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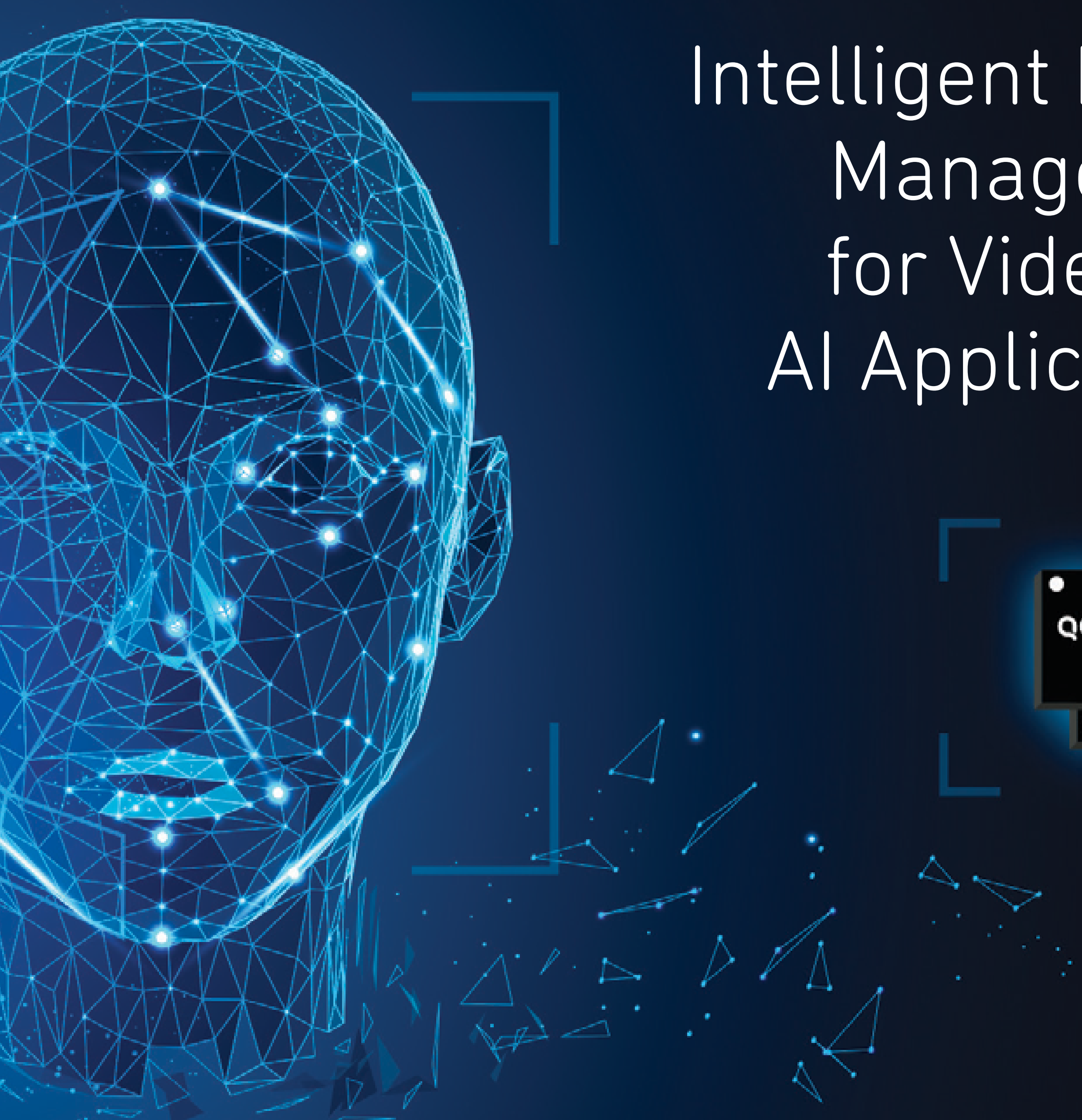
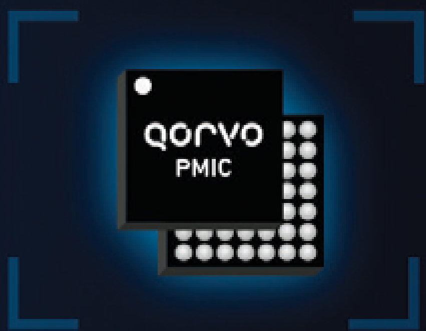
Bodo´s Power Systems®

Electronics in Motion and Conversion

February 2023



Intelligent Power Management for Video and AI Applications



PULSED INDUCTANCE MEASUREMENT

POWER CHOKE TESTER DPG10/20 SERIES

Inductance measurement from 0.1 A to 10 kA

KEY FEATURES

Measurement of the

- **Incremental inductance** $L_{inc}(i)$ and $L_{inc}(\int Udt)$
- **Secant inductance** $L_{sec}(i)$ and $L_{sec}(\int Udt)$
- **Flux linkage** $\psi(i)$
- **Magnetic co-energy** $W_{co}(i)$
- **Flux density** $B(i)$
- **DC resistance**

Also suitable for 3-phase inductors

APPLICATIONS

Suitable for all inductive components from **small SMD inductors** to **very large power reactors in the MVA range**

- **Development, research** and **quality inspection**
- **Routine tests** of small batch series and mass production

KEY BENEFITS

- Very **easy and fast** measurement
- **Lightweight, small and affordable price-point** despite of the high measuring current up to 10000A
- **High sample rate and very wide pulse width range** => suitable for all core materials

AVAILABLE MODELS

Model	max. test current	max. pulse energy
DPG10-100B	0.1 to 100A	1350J
DPG10-1000B	1 to 1000A	1350J
DPG10-1500B	1 to 1500A	1350J
DPG10-1500B/E	1 to 1500A	2750J
DPG10-3000B/E	3 to 3000A	2750J
DPG10-4000B/F	4 to 4000A	7700J
DPG20-10000B/G	10 to 10000A	15000J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16.383mm
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Content


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The Power of Many

As you all know, Wide Bandgap is one of our main focuses. We do a lot to promote this technology, with events, such as Bodo's Expert Talk and by covering it as much as possible in the magazine. Without losing sight of the other topics in power electronics, of course. With all the insights and updates that we receive, it is only natural that I have gained a personal perspective, over the past few years. And while I don't think that SiC competes with GaN, or high with low power, I do feel sometimes that applications like renewables, industrial or mobility, which are obviously on the silicon carbide team, may have a bigger overall impact than low power applications for which GaN is suitable. But maybe I should consider it from a different angle though: Since there is an invasion of smartphones, tablets and other "distractibles", the efficiency gains that gallium nitride can bring while charging and powering these billions of devices cannot be ignored. And these are just a few unnecessary examples, of course there are a lot of important things like servers, tools, e-bikes, motor drives, class d audio and many more. It's like my arguments with my wife discussing whether the automatic motor turn-off in our combustion engine car really is useful or not. Of course, it only saves a tiny amount of fuel and thus CO2 from our car, but it is still a very powerful tool when used by many! With this in mind, it is clear to me that both technologies are equally important and both will play their part in achieving greater efficiency in electronics.

Time is running out and some of the annual events will be here soon, such as the APEC conference and exhibition in March. We all know about the struggles Covid has brought us over the last few years, but it seems we are returning more and more to a continuous schedule of live events. Time to highlight again a popular feature in our March issue, namely the APEC show floor plan within the magazine. The original idea was to print the map in the centerfold of the magazine allowing it to be easily be taken out and used to navigate around the fairgrounds. And of course, to also to find Bodo's partners, as all their logos will appear on this page. We don't have data on how often this tool has actually been used, but what I do know is that it has become very beneficial and admirable to be included on this map. And what can I say, there is still a chance that your logo will appear on the APEC floor plan, even if you are not yet our partner. If you are exhibiting in Orlando and are interested, contact us at apec@bodospower.com to find out how to be included.

Bodo's magazine is delivered by postal service to all places in the world. It is the only magazine that spreads technical information on power electronics globally. We have EETech as a partner serving our clients in North America. If you speak the language, or just want to have a look, don't miss our Chinese version at bodospowerchina.com.
An archive of the magazine with every single issue is available for free at our website bodospower.com.

My Green Power Tip for the Month:
Choose the right technology when you purchase new electrical devices. State-of-the-art technology always compensates for its higher cost through higher efficiency savings over time. The cheapest device is not always the most economical.

Kindest regards,

Events

SEMI-THERM 2023
San Jose, CA, USA Mar 13 – 17
www.semi-therm.org

embedded world 2023
Nuremberg, Germany March 14 – 16
www.embedded-world.de

APEC 2023
Orlando, FL, USA March 19 – 23
www.apec-conf.org

AMPER 2023
Brno, Czech Republic March 21 – 23
www.amper.cz

Smart Systems Integration 2023
Bruges, Belgium March 28 – 30
https://smartsystemsintegration.com

emv 2023
Stuttgart, Germany March 28 – 30
https://emv.mesago.com

ESARS ITEC 2023
Venice, Italy Mar 28 – 31
www.esars.eu/esars2023

electronica China 2023
Shanghai, China April 13 – 15
www.electronica-china.com

PE International 2023
Brussels, Belgium Apr 18 – 19
www.pe-international.net

Silicon Carbide Devices Power Future Electric Vehicle Platforms

Wolfspeed announced the company will be supplying Silicon Carbide devices to power future Mercedes-Benz® Electric Vehicle (EV) platforms, enabling greater efficiency in the powertrain. Wolfspeed's semiconductors will be incorporated into next generation powertrain systems for several Mercedes-Benz vehicle lines.

"Coming from a long-term technical collaboration history between our companies, we have now chosen Wolfspeed as one of our key partners for future Silicon Carbide devices, thus securing preferred long-term supply, technology and quality of this decisive semiconductor component for our electrification offensive," said Dr. Gunnar Güthenke, Head of Procurement and Supplier Quality for Mercedes-Benz. By leveraging Wolfspeed's expertise and Silicon Carbide devices to improve vehicle range and power, Mercedes-Benz plans to have some of the most efficient EVs on the road.

"We are pleased to be supporting Mercedes-Benz, an organization with a long, successful history of providing world-class performance and luxury vehicles, as they introduce next-generation EVs to the market with highly efficient power systems," said Gregg Lowe, CEO of Wolfspeed. "We are continuing to invest in our manufacturing capacity to support a steepening demand curve for Silicon Carbide devices that will not only improve EV performance and drive greater consumer adoption, but also support the sustainability efforts of global automotive leaders like Mercedes-Benz."

www.wolfspeed.com

Collaboration on Laptop Power Adapter Design with Integrated GaN

Chicony Power announced its collaboration with Texas Instruments (TI) to roll out Chicony Power's latest 65W laptop power adapter, Le Petit, featuring TI's GaN technology. Leveraging TI's half-bridge GaN FET with integrated gate driver, LMG2610, Chicony Power reduced the size of its 65W power adapter by 50% and increased

up to 94% power efficiency compared to other 65W adaptors in the market, raising the bar for the laptop power industry. Chicony Power's long-term focus is on smart energy-saving solutions and improving power conversion efficiency in electronic power supply design. Chicony Power has worked closely with international IC companies and consistently provides market's and technical requirements, discusses the new design, and assists IC companies with the feasibility assessment, verification and debugging to help develop solutions in new designs. Chicony Power teamed up with TI for its expertise in high-voltage design and its integrated GaN technology. TI's LMG2610 is designed to be paired with the UCC28780/UCC28782 active clamp flyback (ACF) controllers to create an easy-to-use, high-efficiency and high power-density solution for AC/DC designs under 75 W. Chicony Power leverages TI's integrated GaN technology with active clamp flyback (ACF) controller to enable a whole new world of power supply through this collaboration.

www.chiconypower.com

Elections for Infineon Supervisory Board

In preparation for the Annual General Meeting on 16 February 2023, the Infineon Technologies Supervisory Board has proposed changes in its own composition to accompany the recent strategic decisions. In this context, Dr. Wolfgang Eder (70), Chairman of the Supervisory Board since 2019, and Hans-Ulrich Holdenried (71) have decided to support the renewal of the Supervisory Board and will resign from the Board at the next Annual General Meeting. Dr. Herbert Diess (64) and Klaus Helmrich (64) are the current candidates to succeed them. Subject to a confirming vote by the Annual General Meeting, Dr. Diess is expected to assume the role of Chairman of the Supervisory Board.

