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Bodo´s Power Systems®

Electronics in Motion and Conversion

July 2011

Fast Switching Power Semiconductors

SEMIKRON
innovation+service

SKiN Technology
Wire bond-free

Reliable and space-saving packaging technology for power semiconductors

- Free from thermal paste and solder
- 10 x higher power cycling
- Current density of power unit doubled: 3 A/cm²
- For 35% smaller inverters

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sales.skd@semikron.com **www.semikron.com**

Bodo's Power Systems®

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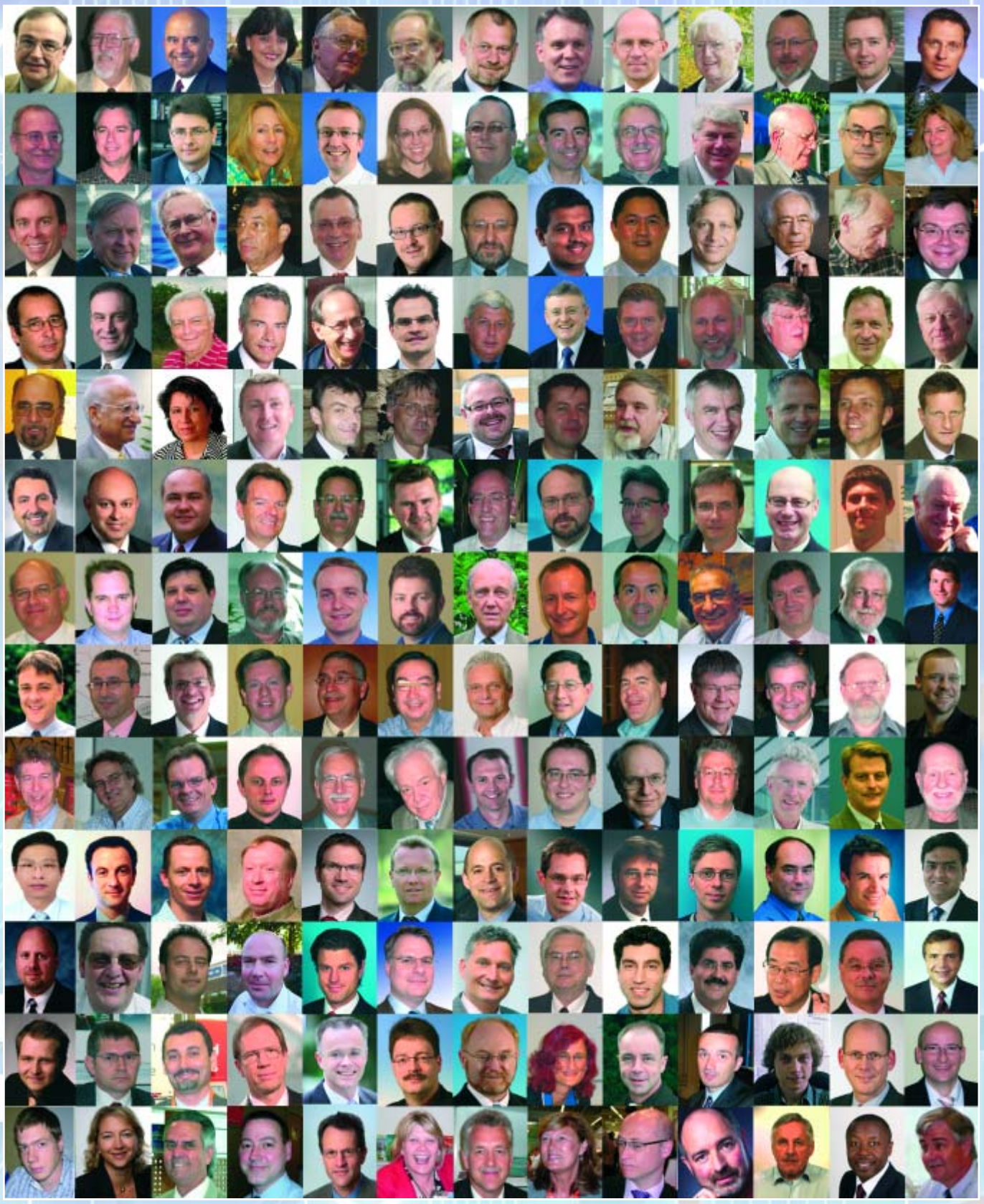
The Gallery



FAIRCHILD SEMICONDUCTOR®
The Right Technology for Your Success™

Fairchild's Board of Directors announces:

Foundation of Technology Development Centre for High-Voltage Semiconductors in Muenchen

The mission of this team is to advance Fairchild's Technology and product portfolio for High Voltage applications for Industrial, Automotive and Consumer markets to take over the leading edge position.

This newly formed R&D centre, located in Muenchen, provides opportunities to their members to closely work with existing global Fairchild Technologists in US, Sweden and Korea, as well as to work in partnerships with Research institutes and hand selected partnership programs with competitors.

The scope of this team includes

- Device and process simulation
- Design and layout experts
- Characterization and testing lab
- Experts for process integration, device architecture, novel materials and module development

For the initial phase, we have opened positions for:

Device Simulation Experts

Job description:
You are responsible to develop and optimize device architecture for Fairchilds next generation IGBT generations, optimize static and dynamic device performance and work with local and Korean process experts to create prototypes.

Job requirement:
We are looking for highly innovative and self-motivated individuals, Master or PhD degree in Electrical engineering, Physics or similar, fluency in English required.
At least 4 years experience in High Voltage Discrete device development, using state of the art simulation software, preferably Synopsis TCAD process and device simulators. Solid knowledge of state-of-the art IGBT device architecture required. 3D simulation, device layout experience and packaging know-how is of advantage but not mandatory.

Device Modelling Experts

Job description:
You will be spearheading a team for device parameter extraction and modelling including behavioural and (semi)-mathematical models for High Voltage devices. Near term emphasis is put on Trench IGBT and Superjunction MOSFET developments.

Job requirement:
We are looking for highly innovative and self-motivated individuals with Master or PhD degree in Electrical engineering, Physics or similar; fluency in English required.
At least 3 years experience in High Voltage device test keys drawings, parameter extraction and device modelling. PSPICE - equivalent circuit and knowledge of electro-thermal behaviour for Power devices is required. Device layout experience would be beneficial.

IGBT Technologist

Job description:
You will be shaping a global team with the distinct focus in IGBT development, focussing on device architecture, new process modules and innovative package solutions for automotive and industrial applications.

Job requirement:
We are looking for a senior technology expert with Master or PhD degree in Electrical engineering, Physics or similar with profound semiconductor background in the field of high-voltage technology.
You need to have at least 10 years experience in IGBT development, wide knowledge of process, device and package topics. Experience with HV-MOSFETS, Superjunction, GTO's or IGCT's as well as experience on specific automotive and industrial applications will be preferred.

We offer:

- Start-up spirit in highly inspirational and expanding team in Muenchen
- space for fundamental and scientific research
- very competitive, performance oriented compensation schemes
- high strategic impact and visibility within a global company

Contact:

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Head of the Fairchild Technology Center in Munich

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Events

SEMICON West,
San Francisco, July 12th -14th
www.semiconwest.org

EPE,
Birmingham, August 30th –Sept.1st
www.epe2011.com

Solar Energy,
Hamburg, Germany Sep. 5th –9th
www.photovoltaic-conference.com

Darnell's Power Forum,
Silicon Valley, CA Sept. 26th -28th
http://DPF.Darnell.com

LED Symposium+Expo,
Bregenz, Austria, Sep. 27th -29th
www.lps2011.com

Semicon Europa,
Dresden, Germany October 11th -13th
www.semiconeuropa.org/

Smart Grid Electronics Forum,
San Jose, CA Oct. 24th -26th
http://SmartGrid.Darnell.com

Blue Skies for Solar Energy

Lately we've been hearing a lot about sunshine. Intersolar, in Munich, demonstrated the great interest in solar's contribution to renewable energy. Activities are underway to make photovoltaic installations more resistant to electrical faults. Three articles in my June issue focussed on protection from over-voltage and over-current and were contributed by LEM, Mersen and Iskra. Besides high efficiency, safe operation is also key. In this issue National Semiconductor explains their upgrade of SolarMagic, which was also demonstrated at the Intersolar Conference.

Elsewhere, the H2Expo in Hamburg demonstrated hydrogen solutions for vehicles. At Sensor and Test in Nuremberg we saw how MEMS leads to higher accuracy in test and measurement technologies. PCIM Asia is underway as I write this editorial and we look forward to further developments being highlighted at the EPE in Brighton and at SEMICON West together with Intersolar in San Francisco in early July – all of which present excellent opportunities to learn more about this exciting technology.

It is summer and we need to refresh our batteries, though having a swim in the Baltic has been a little chilly recently. Time flies and soon it will be Autumn, with more important conferences. Just look at the events list on this page, on my website, or in my e-newsletter. There are many ways to access the information my publication provides.

We have to remain alert to the nuclear disaster in Japan. We don't need further explanation of the problems during the disaster in Fukushima but rather solutions to protect the people and their health. Raising limits for radiation exposure is not the way to move forward, reducing consumption and creating a renewable energy supply is. We have the technology required to achieve this.

Communication is the only way to progress. My magazine provides information to all of you, including those for whom travel to relevant trade shows is not possible. We have now delivered seven issues this year, with 446 pages of information - on time, every time. As a media partner, Bodo's Power Systems is internationally positioned and represented at more than two dozen shows and conferences worldwide.

My Green Power Tip for July:
Invite friends and neighbors to your barbeque. Maximizing the volume on your grill is more economical than cooking just a few pieces for yourself. Dining together is always more efficient and relaxed summertime conversation helps us appreciate one another.

Looking forward to seeing you at one of the next shows!

Best Regards

Solar energy committed to a lifetime of safety and performance

CTSR

LEM commits to renewable energy sources of the future by enabling control and ensuring safety of today's solar power solutions. CTSR transducers combine safety and performance, accurately measuring small AC and DC leakage currents. Easy installation for single or three phase residual current measurement: CTSR is today's choice for the energy of tomorrow.

- Two nominal current ranges: 0.3 and 0.6 A_{RMS}
- Printed circuit mounting
- Large 20.1 mm diameter aperture
- Available with primary inserted conductor
- +5 V single supply
- Up to 11 mm creepage and clearance distances + CTI 600 for high insulation
- Low offset drift
- –40 to +105° C operation
- Reference Voltage access and control
- Self-test and degauss
- High overload capability: 3300 A

www.lem.com

At the heart of power electronics.

LEM®

Suntech and solarhybrid Announce Strategic Partnership

Suntech Power Holdings Co., Ltd., the world's largest manufacturer of solar panels, and solarhybrid AG, a leading solar project developer, announced a strategic partnership for the supply of up to 190MW of solar panels to solarhybrid in 2011.
Under the terms outlined in the agreement, Suntech will become solarhybrid's key partner and will supply solar panels for the majority of solarhybrid's German project pipeline in 2011. Five solar power plants, which solarhybrid is developing in Germany, will be equipped with 172MW of Suntech solar panels. Two additional projects that solarhybrid is currently developing in Italy (10MW) and Slovakia (6MW) will also be powered by Suntech solar panels.
The strategic partnership builds on Suntech and solarhybrid's collaboration on the 24.2 MW Finow Tower I project in Germany in 2010.

www.suntech-power.com

www.solarhybrid.ag

FPGAs Help Drive Smart Grid

Microsemi announced that it is working with Ariane Controls, a powerline communications developer, to provide FPGA technology for the industry's first development platform to support key emerging electric-vehicle charging and related Smart Grid standards.
The Ariane Controls AC-CPM1 AutoGrade J2931 evaluation and development board leverages the performance and flexibility of Microsemi's ProASIC®3 flash FPGAs to speed design cycles for systems implementing automotive standard J2931 for communication between Electric Vehicles (EV) and Electric Vehicle Supply Equipment (EVSE). Microsemi's ProASIC3 FPGAs are the industry's only solution to meet Grade 1 AEC-Q100 automotive qualifications at junction temperatures up to 135?C.

www.arianecontrols.com

www.microsemi.com

Discover Test at SEMICON West 2011

The products, solutions, and answers you need. Revolutionary changes in the design and manufacture of microelectronics are driving innovations in automated test equipment, software, and test methodologies focused on addressing the new and dynamic challenges facing semiconductor test.
At SEMICON West 2011, you can discover and connect to the people, products, and latest innovations in semiconductor test, including the world's leading ATE manufacturers.
Learn from the leading test experts and technologists from across the industry. Hear speakers from VLSI Research, TI, Advantest, Teradyne, ASE, MicroProbe, Galaxy Semiconductor, Verigy and more address critical issues in semiconductor test.

For a complete schedule of Sessions and Events at SEMICON West 2011, please visit

www.semiconwest.org

First Multicrystalline Blocks Crystallized at Fraunhofer ISE

More than four out of ten solar cells manufactured today are made from multicrystalline silicon. This material is relatively inexpensive. Conventionally manufactured multicrystalline solar cells available on the market convert around 17% of the incident solar energy into electricity. Another 40% of the solar cells integrated into PV modules are made from monocrystalline silicon. At efficiencies around 19%, monocrystalline solar cells perform better but are more costly to manufacture due to the more elaborate crystal growing procedure. Which type of silicon solar cell will produce electricity more cost-effectively in the future is still an open issue today. In order to spur on the research in this area, eleven companies and thirteen research institutes have come together to form the cooperative research project SolarWinS (Solar Research Cluster to Determine the Maximum Level of Efficiency for Multicrystalline Silicon). Over the next three years, this group, sponsored by the German Federal Ministry for the Environment, Conservation and Nuclear Safety (BMU), will explore the efficiency potential of multicrystalline silicon as compared to monocrystalline silicon.

www.ise.fraunhofer.de

Würth Elektronik is Approved HDMI Associate

Würth Elektronik eiSos GmbH & Co. KG. is proud to become an HDMI adopter and a HDMI organization member effected April 2011.
The Würth Elektronik HDMI connectors are now listed in the approved connector list which can be found on the website: http://www.hdmi.org/manufacturer/approved_connectors.aspx
The HDMI Associate designation is awarded exclusively to vendors who have demonstrated an ongoing commitment to selling only 100% compliant, fully tested HDMI products. Buying from an HDMI Associate is the assurance that the cable, connector, or other component has been manufactured to exacting performance standards and rigorously tested for reliability
After UL and USB certification this approval is another milestone for the connector range of Würth Elektronik.

www.we-online.com

EconoPACK™ 4

The world standard for 3-level applications

The EconoPACK™4 is an optimized module for 3-level applications like:

- Uninterruptible Power Supply
- Solar Inverter
- High Speed Drives

where a rugged design, high efficiency and less harmonics are needed.

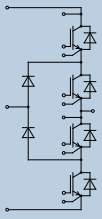
For these applications starting with 50kW up to 125kW, the EconoPACK™ 4 can be used to build up one phase. For higher power ratings modules can be switched in parallel.
All modules are equipped with the state of the art IGBT4.
Further information's are available on request.

The degree of efficiency for two 3-level topologies, NPC1 and NPC2, has to be investigated depending on the switching frequency.

- EconoPACK™ 4 in NPC2 topology for low and medium switching frequencies (approx. $f_{sw} \leq 12kHz$)
- EconoPACK™ 4 in NPC1 topology for high switching frequencies (approx. $f_{sw} \geq 12kHz$)

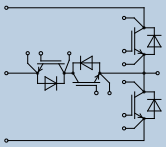
NPC1 topology

- 650V IGBT4
- Optimized for $f_{sw} \geq 12kHz$
- Portfolio
  - F3L200R07PE4
  - F3L300R07PE4



NPC2 topology

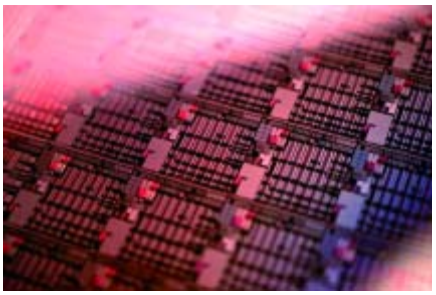
- 650V/1200V IGBT4
- Optimized for $f_{sw} < 12kHz$
- Portfolio:
  - F3L300R12PT4_B26
  - F3L400R12PT4_B26



www.infineon.com/highpower

First Power Devices on 200mm CMOS-Compatible GaN-on-Si

Imec and its partners in the GaN industrial affiliation program (IIAP) have produced device-quality wafers with GaN/AlGaN layers on 200mm silicon wafers. With these wafers, functional GaN MISHEMTs were processed using standard CMOS tools. The used processes are compatible with the strict contamination rules in a standard CMOS processing line (e.g. no use of gold). These first GaN devices on 200mm wafers are an important milestone on the path to cost-effective production of power devices in high-productivity 200mm fabs.
GaN is a promising material for next-generation power devices with a performance



beyond what is possible with silicon. Imec has recently succeeded in producing 200mm GaN-on-Si wafers with crack-free surfaces and a bow of less than 50µm. The wafers were made using an advanced MOCVD system from Applied Materials. The ability to use 200mm wafers is an important milestone, because it brings processing in reach of regular high-productivity 200mm fabs, allowing for an important cost reduction compared to processing smaller wafers on dedicated processing lines.
A second prerequisite for cost-effective processing, next to the wafer size, is that power devices can be fabricated with processes that are compatible with standard CMOS processes and tools.

www.imec.be

Scientists in Freiburg Optimize Efficiency and Costs of PV

On the way from the solar cell to the solar module, the output efficiency decreases. Optical losses occur in solar modules due to the increase in inactive area, reflection on the glass surface and absorption in the top coatings. In addition, there are electrical losses due to series resistance in the cell and string connectors. Gains through encapsulation effects can not compensate for these losses, so that module efficiencies lie about 10-15 % below cell efficiencies. Based on a standard-sized PV module priced at 1.60 €/Wp, these losses amount to approximately 50 €. Putting the focus on minimizing these losses and improving the efficiency, Fraunhofer ISE has set up the Module Technology Center (MTC) which cooperates closely with the photovoltaic industry.

The new Photovoltaic Module Technology Center (MTC) in Freiburg offers a wide range of platforms for processing and analyzing solar modules. This infrastructure enables comprehensive product development, process development and material qualification. With this center, Fraunhofer scientists can now take their developments directly from the laboratory to production scale by turning out significant module quantities and formats. For investigating and optimizing the soldering processes as well as its compatibility with new solar cell types, the researchers have set up various experimental solder platforms. By being able to precisely control the soldering process, high-resolution parameter studies can be performed. A fully automated tabbing and stringing machine serves as a reference for the process development and string patterning. For fabricating the modules, a laminator with a useful area up to 1700 mm x 1000 mm is available.

www.ise.fraunhofer.de

IPC APEX Expo 2011 Best Poster Paper Award

Alpha-Cookson Electronics has been awarded the IPC APEX ExpoTM 2011 award for Best Poster Paper at this year's show, recently concluded in Las Vegas, Nevada, USA. The paper, which was primarily authored and presented by Anna Lifton, details the superior thermal cycling performance of the ALPHA® MaxRelTM alloy in power module assemblies.
The poster paper is a summary of an extensive research and development effort led by Anna Lifton, Senior Research Scientist at Alpha-Cookson's Americas Research Center, located in New Jersey, USA. The comprehensive data package provided key insights into the value of the MaxRelTM alloy. The poster session was the first public disclosure of this reliability data.
Alpha-Cookson Electronics has a long standing relationship with some of the largest power module providers, including companies in Germany and Japan. While the research was initially targeted at preform alloys for power modules, Lifton observed some other unique properties of the MaxRelTM alloy that have enabled Alpha to provide value to solar concentrator and LED companies.

www.alpha.cooksonelectronics.com

SEMICON Europa 2011: Growing on Strengths

The European economy is booming and fabs are working at full capacity and healthy performance. Heinz Kundert, president of SEMI Europe: "We continue our effort to remain competitive in Europe and the Key Enabling Technology initiative by the European Commission offers a significant opportunity to set new milestones in technology and advanced manufacturing". SEMICON Europa 2011 is the place to get breaking news on market developments, latest technology trends and corporate strategies. Demonstrate your support for European competitiveness and visit SEMICON Europa in Dresden. Your attendance is free, just sign-up online prior to the event.
Be there for the discussions - Plan now to visit SEMICON Europa 2011 in Dresden.
Need information about the latest news and trends?
Each of segments at the SEMICON Europa conferences will cover critical issues and the most up-to-date technologies. Don't miss it!

www.semi.org/events

Accelerate The Performance Of Your Design With The PIC32 Microcontroller

Are your growing applications demanding more performance? PIC32 does more with less!

With market-leading performance of 1.56 DMIPS per Megahertz from the MIPS® M4K® Core, Microchip's PIC32 is the right choice when you need to get more done with fewer clock cycles.

