provides power to the USB peripheral device and charges the peripheral's single-cell Lithium battery from the USB bus or a wall adapter power supply and also allows for instant-on operation even with a depleted or missing battery. To comply with USB current limit specifications, the LTC4089/-5 automatically reduces battery charge current as the system load current increases. To ensure that a fully charged battery remains topped off when the bus is connected, the IC directs power to the load through the USB bus rather than extracting power from the battery. Once all power sources are removed, current flows from the battery to the load through an internal 200mOhm low loss ideal diode, minimizing voltage drop and power dissipation. Onboard circuitry is provided to drive an optional external PFET to reduce the overall ideal diode impedance below 50mOhm if required by the application, providing higher efficiency operation.

www.linear.com

DCDC with two LDO Outputs

Micrel launched the MIC2800, a highly efficient, flexible power management IC that provides three output voltages and a power on reset in a tiny 3mm x 3mm MLF-16 package. The solution is ideal for use in cell phones, Smart phones, PDAs, cameras, portable media players, wireless LAN cards and Bluetooth applications.

The MIC2800 features a wide input range of 2.7V to 5.5V, three voltage outputs and a power-on reset. Output 1 is a high frequency, high efficiency DC-to DC switching regulator for up to 600mA while output 2 and 3 are low dropout linear regulators. One of the linear regulators works from a low input voltage, allowing it to post-regulate the switching regulator for best efficiency. For example, the high speed DC-to-DC converter can step down the Li-Ion battery input to 1.8V and the LDO can provide 1.6V by post-regulating the 1.8V rail with greater than 80 percent efficiency. One additional low noise linear output can provide a third voltage such as 2.8V for an analog rail. The IC also offers a LOWQ mode which reduces the total current drawn to less than 50uA.

"As cell phone manufacturers add more features such as video streaming and higher resolution cameras to cell phones, several new chipsets have to be powered to enable these applications," noted Ralf Muenster, Micrel's director of marketing for power products. "The MIC2800 is a no compromise design, meeting the requirements of camera accelerator DSPs or digital multimedia broadcast (DMB) chips used in today's portable applications with the smallest footprints. In addition to these and other auxiliary functions, the part is also suitable to powering a baseband processor core and I/O rails as well as providing a higher low noise analog voltage using the third output."

www.micrel.com

Compact Ultracapacitor Cells

Maxwell Technologies has introduced Power-type versions of its BOOSTCAP "D-Cell"

ultracapacitor cells, packs and modules to provide high-performance, "life-of-the system" alternatives to batteries for automotive electrical power network stabilization and industrial applications.

Dr. Richard Balanson, Maxwell's president and chief executive officer, said that the new, flashlight battery size, BCAP0310 P250 310-farad cell and compact, fully integrated, six-cell 15-volt packs and modules provide simple, low-cost, backup power solutions to avoid malfunctions that occur when multiple simultaneous electrical power demands cause a "voltage sag" that can upset microprocessors that manage electrical subsystems in modern vehicles.

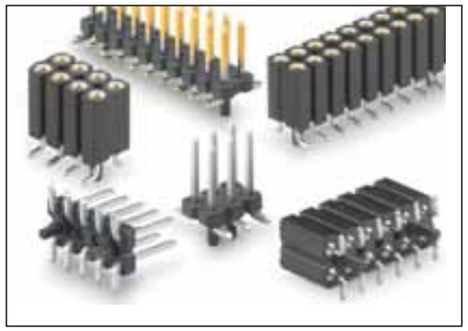
Industrial applications include power on demand for robotic systems and uninterruptible power supplies (UPS).

"With more than 60 million new cars rolling off assembly lines around the world each year, and the proliferation of power-consuming luxury and safety features in current and future vehicles, automotive power network stabilization represents an immediate and very sizeable opportunity for ultracapacitor-based solutions, so we continue to move aggressively to capitalize on Maxwell's position as the global technology leader," Balanson said.