"Now is the right time for changes to the Supervisory Board," says Dr. Eder, Chairman of the Infineon Supervisory Board. "First of all Cypress, Infineon's largest-ever acquisition with its approximately 10 billion USD purchase price, has now been successfully integrated. Second, the new Management Board team, led by Jochen Hanebeck, is doing excellent work. In the context of the most successful fiscal year in company history, we have jointly made extensive strategic decisions and updated the Target Operating Model, plotting a long-term future course for Infineon. I am pleased to have

been able to contribute to Infineon's success during such a decisive phase. In the interest of an age-independent realignment of the Supervisory Board with a longer-term impact, I will not seek reelection. Given the highly challenging environment in which Infineon is active, I am pleased to welcome Dr. Herbert Diess as the ideal candidate to become my successor. He has excellent knowledge of the company and of the industry landscape."

www.infineon.com

PCIM Europe 2023: A Positive Outlook

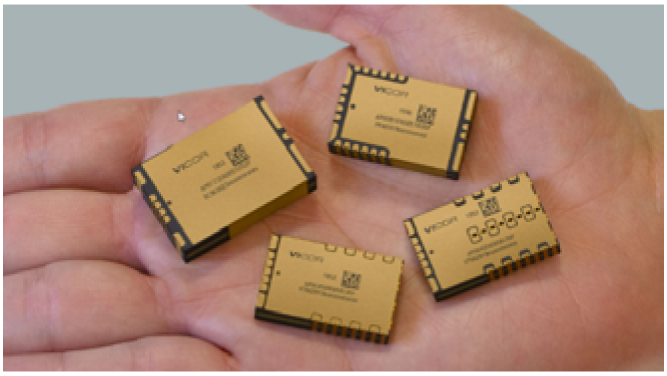
From 9 - 11 May 2023, the PCIM Europe will once again be inviting the power electronics industry to Nuremberg, Germany. Participants can enjoy personal exchange complemented by a wide range of highlights for experts in the field. Just over five months prior to the start of the event, the exhibition for Power Electronics, Intelligent Motion, Renewable Energy and Energy Management reports around 350 registered exhibitors; more than half of them from abroad. With their products and services, these companies represent the entire spectrum of the industry. Numerous key players in the field of power electronics have already confirmed their participation, including Fuji Electric Europe, Infineon, Mitsubishi Electric Europe, Semikron Danfoss, Wolfspeed, Nexperia, Rohm Semiconductor and Hitachi Europe. In addition, the event will again welcome various new exhibitors, thereby further enriching the offering at the PCIM Europe. These include companies such as Texas Instruments Incorporated, Robert Bosch GmbH, Volkswagen AG, Renesas Electronics Europe GmbH and Melexis Technologies NV. The international conference, which will be held in parallel, registered a record with more than 400 submissions upon closure of the application deadline for speakers. This outstanding response promises a high-quality and varied conference program with presentations from research and development of leading companies and universities from all areas of power electronics. The program will be published in January 2023.

https://pcim.mesago.com

Boeing Launches O3b-mPOWER Satellite

The launch of Boeing's O3b mPOWER communication satellite marks a milestone for Vicor Corporation, whose high-performance, radiation-tolerant modules support Boeing's satellite mission. Boeing's O3b satellite will help deliver broadband internet access to the "other 3 billion" (O3b) people around the globe where access is limited or nonexistent. Drawing on an extensive heritage, Vicor power modules are ideally suited for powering advanced communications ASICs and FPGAs that require a very low-noise operating environment enabled by Vicor's soft-switching, high-frequency ZCS/ZVS power stages. The thermally adept modules in an SM-ChiP package provide superior density and efficiency.

The complete source-to-point-of-load solution comprises four SM-ChiP modules powering advanced ASICs and FPGAs from a 100V bus: the BCM3423, a 100V input, 300W, K = 1/3 bus converter; the PRM2919, a 33V input 200W regulator; a VTM2919 150A current multiplier with an output of 0.8V; and a VTM2919 50A current multiplier with an output of 3.3V.



The modules, which are manufactured in Andover, MA, (USA) are available in high-density SM-ChiP BGA packages. ChiPs are rated for operation from –40 to 125°C.

www.vicorpower.com

Hightech Innovation Center in Munich

Moving into the future: The HIC is the innovation center of the Würth Elektronik Group of Companies. The location in Freiham offers the best conditions for driving forward research and development for trend-setting solutions.

Würth Elektronik is relocating its Munich site from Garching to Freiham. With the Hightech Innovation Center Munich (HIC), a state-of-the-art building with a working and test field landscape, has been created in the west side of the metropolis. The facility offers the latest new-work approaches and space for 250 employees in the first construction phase. True to the company's motto "more than you expect," the HIC is not only an investment in the future of the company, but also in Munich as a location. With the facilities, there will be no limits to the engineers and scientists working on exciting topics such as wireless connectivity, sensor technology, power modules, IoT, cloud & software services, and Big Data. Within the next few years, an additional building with another 250 workstations will be built. This will provide sufficient space for growth and development.

At the Garching site, the focus was largely on research and product development. In addition, valuable partnerships had been established due to the close proximity to various semiconductor manufacturers and universities. However, despite several expansions, the premises were still too small for the tech company. The HIC opens up completely new possibilities for the now 140-strong team to drive forward its own innovations "Made in Germany". A special highlight is the large test field, including two EMC test chambers, in which electromagnetic compatibility is tested. The test field accounts for around a quarter of the total area.

www.we-online.com

Top Supplier of Passive Components in the French Market

Bourns announced it has received a Best Supplier of 2022 Award from Syndicat Professionnel de la Distribution en Electronique Industrielle (SPDEI), the French association of electronic components distributors. The award was given to Bourns as one of the five top suppliers of passive components supporting the French market. The SPDEI award acknowledges suppliers based on five key criteria that include partnership with distributors, technology and service innovation, profitability for distributors, allocating resources and providing protection and traceability of design.

"Bourns has made significant investments in the development of innovative passive components designed to meet strict standards and application requirements. It is an honor to receive this award that recognizes Bourns' commitment to engineering high-quality, breakthrough products and our culture of responsive customer service," said James Harrington, Senior Vice President Worldwide Sales at Bourns. "I'd like to congratulate the Bourns France team for receiving this prestigious award based on their outstanding support and performance."

www.bourns.com

EMV 2023: Impulses for the EMC Industry

Parallel to the trade fair for electromagnetic compatibility from 28. – 30.03.2023 in Stuttgart, the industry can look forward to a total of 36 practice-oriented workshops on current EMC topics. Registrations for these are now possible online.

The workshop topics were selected in advance by a 19-member committee of experts. "A large number of participants from industry and science will meet at the EMV 2023 in Stuttgart for expert exchange," explains committee chairman Dipl.-Phys. Detlef Hoffmann from Webasto Roof & Components SE. "The workshop program offers a wide range of topics and allows newcomers, senior experts and decision-makers to find detailed opportunities to deepen their knowledge and expand their experience." In 2023, the EMC workshops will cover the key topics of measurement and immunity, measurement and emitted interference, interference protection/ exposure, and approval and safety. In addition, the program includes specialized topics on aerospace and medical technology, as well as proven fundamentals. The well-timed enables attendees to attend several workshops that build on, or complement each other in terms of content. Six of the workshops will be held in English. Of these, three will be held by Frank Leferink, University of Twente and two by Dr. Diethard Hansen, EURO EMC SERVICE (EES) Dr. Hansen Consulting. For the first time, the speaker Arturo Mediano from the University of Zaragoza will participate with the topic "EMI/EMC debugging using oscilloscopes with time frequency conversion".

https://emv.mesago.com

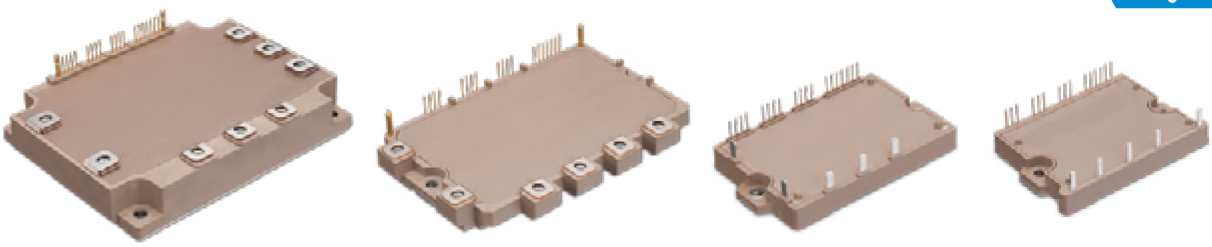
Supporting the Transmission of Renewable Power

Hitachi Energy announced that it has been selected by Hydro-Québec for its high-voltage direct current (HVDC) technology for the transmission of electricity, which will ensure the sustainability of the energy exchange between the Quebec network, in eastern Canada, and New York State in the northeastern United States.

Hydro-Québec, the largest hydroelectricity producer in Canada and one of the largest hydroelectricity producers in the world, is a public company that generates, transmits, and distributes reliable, clean and renewable electricity in Québec. Thanks to its surplus energy, it supplies the Canadian provinces and the northeastern United States.

The Châteauguay HVDC system will enable the transmission of up to 1,500 megawatts of electricity between the electrical networks of Quebec and the state of New York which will contribute to maintaining a low carbon footprint in the region. This system will replace existing equipment which has been in operation since 1984, increasing the efficiency and controllability, plus raising the power conversion capacity of the Châteauguay HVDC system by 50 percent. Hitachi Energy is supplying a "back-to-back" converter station, which converts AC power to DC then reconverts it to AC from DC enabling the interconnection of the 735 kilovolt Canadian and 765 kilovolt New York grids which are "out of phase" and cannot be connected directly via traditional AC systems.

www.hitachi.com

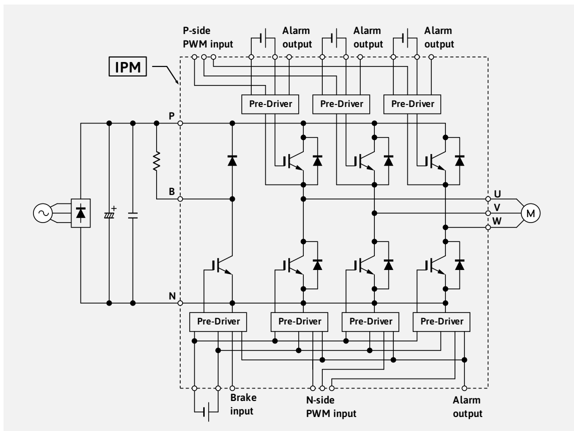


X series – Intelligent Power Modules (IPM)

ideal for Air Conditioners, Elevators and Servo Systems

FEATURES

- Reduction of losses and improvement of energy efficiency by optimizing 7th generation IGBT technology for IPM
- Embedded driver IC for optimum control and protection functions
- One wire provides three alarm signals: over-current, over-heating, under-voltage
- Temperature sensor analog output and warning function
- 6in1 and 7in1 topology (inverter + brake)
- High temperature operating (T_j=175 °C)
- Reduced turn-on loss at high temperature operation by drive control
- Power range from 20 A to 450 A at 650 V and 10 A to 300 A at 1200 V



Part of Energy Industries Division to be Acquired

TÜV Rheinland signs an agreement to acquire ABB's UK technical engineering consultancy, part of ABB's Energy Industries division. TÜV Rheinland will integrate this part into its Industrial Services & Cybersecurity business in the UK. The transaction is expected to close in Q2 2023.

ABB's UK technical engineering consultancy including a network of subcontractors and associates has around 160 people operating from two main sites in the northeast and the northwest of England. A specialist team of technical experts helps global energy customers improve process safety, equipment and asset integrity as well as technical design for new and existing industrial plants.

The combined business will create a scalable, broad-based technical engineering provider delivering a full-service offer to the high hazard industries, supporting customers in the energy transition and energy security.