While performance is important, we know that getting your design to market quickly, with the right feature set is what really counts. Microchip's proven peripheral libraries and MPLAB® Integrated Development Environment offer compatibility across 8-, 16- and 32-bit PIC® microcontroller families making migration easy and your time to market its shortest.

Find out more at www.microchip.com/pic32 or check out what's happening in the community at www.mypic32.com

GET STARTED IN 3 EASY STEPS

1. Purchase a PIC32 Ethernet Starter Kit
2. Download MPLAB® IDE
3. Start designing!

PIC32 Ethernet Starter Kit – DM320004

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MICROCHIP

Best Presentation Award at NEPCON China

Dr. Ning-Cheng Lee Vice President of Technology from Indium Corporation was recognized for Best Presentation of Technology Conference One at NEPCON China (Shanghai) 2011 by Surface Mount Technology Association (SMTA) China East.

Dr. Lee presented Voiding Control for QFN Assembly, which included the challenges and most effective practices for controlling voids during the QFN assembly process. According to Dr. Lee, "Voiding behavior of the QFN can be controlled by improved design in the thermal pad, thermal via, and reflow profile." A copy of Dr. Lee's paper is available at <http://www.indium.com/techlibrary/whitepapers>

Dr. Lee is a world-renown soldering expert and an SMTA Member of Distinction. He has extensive experience in the development of high-temperature polymers, encapsulants for microelectronics, underfills, and adhesives. His current research interests cover advanced materials for interconnects and packaging for electronics and optoelectronics applications, with emphasis on both high performance and low cost of ownership.

www.indium.com

2011 Supplier Excellence Award from Raytheon

Payton America Inc. received the 2011 Supplier Excellence Award from Raytheon

About Payton Planar Magnetics; Payton America Inc., a Deerfield Beach, Florida company, designs, manufactures and markets Planetics®, a custom line of planar transformers and inductors to Original Equipment Manufacturers and their suppliers of power electronics. Payton's headquarter is in Israel, with manufacturing in Israel, Florida and China.

www.paytongroup.com

ECCE2011 Phoenix, AZ, Sept.17th -22nd, 2011

The organizing committee for the 2011 Energy Conversion Congress and Exposition (ECCE) is pleased to announce that the Technical Program Committee has completed its selection process from a submission base of approximately 1100 digests. Following previous years ECCE experience, the conference this year will retain the general flow of plenary session, 11 technical tracks, exhibition with posters and special sessions. Pre-conference tutorials are offered to introduce attendees to new technical methods, tools and products so they can remain at the forefront of their specialties. Rap sessions offer attendees both a reprieve from their daily business and a glimpse of what technologies may loom over the horizon. The plenary session on Monday morning will host keynote speakers of international renown who will launch our journey into energy conversion for a clean energy future. A growing part of the ECCE mission is our quest to attract industry participation in the form of exhibits and special sessions dedicated to topics and products most relevant to power processing, electric machines, electrified vehicles, grid interaction and energy policy. New to ECCE for 2011 is an industry-student interaction event slated for Monday evening in the exhibits hall that will follow the exposition.

ECCE 2011
IEEE ENERGY CONVERSION CONGRESS & EXPOSITION
PHOENIX, ARIZONA | SEPTEMBER 17-22, 2011
IEEE pels

www.ecce2011.org

SEMICON West / Intersolar Adds Power Semiconductor Program

With the growing demand for power semiconductors for alternative energy applications bringing unique manufacturing challenges, SEMICON West adds a program on technology issues for these high power, high temperature systems, July 12 in San Francisco. Speakers include Freescale Semiconductor on vehicle electrification issues, Yole Developpement on market and technology trends, Oak Ridge National Lab on high temperature packaging issues, International Rectifier on GaN progress, SemiSouth on SiC technology, and IBM on smarter silicon technology for PV systems. Details are at:

http://semiconwest.org/SessionsEvents/ctr_043488

Overhead Conductors for the World's Longest Power Transmission Link

Nexans overhead conductors will be used to construct the first transmission line for the Madeira River Power Interconnection project consisting in a 2,375 km HVDC link between the new Rondônia hydroelectric plant and the city of São Paulo, across five Brazilian states and 86 towns and cities.

Nexans, a worldwide leading expert in the cable industry, has been awarded a 20 million euro contract by the IE Madeira consortium to deliver the overhead lines for the world's longest power transmission link, Brazil's Madeira River Power Interconnection.

This new HVDC (high voltage direct current) link, the first of two, will transmit 3,150MW of power produced by the Rondônia hydroelectric plant in northwest Brazil to São Paulo, Brazil's main economic centre, over a distance of 2,375 km. HVDC transmission at 600kV is being used to minimize transmission losses over the long distance and the link will eventually comprise two parallel overhead lines.

www.nexans.com

ECPE Workshops and Tutorials

ECPE Workshop Electronics around the Power Switch:
Gate Drivers, Sensors and Control
29 – 30 June 2011 in Munich, Germany,
ECPE Tutorial Power Semiconductor Devices & Technologies
27 – 28 June 2011 in Cambridge, UK;
Course Chairmen: Prof. F. Udrea, Prof. Ph. Mawby, Prof. D. Silber
ECPE Tutorial Thermal Engineering of Power Electronic Systems (I)
27 – 28 July 2011 in Erlangen, Germany
Course Chairman: Dr. M. Maerz

ECPE Workshop SiC & GaN User Forum
1 – 2 September 2011 in Birmingham, UK
(following the EPE Conference)

The ECPE Calendar of Events 2011 with all ECPE Workshops and Tutorials is available on the ECPE web site for download.

www.ecpe.org

Senior VP of Consumer Products

Intersil Corporation announced Mr. Andrew Cowell has joined the company in the newly created position of Senior Vice President of the Consumer Products Group. This new group has been created from existing consumer-focused product lines within Intersil's Power Management and Analog & Mixed Signal product groups.

Mr. Cowell brings to Intersil extensive global experience in power management solutions for the consumer market. Most recently, Andrew spent the last four years as Vice President of Analog Marketing at Micrel Semiconductor. Previous to this position, Andrew held a variety of technical, marketing and applications management roles at Micrel and Siliconix. Andrew began his career as a design engineer at Advanced Power Supplies.

"Andy's talent and background make him a perfect fit for this new role. His experience driving growth within the consumer market will intensify our focus on new products aimed at this rapidly growing market," said Dave Bell, Intersil's President and Chief Executive Officer. "This new group allows us to create system solutions for the consumer market, while sustaining growth in the industrial, communications and computing markets."

"I am very excited to join the talented team at Intersil," said Andrew Cowell. "The company has a clear vision for its consumer end market and the technology to provide compelling solutions for its customers. I look forward to working with the Intersil team to expand Intersil content within our customers' applications."

Mr. Cowell holds a First Class Honors degree in Electronics from Middlesex University in the UK.

www.intersil.com

APEC Issues Call for Papers for February 2012 Conference

27th Annual Conference to be Held in Orlando. Deadline for submission of digests is July 8, 2011. The IEEE Applied Power Electronics and Exposition Conference (APEC), the leading worldwide conference and exhibit for practicing power electronics professionals, announces a call for technical papers for APEC 2012. The 27th annual APEC event will be held at Disneyworld's Coronado Springs Resort and Conference Center, Orlando, Florida, February 5-9, 2012

The Call for Papers has an early deadline this year since the conference is in early February next year. At the conference, these unique, peer-reviewed papers will be combined with rap sessions, dialogue sessions, and plenary sessions covering all aspects of power electronics.

Important Deadlines:

- Submit a technical digest for publishing a technical paper. Accepted papers will be available in the APEC 2012 conference proceedings and on IEEE Explore for others to reference. Deadline for submission of paper digests is July 8, 2011
- Sign up to review technical papers. The peer review and selection process is a key factor in APEC's success in presenting high-quality papers. Deadline to sign up as a technical paper reviewer is July 8, 2011.
- Notification of paper acceptance: October 3, 2011.
- Final paper submission and author registration: November 18, 2011.

For more information, editors are invited to contact:
Greg Evans, APEC 2011 Publicity Chair
Phone +1-858-279-2100,
e-mail greg@welcomm.com

www.WelComm.com

Shipping 2x Throughput 300 mm Wafer Scanner

Sonoscan has begun shipping its automated 300 mm bonded wafer inspection system that simultaneously scans two wafers and gives users double the throughput of other systems.

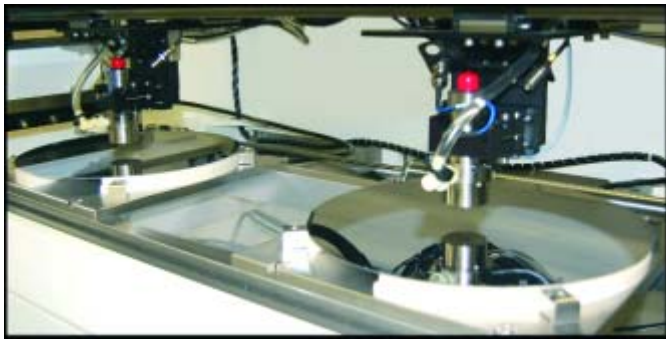

Photo: Twin robotic arms on Sonoscan's AW300 scan two bonded wafer pairs simultaneously.

The system inspects wafer pairs intended for SOI, MEMS and other applications for 300 mm and 200 mm wafers, and bonded by virtually any method. It images disbonds, delaminations, voids and particles at the bond interface, and cracks at any depth.

Based on Sonoscan's well-known C-SAM® acoustic microscope systems, the AW300™ also automates the entire inspection system from carrier attachment and wafer selection through aligning and acoustic imaging to drying and sorting.

About Sonoscan®: Sonoscan is the leading developer and manufacturer of acoustic microscopes and sophisticated acoustic micro imaging systems, widely used for nondestructive analysis of defects in industrial products and semiconductor devices.

For over 30 years, Sonoscan's attention to customer needs and investment in R&D has created systems that set industry standards for speed and accuracy. Key products include C-SAM® systems for off-line and laboratory analysis and FACTS2™ for automated production inspection.

Through its SonoLab division Sonoscan applications engineers, with experience totaling more than two centuries in acoustic microscopy, assist hundreds of customers annually in solving materials problems and quality control issues. SonoLab operates applications testing laboratories in multiple global locations to serve the inspection needs of customers that do not have their own capability.

A robotic arm feeds wafers from two load ports that accept either FOUP or FSOB carriers. Wafers are fed into either of two scanners. To ensure maximum throughput, wafers are sequenced in a staging area where wafers are processed and temporarily stored.

The AW300 uses Sonoscan-made transducers (lenses) ranging from 100 MHz to 400 MHz. All of Sonoscan's UHF transducers are designed, manufactured and matched in-house to ensure optimum performance.

The AW300 is capable of imaging inter-wafer voids as small as 5 microns wide, and delaminations as thin as 100Å. Scanning employs Sonoscan's non-immersion Waterfall™ transducers and vacuum-assisted stages.

Analysis software automatically measures the percentage of bonded and unbonded interface between the two wafers, and the sizes and number of voids. Accept/reject decisions are made automatically according to the user's specific criteria.

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Intelligent Automotive Motor Control Power Switch with Active di/dt Control

International Rectifier has introduced the AUIR3330S Intelligent Power Switch (IPS) with a proprietary active di/dt control feature that significantly reduces conducted EMI and switching losses to simplify design and reduce overall system cost in automotive motor drive applications.

The new 40 V high-side device combines bootstrap regulator, charge pump and high-side driver into a single package to offer a highly integrated solution. The load can be driven up to 40 kHz at 100 percent of duty cycle. Additionally, the AUIR3330S features programmable over-current and over-temperature protection required by applications operating in harsh automotive environments such as pumps and fans. The AUIR3330S also features current sensing feedback, a diagnostic function, very low current consumption in sleep mode and ESD protection.

IR's innovative active di/dt control drastically reduces conducted EMI on the input supply without increasing switching losses, enabling a reduction in the size of the EMI filter and the heat sink for more efficient compact motor systems.

Part Number	Package	Rdson (max at 25°C)	Programmable Over-current shutdown	TJ	Break-down voltage	OC/OT Protection type
AUIR3330S	D2PAK 7-Lead	3.5mohm	5 to 50A	150C	40V	shutdown

The device is qualified according to AEC-Q100 standards, features an environmentally friendly, lead-free and RoHS compliant bill of materials, and is part of IR's automotive quality initiative targeting zero defects.

Production orders are available immediately. Prices are subject to change. Datasheets and qualification standards are available on the International Rectifier website at www.irf.com.

Specifications

International Rectifier (NYSE:IRF) is a world leader in power management technology. IR's analog and mixed signal ICs, advanced circuit devices, integrated power systems and components enable high performance computing and reduce energy waste from motors, the world's single largest consumer of electricity. Leading manufacturers of computers, energy efficient appliances, lighting, automobiles, satellites, aircraft and defense systems rely on IR's power management benchmarks to power their next generation products. For more information, go to:

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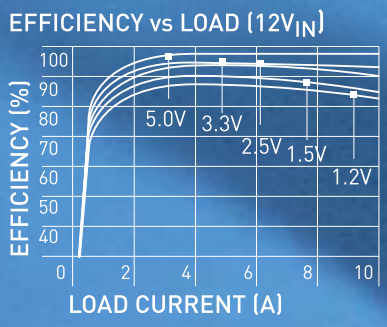

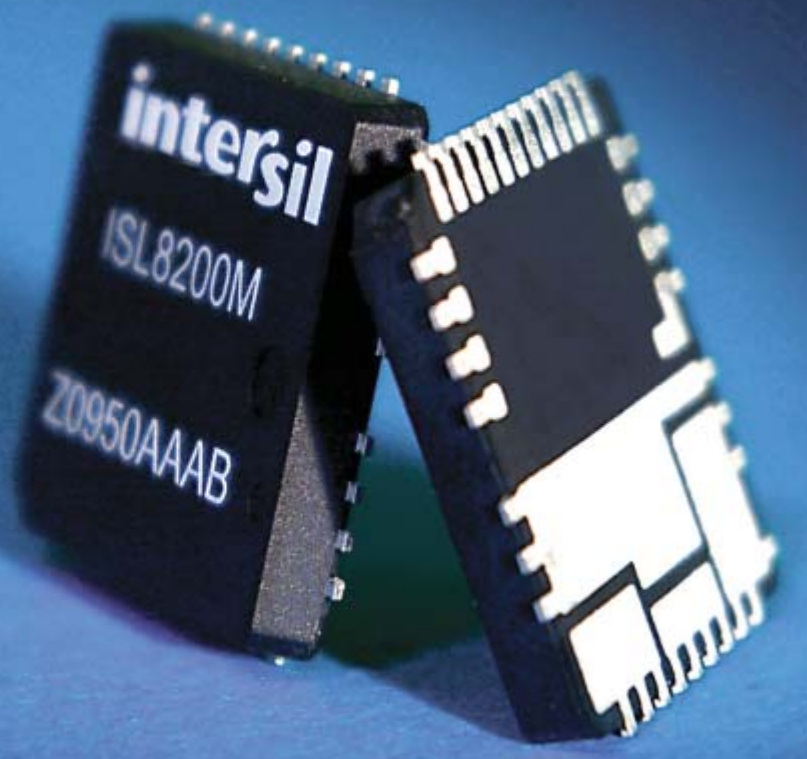

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SolarMagic Chipset and Firmware Detect Hazardous Arc Faults in Photovoltaic Systems

National Semiconductor Corp. introduced the SolarMagic™ arc detection reference design, comprised of analog front end integrated circuits (ICs) and multi-band dynamic filtering firmware, the first commercially available chipset to detect hazardous DC arc faults in photovoltaic (PV) systems.

National has demonstrated the SolarMagic arc detection reference design in its booth in Hall A1.151 at the Intersolar Europe Conference in Munich, Germany, June 8-10.

In PV systems today, intermittent connections or insulation deterioration (faults) can cause DC circuits to generate arcs of considerable energy. The arc, reaching temperatures of over 3,000 degrees C, poses safety risks to surrounding infrastructure and personnel. The 2011 U.S. National Electrical Code (NEC) 690.11 requires an arc-fault circuit detect and protect system as part of all new PV system installations. National's new SolarMagic arc detection reference design includes analog front end ICs and multi-band dynamic filtering (MBDF) firmware. Together, they detect the arc fault condition and provide an alert to shutdown system power, extinguishing the arc.

"It's through National's comprehensive signal processing and power management product portfolio and years of work in the solar industry that we are able to understand and correct PV module over-voltage problems," said Patrick Quinn, general manager for National's Solar IC Division. "Our arc detection reference design along with the new integrated circuits is one of many systems that National is developing for applications spanning the entire solar PV industry."

About National's SolarMagic Arc Detection Firmware

Arcing events in PV arrays are very difficult to detect. An electric arc does not leave a uniquely identifiable electronic signature. In addition, the power lines of a PV array act as very effective antennas for a wide range of electromagnetic interference in the vicinity of the array; inverters also contribute additional noise that is induced onto the power lines. A sophisticated signal processing approach is required to reliably detect the entire range of dangerous arcing events without false alarms when the PV array is operating under safe conditions. National Semiconductor has developed a patent-pending signal processing approach. The MBDF firmware uses a state-of-the-art abstracted pattern recognition approach that does not require the arc signature to match a rigid, pre-described, absolute shape.

Technical Features of National's SolarMagic Arc Detection Chipset

National's SolarMagic chipset is an analog front end (AFE) featuring three highly integrated ICs. The SM73201MM 16-bit, 50 to 250 kSPS, differential input, micropower ADC digitizes the arc signal after the AFE gain and filtering stage, and sends the digital signal to the microcontroller. The SM73308MG low offset, low noise, RRO operational amplifier provides the Vref midpoint for the arc-detect AFE. The SM73307MM dual precision, 17 MHz, low noise, CMOS input amplifier provides gain and filtering of the arc signature signal. Additional National power management chips enable various support functions.

Pricing and Availability

Download the RD-195 arc detection reference design, including an evaluation board, bill of materials and schematic, at http://www.national.com/rd/RDhtml/RD-195.html. Available now, the SolarMagic arc detection chipset is offered in a variety of industry-standard electronic packages and priced at $7.90 in quantities of 1,000 including a license for the MBDF firmware. More information is available at http://www.national.com/en/solarmagic/index.html.

National Semiconductor is a leader in power management technology. Known for its easy-to-use analog integrated circuits and world-class supply chain, National's high-performance analog products enable its customers' systems to be more energy efficient. Headquartered in Santa Clara, California, National reported sales of $1.42 billion for fiscal 2010.

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An Idea to Simplify LED Lighting Purchase Decisions

By Doug Bailey, VP Marketing at Power Integrations, San Jose, CA

The U.S. Department of Energy created the L Prize – "The Race for Super Efficient Light Bulbs" – to spur the market to move to LED lighting products that would eventually replace traditional, but inefficient, incandescent light bulbs. This has created a lot of buzz in the consumer replacement bulb space, where the well-targeted specification is designed to give consumers the confidence to make purchases at relatively high prices in the expectation of a long-term return on their investment (ROI). However, the consumer-level spec does not leverage the full opportunity represented by solid-state lighting technology for applications where the ROI is weighted more in favour of operational efficiency and installation longevity.

In any application where the replacement cost is significantly higher than the cost of the LED bulb itself – such as street lighting, billboards, industrial and commercial complexes, factories, etc., where maintenance may require teams using cherry pickers – the savings realized by the installation of high lifetime LED lights are far more compelling than in a residential application where the replacement cost is limited to the cost of a new bulb.

LEDs have been promoted on the back of their long life and high efficiency. But if LED lights are powered and driven incorrectly – or without regard for environmental conditions – the luminaire will fail long before its laboratory life expectancy, and users and installers will not realize the full benefit. We are already seeing this in China and other places where, in some instances, LED street lights have failed after just a short period of operation.

For PC power supplies, 80 PLUS? has been a highly successful voluntary labelling program that helps informed users (such as large companies) easily understand the ROI of various PCs on offer by OEMs. ENERGY STAR? and other agencies have adopted various aspects of the 80-PLUS program for their labelling schemes and standards. 80-PLUS-certified power supplies are much more efficient than traditional PC power supplies, which are typically designed purely with price in mind and are subsequently very inefficient. Gold status is the 80 PLUS program's highest standard, requiring efficiency levels of up to 90%.

We believe that a similar scheme, combining both luminous efficacy and driver longevity, would be highly beneficial for LED lighting. The early stage of growth of this market is the ideal time for the industry to rally around a simple program that helps consumers at all levels to make good, informed purchasing decisions.

In our proposal, Bronze status would be the lowest standard, applying to domestic household products that operate in fairly benign, indoor surroundings. This level aligns with the L Prize specification. The Silver guideline would be appropriate for offices and schools, where bulb replacement is done by maintenance personnel within a fairly controlled environment. The Gold seal of approval would apply to street lighting, advertising signage, and difficult-to-access outdoor installations which require maintenance by teams of workers equipped with aerial lifts and hydraulic work platforms.