Dr. John M. Miller, Maxwell's vice president for advanced transportation applications, said that the BCAP0310 P250 is the latest addition to company's line of Power-type ultracapacitor products whose versatility and high performance make them a compelling alternative to battery-based solutions for hybrid drive systems, idle stop-start, all-electric braking and steering and other applications in addition to power network stabilization.

www.maxwell.com

Positioning pins for SMD headers



For better fastening of SMD headers onto PCBs, Fischer Elektronik are now able to offer, with immediate effect, designs with positioning pins for double-row male headers (SL LP 6 SMD ...) and female headers (BL 16 SMD ...). Both ends of the headers are provided with centrally arranged plastic tenons which have a diameter of 1.2 mm. The drilled hole in the PCB, having a dimension between 1.2 and 1.3 mm, enables for the headers to be fitted precisely and safely.

The minimum number of contacts is 6 (2 x 3 contacts). The spacing of the drilled holes for accommodating the positioning pins is 2.54 mm for the 6-contact version and this spacing increases with the number of contacts. The maximum number of contacts in the standard version is 40 (2 x 20 contacts). Other numbers of contacts can be supplied on request.

www.fischerelektronik.de

Surge Arrestors for xDSL Applications

STMicroelectronics has introduced a new range of TRISILs designed to protect ADSL/VDSL modems and similar high bit-rate communications equipment. Fully compatible with digital transmission standards such as ADSL2 and ADSL2+, the SMP80MC family of micro-capacitance transient surge arrestors is the first TRISIL series for which the junction capacitance does not depend on the device breakdown voltage. This is first family of devices to combine an 80A repetitive peak pulse current rating with a low capacitance of only 12pF, typical.

Telecommunications systems are particularly vulnerable to lightning-induced surges and two levels of protection are normally required: a primary suppressor on each line to absorb the major part of the overvoltage transient and secondary protection devices mounted on individual PCBs to eliminate the residual overvoltage spikes. Compliant with major standards such as GR-1089 Core, ITU-T-K20/K21, VDE0433, VDE0878, IEC61000-4-5 and FCC part 68, the expanded family provides fast, bidirectional crowbar protection with maximum surge currents up to 80A (10/1000µs). Key parameters of the devices include voltage range from 120V to 270V, a maximum leakage current of only 2µA, a maximum breakover voltage up to 345V and a minimum holding current of 150mA. The devices are housed in surface-mount SMB packages (JEDEC DO-214AA).

Ideal for protecting telephone, fax, modem and similar sensitive equipment against lightning strikes and power crossing events, the SMP80MC devices are in full production and cost $0.18 in quantities of 2500 pieces.

www.st.com

High Current PCB Connector

Anderson Power Products® (APP), a leader in high power interconnect solutions, introduces the new High Current Connector and Contact series. An ideal solution for applications that require high current connections to a PCB, the High Current Connector and Contact Series may be configured in one or two row configurations, in both vertical and straight mounted terminations.

When utilized with the APP Powerpole 15/45 connector housings, the High Current Connector and Contact Series provides' a reliable wire to PCB connection. The connectors are RoHS compliant and have a UL rating of 45 amps per circuit. Additional ratings can be determined by consulting the rating curves.

The APP High Current Connector and Contact series contacts are composed of copper alloy with tin plating, limiting the voltage drop to less than 5.5mV. The connectors are available with accessories that include mounting wings and spacers.

www.andersonpower.com

Power Inductor Sample Kits

NIC Components has introduced a free online facility that allows design engineers to build their own surface mount power inductor sample kits. The quick kit service is accessed via NIC's homepage where design engineers can choose up to 15 different parts from NIC's range of over 300 standard RoHS compliant power inductors. The kits are typically delivered to the customer within five working days of the order being placed.