"We look forward to creating growth, stability and opportunity at a time where we are seeing increased demand for sustainability, decarbonization and business continuity," said Gareth Book, Managing Director TÜV Rheinland UK. "ABB's UK technical engineering consultancy will complement the existing risk, safety and integrity management services provided by TÜV Rheinland. Our aim is to build upon the long-standing customer relationships and trust that ABB and TÜV Rheinland have established in the UK over the last two decades."

www.tuv.com

Formula E Team Kicks Off Season 9 in Mexico City

Mouser Electronics cheers on the DS PENSKE Formula E team as they kick off Season 9 at the Autodromo Hermanos Rodriguez track in Mexico City on January 14, 2023. With a race-ready surface and long corners, Mexico City is one of the fastest tracks on the calendar, featuring a mix of long and fast straights and a technical infield section through Foro Sol stadium. Mouser is partnering with the DS PENSKE team throughout the 2022–23 ABB FIA Formula E World Championship racing season in collaboration with TTI, Inc. and valued manufacturers Molex and KYOCERA AVX.

The DS PENSKE team will be racing the new third-generation Formula E DS E-TENSE FE23, which combines high-performance, efficiency, and stability. The Gen3 cars feature a top speed of 280 kph, are 60 kg lighter than the Gen2 cars, and offer double the regen capacity — meaning more than 40% of the energy used in-race is via regeneration under braking. The team benefits from two past Formula E Champions driving its cars, the reigning World Champion Stoffel Vandoorne and the two-time Formula E Champion, Jean-Éric Vergne.

www.mouser.com

SiC Technology Enhances Performance of DC Optimizers

onsemi and Ampt LLC announced their collaboration to meet the high demand for DC string optimizers. Ampt uses onsemi's N-Channel SiC MOSFET, part of the EliteSiC family of silicon carbide (SiC) technologies, in its DC string optimizers for critical power switching applications.

Ampt string optimizers are used in large-scale PV power plants, enabling lower-cost and higher performing solar and DC-coupled energy storage systems that are collocated within the solar power plant. The string optimizers deliver power from the PV array at a high and fixed voltage for system voltages ranging from 600 to 1500 VDC, reducing the overall current requirements and cost of the power plant. Ampt optimizers enable higher round-trip – charging and discharging – efficiency in the energy storage system and solar power plant by leveraging onsemi's latest SiC MOSEFT technology with lowest ON resistance and switching loses.

"Incorporating onsemi's EliteSiC technology into our DC optimizers helps utility scale solar developers and owners improve their project economics," said Levent Gun, CEO of Ampt. "Clearly, the product performance was a critical decision point for us, but onsemi's technical support during the design phase and their ongoing supply assurance to support Ampt's rapid scaling are the hallmarks of a strong partner."

www.onsemi.com

Sales Achievements Recognised

Distrelec announced the company has received the Award for Best Sales and Accounts Growth from Keysight Technologies, as part of its 2022 Partner Executive Forum which took place in Athens (Greece). Distrelec was selected by Keysight to receive the prize based on a solid 65% year-on-year growth in sales. The distributor's customer base for Keysight products has increased by 15%. Distrelec colleagues Darren Baxendale, Senior Supplier Business Manager, and Charlotte Kennedy, Head Of Category Management collected the prize together in the Greek capital earlier this month.

Charlotte Kennedy stated: "We were delighted to attend Keysight Technologies' Partner Executive Forum where Distrelec was recognised as the 2022 Best Sales and Account Growth Partner. It is a result of our mutual collaboration and our dedication to supplying advanced measurement solutions at the leading edge of technology. We are thrilled with this achievement and we pride ourselves on delivering a portfolio and service offering aligned to customer requirements. Great team effort from everyone!"

www.distrelec.biz

Dr. Richard McDonough Assumes Role as Material Research Scientist

Indium Corporation is pleased to announce that Dr. Richard McDonough has been named Material Research Scientist. In his new role, Dr. McDonough is responsible for developing new thermal materials and products, and providing solutions for customer challenges and applications. He also develops new testing methods to evaluate power and thermal products, and gathers data on new and existing products for marketing presentations. Dr. McDonough joined Indium Corporation in August 2018 as a Product Specialist, most recently supporting the Semiconductor product line as a Senior Product Specialist. He has aided in the development of new products and the improvement of existing processes during his time with the company. Most notably, he assisted with the development of PicoShot® and Indium12.8HF solder pastes for dispensing and jetting applications; helped to progress the development of sintering materials; and served as a dispensing expert for Indium Corporation.

Prior to joining Indium Corporation, Dr. McDonough worked as an Analytical Chemist for Bristol Myers Squibb and as a Nuclear Engineering Officer in the U.S. Navy. He earned his bachelor's degree in chemistry from West Virginia University; his master's degree in physical chemistry from Syracuse University; and his Ph.D. in physical chemistry/biochemistry from Syracuse University.

www.indium.com

Award Reflects Support and Collaboration Spanning Over a Decade

TT Electronics has earned a Supplier Excellence Award from Applied Materials, which recognizes the company's top performing suppliers for outstanding technical and operational achievements in areas including quality, service, lead time, delivery, cost, and responsiveness. TT Electronics received the award for Best in Class Performance.

"Applied Materials congratulates our Supplier Excellence Award recipients for achieving outstanding performance over the past year," said Dr. Paul Chhabra, Corporate Vice President of Global Supply Chain at Applied Materials. "Having strategic relationships throughout the supply chain is more important than ever, and we thank our suppliers for their strong support and collaboration."

"This prestigious award from Applied Materials illustrates the solid relationships we have with leaders in high-growth markets where we consistently deliver world-class customer service and proactive supply chain expertise," said Michael Leahan, Chief Operating Officer, TT Electronics. "TT Electronics has provided global manufacturing and agile supply chain solutions to Applied for over 12 years. This award reinforces TT's reputation as a solid, trusted partner with industry relationships spanning decades and multiple geographies."

www.ttelectronics.com

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Silicon Carbide
- SiC FETs
- SiC JFETs
- SiC Schottky Barrier Diodes

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Let's work together.

LEARN MORE
qorvo.com/go/power-bodos

Boost Your High-Voltage EV/HEV Accessory Circuit Protection

Specifically designed to meet ISO 8820-8 standards, Bourns® POWrFuse™ PF-K products meet the protection requirements of high-voltage accessory circuits in electric vehicles (EVs) and hybrid electric vehicles (HEVs). These advanced industrial fuse links also meet UL 248 and IEC 60269 standards making them optimal EV/HEV circuit protection solutions for a variety of electrical energy storage (ESS), battery disconnect units (BDUs), battery pack and charger protection, and battery management systems (BMS) applications.

POWrFuse™ PF-K models are housed in a midget-style package (10 mm dia. x 38 mm) and are available with bolt and PCB mounting options for Level 1/2 EV/HEV AC/DC inverter and Level 3 battery charging systems. These new high-voltage EV fuses support operation up to 500 VDC, feature a 20 kA at 500 VDC interrupting rating, and have an extended temperature range of -55 to +125 °C. Plus, individual models offer current ratings from 15 to 50 A.

In addition, the latest POWrFuse™ EV fuses have been tested to Bourns' internal automotive quality standards for environmental reliability, transient current cycling and device electrical and fusing characteristics. The standard compliance and robust interrupting rating help to ensure the safety and quality as well as minimal service calls, thereby minimizing the Total Cost of Ownership (TCO)

With Bourns® POWrFuse™ protectors, designers get the enhanced overcurrent performance required for today's EV/HEV designs along with value-added global quality and local support throughout their design/qualification cycle and after systems are deployed. Bourns is known for its long-standing commitment to providing outstanding service that its customers have trusted for over 75 years.

Leverage the powerful wide temperature range, high-cycling, low-level fault current and extremely high interrupting current feature benefits of Bourns® POWrFuse™ PF-K protectors in your next design. Also, look to Bourns for a complete overcurrent and overvoltage protection solution using our advanced SPDs, market-leading Power TVS diodes, high energy MOVs and high voltage GDTs at https://www.bourns.com/products/fuses/powrfuse-high-power-fuses.

www.bourns.com

Erik Rehmann, GVA expert for Quality Management

gva-power.de

„WHERE INNOVATION GOES IN SERIES: GVA"

Our Development, Production and Quality departments are separated by one floor and two flights of stairs – nothing else. Because all GVA experts share the same systemic understanding and the latest know-how. That´s why we are able to mass-produce innovative developments in the shortest possible time. With guaranteed quality – and gladly also for you!

Your GVA expert:
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Environmentally Friendly Production of Lithium-Ion Batteries

Leclanché SA has achieved a breakthrough in the environmentally friendly production of modern G/NMCA cells: As the first manufacturer worldwide, Leclanché is able to reduce the cobalt content in NMCA as cathode material from 20 to 5 per cent and manufacture electrodes using an environmentally friendly water-based process. In doing so, Leclanché completely dispenses the use of the highly toxic organic solvents (NMP) that are otherwise common in the production process. The new G/NMCA cells from Leclanché have a 20 per cent higher energy density - with the same size, weight and performance level. Water binder-based NMCA cathodes are easier to dispose of and are also recyclable.

"With the water-based production of the high-capacity NMCA cathodes, we have reached a decisive milestone in lithium-ion technology," emphasises Dr Hilmi Buqa, Vice President R&D at Leclanché. "Until now, producing them using environmentally friendly processes was considered impossible. But, now we have mastered the process." Leclanché is the first company in the world to implement the environmentally friendly process in the production of Li-ion cells: The newly developed G/NMCA cell has a nickel content of around 90 per cent, which increases the energy density and enables the significant reduction of the cobalt content by 15 per cent. At the same time, it offers a longer service life, high cycle stability and good chargeability. Thanks to the high-volume energy density and high cycle stability, the cells are particularly well suited for electric cars and heavy-duty applications such as ships, buses and trucks.

Water-based manufacturing process from Leclanché

High-capacity NMCA cathodes (nickel-manganese-cobalt-aluminium oxide) allow for a 20 per cent increase in the energy density of a Li-ion cell compared to conventional G/NMC cells. However, these cathodes are manufactured by most manufacturers using organic solvents such as NMP (N-methylpyrrolidone). These are highly toxic and harmful to the environment. In April 2018, NMP was added to the list of Substances of Very High Concern, which can have serious irreversible effects on human health and the environment. The use of NMP has therefore been restricted by the European Commission.

Leclanché, on the other hand, has been using aqueous binders in its production process for around 13 years - and is a global pioneer in this field. No organic solvents are used in the technically simpler process. This not only eliminates the risk of explosion - there is also no health hazard for the employees involved in the production process. Additionally, thanks to the water-based process, Leclanché can dispense with energy-intensive processes for drying, flashing off and recycling the solvents. Thanks to the 10-30 per cent lower energy consumption, the Leclanché process also reduces the carbon footprint of battery cell production. Thus, it offers not only ecological but also economical advantages.

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Intelligent Power Management in the World of Vision Systems

Vision systems are now incorporated into a variety of products. Processing the video signal is typically performed by a dedicated IC requiring multiple power rails, which are best provided by a PMIC or "Power management IC". This article discusses the application and introduces some PMICs that are ideal solutions.

By Yael Coleman, Sr. Product Line Manager, Qorvo

Capturing images has become an integral part of many everyday and not-so-common applications from vehicle cameras through manufacturing inspection, to drones adding AI for machine learning and facial and gesture recognition. According to analysts 'MarketsandMarkets', the demand for video processing electronics is estimated to expand at a CAGR of 18.7% to around $3.2B by 2024 [1], with security and surveillance expected to have the highest growth rates.

The sensors in video systems themselves, whether CCD or CMOS, have become miniature, commodity items and can be low cost and low power, particularly CMOS types. Processing the video output however is often a complex operation and is increasingly done in-camera or at the point of use. For example, a wireless machine vision system might utilize "edge computing" to process data locally, providing faster response to actuators, a lesser burden on centralized computing and lower local power consumption with fewer wireless transmit cycles. Similarly, in the rapidly expanding surveillance drone market, local video signal processing is necessary to provide direct feedback to the navigation system for terrain analysis and to avoid collisions. In this particular example, small size, low weight and minimal power consumption is vital for maximizing available flight time from the on-board battery.