One of the key considerations within any program of this kind is the design of the power supply or LED "driver" element, as the presence of electrolytic capacitors operating at high temperature in the confines of a bulb base or ballast can result in power supply failure long before the LEDs reach the end of their useful life. LED ballast designs with high efficiency (>90%, for example) that avoid the use of electrolytic capacitors and opto-isolators are easy to make using simple single-stage driver architectures. Such designs would be ideal for a Gold-rated application, where longevity and efficiency are the keys to maximizing ROI – but light customers need to know that the choice exists. Compact designs optimized for the consumer market which trade smooth TRIAC dimming for reduced lifetime have been shown to meet the Bronze standard using either classical two-stage or modern single-stage architectures.

We are not suggesting that the LED Lighting Gold/Silver/Bronze program should be a mandatory standard, but we believe that it would help guide buyers, installers, and engineers who are investigating solid-state lighting products.

What do you think? Have you encountered a problem with early failure of solid-state lighting products? Do you agree that the proposed Gold/Silver/Bronze approach might be helpful? Have you any ideas for what should be included in the guidelines?

Please comment on Bodo's website or drop me a note with your ideas at: douglas.bailey@powerint.com.

In the meantime, please visit http://www.powerint.com/en/applications/led-lighting for ideas and practical designs for driving LEDs in a number of different lighting applications, or http://www.powerint.com/en/green-room for a huge information resource covering energy efficiency across all market sectors.

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		2400A	●	●	
		3600A	●	●	
2-Pack	 130 x 140 mm	600A	●	●	
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		1200A	●	●	
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Electronics Industry Digest

By Aubrey Dunford, Europartners

GENERAL

Times are hard for European leaders. Philips will transfer its television business into a joint venture with TPV Technology. This is presented as the only way for the television business to return to profitability. The new company will be 70 percent owned by TPV and 30 percent by Philips. Nokia plans to reduce its global workforce by about 4,000 employees by the end of 2012, with the majority of reductions in Denmark, Finland and the UK.

SEMICONDUCTORS

Worldwide sales of semiconductors were $ 24.7 billion for the month of April 2011, a 2.2 percent decline from the prior month, and an increase of 3.9 percent from April 2010, so the SIA. The month-over-month results are slightly below seasonal patterns in part due to the natural disaster in Japan. The industry continues to mitigate the impact through successful supply chain recovery efforts and should see significant improvement reflected in the second half of 2011.

The top 20 semiconductor suppliers showed an 11 percent increase in Q1'11 sales as compared to Q1'10, so IC Insights. This growth rate is one point greater than IC Insights' full-year 2011 worldwide semiconductor market forecast of 10 percent.

Crocus Technology, a developer of MRAM technology, and Rusnano, a Russian nanotechnology investment fund, have closed an agreement to create an MRAM manufacturing company, with a combined investment totalling $ 300 M. Crocus and Rusnano will form Crocus Nano Electronics (CNE), to build an advanced MRAM facility in Russia. The production facility is scheduled to be in operation within two years and will be capable of producing up to 500 wafers per week. Crocus MRAM innovation originated in the Grenoble-based Spintec laboratory, France. Rusnano also co-invests in the development of MEMS with SiTime, an American company involved in MEMS-based oscillators and silicon timing solutions.

Maxim has acquired privately-held Calvatec, based in Edinburgh, Scotland. Calvatec is a supplier of analog and mixed-signal system-on-chip (SoC) solutions for consumer and communications applications. Calvatec employs 15 people. Maxim reported revenue of approximately $ 2 billion for fiscal 2010 and is a Fortune 1000 company.

TowerJazz, a specialty founder, has completed its previously announced acquisition of Micron Technology's fabrication facility in Nishiwaki City, Hyogo, Japan. The acquisition nearly doubles TowerJazz's current internal manufacturing capacity to 60,000 wafers per month. The total value of the transaction is approximately $ 140 M, of which $ 40 M was paid in cash.

BCD Semiconductor, a Chinese analog integrated device manufacturer, specializing in power management ICs, has acquired Auramicro, a private company incorporated in Cayman Islands with main operations in Taiwan, for approximately $ 5.6 M in cash. The acquisition will expand BCD's DC/DC product portfolio.

OPTOELECTRONICS

Samsung Electronics held a groundbreaking ceremony for a new 7.5 generation fabrication facility in Suzhou, China, which will become part of China's largest LCD production cluster. The facility, which will be constructed by Samsung Suzhou LCD with an investment of about $ 3 billion, is expected to begin mass production in the first half of 2013. The new line will be capable of producing 100,000 glass substrates (1950×2250mm) per month.

PASSIVE COMPONENTS

Overall February sales for German's printed circuit board industry was up 1.1 percent compared to the previous month, and was 20.1 percent higher year-on-year, so the ZVEI.

OTHER COMPONENTS

Eurotech, an Italian supplier of embedded technologies, has acquired Dynatem for an enterprise value of € 1.3 M. Dynatem, based in California, has operated since 1981 in the embedded computing market and specifically in the VME, VPX and CPCI boards segment, with a turnover in 2010 of about $ 3.6 M.

DISTRIBUTION

European distribution bookings in Q1'11 increased by 11 percent when compared to the previous quarter and grew by 8 percent when compared to the same period in the previous year, so the IDEA, the International Distribution of Electronics Association.

DMASS (Distributors' and Manufacturers' Association of Semiconductor Specialists) recorded its all-time high quarter since the creation over 20 years ago. In Q1'11 European semiconductor distribution grew by 33.5 percent to € 1.81 Billion compared to Q1'10. The regional picture in Q1'11 again confirmed the trend from the West to the East: Eastern Europe grew by 59 percent to € 239 M, with the Baltic States, Hungary and Russia leading the peak in terms of growth rates. Denmark, Finland and Germany are the only West European states that have grown overproportionally.

Of the big 4 regions, Germany grew fastest (39.5 percent to € 640 M). Italy grew 29 percent to € 200 M, the UK by 26.2 percent to € 144 M and France by 16.7 percent to € 130 M.

Avnet Memec is becoming the pan-European distributor of Echelon's commercial markets product line for device and system manufacturers. Echelon's line of energy control network products — ranging from microprocessors, twisted pair and power line signaling component technology and system software to infrastructure products — is used in over 100 million devices and 300,000 buildings worldwide.

This is the comprehensive power related extract from the «Electronics Industry Digest», the successor of The Lennox Report. For a full subscription of the report contact: eid@europartners.eu.com
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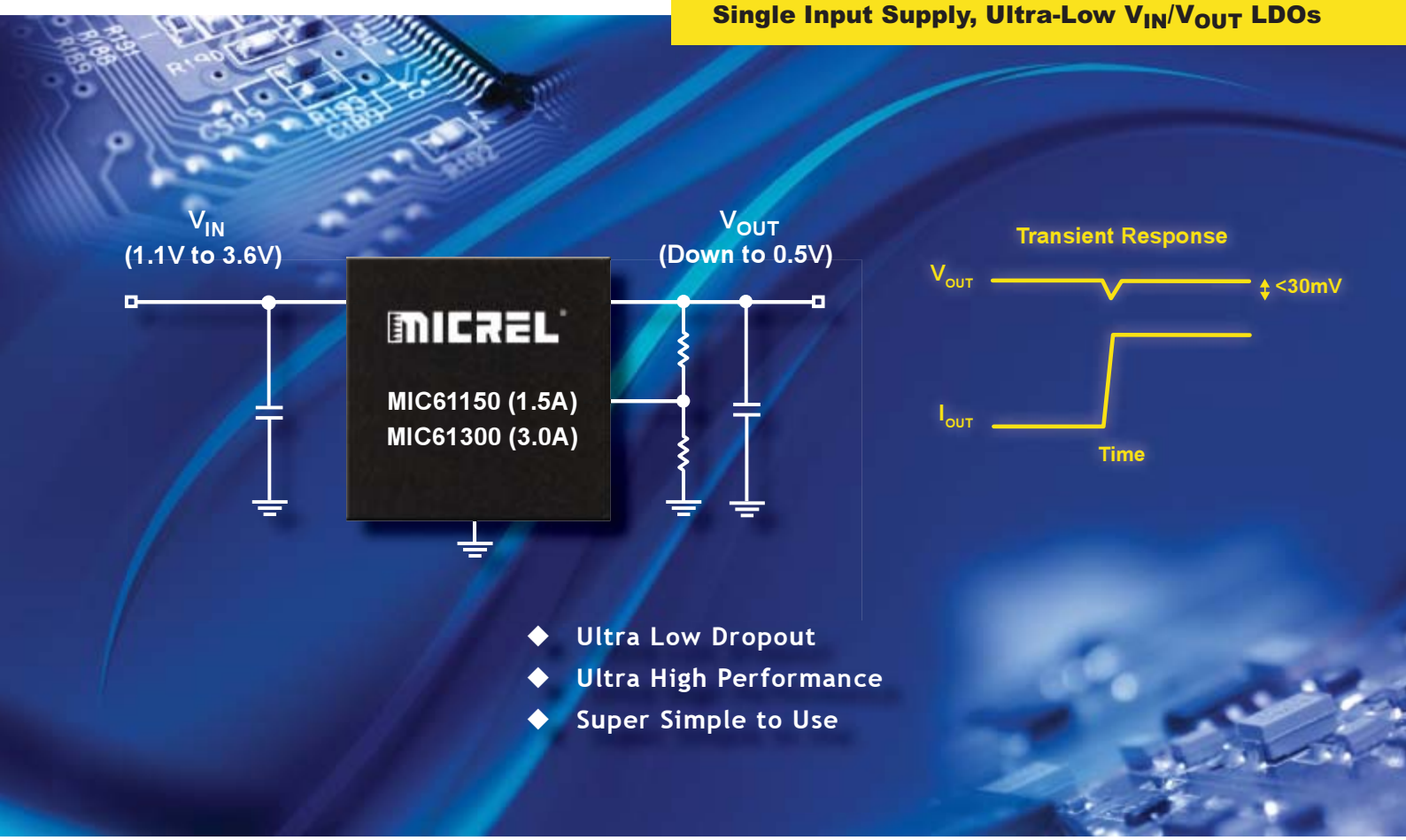

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Powering today's FPGAs, ASICs and DSPs involves the challenge of supplying high currents in very low input-output voltage conditions. This is where Micrel's new family of ultra-low V_{IN}/V_{OUT} LDOs excels. These new Micrel LDOs offer the convenience of adjustable output voltages as low as 0.5V with input voltages as low as 1.1V, while supplying up to 3A of output current.

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The Power Behind Energy Management Systems

By Linnea Brush, Senior Research Analyst, Darnell

What exactly is an "energy management system"? This term describes everything from smart grid products, to energy efficiency standards, to power quality measurement – not to mention control systems, data center management and building automation. Power supply companies have a vested interest in following energy management system trends, since most of them do have a "powering" element somewhere. Finding where power fits into the energy management equation can be challenging, however.

Like digital power management, energy management can find itself in multiple environments and at multiple levels of "management." Managing the energy of a data center, for instance, is very different than home energy management. A smart meter being deployed to save energy as part of the future smart grid is not the same as using dc power to monitor energy in a commercial building.

Sifting through these technologies and making sense of where they fit into the broad power supply landscape is one of the objectives of Darnell's Power Forum (DPF'11), which will be held in San Jose, California, in September. In many cases, technologies such as "energy management systems" have to be broken down into the parts that actually address power management.

Standards are usually where new technologies start. Developing new standards can be a daunting process, since both companies and governments weigh in at this level and have their own vested interests. For example, ZigBee started out as just one of many standards competing for wireless building and home automation and control. It has evolved beyond this and now has a "Smart Energy Working Group" to "enable energy service providers and utilities to wirelessly communicate with and manage common household devices, such as smart thermostats, in-home displays and appliances."

The ZigBee Alliance says that its Smart Energy 2 standard "improves energy efficiency by giving consumers the means to manage their energy consumption more precisely using automation and near real-time information to save both money and energy." ZigBee Smart Energy also "helps utilities and energy providers implement new, advanced metering and demand response programs to drive greater energy management and efficiency while responding to changing government requirements."

The International Organization for Standardization (ISO) launched its International Standard ISO 50001 on energy management systems, an eagerly awaited event because it is estimated the standard could have a positive impact on some 60% of the world's energy use. ISO 50001 will provide public and private sector organizations with management strategies to increase energy efficiency, reduce costs and improve energy performance.

Concurrently, DEKRA Certification announced the launch of their ISO 50001 Certification Service. According to DEKRA, "the purpose of this ISO 50001 International Energy Standard is to empower organizations to establish the systems and processes necessary to improve energy performance, including energy efficiency, use and consumption."

Although these standards are useful for establishing design guidelines and providing compliance parameters, they still need to understood within the context of actual products. This is where the process turns to power quality measurement, since you can't manage what you can't measure.

Power Standards Lab presented such a solution at the recent PCIM Europe Conference in Nuremberg, Germany. Power Standards Lab focused on IEC 61000-4-30, which they claim "is an excellent standard that ensures that all compliant power quality instruments, regardless of manufacturer, will produce the same results when connected to the same signal." According to the company, however, instruments that comply with the Class A requirements of this standard have, until now, been too expensive for common use. A new set of technologies developed by an American company, in cooperation with a Japanese company, demonstrated that it is possible to manufacture three-phase power quality instruments that are fully compliant with the Class A requirements of IEC 61000-4-30 at ultra-low-cost to allow putting these monitoring devices even at entry levels of individual loads.

This new development uses technologies from several fields that have not previously been related to power quality, including digital cameras, Power-over-Ethernet, mobile phones, and submarine sonar systems. The technologies have been packaged in a demonstration instrument, and may be licensed to instrument manufacturers as well. This allows for the gathering power quality and energy consumption information throughout manufacturing facilities or commercial buildings.

Compliance to standards is already happening at the chip level, although in some cases, it is more indirect. For example, Maxim Integrated Products recently introduced the MAX2992, an OFDM-based powerline communication (PLC) modem that pairs with the MAX2991 analog front-end (AFE) to provide a complete PLC chipset for smart grid communications. This chipset complies with the emerging IEEE® P1901.2 standard for OFDM-based communication over power lines. The G3-PLC specification uniquely supports the IPv6 Internet-protocol standard to enable Internet-based energy management systems.

Some of the powering opportunities related to energy management are still emerging, themselves. Seamless Sensing recently unveiled what it describes as its "breakthrough wireless energy monitoring and control solutions," enabled by EnOcean's energy harvesting technology. These new energy-autonomous wireless products have been developed for integration with smart grid networks and are the only such solutions designed specifically for homes in addition to other buildings.

Data centers have different energy management needs, and another emerging technology – dc building power – is expected to provide significant opportunities for power supply makers. Data centers can use 100 times more electricity than a similar size office building. DC technology can improve their energy efficiency by 10 to 20%, compared with ac systems, by trimming power conversion losses. It also reduces power equipment, installation, real estate and maintenance costs, resulting in a saving on total facility costs of up to 30%.

ABB recently purchased a controlling interest in US-based Validus DC Systems, a provider of dc power infrastructure equipment for energy-intensive data centers. “DC systems provide data centers with a game-changing advantage in both operational and capital cost savings and we believe they will be widely adopted in this energy-intensive industry,” according to ABB’s Low Voltage Products division. The investment in Validus complements ABB’s strong technology platform to bolster its entry into the $24 billion market for telecommunications and data center power infrastructure.

Other companies are focusing on energy management in data centers, as well, since the problems are very specific and the solutions can be applied immediately. For example, Emerson Network Power’s SmartRow offers a unique, standalone data center infrastructure that supports up to 20kW of IT equipment in an enclosed, multi-rack configuration with integrated power, cooling, infrastructure management and fire suppression. By reducing room modifications required to support IT equipment, the configuration can reduce initial capital costs by about 10% and cut ongoing energy costs by up to 30%.

These are just some examples of how power fits into energy management systems, but there are many others. Darnell’s Power Forum will include sessions on High Efficiency Power Conversion, Energy Harvesting, Innovations for the Smart Grid, and other topics related to energy management systems. Knowing where the existing opportunities lie is the key to evaluating successful future opportunities.

http://dpf.darnell.com/

Fast Switching Semiconductors, a Blessing or a Curse?

Inside losses need to be cooled away

In order to fulfill the grid codes for power quality and to eliminate bulky filters, power engineers are seeking switches with lower switching losses that allow operation of power converters at higher switching frequencies.

The switching losses of high power semiconductors can not be infinitely reduced without losing ruggedness and reliability due to over-voltages caused by the fast current transients. This aim of the article is to shed some light on this topic while focusing on the optimization of the device and circuit parameters for enabling higher switching frequencies in modern applications.

By Raffael Schnell, Munaf Rahimo, ABB Switzerland Ltd. Semiconductors, raffael.schnell@ch.abb.com

The switching frequency of voltage source inverters determines the quality of the output voltage and current. Low switching frequency causes distortion on the phase current and voltage and thus line perturbation. Due to stringent EMI rules or motor requirements, filtering may be required to smooth the current and voltage waveforms. Unfortunately filtering creates additional losses and makes inverters more costly and bulky. Figures 1 and 2 compare a 50 Hz inverter output current modulated with low switching frequency (figure 1) and higher switching frequency (figure 2). It is obvious that the inverter operating with higher switching frequency offers an output current that is much closer to an ideal sinusoidal current and thus has fewer harmonics. In addition to the significantly improved quality of the inverter output, a higher switching frequency also allows tighter torque and revolution speed control for motor drives especially if a pure PWM technique is used.

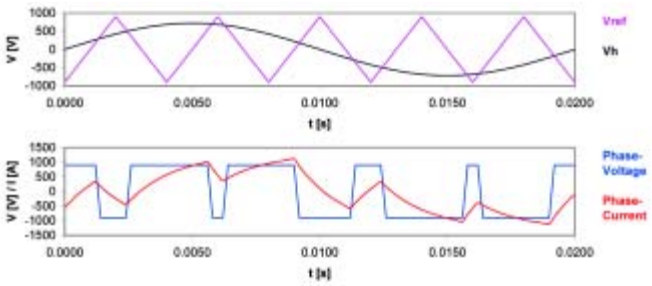

Figure 1: fsw = 250 Hz, fout = 50 Hz

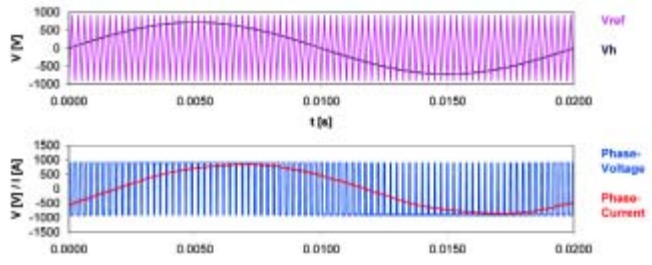

Figure 2: fsw = 4'000 Hz, fout = 50 Hz

Influence of the switching frequency on the inverter rating

Semiconductor switch losses can be divided into conduction losses and switching losses [1]. For a two level VSI with PWM the conduction losses are given as:

$$P_{cond\ IGBT} = \frac{1}{T_0}\int_0^{T_0/2}(V_{CE0}\cdot \hat{\imath}\sin(\omega t) + r_{CE}\cdot(\hat{\imath}\sin(\omega t))^2)\cdot\tau(t))dt \quad (1)$$

The switching losses are given as:

$$P_{sw} = \frac{1}{T_0}\cdot\sum_n E_{sw}(\hat{\imath}) \quad , \quad (2)$$

where the number of switching events n is directly proportional to the switching frequency.

Thus conduction losses are independent from the switching frequency but the switching losses are directly proportional to the switching frequency.

The switching energies ($E_{sw} = E_{on} + E_{off}$) depend strongly on the type of semiconductor switch used. As a general rule of thumb, one can assume that devices with higher voltage ratings have higher switching energies. This can be attributed to the fact that a device with a higher voltage rating needs a thicker silicon-base region. Therefore, the thicker the silicon the more charge needs to be swept out during switching, thus creating additional turn-off losses (E_{off}).

Furthermore, the losses inside the semiconductor switches need to be cooled away, but the cooling capability for a certain device size is

limited. For a HiPak2 standard module (140 x 190 mm) the best heat-sinks achieve thermal resistant values of Rth(s-a) ~ 8 K/kW. With the module internal Rth and the Rth of the interface from module to heat-sink, a total Rth junction to ambient of Rth(j-a) ~ 25..30 K/kW can be achieved. This means that for every kW loss inside the IGBT-switch the junction temperature rises by approximately 30 K. Thus, the thermal resistance and the losses, depending on the switching frequency limit the useable current of IGBT modules.