The quick-kit service has been designed to be as fast and simple to use as possible. The on-screen list of power inductors details key specification points for each part number, including type (shielded or unshielded), dimensions, inductance and tolerance. A photograph of each component is also included to help speed selection. Full data sheets can be accessed via a convenient link adjacent to each part number.

The full list of SMT power inductors can be displayed in ascending order for a range of different parameters to further ease the design engineer's task of selecting the most appropriate parts for their personal sample kit.

For each of the maximum 15 part numbers chosen either five or 10 samples can be supplied. The parts are shipped to the customer in a special Quick-kit box that provides convenient and safe storage of the components.

www.niccomp.com

SOT23 Bipolar Transistors

A range of low voltage bipolar transistors from Zetex Semiconductors extends the power handling capability of the SOT23 package, enabling designers to shrink products by replacing much larger SOT89 and SOT223 equivalent parts.

Using its advanced lead frame design and bipolar process capability Zetex is offering two NPN and two PNP devices, each capable of dissipating up to 1.25W. The ZXTN23015CFH and ZXTN25020DFH NPNs have VCE ratings of 15V and 20V respectively, while the ZXTP23015CFH and ZXTP25040DFH PNPs are in turn rated for 15V and 40V operation.

Handling continuous currents up to 6A, the transistor series enables significant increases in power density to be made, and by supporting pulse current peaks up to 15A, it provides the ability to drive higher capacitance MOSFETs and IGBTs at much higher speed in power supply applications.

Also characterised by their very low saturation voltage – 30mV at 1A collector current for the 15V NPN – these SOT23 bipolars make highly efficient switches for battery powered equipment and ensure heat dissipation is kept to an absolute minimum. The transistors' high gain means large loads can be driven by ICs without the need for additional buffer circuitry.

www.zetex.com

Astec Universal Input PSUs

The launch of the LPT50 series of power supply units from Astec Power, available through UR Group, completes the family of LP50 PSUs, adding triple-output models to the range and consolidating Astec's position as the leader in low power AC-DC products.

The new LPT50 triple-output models have convection-cooled ratings of up to 55W in the same compact package as the existing LPS50 series. Housed in a footprint of just 101mm x 51mm, with a height of only 33mm, they are ideal for use in 1U height applications. Medical versions, dubbed LPT50-M, mirror the output combinations of the LPT50 series and are approved to EN6060-1 and meet EMC EN55022 Class B.

The existing LPS50 series delivers up to 60W (for convection) in single output variants. These models all feature universal input (90-264V AC or 127-300V DC) with remote sense, overload and short circuit protection, adjustable output voltage and built-in EMI filter. Output adjustment range is 20%, more than twice that of most products on the market. Medical versions, the LPS50-M series, are also available. Both the standard and medical versions meet EMC EN55022 level B.

www.ur-group.co.uk

3-MHz DC/DC for Li-Ion

Texas Instruments introduced a tiny, high-performance power conversion integrated circuit (IC) to work in tandem with processing platforms that use TI's SmartReflex power and performance management technologies. Designed to extend battery life in 3G phones and other portable electronics, the flexible converter features a 3.4-Mbps I2C communications interface and ultra-fast transient response from a tiny chip scale package. See: www.ti.com/sc06098.

TI's TPS62350 synchronous, step-down DC/DC converter supports up to 800 mA over the input voltage range of a single-cell Lithium-Ion (Li-Ion) battery. The device's integrated I2C communications interface allows it to adjust output voltage between 0.75 V and 1.53 V, efficiently supporting TI's advanced digital signal processors (DSPs), SmartReflex technologies-enabled OMAP processors, like TI's OMAP3430 processor, and other processor core power supplies in cell phones, PDAs, digital still cameras. It also supports handheld computers that use Intel's XScale processors. The TPS62350 can operate in a power-save mode at light-load currents, and can be placed in a shutdown mode where the power consumption is reduced to less than 1 µA.

The device's serial interface is compatible with fast/standard and high-speed mode I2C specification, which allows data transfer at up to 3.4 Mbps.