Vison processor ICs need multiple power rails

For the simplest applications, a vision processor, often a 'System on Chip', might only consume around 0.5W, but still requires multiple voltage rails with their own power up/down sequencing requirements. These rails typically range from 3.3V to sub-1VDC for core, I/O, analog, memory, housekeeping and connectivity functions. Figure 1 shows the rails for an example vision processor IC. Fully featured vision processor chips with 8K quality video, complex, high-speed functions and features such as multiple cores, extended interface options, debug facilities, a display controller and ASIL security for automotive applications will consume higher power and require a higher number of rails. These applications require on-board power management techniques such as dynamic voltage and clock frequency scaling and multiple idle, "sleep" and "deep sleep" modes to maximize battery life and flight time.

SUPPLY VOLTAGE (V)	DESCRIPTION
3.3	Isolated I/O voltage supply for pad segment GPIO0 and PMC
1.8 or 3.3	Isolated I/O voltage supply for multi-voltage I/O segments
1.5/1.8/2.5/3.3	Isolated I/O supply for multi-voltage Ethernet I/O segments
1.2/1.35/1.5	LPDDR2/DDR3L/DDR3 I/O supply
1.8	LFAST I/O bank supply
1.0	Core logic low voltage supply
1.8	Internal analog and PLL subsystem supplies
	ADC voltage reference
1.0	Internal analog and PLL subsystem supplies

Figure 1: Typical vision processor "System on Chip" power rails

The required voltage rails are powered from a local single cell Lithium-Ion battery, and power conversion must be implemented efficiently for maximum battery run-time. The best solution to accomplish these goals is a "Power Management IC" (PMIC) which integrates multiple programmable and configurable DC-DC converters with remote configuration and control, to achieve initial set-up, dynamic voltage scaling, and sequencing. A typical example of a fully featured PMIC is Qorvo's ACT88760 [2]. The ACT88760 is ideally suited for video processing applications, but it can can also power a wide range of processors, FPGAs, wearables, peripherals and microcontrollers (Figure 2).

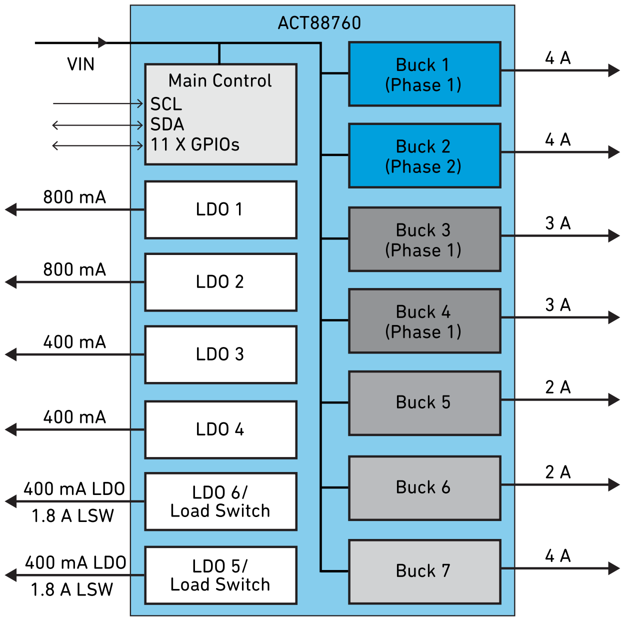

Figure 2: A Power Management IC suitable for video processor ICs

The ACT88760 is designed for a 2.6 to 5.8V input, which matches single Li-Ion or Lithium-Polymer cell voltages, and features seven buck converters with current ratings from 2A to 4A. Pairs of bucks can operate in dual phase mode for 8A output and each buck can be programmed from 0.5V to 3.8V. Six low drop out (LDO) linear regulators are included, two of which can be configured as low-resistance load switches. In addition, ten general purpose I/O (GPIO) pins are configurable for a variety of system functions which can also be accessed through an I2C interface. Examples of configuration are changing the output voltages, start-up times, output slew rates, system level sequencing, switching frequency, sleep modes and other operating modes. The ACT88760 is an integrated converter and only requires a few external components. Qorvo designed the ACT88760 with a 2.25MHz switching frequency to maximize load transient response and minimize the external component sizes. In deep sleep mode, the PMIC quiescent current is only 65μA with a single LDO regulator enabled to keep the system "alive" but ready to respond to a "wake-up call". Quiescent current is only 10μA with all regulators disabled. The ACT88760 is available in a tiny 81-pin 3.85 x 3.85mm WLCSP package to fit into the most space-constrained applications. The part is supported by the Qorvo "ActiveCiPS™" dongle which, in conjunction with the device evaluation board, allows user monitoring and configuration through an intuitive GUI, without any special firmware or software. Having chosen default parameters for a particular end-product, the user can upload the configuration to Qorvo who then ships pre-programmed parts with the required functionality.

Figure 3: The Qorvo "ActiveCiPS™" dongle

PMICs can include battery charge control

For some battery powered video applications, battery charge control is required, which can also be implemented in PMICs such as the Qorvo ACT81460 [2]. This device is suitable for lower power home security camera applications and features two 0.4A buck regulators, a buck-boost regulator, a boost regulator, and three LDOs each rated at 100mA. All outputs have programmable voltages and start-up/shut-down characteristics. The PMIC includes a 0.8A linear battery charger with comprehensive charge control modes: trickle, pre-conditioning and fast charge, depending on the battery charge state. Battery loading can be as low as 2.1µA with switching regulators disabled but still with internal monitors and references enabled. It provides four GPIOs along with an I2C interface for monitoring and control, including dynamic voltage scaling. The device operates from 4V to 5.5V input while the battery range is 2.7V to 4.5V. As with the ACT88760, outputs can be sequenced and enabled via an I2C interface and configured using the using the ActiveCiPS™ dongle. Low power modes are implemented including "Sleep" and "Deep sleep" and quiescent current is just 6µA, even with six regulators and three load switches enabled.

Conclusion

PMICs are ideal companions for vision processors and SoMs where multiple tightly-regulated voltage rails are required, with sequencing and active control to minimize losses, both in the end-load and in the PMIC itself. As a bonus, standard PMICs that can be pre-configured and remotely controlled such as those from Qorvo can be used in multiple applications with consequent savings in purchased volumes and stocking costs.

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ACT88760: https://www.qorvo.com/products/p/ACT88760

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Parallel Operation: Influence of Power Module Parameters

The challenge of IGBT module paralleling is to understand the necessary de-rating of power converters under consideration of different module parameters. This understanding is important for proper module parallel operation inside the thermal and safe operation limits. This article describes the methodology of how to analyze the influence of module parameters on current sharing and switching energy imbalance for parallel operation of power modules.

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Introduction

The current imbalance during module operation can be caused both by the characteristics of the paralleled power modules, such as the different forward voltage and by the design of the power converter itself. The interface of power modules, such as power connection on DC and AC side, the design of gate driver, and the gate driver connection to the power modules, have an influence on static and dynamic current imbalance of modules connected in parallel. An overview of the various factors that influence the performance of the power modules connected in parallel is shown in figure 1.

In the chapters below, the focus is on the analysis of the IGBT and diode characteristics with regard to current imbalance in parallel-connected power modules. For the following analysis, uniform cooling conditions are considered.

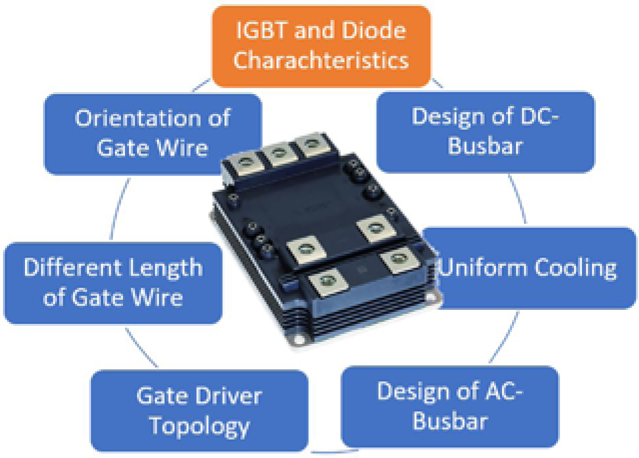


Figure 1: Factors affecting the performance of power modules connected in parallel

Evaluation Setup and Test Sample

Each rolling stock manufacturer has its own unique converter design, so it would be difficult for semiconductor manufacturers to make representative power module analysis without standardized test setup. This difficulty was discussed in Horizon 2020 Project "Shift2Rail" [2]. The project members agreed to define a standardized interface between semiconductor supplier and power converter manufacturer to discuss de-rating for power modules. The reference setup is shown in figure 2. One of the goals for reference setup is to reduce the influence of external components on the current imbalance of parallel connected power modules as much as possible. On the DC side, each power module has an individual DC-link capacitor; the AC power connection is made via a wide busbar with a central load connection under the modules. Only one central gate driver is used in combination with a low-inductive interface board to control the paralleled modules.

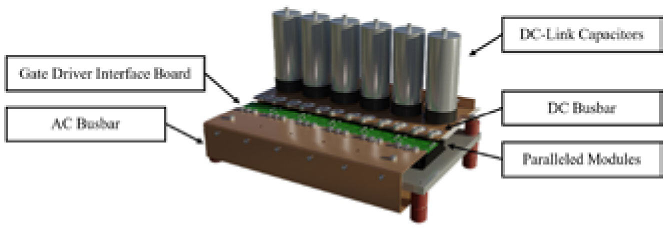


Figure 2: Reference test setup for paralleling evaluation

The reference test setup was chosen for investigation of module parallel connection in the following chapters. CM450DA-66X module in the LV100 package is a representative X-Series power module that was selected as device under test for performing the evaluation and analysis. The X-Series line-up with silicon chipset and aluminum base plate is shown in table 1. These power modules feature the latest X-Series 7th Gen. cutting edge chip set with CSTBT™(III) trench IGBT and RFC diode. Both IGBT and diode chips have a positive temperature coefficient for forward voltage over a wide current range. This feature is beneficial for thermal balancing between the parallel connected modules during operation if the temperature is not evenly distributed across the heatsink. The NTC temperature sensor, which is integrated into the module, allows the monitoring of case temperature for each individual parallel connected module. In addition, the dual-power modules of the X-series use a new innovative aluminum base plate with integrated AlN ceramic insulation, the so-called MCB (Metal Casting direct Bonding) baseplate. The new baseplate structure has a significantly smaller junction to case thermal resistance compared to conventional structure, which allows output-power increase or reduction of the operating junction temperature. In addition, Mitsubishi Electric's X-Series power modules offer features for demanding railway application such as high CTI value of housing material, partial discharge measurement, high quality control and traceability.

Chip	Package / Baseplate	1.7 kV	3.3 kV	4.5 kV	6.5 kV
X-Series (Si)	6 kViso / Aluminium 	CM1200DA-34X (1200 A Dual)	CM450DA-66X (450 A Dual) CM600DA-66X (600 A Dual) CM600E1A-66X (600 A Chopper)	-	-
	10 kViso / Aluminium 	-	CM450DE-66X (450 A Dual) CM600DE-66X (600 A Dual)	CM450DE-90X (450 A Dual)	CM300DE-130X (300 A Dual) (under feasibility)

Table 1: LV/HV100 X-Series line-up

Correlation of Power-Module Parameters and Parallel-Switching Waveforms

To investigate the impact of different IGBT power module parameters on the current sharing, parallel connections of ten different pairs of power modules have been measured. Afterwards, linear regression analysis is performed to correlate characteristics of switching waveforms and power-module parameters. Please find more information in [3].

The devices under test are 3.3 kV / 450 A (CM450DA-66X) power modules in the LV100 package. These devices show a natural distribution in their electrical parameters. Hence, collector-emitter saturation voltage ranges from 2.61 V to 2.81 V, gate-emitter threshold voltage ranges from 6.56 V to 7.70 V, and diode forward voltage ranges from 2.20 V to 2.45 V. The ten pairs have been analyzed in terms of their switching characteristics during turn-on, turn-off and reverse recovery.

Turn-Off Switching Analysis

Figure 3 shows two exemplary turn-off measurement results. When IGBT device parameters are similar, nice current sharing can be achieved. On the contrary, in case of different power module parameters, the load current unequally shares between power modules.