Using the ABB simulation-tool [2] the maximum inverter phase current can be computed taking the typical module losses and thermal limitations into account. The inverter rating (3-phase) can be calculated with the phase-current:

$$S = V_{rms} \cdot I_{out,rms} \cdot \sqrt{3} \qquad (3)$$

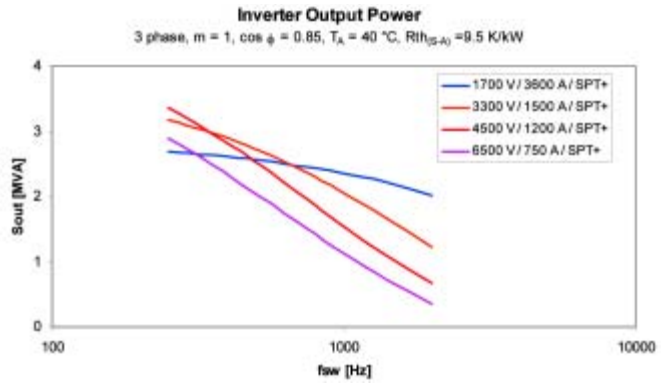

Figure 3: Inverter output power

In Figure 3 possible inverter ratings using ABB IGBTs of the latest generation in 140 x 190 mm HiPak2 modules are shown.

As already mentioned, high voltage devices tend to have higher switching losses and thus show a much steeper decline in output power with switching frequency compared, for example, to a 1700 V device. Thus the quest to optimize high voltage devices is beyond doubt.

Optimizing for low switching losses

As seen below Semiconductor devices follow a so called technology curve (e.g. VCEsat vs. Eoff). Therefore they can be optimized for operation with a higher switching frequency. This would be of particular interest for IGBTs with higher voltage ratings as they suffer in performance in the high switching frequency range above 1 kHz (figure 3) compared to 1700 V and lower rated modules.

Figure 5 shows the inverter output current for three variants of the technology curve (figure 4). The faster and slower variants have been

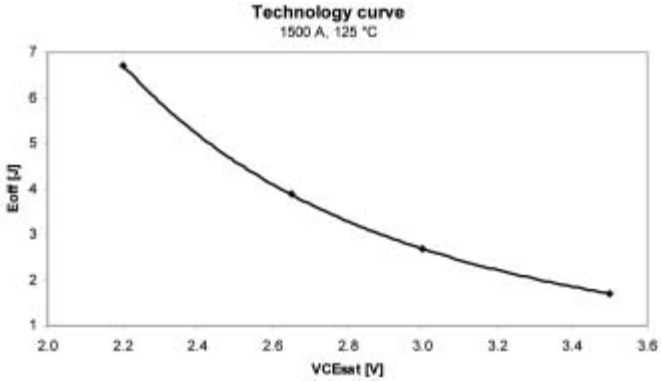

Figure 4: Typical technology curve of the 3300V / 1500A SPT+ IGBT module

produced and tested whereas the fast variant is an extrapolation on the technology curve for reference purposes.

The freedom to move the device on the technology curve is, however, limited. In addition to semiconductor physics factors such as leakage current and safe operating area (SOA), and for faster device switching speed, limit the practical use of devices with low switching losses.

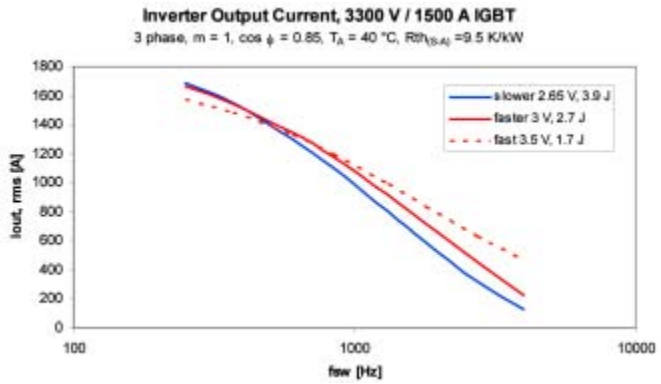

Figure 5: Output power for different optimizations

Overvoltage implications

In high power modules with a large number of chips in parallel and thus high current ratings, the switching speed must be limited due to the unavoidable presence of stray inductances in the circuit and the fact that di/dt nearly scales linearly with the number of chips in parallel (figure 6).

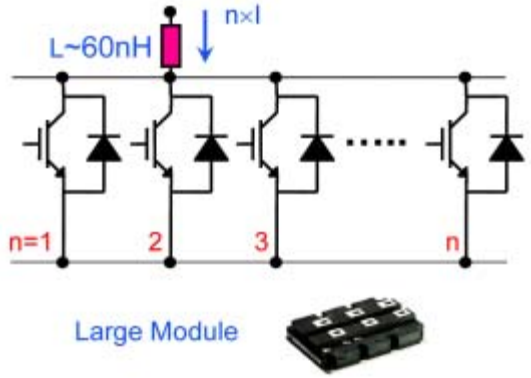

Figure 6: Stray inductance impact on large modules

For low power devices, the nominal current is in the range of 1A up to 50 A the di/dt is moderate. Today's high power modules offer nominal current ratings in the range of 400A up to 3600 A, which result in current slopes that are at least a factor of 10 to 100 times higher compared to low power modules or discrete devices. In addition, high current / high voltage modules have significantly larger foot-print areas and the current leads need to be robust in terms of current and voltage. This inevitably makes the design of low inductive bus-bars more difficult.

The peak turn-off overvoltage (V_{CEM}) needs to be kept below the maximum device rating (V_{CES}):

$$V_{CEM} = \left|di/dt\right| \cdot (L_{\delta\,CE} + L_{\sigma}) + V_{DC} \leq V_{CES} \quad (4)$$

Thus the influence of the stray inductance in Equation 4 eliminates the prospect of an ideal switch with infinite switching speed (no switching losses). Figure 7 shows an example of the turn-off switching waveforms of two differently optimized modules of the same technology curve (figure 4).

Though the difference on the technology curve of the two devices shown in figure 7 is not too great, the implications caused by the overvoltage can be severe. The faster device is already operating outside the allowed SOA since the peak voltage is above 3300 V. A further move on the technology curve towards lower turn-off losses would be impractical.

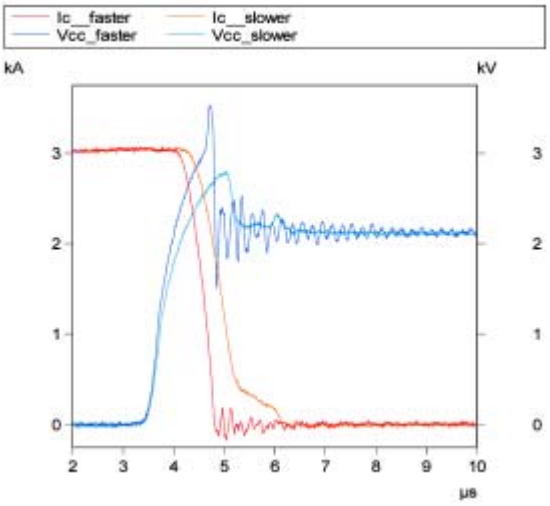

Figure 7: turn-off switching at SOA conditions (Vcc = 2.1 kV, Ic = 3 kA, Ls = 185 nH, Tj = 25 °C)
Faster: (VCEsat = 3 V, Eoff = 2.7 J at nominal conditions)
Slower: (VCEsat = 2.65 V, Eoff = 3.9 J at nominal conditions)

Outlook

System designs with higher switching frequency requires devices with lower switching losses. There is no such thing as an ideal switch since parasitic inductances can never be eliminated completely. Especially in the case of high power devices with large current ratings, the overvoltage issue also limits the use of low switching loss devices manufactured with advanced semiconductor materials such as SiC and GaN. Figure 9 illustrates the recovery behavior of similarly rated 1200 V silicon and silicon carbide diodes.
The question is: What can be done to escape this vicious circle?

- **Packaging/Integration:** In the area of low power/voltage a trend to better integrate the power semiconductors into the converter is visible. This allows more compact systems with the switches closer to the capacitors which can lower the parasitic impedance. For higher power ratings > 500 kW integration is more difficult due to manufacturing issues but mainly due to the market. There is still a clear line between converter and semiconductor manufacturers, each with their core competence. For example a high power phase-leg configured standard module above 1700 V has still not evolved, although this would be the first step into lowering parasitic inductance. Second source concerns on the converter manufacturer's side and the fear of developing a module for a niche market on the module producer's side present a too big a hurdle so far.

- **Softer switches:** FCE-concepts, e.g. utilized in BIGT (reverse-conducting IGBT) tehnology [5] offer softer switching to a certain extent. Figure 8a for diode recovery and 8b for IGBT turn-off mode

show the comparison of a BIGT to a similar IGBT / diode combination. In addition the BIGT technology merges the diode and IGBT to the same silicon, thus increasing the useable silicon area for both IGBT- and diode-modes. This lowers the thermal resistance which in turn allows to operate a BIGT device with the same switching frequency at higher currents or with the same current at higher switching frequencies.

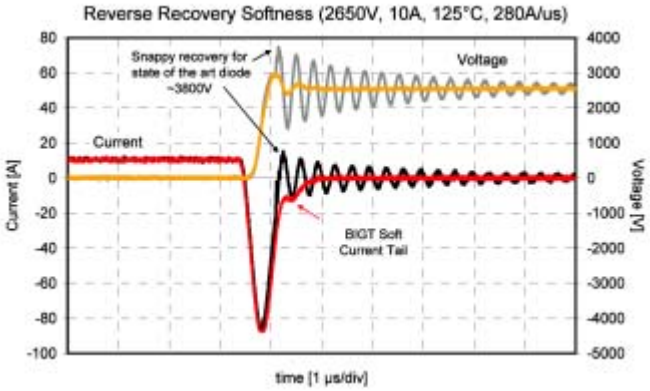

Figure 8a: Diode recovery mode (chip level)

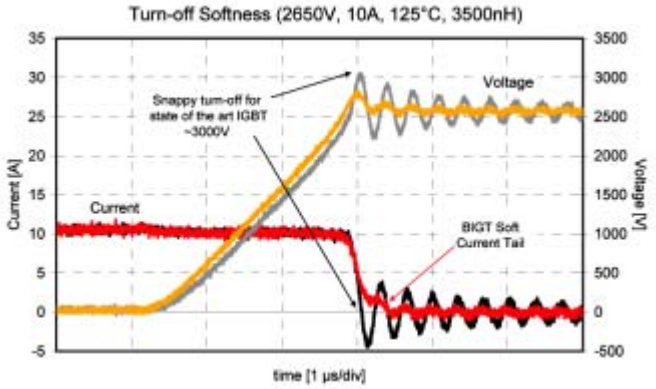

Figure 8b: IGBT turn-off (chip level)

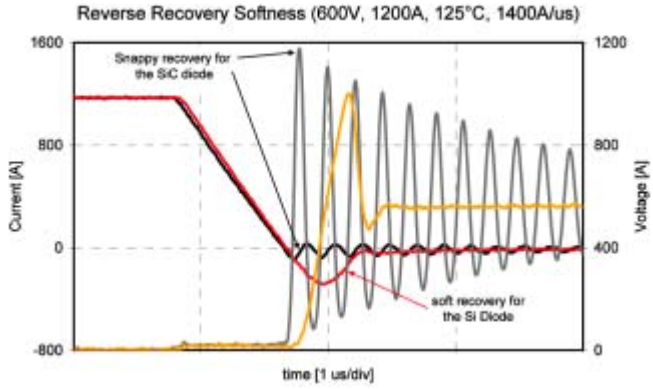

Figure 9: Diode recovery for similar rated diodes

- **Converter Topologies:** Techniques do exist that reduce at least part of the switching losses (e.g. snubbers). However, the increased part count and the associated cost increase as well as reliability limitations of such circuits have always been considered as drawbacks. On the positive side, improved techniques exist for the simultaneous increase of power and frequency [4] by separating switching and conducting functions, so that future systems might well allow high frequency and high power. Such new circuit techniques could allow the optimization of semiconductors and substantial frequency increases without power de-rating.
  On the other side multi-level topologies allow an increase in power quality with significantly reduced switching frequency of the power switches.

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[4] US Patent N° 7,417,409 B2.

1st SiC JFET Easy1B Module

Very low switching losses enable ultra low loss power electronic designs

Reducing losses is one of the most challenging trends in power electronics. Wide band gap devices like SiC switches are known to show best performance in terms of lowering conduction and switching losses. It is one decade ago, that Infineon introduced the SiC Schottky barrier diode to the market. Now the SiC JFET is matured and convinces with low power loss.

By Marc Buschkühle and Daniel Domes, Infineon Technologies AG, Warstein

In combination with all advantages of Infineon's Easy1B PressFIT housing concept, a highly efficient, reliable, robust and ease of use solution can be shown.

SiC power devices

The integration of SiC power devices into a power module is not a completely new task. Some years ago, the loss saving potential of SiC Schottky barrier diodes was demonstrated reducing the turn-on energy of IGBTs and the recovery losses of the diodes, respectively. Since the SiC JFET is available as a product very soon, the full SiC loss saving potential can be leveraged by getting rid of IGBTs tail current losses as well. Target applications for the new SiC JFET module will be the efficiency sensitive field of renewable energy and UPS systems.

Simple Direct Driven JFET Topology

For the new 1200V/30A SiC JFET module a half bridge topology was chosen to suit most customer needs. This enables a fast time to market and drives efficiency up to a new level.

In Figure 1 the module schematic, the Easy1B module itself and an exemplary chip arrangement can be seen. One switch consists of three single SiC JFET chips with maximum on-state resistance at 25°C junction temperature of 100mΩ each.

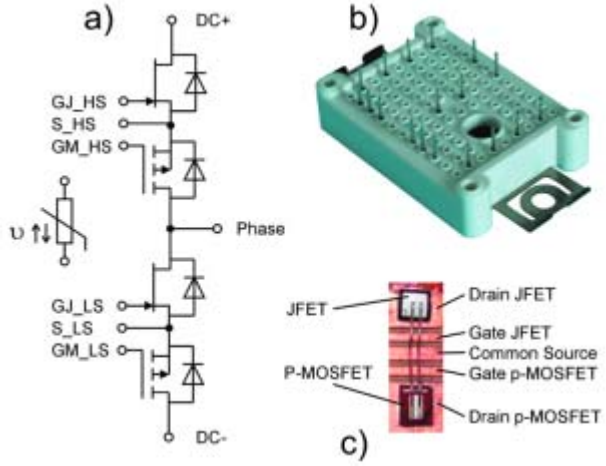

Figure 1: Direct Driven JFET:
a) Module schematic
b) 1200V/30A Easy1B module FF30R12W1J1_B11
c) Exemplary chip arrangement

Two parallel low voltage p-channel MOSFETs with just 3-4mÙ each are connected in series to the JFET group. The basic approach is the so-called "Direct Driven JFET"

The main idea behind this, is to permanently turn on the low voltage MOSFET in normal operation. Then, the JFET is controlled by means of its own gate drive stage performing the desired switching caused by the logic control signal. Compared to a conventional Cascode circuit, the Direct Driven JFET approach allows lowest dynamic losses combined with a good controllability of the JFET switching transients.

The p-channel MOSFET was chosen because it allows the lowest stray inductance in the JFET gate drive path and makes an integration of the whole driver circuitry in one single gate drive IC most simple.

Regarding the last mentioned aspect, Infineon is currently developing an IC solution, which will allow the customer to operate the Direct Driven JFET circuit like a conventional normally-off switch. Furthermore, all the safety aspects will be managed inside the IC without the need of taking care from customer side.

Optimized Module design

Since a family of silicon carbide diodes is already in high volume production used in Easy modules (Figure 2), as a logical consequence the Infineon silicon carbide JFET devices will be introduced in conjunction with the well known compact Easy1B housing.

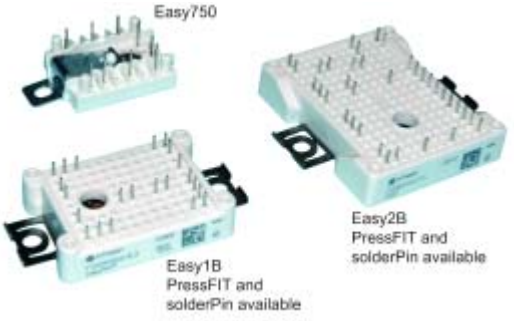

Figure 2: Highly flexible Easy module Family with up to 165 possible Pin positions

The Infineon Easy module concept was commercialized many years ago and has proven flexibility, quality and reliability in daily use in numerous high volume industrial applications. Furthermore the success story of the EasyB module continues as it will be used for automotive applications as well (www.infineon.com/autoeasy).

For simplified handling and highest quality of interconnections, the modules are equipped with PressFIT contacts. The mounting effort can be reduced enormously compared to standard soldering alternatives and production costs can be decreased.

Due to the flexible module Pin-Grid of 89 possible Pin positions an optimized layout with lowest stray inductances is done for the SiCJFET Easy1B module.

This is one fundamental basic in handling of high speed switching devices like SiC JFET. With simulations and tests within the lab an optimized layout down to 10-15 nH is achieved.

Low ohmic Static behavior

The output characteristic of the 1200V/30A SiC JFET module can be seen in Figure 3. Regardless whether the module is operated in forward or reverse direction, for the gate-source-voltage vGS=0 the JFET behaves pure ohmic. If the JFET is turned off in reverse conduction mode (e.g. vGS=-19V), the intrinsic body diode can take over the load current. This is a very important fact, since there is no need for an additional freewheeling diode which would result in additional module area and costs.

Another advantage is given by using the JFET channel even if the load current flows in reverse direction. In contrast to standard diodes the low ohmic static behavior can be seen as well.

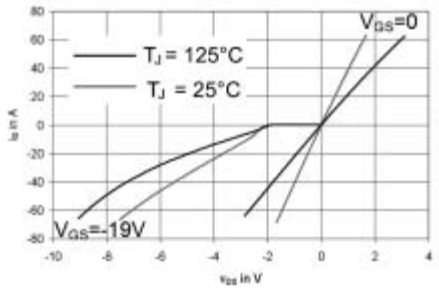

Figure 3: Low ohmic Static behavior of the 1200V/30A SiC JFET module

Lowest switching losses

The switching waveforms of the JFET module can be seen in Figure 4. Compared to the Direct Driven JFET topology with n-channel MOSFET, the p-channel MOSFET solution introduces no additional stray inductances to the JFET's gate drive circuit resulting in very fast turn-on and turn-off responses.

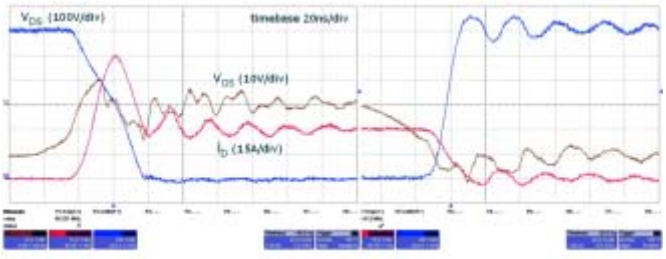

Figure 4: Switching waveforms of the Direct Driven JFET module at TJ=125°C, VDC=600V, iD=30A and RG,ext=0

The switching waveforms show the current commutation between lowside JFET group and highside JFET body diodes. With respect to the recovery current in the turn on waveform, current only changes while the Drain-Source-voltage drops. Therefore, the main part of the reverse recovery current is of capacitive nature. The commutation against the JFET body diode can be regarded as quite similar compared to low loss Schottky diode commutation.

In Figure 5 the low switching losses of the Direct Driven JFET module are depicted. Due to the absence of diode tail current, no recovery-losses occur.

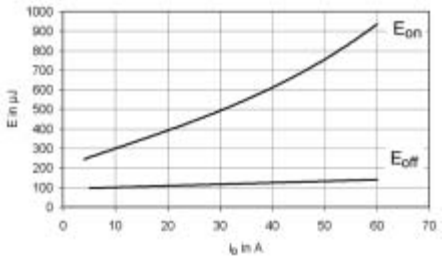

Figure 5: Dynamic losses of the half bridge JFET module at TJ=125°C and RG,ext=0

Efficiency exceeds 99%

To demonstrate the loss-saving-potential of the SiC JFET module, a total loss calculation for a 22kVA three-phase two-level inverter was done. As a challenger for the JFET-module, a 1200V/25A HighSpeed3-IGBT equipped with two 1200V/7.5A SiC Schottky barrier diodes was chosen. The turn-on and turn-off energies for switching the HighSpeed3-IGBT at 600V, 30A and TJ=125°C are measured to be 916µJ (JFET 490µJ) and 1480µJ (JFET 117µJ), respectively.

Like shown in Figure 6, the excellent JFET properties enable loss reduction down to 35% of those of fastest IGBT technology combined with SiC-diodes.

Up to approximately 35kHz switching frequency, the JFET inverter's efficiency exceeds 99%.

Apart from the efficiency point of view, the JFET module is ideally suited for power electronic designs with high switching frequencies targeting the decrease of passives volume for achieving high power densities and lowered overall system costs.