The dynamic voltage scaling feature allows the TPS62350 to adjust voltage levels in 12.5-mV steps and seamlessly switch to an efficiency-optimized light power factor mode (PFM), a transient-optimized fast PFM mode or a forced PFM mode.

SmartReflex technologies coordinate the power consumption and performance of all major system components, including multiple processing cores, hardware accelerators, functional blocks and peripherals. A library of power management cells enables a granular approach to system partitioning of the portable device's power domains. Finally, SmartReflex technologies provide an open software framework that enables intelligent coordination among lower-level hardware technologies and compatibility with OS-based and third-party power management software.

www.ti.com

Fully Integrated PoE Interface Modules

C&D Technologies has launched a family of fully integrated Powered Device (PD) interface modules that will significantly reduce component count, design time and installation cost of Power over Ethernet (PoE) applications. The NMPD series of compact power extraction modules are the industry's first PD interfaces to feature on-board DC/DC conversion, and provide a full IEEE802.3af-compliant data and power interface to an Ethernet line including short-circuit protection.

The NMPD modules are ideal for PoE designs in applications ranging from security equipment and public address systems to remote environmental monitoring, telemetry and industrial control. Operating with a maximum output power rating of 10W, the modules extract power from a CAT5 twisted pair Ethernet cable when sourced by IEEE802.3af-compliant power sourcing equipment (PSE).

Each module integrates data isolation transformers, PSE handshaking and signature control functionality, and a UL-approved DC/DC converter delivering an isolated DC output voltage. As a result, the need for external power sources and isolation transformers is eliminated. Typical signature resistance and signature capacitance is 25kOhm and 100nF respectively, while classification current is 4mA.

www.cd4power.com

New Solid Tantalum Chip Capacitor

Giving designers a new source of small-footprint capacitors for mobile electronic systems, Vishay Intertechnology has announced the release of a family of leadframeless tantalum capacitors with face-down terminations.

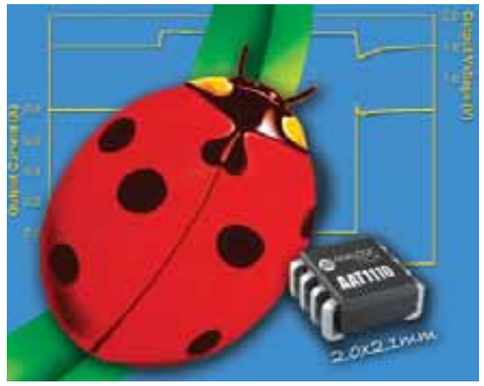
Vishay's new 298D MicroTan™ surface-mount capacitors provide capacitance values from 1 ÌF at 16 V to 47 ÌF at 4 V in the small 0603 and 0805 footprints, requiring less printed circuit board space and thus enabling smaller, more stylish end products.

Ideal for signal processing and power management applications in mobile phones, digital cameras, and MP3 devices, the 298D devices offer a capacitance tolerance of ±20%, voltage ratings from 4 WVDC to 16 WVDC, low ESR, and 0.01 CV DC leakage values.

The new devices are rated to operate over the temperature range of –55° C to +85° C, and can be operated to +125° C with voltage derating. Offering lead (Pb)-free and RoHs-compliant terminations, the 298D capacitors are provided in 8-mm tape and reel packaging available per EIA-481-1 and reeling per the IEC 286-3.7 inch [178 mm] standard.

www.vishay.com

Industry's First 800mA Step-Down DC/DC Converter



Designers of cellular phones, digital cameras and other small portable devices continue to expand their feature set and in the process move to higher performance processors that demand increased levels of power. By mounting an 800mA converter in a tiny SC70JW package, AnalogicTech's AAT1110 delivers the higher current that these new designs require yet still enables the smallest solution size possible.