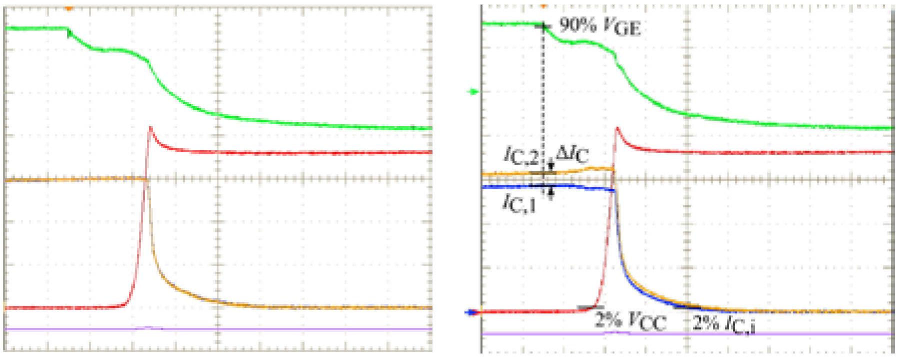
With linear regression analysis of the ten pairs, the correlation between IGBT power module parameters and switching characteristics is determined. It is found that the difference in steady state current ΔI_C correlates with the difference in collector-emitter voltage only. Other power module parameters are found to be insignificant (determination coefficient < 95%). Linear regression analysis leads the following relationship for the current imbalance. Please refer to [3] for further details.

$$\frac{\Delta I_C}{I_{Cavg}} \approx -0.56\ \mathrm{V}^{-1} \cdot \Delta V_{CEsat} \qquad (1)$$

Turn-On Switching Analysis

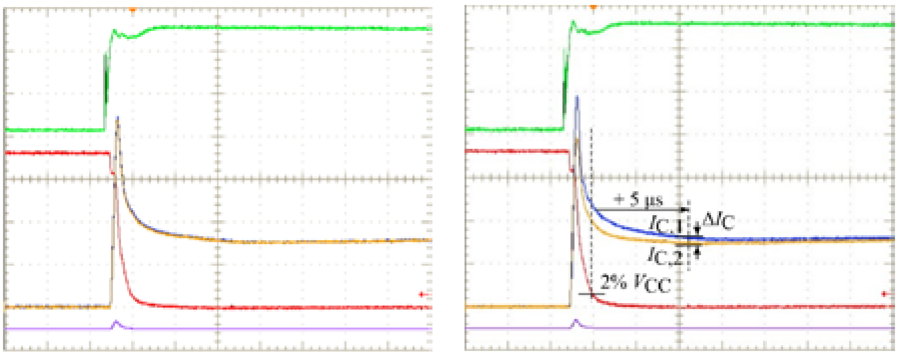
Figure 4 shows turn-on switching waveforms with two power modules connected in parallel. If power module parameters are similar, the current will share equally between both power modules. However, when power modules are different, unequal current sharing between power modules is to be expected.

It is found that current sharing correlates with gate-emitter threshold voltage difference $\Delta V_{GE(th)}$ and difference in forward voltage of the complementary free-wheel diodes ΔV_{EC}. Linear regression analysis leads the following relationship for the current imbalance. Please refer to [3] for further details.



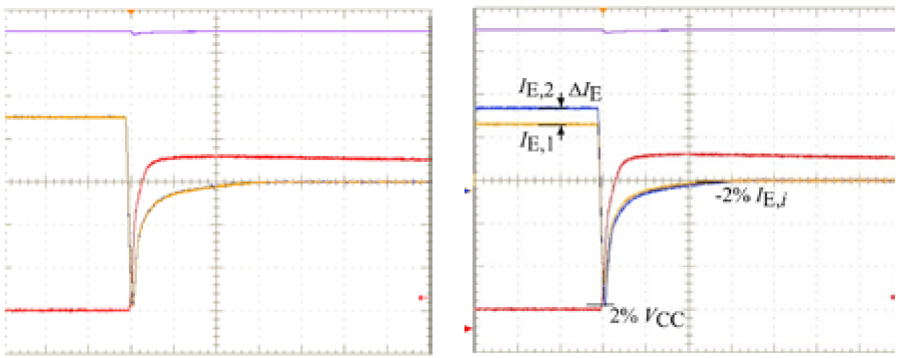
(a) similar device parameters (b) different device parameters

Figure 3: Exemplary turn-off waveforms (green: V_{GE} 10V/div, blue: I_{C1} 150A/div, yellow: I_{C2} 150A/div, red: V_{CE} 500V/div, 2.0 us/div)



(a) similar device parameters (b) different device parameters

Figure 4: Exemplary turn-on waveforms (green: V_{GE} 10V/div, blue: I_{C1} 300A/div, yellow: I_{C2} 300A/div, red: V_{CE} 500V/div, 2.0 us/div)



(a) similar device parameters (b) different device parameters

Figure 5: Exemplary reverse-recovery waveforms (blue: I_{C1} 300A/div, yellow: I_{C2} 300A/div, red: V_{CE} 500V/div, 2.0 us/div)

$$\frac{\Delta I_C}{I_{Cavg}} \approx -0.18\ \mathrm{V}^{-1} \cdot \Delta V_{EC} - 0.18\ \mathrm{V}^{-1} \cdot \Delta V_{GE(th)} \qquad (2)$$

Diode Reverse-Recovery Switching

Exemplary switching results of diode reverse recovery are shown in figure 5. Again, the current shares equally between two power modules if the power-module parameters are similar. If the power module parameters are different, differences in the static current and in the peak reverse recovery current becomes visible.

Linear regression analysis shows that the static current sharing correlates solely on difference of diode forward voltages ΔV_{EC}. Other power-module parameters are found to be insignificant. The following relationship for the current imbalance is found. Please refer to [3] for further details.

$$\frac{\Delta I_E}{I_{Eavg}} \approx -0.78\ \mathrm{V}^{-1} \cdot \Delta V_{EC} \qquad (3)$$

De-rating Calculation up to Six-Times Paralleling

Based on derating factors for currents and energies, that were derived in previous chapter, the required derating in case of parallel connection of more than two modules can be defined. For this, it will be assumed that one of the paralleled modules has a minimum characteristic (resulting in maximum switching energy or current) while all other modules have the maximum characteristics (leading to minimum switch-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ing energy or current). By using the following equation, the derating ratio for the collector current for more than two parallel connected modules can be calculated as an example.

The parameter n is the number of parallel connected modules. The parameter x is the identified imbalance ratio from the measurement of two parallel connected

$$\frac{I_{C,max}}{I_{C,avg}} - 1 = \frac{I_{C,max}}{\left((n-1)I_{C,min}+I_{C,max}\right)/n} - 1 = \frac{n \cdot I_{C,max}}{\left((n-1)\frac{1-x}{1+x}I_{C,max}+I_{C,max}\right)} - 1 = \frac{n}{\left((n-1)\frac{1-x}{1+x}+1\right)} - 1 \quad (4)$$

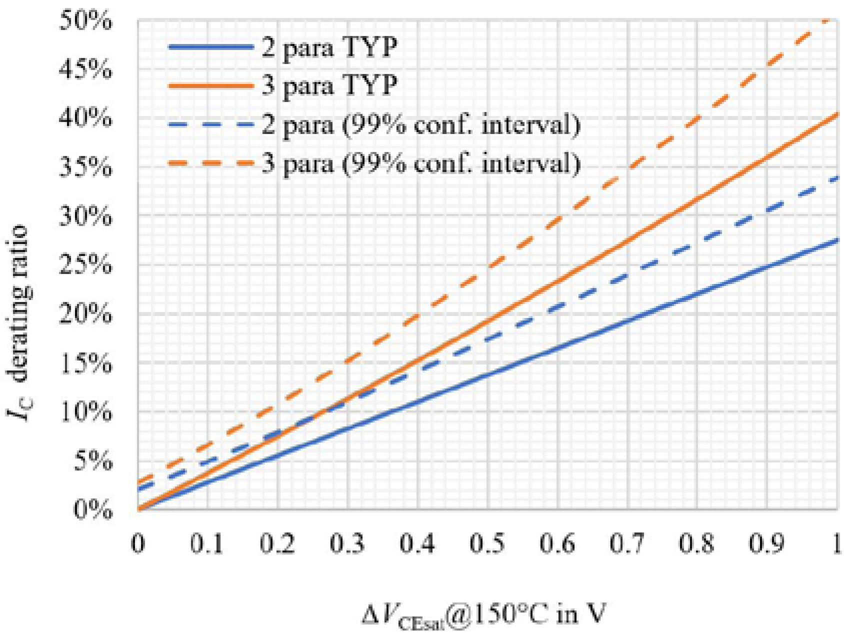

Figure 6: Collector current derating ratio versus forward voltage difference

modules (for example ($\Delta I_C/I_{Cavg}$ according to (1) and (2) or ($\Delta I_E/I_{Eavg}$ according to (3)). As a result, the de-rating dependency on the grouping parameter can be defined as shown in figure 6. The figure already illustrates that confidence intervals, as determined by the regression analysis, become also very helpful regarding the derating ratio of multiple power modules.

The previous analysis shows that if small parameter variation is guaranteed, a small derating ratio and good current sharing is achievable. This is demonstrated by figure 7. It shows switching type test results of a 6-times parallel connection. The current homogenously shares among the six power modules which leads to good balance of losses and optimal utilization of available chip area.

Conclusion

This article explains a methodology to investigate the influence of power-module parameters on the switching characteristics of a parallel connection. For each switching type, IGBT turn-off, turn-on and diode reverse recovery, the influence of the different device parameters is investigated. Considering only the significant parameters, a model is provided to calculate differences in switching characteristics on arbitrary device parameters. It is shown how the results are transferred to parallel connection with more than two devices. Finally, homogeneous current sharing between six devices in a parallel connection is confirmed. The switching waveforms proof that with well-designed converter layout and well-paired LV100 modules ideal current sharing is achieved.

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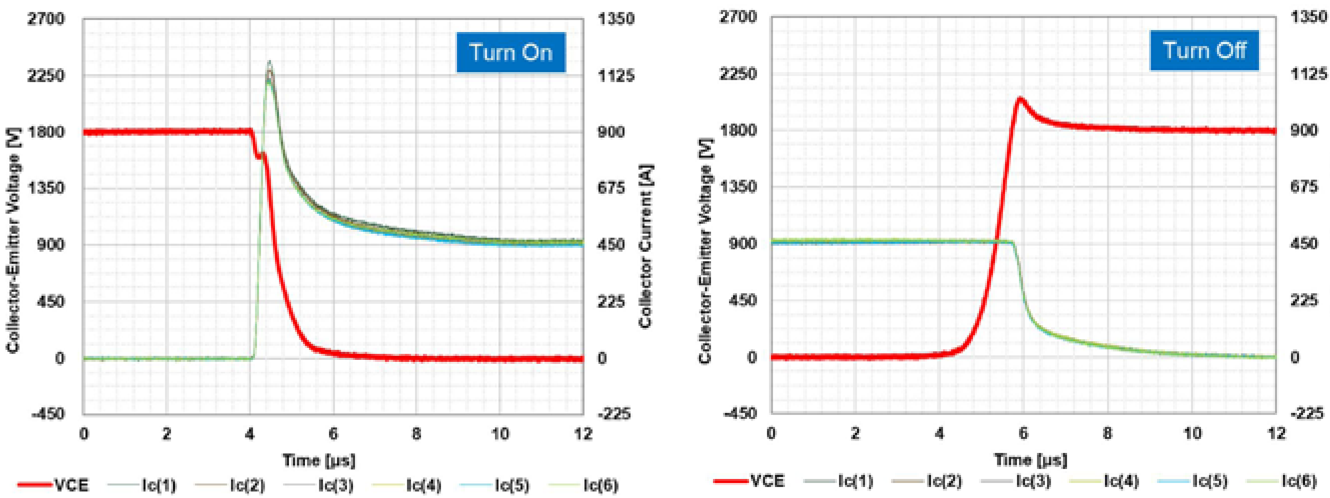

Figure 7: Switching waveforms for 6-times parallel connection
(conditions: V_{cc} = 1800V, I_c = 2700A (450A per device), T_j = 150°C, V_{GE} = +15V / -9V, $R_{G(on)}$ = 2.7Ω, $R_{G(off)}$ = 62Ω, C_{GE} = 33nF)

Immersed and Integrated Converter (30 kW) for Fuel Cell System in Aircraft Application

Integrated systems typically use several independent subsystems from different manufacturers connected to each other. To improve power density, some subsystems can be advantageously designed together. In the case of a hybrid system combining a fuel cell and a battery, the DC/DC converter dedicated to adjusting the voltages of the power sources can be coupled within the stack and share the cooling circuit.