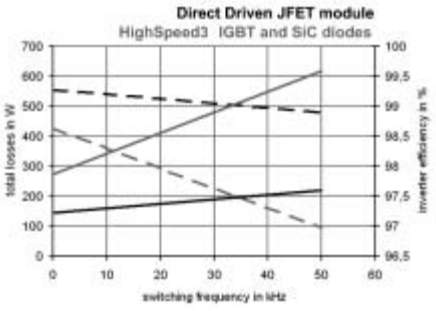

Figure 6: Calculated total inverter losses (solid lines) and efficiency (dashed lines),S=22kVA, VDC=600V, Uph=230V, Iph=31.8A , cosö=0.9, TJ=125°C

Summary

A new normally-on SiC JFET based Easy1B Half bridge module was shown. The Direct Driven JFET topology makes use of series connected p-channel MOSFETs. Combined with an adequate gate drive circuit, the Direct Driven JFET approach can be regarded as practically normally-off. The very low switching losses of the JFET module enable ultra low loss power electronic designs. Benchmarked on fastest IGBT technology combined with SiC Schottky barrier diodes, the SiC JFET module can decrease overall inverter losses down to 35% by providing efficiencies of more than 99% for switching frequencies up to 35kHz.

www.infineon.com/highpower

Single Chip Provides Power for 13/18V or 21V Set-Top Box LNB Designs

A fully integrated way to provide power to the low noise block

Historically, the satellite set-top boxes have provided power to the LNB (low noise block) which resides on the satellite dish on the roof via the same coaxial cable which is used to receive RF signal with the programming information from the dish.

By Ajmal Godil, Intersil

In order to increase the received bandwidth, two different DC voltages which are usually 13V and 18V are sent to power the LNB for locking into different frequencies in receive mode. In addition, the set-top box uses 22KHz DISEQ tone to communicate with the LNB via the coaxial cable. In summary, the coaxial cable carries: 13/18V DC voltage for LNB, 22KHz tone for communicating with the LNB and dish, and RF signal coming back from satellite dish back to set-top box with the TV programming information. In some new set-top box designs, they only require 21V to be supplied to the LNB via the set-top box and uses high frequency modulation to communicate with the LNB.

In the current LNB power supply design, people have been using an LNB power supply chip along with a separate boost converter to implement a design which would cover both old and new set-top box designs as shown in Figure 1.

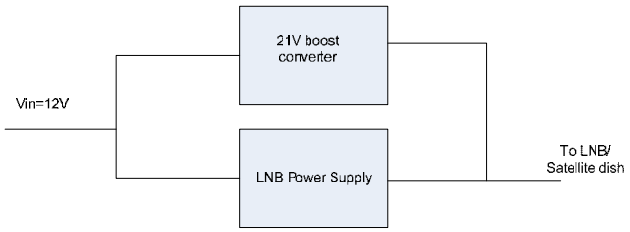

Figure 1: Current LNB power supply design

The ISL9492 is a fully integrated LNB power supply which can be used to simplify the LNB design by allowing a single chip to meet the power requirements of both old and new set-top box designs as shown in Figure 2.

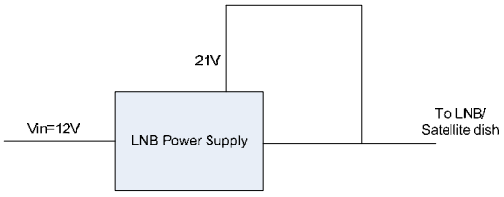

Figure 2: ISL9492 LNB simplifies set-top box power supply design

This ISL9492 is a highly integrated voltage regulator and interface IC with integrated Boost power MOSFET, specifically designed for supplying power and control signals from advanced satellite set-top box (STB) modules to the low noise blocks (LNB) of singe antenna ports.

The device is consists of a current-mode boost PWM and a low-noise linear regulator along with the circuitry required for DiSEqC tone generation, modulation and I2C device interface. The device makes the total LNB supply design simple, efficient and compact with low external component count. This part also has the following digital outputs for in-house error keeping:

1) Over-temperature
2) Open Cable fault
3) Back Bias in case of lightening surge
4) Over-current
5) Over and under output voltage
6) Received tone detect

The I2C control allows the single chip to be used in both designs by providing individual control on just the boost circuit to provide 21V or both the boost and internal LDO to provide 13V/18V along with the 22KHz Diseq tone as shown in Figure 3.

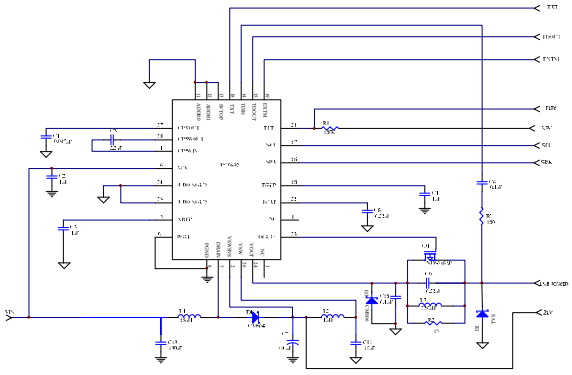

Figure 3: ISL9492 single chip solution allows old and new set-top box designs

Conclusion:

The ISL9492 is a very simple, cost effective and fully integrated way to provide power to the low noise block (LNB) on the satellite dish for both old and new set-top box designs which require 13/18V with 22KHz Diseq tone or 21V.

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Point-of-Load DC-DC Converters

Delivering high efficiency and high step-down ratios with ultra-fast transient response

Point-of-Load (POL) system designers in industrial, networking/communications, and high–end consumer applications are constantly challenged with numerous important design choices.

By Sridhar Gurram, Product Marketing Manager, Micrel, Inc

Balancing the benefits of solutions based on discrete ICs against the use of integration devices seems to be the most fundamental design challenge designers face as each option offers tradeoffs. Also, the design cycle time and time to market requirements weigh heavily on the choice of the available solutions. Finally, system reliability, high density and single supplier capabilities play an important role in choosing the power converters.

To top it all off, two-stage power conversion employed by POL systems for low duty cycle operation is wasteful of both board space and power, since it entails two sets of stage conversion losses. This article talks about the types of tradeoffs designers face and the benefits of specific solutions.

Saving Board Space and Power

One of the most expedient ways to save on both board space and power is to eliminate costly external components while reducing output capacitance. Micrel's SuperSwitcher II™ family combines a high performance Synchronous PWM controller with high density MOSFETs in a space saving 5mm x 6mm QFN package. The patented Hyper Speed Control™ architecture enables ultra-fast transient response while reducing the output capacitance and also makes (High V_{IN})/(Low V_{OUT}) operation possible. This wide input DC-DC converter family is an excellent choice for many industrial, networking/communications, and high–end consumer applications. The SuperSwitcher II™ family eliminates the need for external compensation components resulting in compact, reliable, and lower-cost designs.

Unlike solutions utilizing traditional voltage mode and current mode control topologies, Micrel's SuperSwitcher II™ family utilizes a patented Hyper Speed Control™ control architecture. This psuedo-fixed frequency, adaptive ON-time control topology uses a comparator instead of a traditional error amplifier to turn the converter on and off thereby simplifying the external compensation loop and thus avoiding some of the problems associated with standard control schemes. These DC-DC converters have a variable control loop that dynamically adjusts the on-time based on input and output voltages on a cycle-by-cycle basis which allows the converter to operate in a pseudo-fixed frequency mode. Keeping the switching frequency variations within ±20 percent of its nominal frequency results in very predictable EMI characteristics which makes filtering and other suppression techniques much easier and cheaper to implement.
(Reference Figures. 4,5)

The SuperSwitcher II™ family of DC-DC converters are Any Capacitor™ stable and work equally well with ceramic or electrolytic input/output capacitors, thus providing engineers more design flexibility and lowered BOM costs.

Design Flexibility

Designed for 5/7/12 Amps of output load current at 300kHz switching frequency, the MIC2XXXX family operates from a wide input voltage range of 4.5V to 75V, and provides output voltage as low as 0.8V. The family's thermally-enhanced package with slim 0.85mm profile, allows mounting on the backside of the motherboard, making the devices ideally suited for space constrained, high-density and high efficiency applications. These DC-DC converters with ultra-fast transient response have a scalable common footprint so that designers can simply, 'cut and paste' their design to significantly reduce risk and enable faster-time-to market. (Reference Figures 6 and 7)

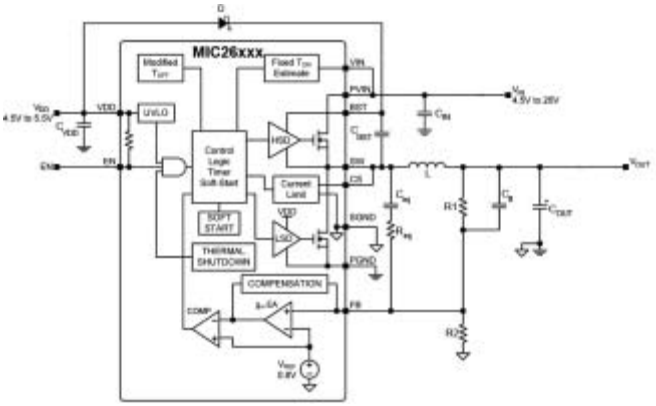

Figure 1: Internal Block Diagram

Control Scheme

As shown in Figure 1, in continuous conduction mode of operation where the inductor current flows continuously, the output voltage is sensed by the feedback pin FB via the voltage divider R1 and R2, and compared to a 0.8V reference voltage V_{REF} at the error comparator through a low gain transconductance (gm) amplifier. If the feedback voltage decreases and the output of the gm amplifier is below 0.8V, then the error comparator will trigger the control logic and generate an ON-time period. The ON-time period length is predetermined by the fixed t_{ON} estimation circuitry:

$$t_{ON\,(ESTIMATED)} = \frac{V_{OUT}}{V_{IN} \times fsw}$$

where V_{OUT} is the output voltage and V_{IN} is the power stage input voltage and f_{SW} is the switching frequency.

At the end of the ON-time period, the internal high-side driver turns off the high-side MOSFET and the low-side driver turns on the low-side MOSFET. The OFF-time period length depends upon the feedback voltage in most cases. When the feedback voltage decreases and the output of the gm amplifier is below 0.8V, then the ON-time period is triggered and the OFF-time period ends. If the OFF-time period determined by the feedback voltage is less than the minimum OFF-time t_{OFF}(min), the control logic will apply the t_{OFF}(min) instead. t_{OFF}(min) is required to maintain enough energy in the boost capacitor (CBST) to drive the high-side MOSFET.

The maximum duty cycle is obtained from the tOFF(min):

$$D_{MAX} = \frac{t_S - t_{OFF\,(MIN)}}{t_S}$$

where $t_S = 1 / f_{SW}$.

It is not recommended to use these devices with an OFF-time close to t_{OFF}(min) during steady-state operation. Also, the minimum t_{ON} results in a lower switching frequency in high V_{IN} to V_{OUT} applications, such as 24V to 1.0V. During load transients, the switching frequency is changed due to the varying OFF-time.

To illustrate the control loop operation, both the steady-state and load transient scenarios will now be analyzed. For easy analysis, the gain of the gm amplifier is assumed to be 1. With this assumption, the inverting input of the error comparator is the same as the feedback voltage.

Figure 2 shows the control loop timing during steady-state operation. During steady-state, the gm amplifier senses the feedback voltage ripple, which is proportional to the output voltage ripple and the inductor current ripple, to trigger the ON-time period. The ON-time is predetermined by the t_{ON} estimator. The termination of the OFF-time is controlled by the feedback voltage. At the valley of the feedback voltage ripple, which occurs when V_{FB} falls below V_{REF}, the OFF period ends and the next ON-time period is triggered through the control logic circuitry.

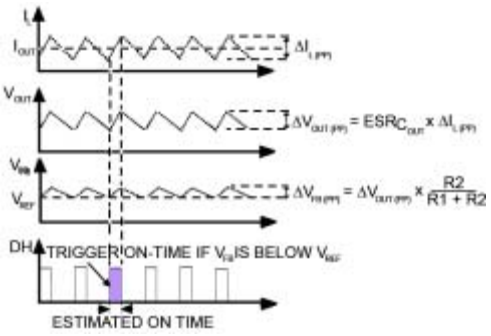

Figure 2: Steady State Response

Figure 3a and 3b shows the operation during a load transient for both traditional PWM Control and Micrel's Hyperspeed™ Control topologies. In a standard PWM control scheme, during a load transient, the duty cycle is increased and the output takes one full switching cycle to respond while keeping the switching frequency relatively constant.

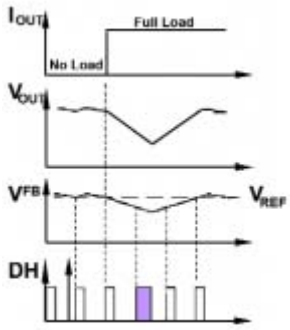

Figure 3a: PWM control Load Transient Response

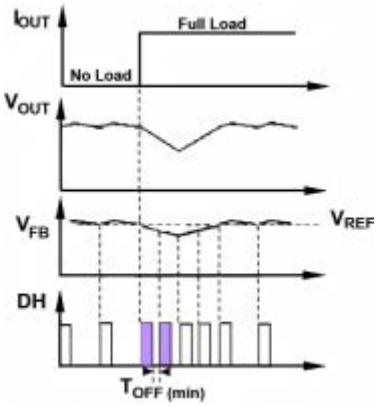

Figure 3b: Hyper Speed Control Load Transient Response

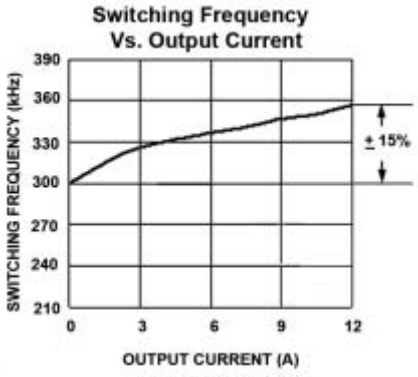

Figure 4: Switching Frequency

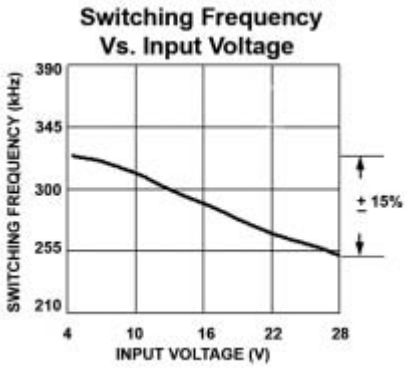

Figure 5: Switching Frequency

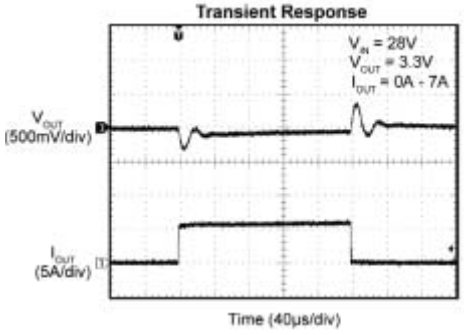

Figure 6: Transient Response

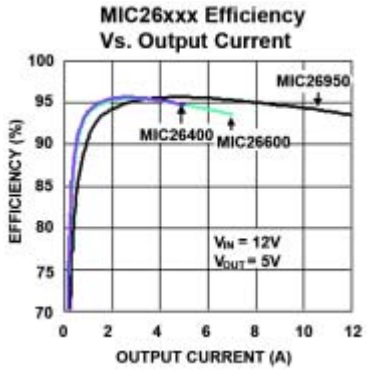

Figure 7: Efficiency Vs. Output Current

With Hyper speed™ Control topology, the switching frequency changes during the load transient, but returns to the nominal fixed frequency once the output has stabilized at the new load current level. With the varying duty cycle and switching frequency, the output recovery time is fast and the output voltage deviation is small.

Unlike true current-mode PWM control, the SuperSwitcher II™ family uses the output voltage ripple to trigger an ON-time period. The output voltage ripple is proportional to the inductor current ripple if the ESR of the output capacitor is large enough. The control loop has the advantage of eliminating the need for slope compensation.

In order to meet the stability requirements, the feedback voltage ripple should be in phase with the inductor current ripple and large enough to be sensed by the gm amplifier and the error comparator. The recommended feedback voltage ripple is 20mV~100mV. If a low ESR output capacitor is selected, the feedback voltage ripple may be too small to be sensed by the gm amplifier and the error comparator. Also, the output voltage ripple and the feedback voltage ripple are not necessarily in phase with the inductor current ripple if the ESR of the output capacitor is very low. In these cases, ripple injection is required to ensure proper operation.

Conclusion

In summary, Micrel's SuperSwitcher II™ family extends the benefits of its adaptive on-time (AOT) control architecture to point-of-load (POL) applications and products with complex power management needs requiring high performance. Combining small size, high efficiency, ultra-fast transient response, high power density and design flexibility, these DC-DC converters help power designers reduce design cycle time to meet the industry's most aggressive time-to-market requirements.

www.micrel.com

Note: SuperSwitcher II, Any Capacitor and Hyper Speed Control are trademarks of Micrel, Inc.

Device	Input Voltage	Output Voltage	I_{OUT}	Switching Frequency	Package(s)
MIC26400	4.5V - 26V	0.8V-5.5V	5A	300KHz	5mm x 6mm QFN-28L
MIC26600	4.5V - 26V	0.8V-5.5V	7A	300KHz	5mm x 6mm QFN-28L
MIC26950	4.5V - 26V	0.8V-5.5V	12A	300KHz	5mm x 6mm QFN-28L
MIC27600	4.5V - 36V	0.8V-5.5V	7A	300KHz	5mm x 6mm QFN-28L
MIC28500	4.5V - 75V	0.8V - 0.8*V_{IN}	4A	100KHz-500KHz	5mm x 6mm QFN-28L

Table 1: Device Overview

EPE 2011 Birmingham UK

14th European Conference on Power Electronics and Applications

30 August to 1 September 2011

Power Electronics and Adjustable Speed Drives: Towards the 20-20-20 Target!

Announcement

www.epe2011.com

Notification 1 March 2011
Final Papers 1 June 2011

ANNOUNCEMENT

Shielded Gate Power MOSFET Technology Enables Lower Conduction and Switching Losses

Power supply designer boost efficiency and power density to new levels

Regulatory bodies as well as end customers find themselves striving for higher efficiency in DC-DC power supplies. New designs require lower Specific On-resistance while not sacrificing Unclamped Inductive Switching (UIS) capability or increasing switching losses.

By Mike Speed, Joe Yedinak and HL Lin, Fairchild Semiconductor Corporation

The shielded gate MOSFET has provided the answer for designers of DC-DC power supplies in the 30V to 200V range. RDS-on reductions of 50% or greater have been realized with improved switching performance leading to higher efficiencies and opening the door for higher frequency operation. This article discusses the advantages of the shielded gate MOSFET in the mid-voltage MOSFET area (40-300V).

Power Design Challenges

Designers are continually facing the challenge of designing higher power density DC-DC designs with increased efficiency. Advancements in power MOSFET technology has helped to keep this initiative possible. The power MOSFET designer must consider the trade-offs between RDS-on and Qg as reducing one typically increases the other. A new trench MOSFET process allows for a reduction in RDS-on WITHOUT incurring a Qg penalty. This technology, known as shielded gate, enables reduction of the epi resistance associated with achieving the BVdss, the key component of RDS-on, in Mid-voltage MOSFETs. As shown in Figure 1, this technology has particular benefits in the >100V area.

Rds(on) Vg = 10V, 200A/cm^2	
Vds = 30V	Vds = 100V
R_{Chan} = 47%	R_{Chan} = 16%
R_{EPI} = 29%	R_{EPI} = 78%
R_{Sub} = 24%	R_{Sub} = 6%

Figure 1: Components of RDS-on for Conventional Trench

Figure 1 shows the RDS-on components comparing a 30V with a 100V rated conventional trench MOSFETs. The RDS-on contribution from the epitaxial is much larger percentage for the 100V. Using a charge balance technique like the shielded gate, this epitaxial resistance can be reduced by more than half without increasing the total Qg or the Qgd component.

The Charge Balance Technique

Figure 2 compares the cross-sections of a conventional and a shielded gate trench device. By incorporating a shield electrode for charge balancing, the resistance and length of the region supporting the voltage is reduced and a significant reduction in RDS-on can be realized.

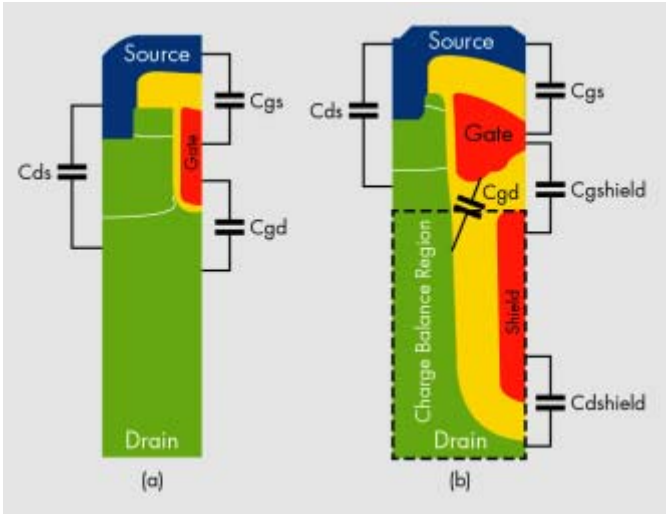

Figure 2: (a) Conventional vs (b) Shield Gate Charge Balance Trench Structure

Further, the shield electrode resides below the gate electrode converting most of the gate to drain capacitance (Cgd or Crss) at the bottom of the conventional trench MOSFET to gate to source capacitance (Cgs). Hence, the shield electrode shields the gate electrode from the drain potential.