The AAT1110 is the industry's first 800mA step-down DC/DC converter in a tiny 2.0x2.1mm SC70JW package. Optimized for extremely fast transient response, this latest member of AnalogicTech's rapidly growing voltage converter family is ideally suited for powering up heavy loads in high performance, ultra-portable convergent systems, such as PDA handsets and smart phones.

The AAT1110 operates across an input range of 2.7V to 5.5V, and output levels as low as 0.6V. The device delivers up to 800mA of current while maintaining a low 27microamp no load quiescent current. It is available in either a fixed version with internal feedback or a programmable version with external feedback resistors.

The AAT1110's fast transient response meets the tough specifications required to power the baseband chipset in GSM phones. A high 1.4MHz switching frequency helps reduce solution footprint by allowing the use of extremely small external inductors and capacitors. Integrated soft-start capability eliminates any output voltage overshoot when the enable or input voltage is applied.

www.analogictech.com

3.6kV Reverse Blocking GTO Thyristor

Westcode Semiconductors announced a new addition to its range of GTO (gate turn-off) thyristors. The new symmetrical 3.6kV blocking device has a nominal current rating of 1000A and is encapsulated in a 47mm pole face hermetic pressure contact package. The device has been developed using Westcode's unique cathode chip pattern, which offers unrivalled robust switching performance in the megawatts of controlled power.

These GTO Thyristors expand the high power device offering from IXYS, to offer the full spectrum of bipolar power devices that are needed in the market for mass transit, electrical power generation and distribution.

This addition to IXYS extensive range of Westcode branded GTO thyristors has a controllable turn-off current of 1000A when used with a 2µF snubber capacitor and is suitable for a 1.5kV DC link voltage. The device offers maximum VRRM (reverse blocking voltage) capability equivalent to 80% of rated VDRM (forward blocking voltage). The new device will be available in four blocking voltage versions: S1000NC300 (VDRM/VRRM=3000V), S1000NC30Y (VDRM=3000V & VRRM=100V), S1000NC36D (VDRM=3600V & VRRM=3000V) and S1000NC36Y (VDRM=3600V & VRRM=100V).

The introduction of this product continues to strengthen IXYS support of this technology in core traction markets by addressing key customer demands. The robust operating properties of the GTO thyristor make the 3000V VRRM versions, S1200NC300 and S1200NC36D, particularly suitable for chopper drives as typically applied in mass transport systems such as the tram or trolley bus.

This versatile device is also suitable for other applications in traction systems such as auxiliary power supplies or braking choppers. Other potential applications outside traction include all power conversion systems up to 500KW with DC link voltages to 1.5kV. In addition to its suitability for new designs: The new device has characteristics compatible with the now obsolete Westcode type WG10026Rxx to WG10036Rxx offering a solution for spares and series build continuation.