By Sylvain Mercier, Bruno Beranger, Jacques Ecrabey, and Frédéric Gaillard, Univ. Grenoble Alpes, CEA, Liten

“Smart fuel cell” technology

To hybridize a fuel cell and a battery, a DC/DC converter is typically used to adapt the output voltage of the fuel cell. To optimize the power density of both subsystems, the converter can be integrated on an end plate of the stack and can use the same cooling circuit as the fuel cell. The system called “smart fuel cell” also integrates the monitoring of the stack. The filtering and connection between the subsystems are optimized through their integration. Several smart modules can be connected in parallel to increase the available power for the targeted application that allows keeping a good efficiency.

This development is part of a European research project (Flhysafe) which consists to provide emergency power on an aircraft. This project has received funding from the Clean Hydrogen Partnership under Grant Agreement No 779576. This Joint Undertaking receives support from the European Union’s Horizon 2020 Research and Innovation programme, Hydrogen Europe and Hydrogen Europe Research.

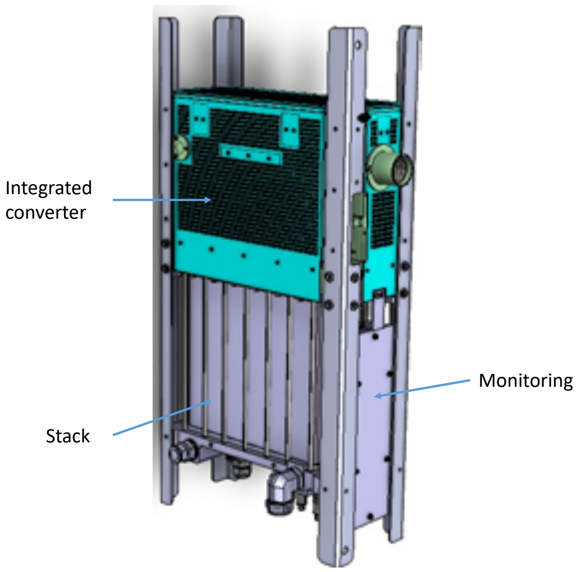

Figure 1: “Smart fuel cell” technology

DC/DC converter design

The integrated converter adapts the output voltage of the fuel cell (180 V to 220 V in steady-state) to the internal Direct Current (DC) bus voltage (500 V to 560 V in steady-state). To save weight in the developed system, a non-isolated converter is designed and the fuel cell stack is insulated from the metal frame of the system. The converter is based on a 12-phase interleaved boost converter. The input ripple current applied to the stack is thus reduced and the input/output capacitances are minimized. A field programmable gate array associated with a microcontroller controls the high number of phases at the expected operating frequency (100 kHz). The input current or the output voltage can be controlled. The switches are commercial Silicon Carbide (SiC) modules (Wolfspeed). The twelve inductors are based on a specific development (68 µH per phases, Exxelia). A ring core is used with a single layer of conventional wire (one strand). This optimizes the cooling and avoids the risk of overheating the wiring. Precautions had to be taken regarding the materials compatibility with the cooling fluid (Nycodiel).

The converter is cooled by the same cooling circuit as the fuel cell stack. An efficient and custom solution, a cooling box, removes heat by a dielectric fluid from the immersed passive devices and the baseplates of power semiconductor modules. The input power supply is also mounted on the cooling box.

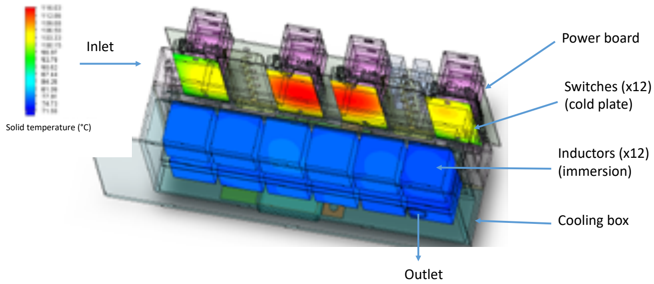

Figure 2: Cooling of the SiC modules and inductors

In order to comply with the tradeoff between the pressure drop of the cooling box (175 mbar) and the operating junction temperature of the MOSFETs (120°C), the current supplied by the fuel cell must be limited to 175 A, which corresponds to a converter output power of 30 kW. This power could be increased if the voltage of the fuel cell is increased.

DC/DC converter manufacturing and assembling

To fit the area of the end plate, four electronic boards are mounted around the cooling box. The electrical connections between the power board and the control board are numerous (96). To mitigate the effect of bad connections using wires, board-to-board connectors are used. The number of connectors is thus reduced. The input board integrates the input filtering and the main power supply. The input current sensor is electrically connected to this board. The output board integrates part of the output filtering and the output current sensor. The SiC modules, gate drivers and phase current measurements are present on the power board. The control board integrates the programmable integrated circuits. The communication and voltage measurements (input and output), the electrical isolation of the gate drivers, and the hardware protections are also implemented on this board.

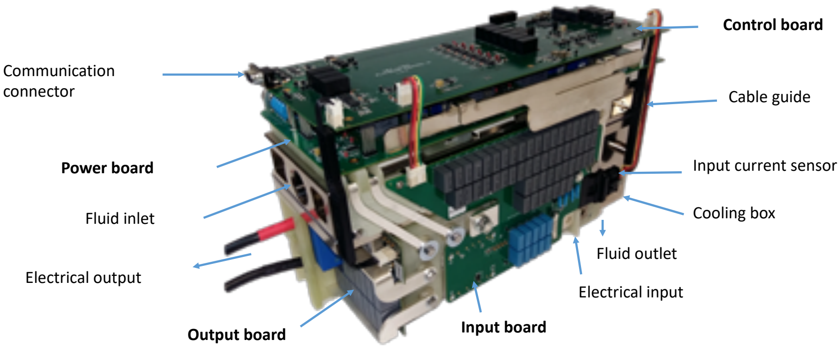

Figure 3: Integrated immersion-cooled converter

The cooling box is made by machining an aluminum alloy (6061 T6) with a high thermal conductivity (167 W/m.K at 20°C). Four insulated and waterproof feedthroughs connect electrically the inductors and the electronic boards or the bus bars. Nitrile seals ensure the tightness. The cover of the cooling box integrates channels to evacuate switch losses. The thermal resistance per module is efficient (less than 0.1 °C/W). To share the coolant inside the cooling box, two plates are used. The first one divides the coolant between the modules and the inductors. The second one divides the coolant through the different inductors.

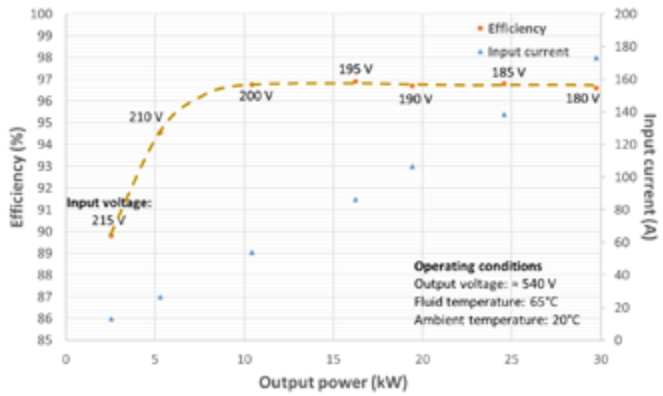

Figure 4: Efficiency of the prototype

The area of the converter is 585 cm². For a height of 27 cm, the volume is 16 L. The mass is close to 19.5 kg. The volume and the mass do not take into account the housing and the coolant.

To improve performance in terms of vibration and shock, mechanical parts have been designed such as pads to hold the boards together and stiffeners to hold the stack with the converter. The heavy inductors are also clamped by holding parts inside the cooling box.

DC/DC converter tests

The converter complies with most of the electrical, thermal, mechanical and fluidic requirements.

In terms of electrical requirements, the efficiency of the converter is approximately 96.5% from an output power of more than 10 kW and an output voltage of 540 V. Hard switching is used and the SiC MOSFETs have been slowed down to match the conducted emissions on the power wires. Efficiency could be improved by increasing the switching speed of the MOSFETs despite a likely higher level of conducted noise or larger filtering. In operation, a duration of 1 s is required to provide the application load steps (from 2 kW to 21 kW or from 21 kW to 30 kW). This duration complies with the dynamic of the fuel cell. The output voltage ripple is limited to 510 mV for an output power of 30 kW (worst case). This amplitude is less than 0.1% of the supplied voltage. A duration of 350 ms is necessary to start the converter.

Conclusion

To improve the power density of a fuel cell system, a "smart fuel cell" technology has been developed to integrate the stack, a non-isolated DC/DC converter and monitoring together. The filtering and connection between the subsystems are thus optimized through their integration. The area available on the end plate led to the development of a DC/DC converter with an unusual form factor. The electronic devices and boards are mounted outside of a cooling box. The cooling box is specially designed to remove heat from devices inside by dielectric fluid immersion, inductors, and the devices outside, switches.

Integration of the converter into the fuel cell, which is being developed by Safran as part of the project, is scheduled for early 2022. Functional and environmental tests will then be carried out at INTA in Spain, among other facilities.

https://liten.cea.fr/cea-tech/liten/english

Managing Thermals: 3 Ways to Break Through Power-Density Barriers

The number of semiconductors in nearly every application is multiplying, and many of the design challenges facing electronics engineers all tie back to the need for greater power density.

By Robert Taylor, Applications Engineer, Texas Instruments

A few example applications come to mind:

- **Hyperscale data centers:** Rack servers are using an incredible amount of power, challenging utility companies and power engineers to keep up with increasing demands.
- **Electric vehicles:** The transition from internal combustion engines to 800-V battery packs comes with an exponential increase in semiconductor content for the powertrain.
- **Commercial and home security applications:** As video doorbells and Internet Protocol cameras become more prevalent, their shrinking sizes put constraints on the necessary thermal solution.

What stands in the way of achieving higher power density? Well, thermal performance is an electrical byproduct of power-management integrated circuits (ICs), which you can't ignore or "optimize out" with filtering components at the system level. The mitigation of thermals requires critical microadjustments throughout every step in the development process so that the design can achieve its system requirements for a given size constraint. Following are three key areas TI focuses on to optimize thermal performance and break through power-density barriers at the chip level.

Process technology innovations

Many global semiconductor manufacturers are racing to offer power-management products that leverage process technology nodes to achieve higher performance capabilities in industry-standard packages. For example, at TI we continue investing in 45- and 65-nm process technologies that leverage our internal technology development, along with 300-mm manufacturing efficiencies to offer products optimized for cost, performance, power, precision and voltage levels. Our process technology advancements also help us create products that maintain high performance under various thermal conditions. For instance, reducing the specific on-state resistance (RSP) or drain-to-source on-state resistance (RDS(on)) of integrated metal-oxide semiconductor field-effect transistors (MOSFETs) minimizes die size while enhancing thermal performance. The same is true for other semiconductor switches such as gallium nitride (GaN) or silicon carbide.

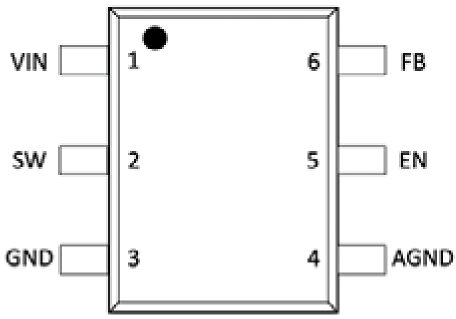

Figure 2-1. TPS566242/7 Pin Out

Figure 1: The TPS566242 synchronous buck converter delivers up to 6 A of continuous current

Take the TPS566242 buck converter, shown in Figure 1. New process nodes optimize the pin layout by integrating features and providing an extra ground connection that helps deliver 6 A of output current from a 1.6-mm-by-1.6-mm small outline transistor (SOT)-563 package. If you asked me five years ago if tiny, simple leaded packages would be capable of that type of performance, I'd have been skeptical. But that's the beauty of process technology!