Figure 3 compares the capacitive components of the conventional and the shielded gate trench MOSFET having equivalent RDS-on. By reducing the Crss the switching losses are minimized by shortening the time it takes to transition from the off to the on state or the on to the off state. In particular, reducing the Qgd, as show in Figure 4, reduces the switching energy losses by minimizing the time the device has the simultaneous application of high voltage and current.

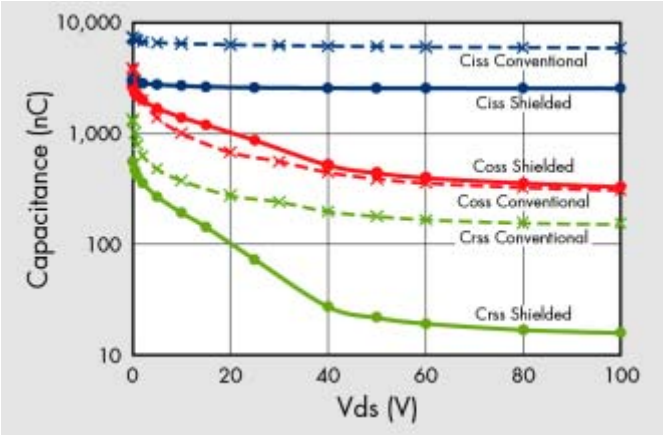

Figure 3: Comparison of Capacitive components for Conventional and Shield Gate Trench with equivalent 20A RDS-on 5.7mΩ.

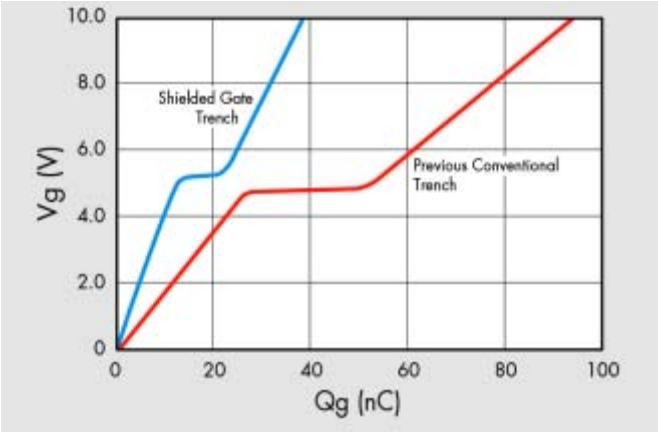

Figure 4: Comparison of Qg curves at 20A and 50V for Conventional an Shield Gate Trench with equivalent 20A RDS-on 5.7mÙ

Further, the shield and its resistance act as a built in snubbing resistance (Rshield) and capacitance (Cdshield) network depicted as component of the Coss in Figure 3. This snubbing network slows down the transition of the switching from low to high voltage. This feature of the shielded gate helps to reduce EMI, dv/dt induced turn-on, and avalanching during switching transitions.

Performance Improvements in DC-DC 1/16 Brick Module

The Fairchild FDMS86252 150V shielded gate MOSFET was compared against competitive MOSFETs in the primary of a 48V input and 3.3V output isolated DC-DC converter operating at 400kHz over the current range of 10 to 20 amps. In Figure 5 the FDMS86252 shows a minimum of 0.4% improvement in efficiency with shielded gate. That translates to at least a 0.32W power improvement that seems small but is crucial in DC-DC design where every percentage point is crucial when trying to meet regulatory requirements.

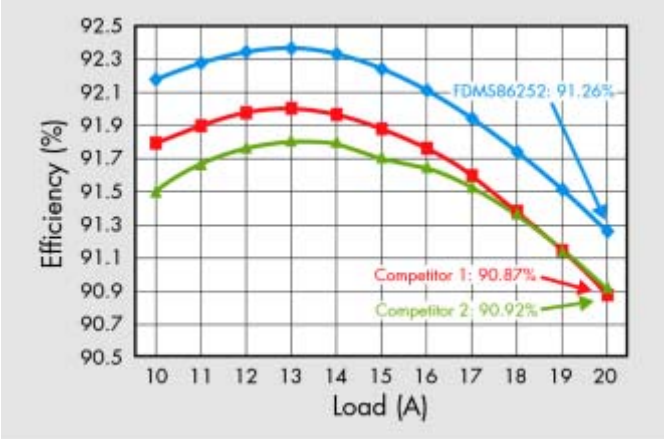

Figure 5: Comparison of Fairchild FDMS86252 150V shielded gate MOSFET against a competitor in a 48V VIN; 3.3V VOUT, Isolated DC-DC converter operated at 400kHz.

Summary

Fairchild's new PowerTrench® MOSFET Technology described above exhibits better RDS-on and Qg improvement over previous generations. This technology has enabled the power supply designer to boost efficiency and power density to new levels. Shielded gate MOSFETs are available from Fairchild Semiconductor Corporation.

www.fairchildsemi.com

Practical Experience of ERP-System Implementation in Power Semiconductor Devices Manufacturing

Proton-Electrotex JSC, in Orel is a Russian company working in the area of development, production and sales of power semiconductor devices – diodes and thyristors of disk, stud, and module type, as well as power stacks. The produced devices are well known on the world market of power electronics since export equals about 60% of the total sales volume. Young, dynamic company has official representative offices in Russia, Europe, Asia, the CIS countries, and the joint venture in China.

By Peter Semenov, Chief of Production and Dispatching Office, Proton-Electrotex JSC

Power semiconductor devices manufacturing is a complex, demanding process, which is highly specialized in many respects, so application of the ready-made templates is not sufficient for its automatization, even if they are successfully practiced by other manufacturers.

ERP-system implementation in our company is accompanied by continuous processes optimization as required by the specific character of the industry.

Premises

Proton-Electrotex JSC can be safely related to a category of medium enterprises: it develops without any outward investments at the expanse of its own profits. That is why the economic viability of various manufacturing, labour or financial resources is a question of major importance for us.

With an increase in sales we faced a problem of misallocation of human resources and manufacturing facilities. The manufacturing department was unable to secure a large number of orders because of quite elaborate operational procedures. Another factor that complicated the manufacturing process was a wide product range.

We saw two possible ways out of the existing situation:

- An extensive way. Investments in the output expansion (that were not scheduled in the near term) could jeopardize the manufacturing activity on the whole and lead to earnings dilution of the output product.
- An intensive way. Optimization of available resources for the purpose of using their potential to the uttermost.

The second way was chosen which presupposed implementation of an automated system of accounting of production process and planning for securing rhythmical production.

In 2008 it was decided to implement the SyteLine 7 ERP-system.

Why ERP- SyteLine?

The bottom line in the choice of this product was the fact that the system, considering the financial side of the company's activity, "looked" at the information support of the business processes of the industrial enterprise from the perspective of manufacturing process. Certainly not only does this system contain modules of accounting of production process, resources monitoring and planning unit, but also sales and supply automation components that are integrated with each other as required. Before the ERP was implemented certain functional information fields used to be isolated which obviously hindered solution of a range of production tasks with due level of efficiency.

The system consists of several units: "Supply Logistics", "Accounting of Production Process", and "Planning".

Implementation of the "Supply Logistics" which includes inventory accounting, supply and sale, allowed to systematize the information on the commodities and materials. Today the employees can get a quick and timely access to the data on the available material assets – from procurement activities to the manufactured goods available in stock in a corresponding section. The "Supply Logistics" unit is a starting point not only for the manufacturing process (as an estimation criterion for supplying with required materials) but for planning as well: order schedules are determined with account for the supplies on hand, capacity utilization, etc.

The work of the "Accounting of Production Process" unit is focused on getting exact and timely information on the production flow along the process route and also – by means of specially developed reporting forms – on diagnosing fluctuations. New opportunities for motivating the employees of production sectors have been offered. With implementation of the ERP-system it has become possible to see the whole manufacturing situation and each individual worker's efficiency in real-time mode, the analysis of

the findings allows to create flexible incentive system, motivating the employees for better performance.

The next step in implementing the ERP-system in our company was the adjustment of the “Planning” unit. A pull planning type was chosen, a type when production process is planned by way of “pulling” material resources by a following production link from a preceding one along the whole track in supply chain. Having received such data as quantity and date by which this or that order must be completed, the system will plan when the task to the manufacturing department should be assigned and its exact volume for each sector. The estimation is built on the time standards for each operation, calculated on the stage of implementation of the «Accounting of Production Process” unit. If it is not practical to complete the order by a specific date, the system will offer a new date. As far as tactic planning is concerned, the shift-day tasks are automatically generated by the system proceeding from the data on the production capacities and maximum volume capacity of the equipment tools.

Speaking about general motifs of implementing the ERP-system, it was definitely a necessity of creating a single information space of the company which meant narrowing such directions as customers and suppliers relationship, warehouse management, detailed accounting of production process in different cross-sections (by work centers, by product type, etc.), production planning down to a single structural principle. Along with implementation of the ERP-system a range of operations in the field of information integration like SyteLine integration with the 1C accounting system are supposed to be performed.

“Turn-key” Adjustment

With implementation of the ERP-system it was decided to move the tactical planning and production management from the level of production and assembly supervisors to the level of a newly organized Operations Control Department.

Solving production tasks requires a thorough analysis of the manufacturing processes which leads to a necessity of implementing highly specialized automatizaton functions. Thus, for example, it was estimated that manual input of the information at several production sectors was extremely ineffective and involved a prohibited amount of mistakes and a time gap between the factual rise of the information and its input into the system. To eliminate these problems it was decided to implement a barcode technology using stationary data terminals at the shop-floor level.

Another example is a so-called "Prove-Out" module which we implement by our own efforts. The specificity of the power semiconductor devices manufacturing presupposes gathering and analyzing of large amount of information. This program allows to carry out an automated selection of semiconductor devices to fit a certain client order or a plan. This is a unique software integrated with the ERP-system and a barcode technology data collection system.

Despite the results obtained it is necessary to continue augmenting the automatization potential, extensively involving other directions.

Obvious advantages

The advantages that are becoming more and more evident with growing mass character:

- Awareness of a global information realm existence which integrates the supply, production and sales flows.
- Flexible management of these flows at the level of ordinary users as well as at the level of top management.

Consistency in the work of various segments of the company that allows to reduce the administrative costs considerably and eliminate a problem of data integration for various applications because of the whole company working in one integrated system.

Step-by-step accounting of production flow along the process route in real time mode, as a result – more information for operational control and short-term planning in “manual” mode at the initial stage.

Creation of a range of business processes as a synergy effect of ERP-system implementation.

It’s not all as easy as it sounds

Considering the acquired experience we can share the following recommendations with the companies planning to implement an automatization system.

Implementation is quite a costly procedure both in regards of material expenses and people, that is why it is necessary to carry out a detailed analysis of certain ERP-system answering the company’s special needs. Purchase of a program doesn’t mean it will immediately start doing the planning, forming production tasks, reducing the stock, and cutting production costs and - as a consequence - increasing profits. Implementation of the system can take several years, especially for small-scale industries with wide range of products. The success of the whole thing can depend on sufficient amount of accurate reference data, collected at the preparation stage of the implementation. There should be several competent software specialists or an IT Department because the canned solutions offered by the developer can not always satisfy your requirements.

In conclusion

Today automatizing a company’s activity we primarily solve production tasks. However, if the automatization of our company’s business is built on the manufacturing processes, it is not of course limited by them.

In the future we are planning to implement a budgeting system, a CRM-system, modules of interaction with suppliers and equipment maintenance modules, to automatize a system of preparation and updating the reference data and finally to create an analytics module designated for an individual working place. Anyway, despite all the complexity if automatization implementation this is a logical direction of a company’s development without which it is hard to imagine modern manufacturing.

Reducing the Cost of Using Off-The-Shelf Power Management ICs

With the demise of industry wide second sourcing and the move to developing purely proprietary designs, Power Management IC companies have raised the profit bar to new heights. Good for them…bad for you.

Bob Frostholm, JVD Inc.

With the notable exceptions of cellular phones, notebooks, and other highly competitive consumer driven applications, Power Management product designs can easily last for years, even decades without change.

There are many hidden costs associated with using off the shelf Analog solutions. As you will see shortly, the biggest hidden cost is the cost of the off-the-shelf product itself.

Look at the IC Master (www.icmaster.com) and investigate DC to DC Converters…1,214 pages, with 25 parts per page…over 30,350 DC-DC converters from which to choose plus over 40,000 SMPS controller chips, and 98,000 voltage regulators. With so many standard products to choose from, is there really a need for Analog ASICs?

The answer is unequivocally, yes. According to market research company Gartner, ASICs represented 54% of the Analog market in 2010, while InStat places the figure closer to 59%. Regardless, it is evident that the demand for Analog ASICs far exceeds that of standard Analog ICs.

Why?
A. Differentiation B. IP Protection C. Cost D. All of the Above…
The answer is D.

Lack of Differentiation
The quantity and variety of Analog ICs being introduced gives the OEM a large number of options to choose from when beginning a new design. However, no one chip is a best solution for every OEM.

Analog ASICs provide the perfect solution for OEMs seeking to offer unique products into the marketplace. Features not available in standard products are easily incorporated into an Analog ASIC. Similarly, features found in standard products that are not needed for a particular product can be eliminated and thus reduce the cost of the overall solution. Analog ASICs allow the end equipment manufacturer to introduce the customization that incorporates their company's uniqueness.

Lack of IP Protection
Additionally, the use of standard Analog products opens the door to design plagiarism. The use of standard products reveals exactly what you are doing and how you are doing it. While it may have taken your company 15 months to design, debug and release your new product to market, by exposing your complete circuit design, your competitor can avoid the first two lengthy and expensive steps and move almost immediately into production.

Your competitor has a strong advantage; no design costs to recover. Not having these expenses to amortize puts him at a significant cost advantage.

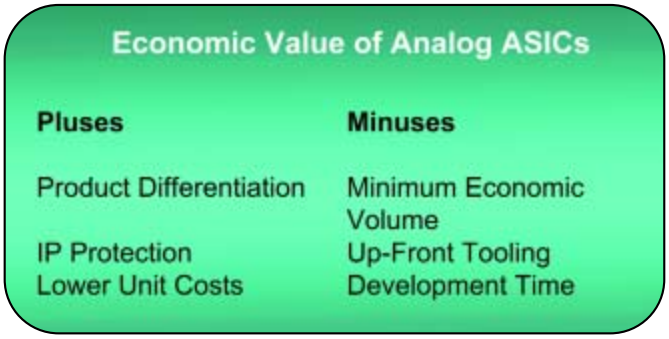

Figure 1: Economic Value of Analog ASICs

Hiding your circuit design in an Analog ASIC creates a serious impediment to your competitors who might otherwise attempt to reverse engineer your ideas into their competing product.

Standard Products Cost Too Much
Analog ASICs are not for everyone. Like any component choice, they must offer the best economic value for the application. Any associated up-front NRE costs (Non-Recurring Engineering) must be factored into the equation along with hard tooling (wafer fabrication masks, test hardware and software and more). In addition, there is the issue of time. Analog ASICs can take from six months up to a year or more to be ready to use in a production environment.

Analog ASIC NRE and tooling costs vary greatly; from $60-$75K on the low side to several hundred K dollars on the high end. Initially, the emotional impact of a large up-front charge can be blinding and often the gut reaction is to dismiss the option entirely without further investigation. Unfortunately, this is where most Analog ASIC discussions erroneously end, when in fact it is just the beginning.

When you buy a standard Power Management IC, what portion of the price you pay is actually the cost to make the chip? Unfortunately, you will never know the exact answer to this question. But if you are using the latest technology, it could be as low as 10-20%, meaning 80-90% of what you are paying is contributing to the chip supplier's gross profit.

Gross Profit = Company Annual Sales – Actual Cost to Build the Products Sold

Public Power Management IC companies report their Gross Profits in their annual report, reflecting sales over the recent 12 month period. GPM is an average; meaning half of the company's sales during that prior year achieved more than the reported GPM and half were below the reported GPM.

Depending on the manufacturer of the Power Management chips you want to use, and the GPM of the products you selected for your new design, it may be cost advantageous to consider replacing them with an Analog ASIC as you develop your product. Independent Analog ASIC companies offer aggressive NRE, Tooling and unit prices to win your business.

The economic value (EV) of an Analog ASIC is easy to calculate once you know the expected volume costs (EVC) of all the Standard IC functions you hope to displace.

1. Identify the high cost points of your design… the Buck-Boost Converters, LDOs, A/D and DAC, Op Amps …etc.

Selected Analog IC Players
Approx. Gross Profit Margins

	2010	2009	2008
ADI	65%	55%	61%
LTC	77%	75%	77%
Maxim	60%	52%	61%
MPS	56%	59%	61%
National	66%	63%	64%
Semtech	58%	55%	54%
SM SC	50%	51%	52%
Volterra	61%	60%	57%

Figure 2: Selected Analog IC Players

2. Contact a well established Analog ASIC Company that does hand crafted Analog designs. Avoid the ubiquitous "Mixed-Signal" ASIC companies. Their analog skills are often limited to selecting analog cells from a fixed digital library, not creating innovative designs that will bring value to your chip. Simply using cells from a library to build your custom power Management Chip can be a recipe for failure.

3. Estimate the lifetime volume (LV) requirement of your design and request a quotation for NRE, tooling and unit costs (UC).

EV = (EVC- [{(NRE + Tooling)/LV} +UC])

For example, high cost points in a recent design were identified as a Linear Tech Gain Programmable Precision Instrumentation Amplifier, a National Micro Power Ultra Low-Dropout Regulator, an Analog Devices 40 µA Micropower Instrumentation Amplifier, and several other components.

The expected combined volume cost for these components was $3.56. All were able to be combined into an Analog ASIC that sold for $0.93. Total NRE and Tooling was $278K. The product lifetime was expected to be ten years, with monthly volumes averaging 15K units.

EV = ($3.56) – [($278,000)/1,800,000) +$0.93]

EV = $2.47/ product

By developing a simple sensitivity analysis chart, it is easy to see the impact if there is some degradation to the prices of the standard Analog ICs. The analysis also projects lifetime savings based on under and over achievement of the lifetime volumes of the chip.

Total Lifetime Cost Savings

Lifetime Volume in K Units	Cost of Components Being Replaced			
	$3	$2.50	$2	$1.50
250	$289,500	$164,500	$39,500	($85,500)
500	$877,000	$627,000	$377,000	$127,000
750	$1,514,500	$1,139,500	$764,500	$389,500
1,000	$2,202,000	$1,702,000	$1,202,000	$702,000
1,500	$3,427,000	$2,677,000	$1,927,000	$1,177,000
2,000	$4,652,000	$3,652,000	$2,652,000	$1,652,000
2,500	$5,877,000	$4,627,000	$3,377,000	$2,127,000
3,000	$7,102,000	$5,602,000	$4,102,000	$2,602,000

Sweetspot based on current volume estimates and current costs of off the shelf components

Figure 3: Total Lifetime Cost Savings

The argument is compelling in terms of the savings by using an Analog ASIC versus standard analog ICs.

Conclusions

Studying GPM can offer an early indication of the viability of your design conversion to an Analog ASIC. If possible, review the GPM of your selected Analog IC vendors. Remember, half their sales revenue is generating GPM greater that the figures shown in their annual report. Where do the products you use fit into that equation? If you are purchasing new designs, chances are that the products you are

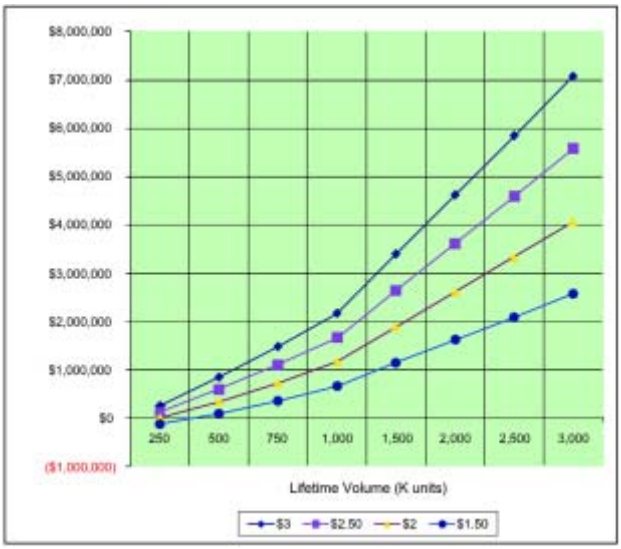

Figure 4: Lifetime cost savings graph

using are well into the upper half. If you are thinking of saving money with a cost down of your product, and you have the time to develop a custom solution, you might want to consider an Analog ASIC.