www.westcode.com

Companies in this issue

Please note: **Bold**—companies advertising in this issue

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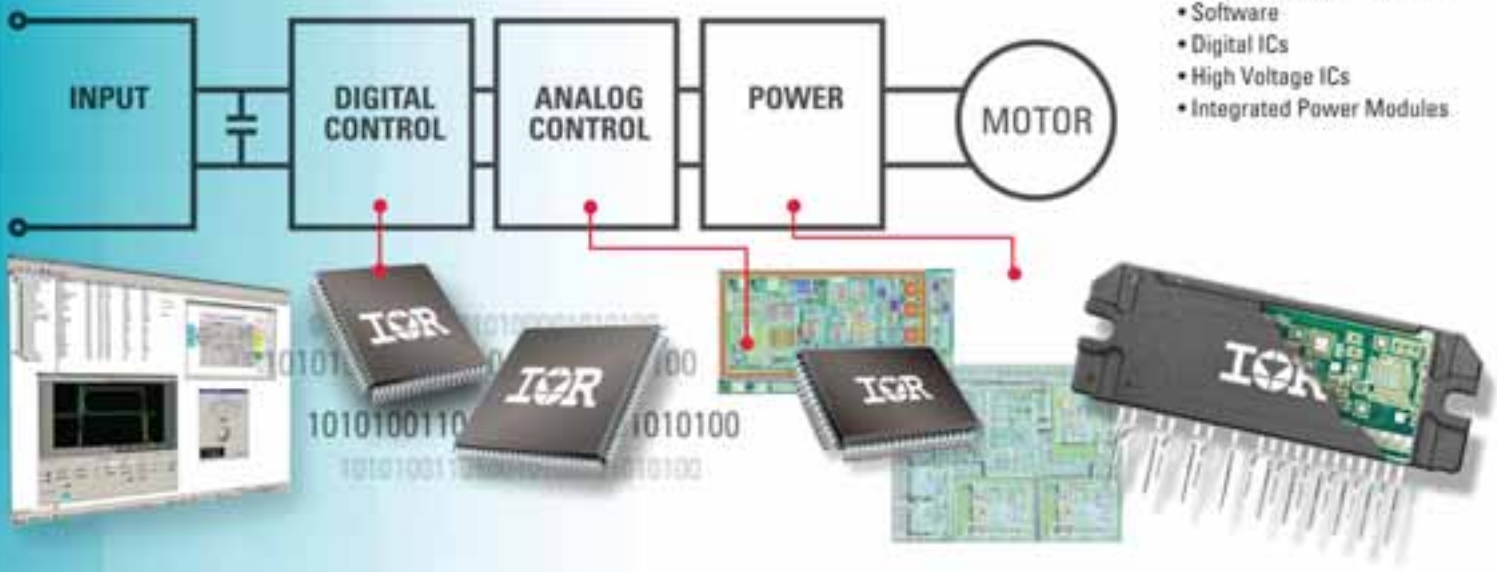

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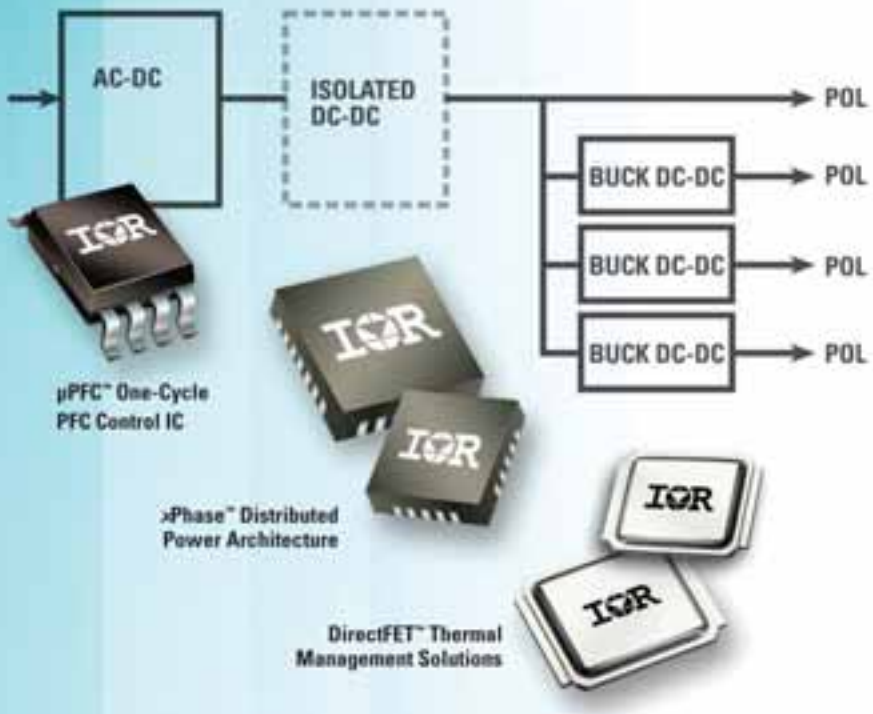

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