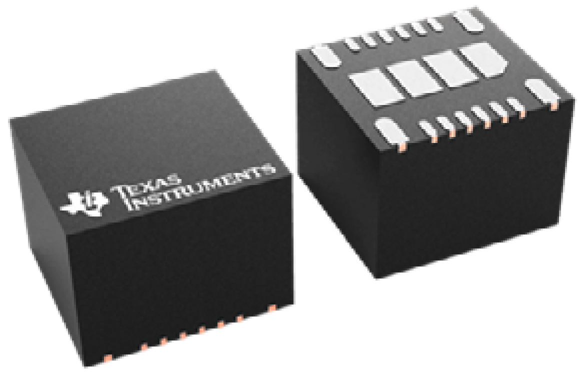

Figure 2: The TLVM13660 includes four thermal pads on the bottom and has all signal and power pins accessible from the perimeter for easier layout and handling

Circuit-design techniques

In addition to more efficiency at the process technology level, creative circuit design also plays an important role in improving power density. Designers have historically used discrete hot-swap controllers to protect high-current enterprise applications. As a protection function, they are reliable, but with end-equipment manufacturers (and consumers) requiring more current capability, discrete power designs can grow far too large, especially for applications such as server power-supply units (PSUs) that often require 300 A of current or more.

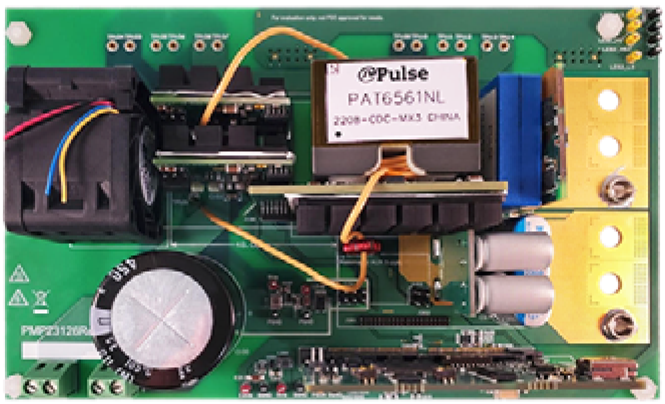

Figure 3: 3-kW phase-shifted full bridge with active clamp reference design

The TPS25985 eFuse pairs an integrated 0.59-mΩ FET with a current-sense amplifier. This amplifier, plus a new active current sharing approach, provides an easy way to allow for temperature monitoring. By pairing efficient switches with creative integration approaches, the TPS25985 can deliver up to 80 A of peak current, and you can easily stack multiple eFuses for higher power.

Thermally optimized packaging R&D

Although reducing the amount of heat dissipated into the printed circuit board (PCB) or system is is a basic requirement, the reality is that undesirable heat still lingers, especially as the power requirements or your system's ambient temperature increase. TI has recently enhanced the performance of its HotRod quad-flat-no lead (QFN) packages, including larger die-attach pads (DAPs) to facilitate greater heat dissipation. Figure 2 shows the total DAP area and pin accessibility of the 6-A, 36-V TLVM13660 step-down power module.

To learn more about the evolution of these packages, see the article, "Designing with small DC/DC converters: HotRod QFN vs. Enhanced HotRod QFN packaging.": http://www.ti.com/lit/slyt816

System-level thermal solutions

For high-power applications like server PSUs, GaN with top-side cooling is a highly effective way to remove heat from the IC without heating up the PCB. The LMG3522R030-Q1 GaN FET integrates a gate driver and protection features in a top-side cooled package. Figure 3 illustrates the isolated DC/DC section of the 3-kW Phase-Shifted Full Bridge With Active Clamp Reference Design with >270-W/in3 Power Density, which leverages the LMG3522 and achieves a peak efficiency of 97.74%.

Conclusion

Maintaining performance while reducing the impact of thermals can only happen with a multifaceted approach to process and packaging technology and power design expertise. At TI, it's a challenge that our product designers, systems engineers, packaging R&D and manufacturing teams are all hyperfocused on – to achieve greater power density without thermal pitfalls.

Additional resources

- Find devices and technical resources to solve your density challenges at http://www.ti.com/powerdensity.
- Watch our training series, "Understanding the Fundamental Technologies of Power Density." at https://training.ti.com/understanding-fundamental-technologies-power-density
- Create a custom power-supply circuit with WEBENCH® Power Designer at https://www.ti.com/design-resources/design-tools-simulation/webench-power-designer.html.

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Switching Power Supplies with More than 96% Efficiency Due to the Use of GaN Transistors

The field of power electronics has evolved rapidly in recent decades. This is primarily due to the increasingly fast-switching semiconductor switches, which make it possible to design ever smaller components for storing electric energy, such as capacitors and inductances. Combined with an increased efficiency, this allows the realization of smaller power-electronic components such as power supply units and DC-DC converters.

By Sebastian Fischer, Dipl.-Ing., Managing Director Traco Power Germany
Erich Hinterleitner, Development Engineer Traco Power

The semiconductor switches have been continuously enhanced over the past decades. The latest semiconductor switches, e.g., Super Junction MOSFETs (SJ), silicon carbide MOSFETs (SiC) and transistors on a Gallium Nitride basis (GaN), achieve switching times almost ten times shorter than those of traditional MOSFETs. This leads to noticeably lower switching losses, which in turn allows for higher switching frequencies. Due to this and the increased efficiency, it is possible to realize a smaller design volume for switching power supplies.

However, please note that these advantages do not apply to all switching topologies used for switching power supplies and DC-DC converters. Due to the availability of efficient and low-cost controller ICs, various resonance converter concepts have been in use in recent years that are characterized by the fact that at the moment when the power is switched on or off, the current or voltage at the switching element is already at zero, thus preventing any power or energy loss (ZVS or ZCS: Zero Voltage Switching and Zero Current Switching). Since these switching concepts, which generally involve true resonance converters, do not generate any power loss as a matter of principle, no further reduction in the switching losses should be expected when using even faster-switching components. For example, Figure 1 shows the general circuit diagram of a typical Traco Power industrial power supply unit with a PFC converter at the input and a resonance converter at the output. The entire electrical energy flows through the elements labeled L and C, and the values of the capacitor and the inductance essentially determine the converter's switching frequency based on the resonance frequency.

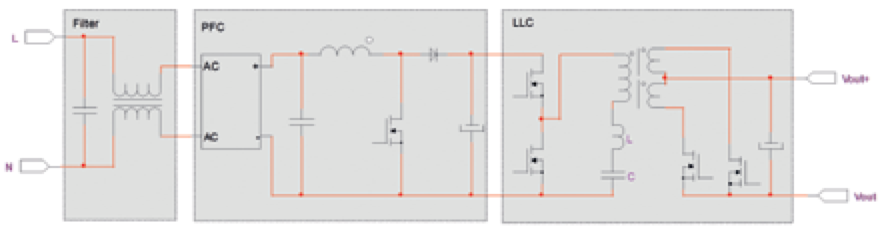

Figure 1: Typical general circuit diagram of a Traco switching power supply with a boost converter at the input for generating a sinusoidal input current and a resonance converter for potential separation and voltage regulation

The power supply unit's input is equipped with a voltage-boosting DC-DC converter (PFC converter), which forces a quasi sinusoidal mains inlet current at the input for correcting the power factor. The downstream resonance converter serves for adjusting the voltage level, achieving the galvanic isolation from the mains voltage, and regulating changes in mains voltage and load. However, since a resonantly or semi-resonantly switching PFC converter is very elaborate and can only be realized in a highly complex fashion, the use of the newly available, very fast-switching transistors as active high-frequency switches offers a viable option for this boost converter.

To be able to significantly increase the switching power supply's efficiency with these fast-switching components by means of lower switching losses, it is necessary to also reduce conducting losses in diodes and rectifiers. In this regard, a so-called "totem pole" topology is recommended for the boost converter. This makes it possible to reduce the traditionally used mains rectifier with its relatively high conducting losses from four to two diodes. The corresponding details are shown in Figure 2. This circuit was designed and tested with GaN transistors. The advantages and disadvantages as well as the associated technical challenges are described below.

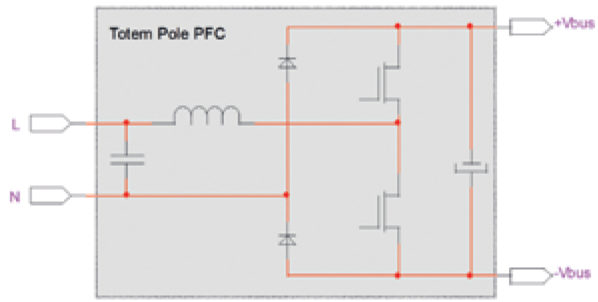

Figure 2: "Totem pole circuit" for correcting the power factor of the mains inlet current

Why use GaN?

Super Junction MOSFETs (SJ) switch very rapidly, are easily replaced, and are inexpensive and readily available. Disadvantages are the relatively high control power when operated at higher switching frequencies, and the high switching loss, as well as the body diode's long recovery time in reverse operation.

Silicon carbide MOSFETs (SiC) are faster than SJ MOSFETs, they are well-suited for high blocking voltages, and have a robust avalanche behavior and a body diode with very short reverse recovery times. However, the control of these transistors is somewhat more complex, since a negative gate preload may be required.

Gallium nitride (GaN) transistors are generally available in two different designs: self-conducting and self-blocking. Depending on type and manufacturer, this leads to different requirements re-

garding the gate control of these components. The GaN transistor's advantage, however, is the up to ten times shorter switching time and the elimination of the body diode. Under certain circumstances, this advantage may justify the added expenditures for the control and management of these components. To be able to fully use all advantages of the GaN transistors, a more complex gate control circuit is required, which is often already integrated on the switch circuit breaker's chip. The disadvantage is that components by different manufacturers are no longer compatible and cannot easily be exchanged with each other.

Fast switching with a boost converter (PFC converter) with GaN transistors

In Figure 3, the boost converter is designed as a "totem pole circuit." The output voltage is always higher than the input voltage. Depending on the input voltage's polarity, the two transistors alternately work as an active switch or as an active free-wheeling diode for the choke current. These transistors are alternately controlled with a duty cycle of "D" and "(1-D)." When using the very fast-switching GaN transistors for both switches, the stage can be operated with continuous choke current. This means that the choke current does not have to be zero when the switch is turned on or off, since only very low switching losses will result. Therefore, the storage choke can be operated with significantly lower high-frequency alternating current. Since, under control-technology aspects, the current through the choke and the rectifier diodes is properly controlled, for further reduction of the power loss the rectifier diodes can also be replaced with SJ MOSFETs, which have a very low ON-resistance. This results in the further reduction of the overall power loss and thereby also to an increased efficiency.

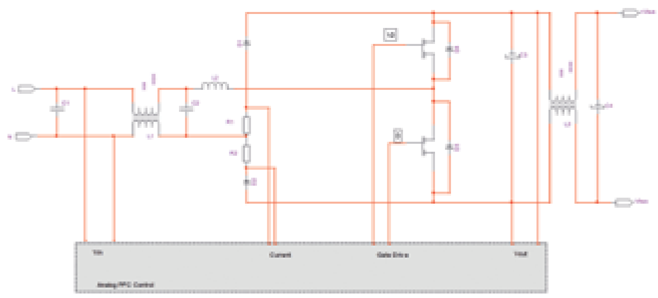

Figure 3: Totem pole input converter with input and output filter to prevent radio interferences

Since the GaN transistors have switching times of only a few nanoseconds, parasitic inductances and capacities are induced to generate extremely high-frequency oscillations, which results in significant disturbances at the input and output and negatively affects the measurements. Therefore, the filters shown in Figure 3 were used. The measured switching signals, measured in each case between the GaN transistors' drain and source terminals, are shown in Figure 4; the associated measuring design is shown in Figure 5. With the GaN transistor used here, it became apparent that SiC diodes (D3 and D4) parallel to drain-source are necessary to prevent oscillations during the dead time (GaN conducts in reverse, gate "off").