While cost is a compelling reason to move to an Analog ASIC because it is an easily measured metric, do not underestimate the value of IP Protection and Unique Differentiation. Many times these critical aspects of an Analog ASIC's economic value are overlooked.

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Convert from Inputs Down to 1.5V, Deliver Up to 15A Output, without an Auxiliary Bias Supply

Many next-generation designs for multi-ASIC embedded systems and dual-core single-board computers utilizing 48V or 24V distribution backplanes are migrating towards a 3.3V system bus -- away from 5V system bus architectures -- as the designing-out of legacy 5V digital devices leaves a need for only 3.3V $_{DD}$ voltages, and lower. Are there other reasons? -- Yes!

When implementing a 3.3V bus, overall power consumption of the system can be reduced--compared to incumbent architectural approaches -- but only when proper DC/DC point-of-load (POL) converters are selected for subsequent down-conversion of the bus voltage to power DDR memory, FPGA core, or high-speed transceivers, for example.

By Jason Sekanina, Design Engineer, µModule Power Products and Alan Chern, Product Evaluation Engineer, µModule Power Products, Linear Technology Corp.

Running only one bus line (3.3V) simplifies circuit design and free-up board space, but is not always feasible. Often, higher-power DC/DC POL regulators require bias above 3.3V to drive their power switching MOSFETs.

Isolated bricks have improved their efficiency in converting 48V and 24V down to 3.3V — at ever-higher output power levels.

The challenge really appears when the loads that are downstream from the 3.3V bus require more than 5A to as much as 12A. Although this requirement seems rare, advances in FPGAs, processors and ASIC technologies enable designers to use more of these devices to boost performance in smaller circuit boards. Applications with 10A loads are increasingly common.

One recent customer asked for 30A from a 1V rail, powered from a 3.3V input bus. However, traditional low input voltage high power switchmode DC/DC converters with N-channel MOSFETs rely on a second regulator (housekeeping) circuit to provide higher-than-bus Vin voltage for MOSFET gate drive–increasing layout complexity, size and cost. When 5V (or higher) is not available, delivering high current to loads from a 3.3V input bus is usually very inefficient. The resulting excessive power dissipation increases the junction temperature of the regulator and surrounding components, and only serves to undermine system lifetime reliability.

To the rescue

The LTM®4611 is a low profile µModule step-down switch mode DC/DC converter in a compact 15mm × 15mm × 4.32mm LGA surface mount package. The switching controller, MOSFETs, inductor and support components are housed in the package, so design is reduced to selecting a few external components. The LTM4611 operates from an input voltage of 1.5V to 5.5V (6V, absolute maximum), making it suitable for a variety of power architectures—particularly data storage and RAID (redundant array of independent disks) systems, ATCA (advanced telecommunications computing architecture) and networking cards—where one or several commonly bussed voltages are 5V, 3.3V, 2.8V, and/or 2.5V.

While it is uncommon to see bus voltages lower than 2.5V due to the distribution losses (voltage drops) associated with relatively high bus currents, the ability of the LTM4611 to deliver full power to its load from a 1.5V input is particularly advantageous in applications where load voltages must be precisely regulated even as momentary or sustained electrical events induce input-bus line-sag. Transient events on the system bus can occur normally due to the operation of motors, transducers, defibrillators or an uptick in microprocessor activity. Fault events on a system's distributed bus may leave the bus voltage compromised, but still above 1.5V. The LTM4611's ability to deliver

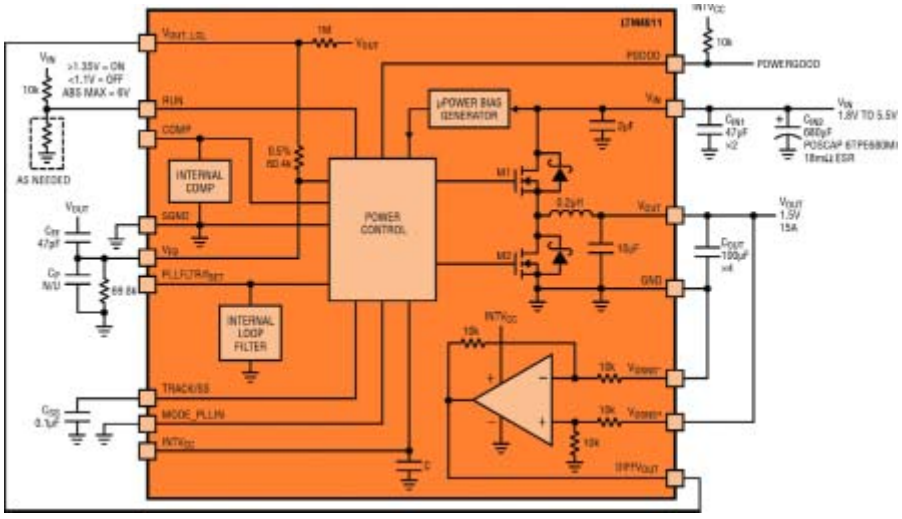

Figure 1: Simplified block diagram of the LTM4611, and typical application

full power from as low as 1.5V input allows it to be considered for mission-critical medical and industrial instruments that have the highest standards for uptime and bus-sag ride-through capability. Precision-regulated power can even be provided by the LTM4611 to its load during so-called “dying-gasps”—sudden, unexpected loss of system power, such as those monitored by utility smart meters—where it is highly desirable to be able to operate from the decaying voltage provided by backup batteries or supercapacitors for as long as possible.

There is another advantage in the LTM4611’s ability to operate from as low as 1.5V: as the number of rails increases in today’s power system, so are the number of layers of copper in printed circuit boards (PCBs) required to route (distribute) the power effectively to the load. Consider a hypothetical example: it can be difficult to route a distributed 3.3V bus to both 3.3V-to-1.5V and 3.3V-to-1.2V DC/DC converters without increasing the number of layers of copper in the PCB. Alternatively, one LTM4611 could convert the 3.3V bus to a distributed 1.5V copper plane, while another LTM4611 could efficiently convert the 1.5V plane voltage to 1.2V at the POL. The resulting total solution size on the motherboard could be quite compelling, while eliminating the need to route 3.3V bus potential to an entire section of the PCB. The option to minimize the number of layers of copper in the manufacture of the PCB has potential for cost and material savings, and associated benefits to PCB yield in mass-production and PCB reliability.

Brains and Brawn; Self generated BIAS supply

The LTM4611 does not require an auxiliary bias supply to power its internal control IC or MOSFET-drive circuitry; it generates its own low power bias from the input-source supply. This internal bias supply enables the LTM4611 to operate from as low as 1.5V input — providing strong gate drive signals to its power MOSFETs at all line voltages — and realize high efficiency in systems utilizing 5V, 3.3V or lower bus voltages. The muscle behind the LTM4611 is a buck-converter topology that steps down its input voltage to deliver as low as 0.8V, up to 15A continuous, to its output. A voltage drop less than 0.3V from input-to-output and at 15A load is achievable, with proper selection of input-power source (dependent on source dynamic characteristics and transient load response) and local bypass capacitance. The LTM4611 employs a fixed-frequency peak-current-mode control buck-converter scheme, operating at 500kHz by default. Optionally, the switching frequencycon be adjusted to between 330kHz and 780kHz by resistor-pin strapping LTM4611´s PLLFLTR/f_{SET} pin — or, synchronized to a 360kHz to 710kHz clock signal presented to its MODE_PLLIN pin.

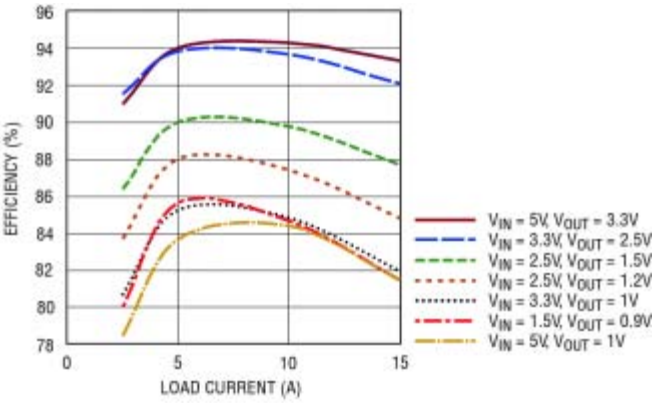

Figure 2: LTM4611 efficiency vs load current for various input and output voltages

Current Sharing of Multiple Supplies for 60A or More

Current sharing of four modules is supported for solutions up to 60A output. More modules can be paralleled for even higher output current — contact Linear Technology for details. Current mode control makes current sharing of modules especially reliable and easy to implement, and ensures module-to-module sharing of current during start-up, transient and steady-state operating conditions.

This is in contrast to many voltage mode modules, which achieve current-sharing by employing either master-slave configurations or by using "droop-sharing" (also called "load-line sharing"). Master-slave configurations can be vulnerable to nuisance overcurrent-tripping during start-up and transient load conditions, while droop-sharing results in compromised load regulation specifications while offering little assurance of good module-to-module current matching during transient load steps.

The LTM4611 typically provides better than 0.2% load regulation from no load to full load—0.5% maximum over the full internal module temperature range of -40°C to 125°C.

Easy POL Application: 1.8V–5.5V Input to 1.5V Output at 15A

The block diagram in Figure 1 shows the LTM4611 operating from 1.8V-to-5.5V input and delivering 1.5V output, up to 15A. The output voltage is programmed by a single resistor from VFB to GND. The control loop drives the power MOSFETs and output voltage such that VFB is equal to the lesser of 0.8V or the voltage on the TRACK/SS pin. A soft-start capacitor, CSS, on the TRACK/SS pin programs the start-up rate of the LTM4611's output when the module's RUN pin exceeds 1.22V (±10%). CSS assures monotonic output voltage waveform start-up and supports smooth power-up into pre-biased output voltage conditions. A resistor-divider from another rail can be applied to the TRACK/SS pin to program coincident or ratiometric tracking of the LTM4611's output rail to the reference rail. This is a handy feature when powering digital devices with stringent rail-tracking requirements during system power-up and power-down.

Remote Sensing for Accurate POL Regulation

Routinely, high current low voltage FPGAs, ASICs and microprocessors require extremely accurate voltages of ±3% of nominal V_{OUT} (or better) regulated exactly at the POL terminals usually, V_{DD} and D_{GND} pins. To meet this regulation requirement where it is hardest to do so — for output voltages below 3.7V — the LTM4611 provides a unity gain buffer for remote sensing of the output voltage at the load's terminals.

Voltage drops across the V_{OUT} and GND copper planes in the PCB are an unavoidable result of resistive distribution losses physically between the module and the load. As shown in Figure 1, the differential feedback signal across the POL (VOSNS+ minus VOSNS-) is reconstructed at DIFF_V_{OUT} with respect to the module's local ground, SGND, thus allowing the control loop to compensate for any voltage drop in the power-delivery path between the module's output pins and the POL device.

The LTM4611 includes an output voltage power good (PGOOD) indicator pin that supplies a logic high open-drain signal when output voltage is within 7.5% of nominal V_{OUT}; otherwise, PGOOD pulls logic low. The LTM4611 provides foldback current-limiting to protect itself and upstream power sources from fault conditions on its output. The LTM4611 also includes an output overvoltage protection feature: when the output voltage exceeds 107.5% of nominal, the internal low side MOSFET is turned on until the condition is cleared.

How Green is Your Machine?

DC/DC power conversion efficiency and thermal management is as important today as ever. The LTM4611 provides compelling efficiency in a small land pattern (only 15mm × 15mm) and low physical volume (at only 4.32mm tall—it occupies only one cubic centimeter), in a thermally enhanced LGA (land grid array) package. Figure 2 shows the LTM4611 efficiency for various combinations of input and output voltage conditions. Besides high efficiency, the power dissipation envelope of the LTM4611 is relatively flat for a given input voltage and output loading condition, which makes the thermal design and re-use of the LTM4611 in follow-on products easy—even as rail voltages migrate to lower values due to IC die shrink.

For an increasing number of applications, reducing power loss at light loads is as important as reducing power loss at heavy loads. Digital devices are increasingly and deliberately designed to operate in lower-power states for as long as possible and whenever practical (for energy conservation), and draw peak power (full load) only intermittently. The LTM4611 supports Pulse-Skip Mode and Burst Mode® operation, which yield substantially higher efficiency at lighter load currents (< 3A) than Forced Continuous Mode operation offers.

Thermally Enhanced Packaging

The device's LGA packaging allows heat-sinking from both the top and bottom, facilitating the use of a metal chassis or a BGA heat sink. This form factor promotes excellent thermal dissipation with or without airflow. Figure 3 shows an infrared thermal image of the top surface of the LTM4611, demonstrating a power-loss of 3.5W with no airflow, tested on a lab bench, converting a 5V input to a 1.5V output at 15A. The hottest surface temperature measures about 65°C.

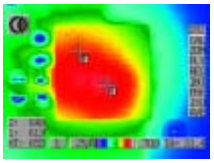

Figure 3: Top thermal image of an LTM4611 regulator producing 1.5V at 15A from at 5V Input. Power loss is 3.5W. No-airflow bench testing results in a 65°C surface temperature hotspot

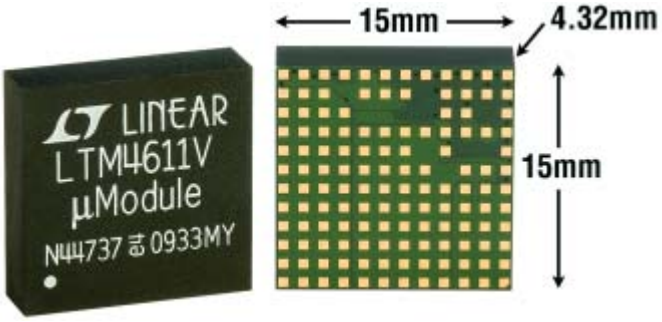

Figure 4. LTM4611 is a complete low Vin DC/DC regulator system in a small surface mount package

Conclusion

The LTM4611 is a µModule buck regulator that easily fits into POL applications needing high output current from low voltage inputs—down to 1.5V. Efficiency and thermal performance remain high across the entire input voltage range, simplifying placement in POL applications. Providing up to 15A of load current — and easily parallelable for generating up to60A — the LTM4611 can help simplify and enable board-mount power solutions for next generation 3.3V system bus architectures and beyond.

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MiniSKiiP® PIM Modules with Mitsubishi IGBTs

Vincotech, a supplier of module-based solutions for power electronics announced that it will add the latest Mitsubishi IGBT technology to its range of MiniSKiiP® PIM modules. The new modules feature Mitsubishi Generation 6 chips ranging from 15A, 1200 V to 100A, 1200V. They come in three different housings.

Featuring the latest Mitsubishi Generation 6 IGBT chip technology, the new MiniSKiiP® PIM modules are available in three sizes for motor drive applications ranging up to 30kW:

MiniSKiiP® size 1 (42 by 40 mm²)
for 15A, 1200V

MiniSKiiP® size 2 (59 by 52 mm²)
for 25A, 1200V to 35A, 1200V

MiniSKiiP® size 3 (82 by 59 mm²)
for 50A, 1200 V to 100A, 1200V

All modules feature a 3-phase input rectifier, a 3-phase output inverter, a brake chopper, and an added thermistor to measure temperatures (PIM topology). Pins match the previous version's array to enable easy upgrading. The modules will also be offered with pre-applied thermal grease. Samples are in the works for September 2011, with serial productions late for Q1 2012.

www.vincotech.com

Doubling Power Output Capability of LinkZero™-AX Zero-Standby Switcher

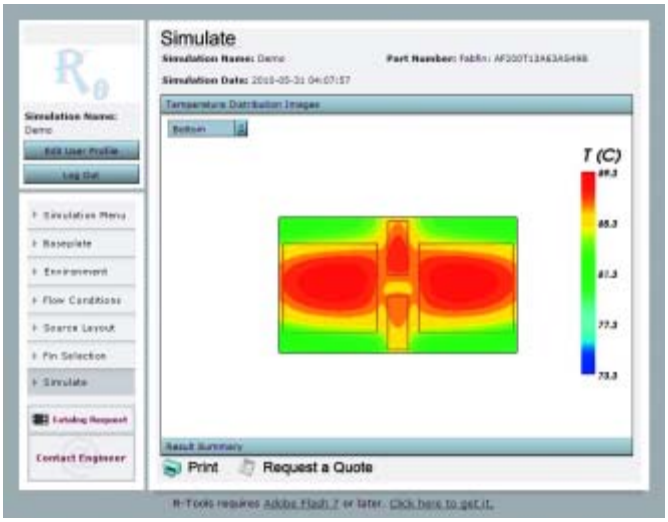
Power Integrations introduced two new members of its LinkZero-AX product family (LNK585 and LNK586), along with a PI University introductory video course that explains how designers can achieve 0.00 watts of standby energy consumption. Launched in October 2010, the LinkZero-AX integrated offline switching IC family now offers increased main power output up to 6.5 watts — double the maximum output of earlier members of the product family. The expanded power range enables designers to utilize LinkZero-AX in a wider array of applications, including those with multiple auxiliary power functions, as is often the case in appliances, TVs, and remotely controlled electronic lighting ballasts.

LinkZero-AX eliminates wasted energy by employing an innovative power-down mode that effectively turns off the auxiliary power supply when the application is idle, shutting down switch-mode operation and internal switch control circuits. LinkZero-AX can be re-awakened from power-down mode with a reset pulse or button press. Also, the bypass pin can provide up to 500 ìA for use by any system-control or sensing circuit.

www.powerint.com

New Free Online Tool for Thermal Modelling of Heat Sinks

Mersen is introducing a new version of R-Tools a free online thermal modelling tool for heat sinks. The new version is based on an advanced three-dimensional numerical model. It is available by browsing to R-Tools and completing some brief login instructions.



The simple but highly effective online tool provides a quick overview of technical possibilities for the construction of various heat sink solutions based on the technologies of high density Mechanically Swaged Fins (FabfinTM) and Liquid Cooling (AquasinkTM). Simulation of extruded profiles is possible too.

By filling in details of the components to be cooled, the selected heatsink and the cooling conditions the user gets a graphical source layout and a full simulation of the cooling cycle achieved. All parameters can be suitably altered and refined in order to explore various technical solutions for a given application. All simulations are stored under their respective project names on the individual user's online account. For further optimisation single parameters of the head sink model can easily be altered subsequently providing the user with a swift simulation of the impacts achieved.

www.r-theta.com/rtools_front.html

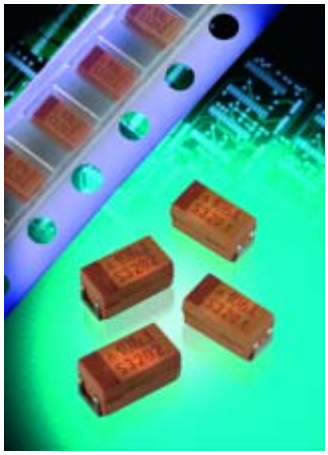
MOSFETs with Very Low On-Resistance

MOSFETs from Advanced Power Electronics Corp. (USA), a leading Taiwanese manufacturer of MOS power semiconductors for DC-DC power conversion applications, feature a very low Rds(on) of 1.59mÙ maximum. AP1RA03GMT-HF-3 devices are simple to drive and feature a very low Figure-of–Merit and gate charge enabling fast switching. Targeting applications such as point-of-load DC-DC conversion in motherboards, notebook computers, servers, DC-DC modules, inverters, battery chargers, the new MOSFETs are available in RoHS-compliant, halogen-free packaging. APEC's low profile PMPAK® 5x6mm package is specially designed for DC/DC applications and combines an industry-standard SO-8 footprint with a heatsink mounted on the underside for improved thermal performance. Comments Ralph Waggitt, President/CEO, Advanced Power Electronics Corp. (USA),: "Advanced power MOSFETs from APEC provide designers with the best combination of fast switching, rugged design, low on-resistance and cost-effectiveness."

www.a-powerusa.com

First 125V Tantalum Polymer Capacitor

AVX Corporation has announced the capability to manufacture a 125V tantalum polymer capacitor, more than twice the rated voltage of similar products on the market today. Passing the 100V milestone for the first time represents a significant development in the field of high voltage tantalum capacitors and extends the range of such devices available to engineers for new consumer product applications such as telecommunications equipment, LED TVs and power supplies for notebook computers, as well as a host of industrial applications.



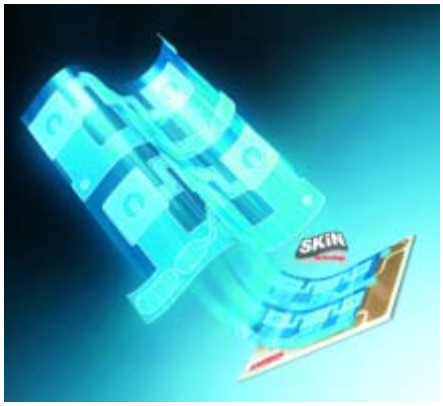
AVX developed the new high voltage tantalum capacitor by optimizing processes which enhance capacitor performance and working in close co-operation with polymer suppliers. Conductive polymer has been proven to provide low ESR and reduced ignition failure mode solution. In addition, due to the nature of polymer capacitors surge robustness, lower derating of 20% can be used. However, the working voltage of tantalum-polymer capacitors was limited until now due to the maximum achievable breakdown voltage. AVX's new developments in polymer technology addresses these limited working voltage issues and is expected to result in even higher-rated products in the future.

www.avx.com

New Packaging Technology Replaces Wire Bonding

Semikron has developed a revolutionary packaging technology for power semiconductors which does away with bond wires, solders and thermal paste. The new SKiN Technology is based on the use of a flexible foil and sintered connections rather than bond wires, solders and thermal paste. The current density is doubled to 3 A/cm2 compared with 1.5 A/ cm2 achievable with standard wire bond technology. The converter volume can therefore be reduced by 35%. This reliable and space-saving technology is the optimum solution for vehicle and wind power applications.

This results in a higher current carrying capacity and 10 times the load cycle capability – unthinkable with the restrictive wire bonding used in power electronics in the past. Wire bonding has been the main method of connecting the chip upper to a DBC substrate for the past 25 years. Wire bonding is not up to the higher current density that technical advances have brought about, meaning reliability is impaired. In the new packaging, a sintered foil now replaces the wire bonding on the chips, and the underside of the chip is sintered to the DBC. This results in optimum thermal and electrical chip connection, since sintered layers have a lower thermal resistance than solder equivalents. The sintered foil connects the chip across its entire surface, whereas bond wires connect the chips at the contact points only. Thanks to the high load cycle capability that this new packaging technology offers, higher operating temperatures are possible. Given the move towards new materials such as SiC and GaN, these elevated temperatures can then be fully exploited.



But it's not only the wire bonding that has been done away with in the new packaging solution. In fact, the new packaging is free of solder thermal paste. Instead, a sinter layer replaces the thermal paste layer and the soldered base plate. Thermal paste is responsible for around 30% of the total thermal resistance in a system. By replacing this, the thermal conductivity between chip and heat sink is improved, resulting in a 30% increase in usable electric current.

www.semikron.com

WideLead Package Reduce Lead Resistance by 50 Percent

International Rectifier announced the introduction of a family of automotive qualified MOSFETs housed in a novel WideLead TO-262 package that reduces lead resistance by 50 percent compared to traditional TO-262 packages while offering 30 percent higher current.

Designed for generic heavy load/ high power through-hole applications requiring low on-state resistance (Rds(on)), Electric Power Steering and battery switches used in internal combustion engine (ICE) cars, and micro and full hybrid vehicles, the new automotive MOSFETs combine IR's advanced silicon and state-of-the-art packaging technologies to offer significant performance improvements while being compatible with existing design standards.

In standard TO-262 through-hole packages, source and drain leads can add up to 1mOhm of resistance, in addition to the on-state resistance (Rds(on)) of the MOSFET. The new WideLead TO-262 through-hole package reduces lead resistance to less than half a milliohm, greatly reducing conduction losses and heating in the leads to deliver 30 percent more current carrying capability than a traditional TO-262 package for a given operating temperature. Under evaluation, the lead temperature of the WideLead was 30 percent cooler than the standard TO-262 at DC currents of 40A and 39 percent cooler at 60A. Furthermore, other packaging enhancements allow the WideLead to deliver 20 percent lower Rds(on) compared with the same MOSFET in a standard TO-262 package.

www.irf.com

Compact, Cost Effective and Fully Regulated 6 Watt AC/DC Converter

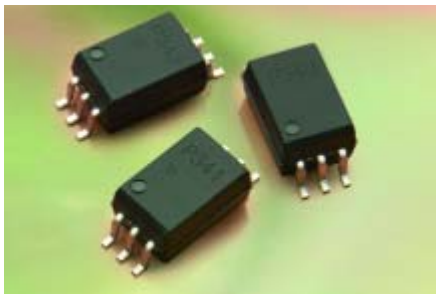
RECOM extends its product family of isolated AC/DC-power modules with fully regulated single- or dual outputs ideal for applications with low power or standby function. The new RAC series now offers a 6 watt output power with wide inputs from 90-265VAC. The RAC-06 family combines high efficiency with short circuit protected DC-outputs of 3.3, 5, 9, 15 and 24V single or ±5, ±12, ±15V dual. The line regulation is specified at 0.3%, the load regulation is <±0.5% and does not require post regulation, while efficiencies reach 80%.

These converters are available for both PCB-mounting or with flying leads. The very compact RAC 06 also features an integrated input filter to EN55022 Class B, offers 3 kVAC isolation and is CE and UL certified. Designed for a high operating life time (MTBF >400.000 hours) these RECOM converters carry a 3 year warranty.

www.recom-electronic.com

Optocoupler Family for Robust IGBT Gate Drive

Avago Technologies announced a new generation of gate drive optocouplers that deliver industry-leading performance from a small-footprint package. The new ACPL-P34x and ACPL-W34x optocoupler family is based on process technology that enables higher output current drive with rail-to-rail capability, providing high-voltage insulation and robust protection for industrial drive, inverter and power supply applications. The



optocouplers are available in a stretched SO6 package that is 40 to 50 percent smaller than industry-standard Dual-inline (DIP) package. With output current up to 4A – the market's highest in this package – the family provides reliable, fast and efficient system performance.

www.avagotech.com

Sinter Technology to Improve Power Module/Device Processes and Reliability

ALPHA® Argomax™ sinter technology will enable die attach processing that will meet the increasingly demanding performance requirements of hybrid electric vehicles, wind and solar power generation, transportation, industrial applications, consumer electronics, telecommunications and more. ALPHA® Argomax™ meets or exceeds the challenging die attach application requirements facing the power generation and consumption market today. It is easy-to-use and is engineered to perform extremely well in low pressure, fast sintering, high volume manufacturing processes, resulting in highly reliable lead-free metallic bonds.

Indeed, ALPHA® Argomax™ brings the die attach technology to new heights by reaching a thermal conductivity level of 200-300 W/m°K and lowering the resistivity to its minimum; 2 - 2.5 µÙcm, while Argomax™ is processed at temperatures as low as 230 - 300°C. In addition, no compromise was made on reliability as results obtained will be greater than 3 to 5 times that of solder.

Get high throughput and yield with ALPHA® Argomax™ sinter technology, while adding value to your high volume manufacturing processes. Consistent with Alpha's ongoing commitment to environmental responsibility, Argomax™ will enable energy-efficient power devices and lead free bonding. Alpha supports its customers every step of the way in the adoption of its new Argomax™ sinter technology -- from first proof of principle in Alpha's laboratories, through implementation on your manufacturing line.

As part of our green philosophy, ALPHA® Reclaim services will meet and exceed your health, safety and environmental standards.

www.alphadieattach.com

Low Power External Power Supplies with Integrated USB Connector

CUI Inc's power line announced the release of a new 5 W multi-blade wall mount external power supply with an integrated USB connector. These adapters are designed for global use and come standard with user reconfigurable AC input blades for operation in the United States, Europe, the United Kingdom, and Australia. The units meet current European efficiency standards and exceed the US EISA 2007 efficiency regula-

tions for external power supplies.

The EMSA050100-I38-SZ is a 5 V, 1 A level V adapter with a key feature of integrating a USB connector directly into the power supply base. This creates a compact solution that can provide 5 V out through an industry standard connector.

www.cui.com

Motor Drivers for Stepper, Brushed DC Motors

Texas Instruments expanded its DRV8x motor driver family with eight new devices supporting up to 5 A for higher-current bipolar stepper and brushed DC motors. The new DRV8x motor drivers provide RDSon as low as 100 milliohms, more than 60 percent less than the previous generation, enabling higher current and better thermal performance. Microstepping options within the family include up to 256 microsteps and greater with an external microcontroller or up to 32 microsteps with an on-chip indexer.

www.ti.com/drv8x-preu

New Motor Driver LSI

Semiconductor manufacturer ROHM has developed the BD65491FV (1-channel) and BD65492MUV (2-channel) high-speed motor drivers for use in a broad range of digital camera lens drive and home appliance motor drive applications.

Increasingly advanced functionality in battery-operated mobile devices, compact office equipment, and home appliances is being accompanied by growing demand for lower power consumption. At the same time, manufacturers are under pressure to lower device drive voltages as the number of battery cells is reduced and more compact actuators developed.

To satisfy these needs, it was necessary to increase switching speeds and lower on-resistance in order to improve drive efficiency, and to eliminate switching transistors' gate drive step-up circuit (charge pump circuit) in order to lower current consumption.

www.rohm.com/eu

Expanding DC Power Jack Line-Up

CUI Inc announced an addition to their Components line which now includes a locking nut dc power jack for panel mount requirements. These rugged dc jacks have a center pin diameter of 2.1 mm or 2.5 mm and an outside diameter of 5.5 mm. Contact resistance is 30 m Ù MAX and insulation resistance is 100 M Ù MIN @ 500 Vdc. The jacks are able to withstand a voltage of 500 Vac R.M.S. for one minute and have a voltage rating of 20 Vdc at 5 A.

Options include long bushings for mounting to thick enclosures, locking nuts with washer, and pins that are designed to solder directly to wire leads or printed circuit boards in vertical and right angle orientations. All power jacks are RoHS compliant.

www.cui.com

Development Board for Gallium Nitride (eGaN®) FETs

Efficient Power Conversion Corporation announced the introduction of the EPC9003 development board to make it easier for users to start designing with EPC's 200V enhancement-mode gallium nitride (eGaN) field effect transistor (FET) in applications such as solar microinverters, class D audio amplifiers, Power over Ethernet (PoE), and synchronous rectification.

The EPC9003 development board is a 200 V maximum input voltage, 5 A maximum output current, half bridge with on board gate drives, featuring the EPC2010 200V eGaN FET. The purpose of this development board is to simplify the evaluation process of the EPC2010 eGaN FET by including all the critical components on a single board that can be easily connected into any existing converter.

The EPC9003 development board is 2" x 1.5" and contains not only two EPC2010 GaN FETs in a half bridge configuration with gate drivers, but also an on board gate drive supply and bypass capacitors. There are also various probe points to facilitate simple waveform measurement and efficiency calculation. A Quick Start Guide, http://epc-co.com/epc/documents/guides/EPC9003_qsg.pdf, is included with the EPC9003 development board for reference and ease of use.

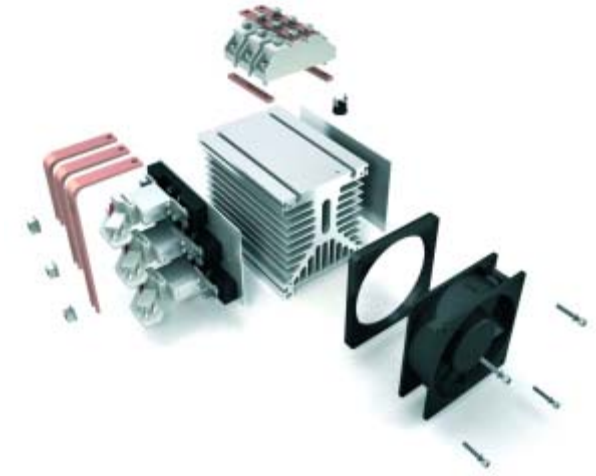
www.epc-co.com

MOSFET with Ultra-Low ON Resistance Saves Space and Power

Toshiba Electronics Europe has announced a new addition to its family of low voltage MOSFETs. The new n-channel device - which is a member of the company's continuously expanding SSM series of small signal MOSFETs – has very low loss characteristics that make it ideal for power management in a variety of portable, battery-powered applications.

www.toshiba-components.com

Power Electronic Assemblies from Single-Source Supplier



SindoPower is now offering power electronic assemblies for up to 250 A in the form of DIY kits containing heat sink, fan, single-phase and 3-phase diode semiconductor modules, sensors, complete with screws, tracks and assembly instructions. The new SEMISTACK kits can be configured online: to do so the customer selects the current, voltage, circuit topology, temperature sensor, and airing system. The online configurator then shows the right components as a finished single-source assembly.

Customers no longer have to purchase the parts they need from different vendors and can assemble the parts in compliance with their own standards. The SEMISTACK kit guarantees correct assembly without auxiliary parts and in line with specified standards. SEMISTACK kits come from a single-source supplier and enable quick, easy and reliable assembly of electronic parts, especially for small production lots.

www.sindopower.com

High Current Density with High Accuracy Six Channel Linear LED Drivers

Micrel, Inc. unveiled a pair of new linear WLED drivers aimed at further expanding its portfolio of lighting products. The

MIC4811/MIC4812 are six channel, constant-current sink LED drivers targeting billboard, marquee, instrument and other large, general-purpose LED displays.

The MIC4811/MIC4812 are high efficiency linear White LED (WLED) drivers designed to drive up to six high current WLEDs for signage lighting. The MIC4811/MIC4812 provide the highest possible efficiency at low source voltages as this architecture has no switching losses present in traditional charge pumps or inductive boost circuits. These linear drivers maintain constant current for up to six WLEDs and feature a typical dropout of 100mV at 50mA (MIC4811) and 190mV at 100mA (MIC4812).

The MIC4811/MIC4812 feature Dynamic Average Matching™ (DAM™) which is specifically designed to provide optimum matching across all WLEDs. The high accuracy (±1% typical) current regulated WLED channels ensure uniform display illumination under all conditions. The brightness is controlled through an Ultra Fast PWM™ interface operating down to less than 1 percent duty cycle.

www.micrel.com

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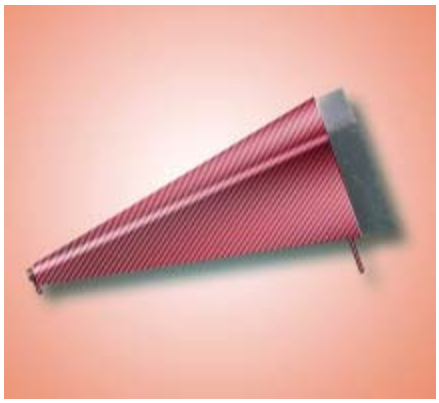
Distributor for ATC Ultra-Broadband Inductors

Richardson RFPD, Inc. announces it has been selected by American Technical Ceramics (ATC) as the global exclusive distributor for the new 506WLC Series of Ultra-Broadband Inductors. This select group of inductors has been engineered with a powdered iron ferrite core and gold plated terminations to provide reliable and repeatable ultra-broadband performance beyond 40 GHz. These inductors are ideal for many applications, including use in trans-impedance amplifiers, ultra-broadband DC coupling networks, and broadband test equipment.



Characteristic of the 506WLC inductors is their distinctive pyramid shape, which allows the copper wire to be tightly wrapped around its core and, thus, provide maximum inductance within the overall dimensions of the product. Their shape also makes these parts easy to handle during hand soldering operations.

www.richardsonrfpd.com

Wireless Networking Solution with Energy Harvesting System

Silicon Laboratories Inc. introduced the industry's most energy-efficient wireless sensor node solution powered by a solar energy harvesting source. The new turnkey energy harvesting reference design enables developers to implement self-sustaining, ultra-low-power wireless sensor networks for home and building automation, security systems, industrial control applications, medical monitoring devices, asset tracking systems and infrastructure and agricultural monitoring systems.

www.silabs.com

30V Buck Switching Regulator

Microchip announces its first 30V-input buck switching regulator. The MCP16301 combines a wide input voltage range of 4V to 30V, and a 600mA output across a voltage range of 2V to 15V, with up to 95 percent efficiency. With a high-side switch integrated into the small 6-pin SOT-23 package, the MCP16301 minimises the number of external components to enable an efficient and compact solution for stepping down 12V to 24V DC power rails to drive PIC® microcontrollers and other low-voltage devices. The MCP16301 is suitable for use in set-top boxes, LED lighting, HVAC systems and power meters in addition to other applications in the industrial, telecommunications, consumer and automotive markets.

www.microchip.com/get/TQEG

ADVERTISING INDEX

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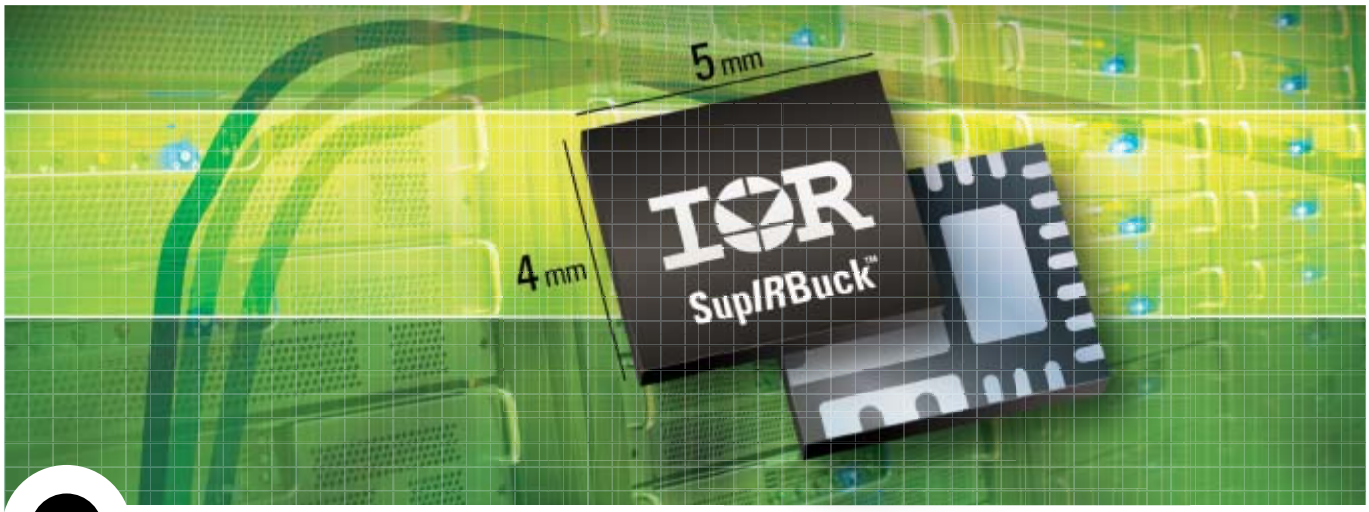
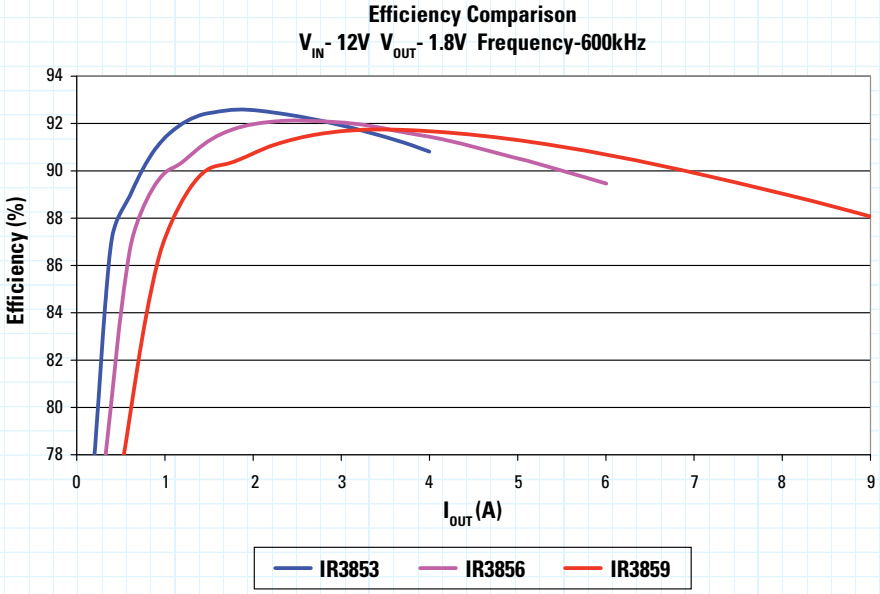


4x5mm Family Shrinks Sup*IR*Buck™ Footprint By 33% Up To 9A

Sup*IR*Buck™ integrated regulators save energy, space and system cost for your POL design



Features

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- Wide input voltage range 1.5V to 21V
- Integrated controller, bootstrap diode, control FET and Sync FETKY
- Programmable frequency up to 1.5MHz
- ± 1% accurate 0.7V reference voltage

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mypower.irf.com/Sup*IR*Buck

Specifications

Part Number	I_{OUT} (A)	Reference Design
IR3853M	4	IRDC3853
IR3856M	6	IRDC3856
IR3859M	9	IRDC3859

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