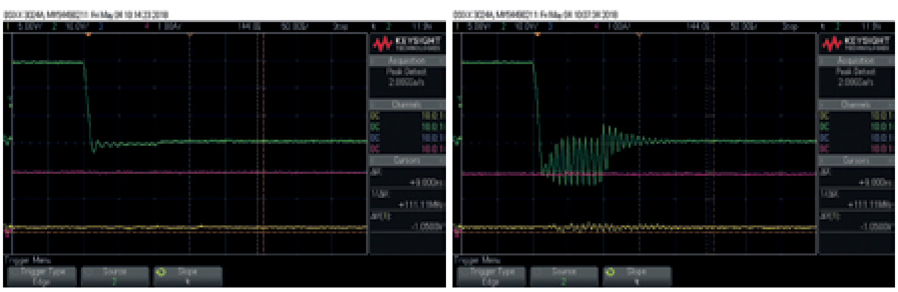

Figure 4 a) *Figure 4 b)*

Figure 4: Switching behavior of a GaN transistor in a PFC converter with (a) and without (b) external SiC parallel diodes for preventing transient responses

The measurement of the switch-off behavior of the drain-source voltage at the GaN transistor is shown in Figure 4, both with and without external parallel diodes. The switching process takes less than 7 nanoseconds, which means it is approximately ten times shorter than in standard MOSFETs. This also results in a reduction of switch-on and switch-off losses by the same factor compared to traditional MOSFET switches.

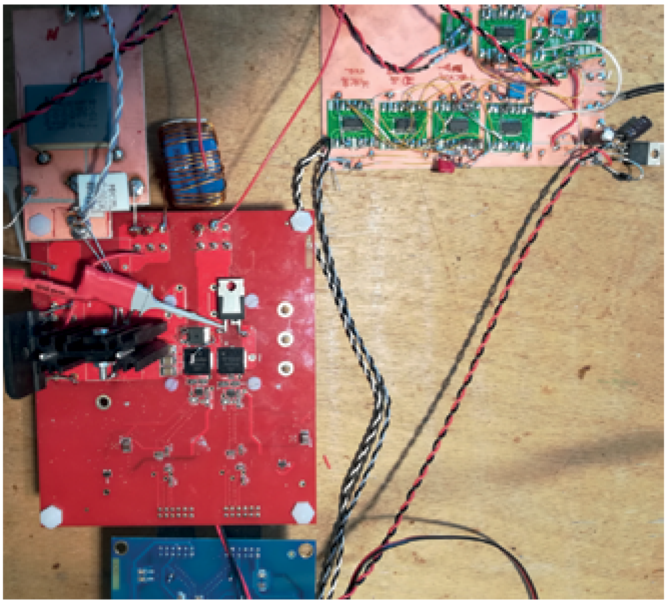

Figure 5: Measuring design

The circuit illustrated above is designed for an output of 1000 W; the two switching transistors are 80mOhm GaN transistors. The control and regulation was set up discretely and analog, so that all operating parameters can be influenced and set. The oscillations after switch-off shown in Figure 4b generate hard-to-filter high-frequency disturbances that would require a high filtering effort; therefore, they must be avoided.

Lower inductances with the use of GaN transistors

The losses and the size of the inductance have a significant impact on the efficiency of the boost converter (PFC converter). The stored energy of an inductance is in quadratic relation to the current's amplitude during switch-on and switch-off; at the same time, the Ohmic losses increase quadratically to the current. On the other hand, the hysteresis losses in the inductance depend on the magnetic core's volume, the current's alternating component and thus on the stroke of the change in magnetic flow density and the switching frequency. The evaluated test design used a mean switching frequency of 100kHz. The measurements of the choke current for the input voltages of 110VAC and 230VAC are shown in Figure 6. Since the level of the ripple current depends on the difference between the input voltage and the boost voltage, a lower input voltage (Figure 6a) leads to a higher ripple current than operation with a higher voltage (Figure 6b). The heat loss of the magnetic material in the inductance is much greater at a low input voltage and must therefore be taken into account for this unfavorable operating situation.

Since the core losses decrease along with a lower ripple factor of the current in the inductance, a PFC converter with GaN transistors provides the option of using magnetic materials for the inductance with a very high magnetic saturation flux density, despite relatively high specific hysteresis losses. This makes it possible to use higher switching frequencies at a low switching loss with several hundred kHz. This allows a further reduction of the inductance's construction size.

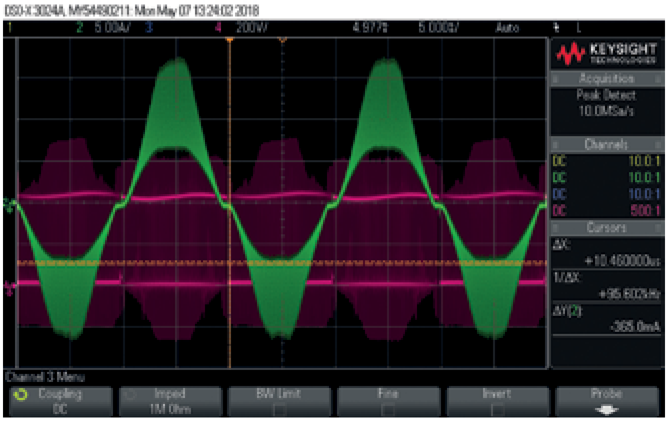

Figure 6 a) Current in the choke (L2) @ 110V

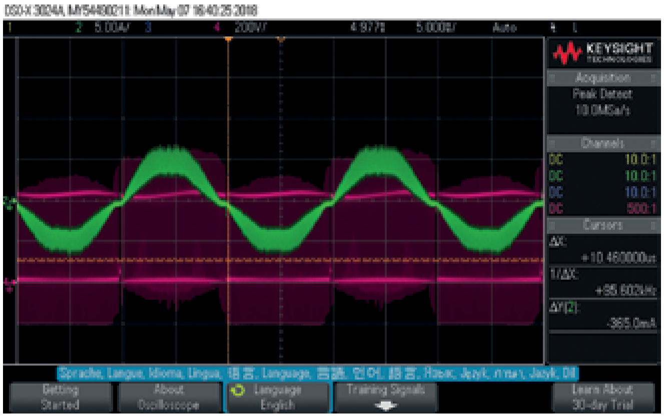

Figure 6 b) Current in the choke (L2)@ 230V

Figure 6: Measurement of the current in the boost converter's (PFC converter's) inductance at a) mains input voltage of 110VAC and b) mains input voltage of 230VAC

Increased disturbances due to faster switching

The extremely short switching processes in the GaN transistors result in the generation of square-wave currents and voltages, which - due to the extremely high activation and deactivation edges - generate high-frequency interference voltages and currents. These are undesirable and must be properly filtered to prevent the transmission of electromagnetic interferences from the switching power supply to its surroundings via the connection lines or via radiation. Common-mode interferences are the hardest to filter; corresponding measurements are shown in Figure 7.

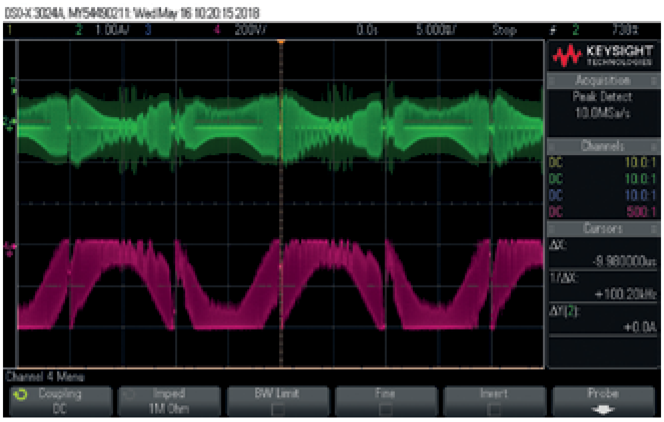

Figure 7: Common-mode interference current (green) and common-mode interference voltage (red) in a PFC converter at a full load of 1000W and a mains voltage of 230VAC

A detailed view shows that the common-mode voltage at 100Hz very quickly reverses its polarity; the high-frequency proportion is caused by the boost diode's energetic recovery. In this process, the current is unable to find a path through the diodes D1 D2 and therefore flows back to the grid via the Y capacitor as common-mode current. Using an intelligent control for the active boost diode and replacing the passive rectifier diodes D1 D2 with MOSFETs, this current can be reduced significantly.

Increased efficiency and decreased construction size with GaN transistors

A PFC converter's efficiency generally consists of the semiconductor switches' conduction and switching losses and the inductance's Ohmic and magnetization losses. The total losses were measured and the proportions of the individual losses were calculated; they are shown in Figure 8.

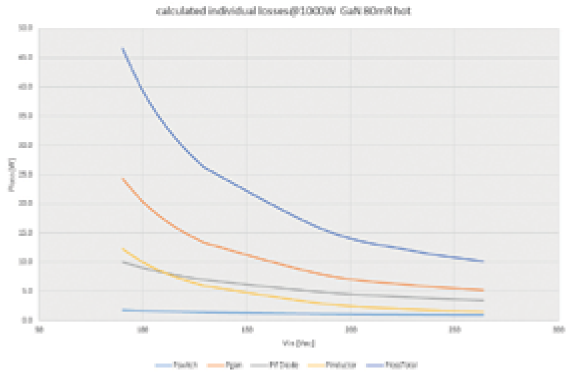

Figure 8: Allocation of the total losses in relation to the mains input voltage to the individual components at a mains voltage of 230VAC

Due to the higher currents at a lower input voltage and higher losses in the inductance's magnetic material, the efficiency strongly depends on the mains input voltage. This relationship is summarized once more in Figure 9.

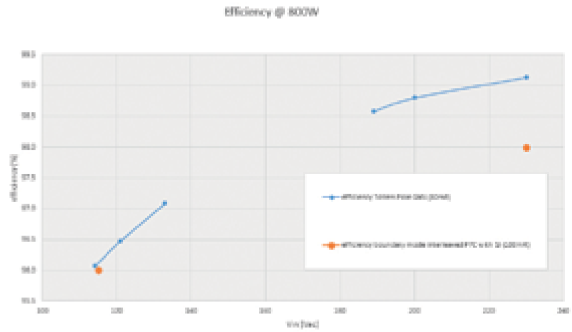

Figure 9: Overall efficiency of the totem pole PFC converter with GaN transistors (blue) in relation to the mains input voltage, compared to "boundary-mode interleaved" PFC with SJ MOSFET (orange)

Summary

In summary, it can be stated that the use of GaN transistors with a suitable circuit design in PFC converters can result in an extremely high efficiency of more than 99%; however, the ON-resistance of economically feasible GaN transistors for low mains voltages remains clearly too high, and activated MOSFETs must be used as mains diodes. This results in an efficiency that is 3 to 5% higher than that of a PFC converter with conventional MOSFETs with a bridge rectifier. The combined use of a PFC converter and a resonance converter in a switching power supply can thus result in an overall efficiency of more than 96%.

The use of GaN transistors in switching power supplies opens new possibilities in regard to switching frequency, efficiency and construction size. However, a prerequisite for an economic use in switching power supplies and DC-DC converters with an output up to 1000 W is a further reduction in the price of these components.

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The Golden Rule of Board Layout for Switch-Mode Power Supplies

This article explains the basis for achieving an optimized board layout, a critical aspect in the design of switch-mode power supplies. A good layout ensures stable functioning of the switching regulator and minimizes radiated interference as well as conducted interference (EMI). This is widely known by electronics developers. However, what is not generally known is how an optimized board layout for a switch-mode power supply should look.

By Frederik Dostal, Power Management Expert, Analog Devices

Figure 1 shows the circuit of an LT8640S evaluation board. It is a step-down (buck) switching regulator that can tolerate input voltages of up to 42 V and is designed for output currents of up to 6 A. All components have been placed very compactly. Placing the components as closely together as possible on the board is a general recommendation. While this statement is not false, it is also not particularly suitable if the goal is to obtain an optimized board layout. In Figure 1, there are quite a few (11) passive components surrounding the switching regulator IC.

The first step is to find out which paths in a switching regulator topology are critical. In these paths, the current flow changes with the switch transitions. Figure 2 shows a typical circuit for a step-down converter (buck topology). The critical paths are shown in red. They are connecting lines in which either the full current or no current flows, depending on the states of the power switches. These paths should be as short as possible. For a buck converter, the input capacitor should be situated as close as possible to the VIN pin and GND pin of the switching regulator IC.

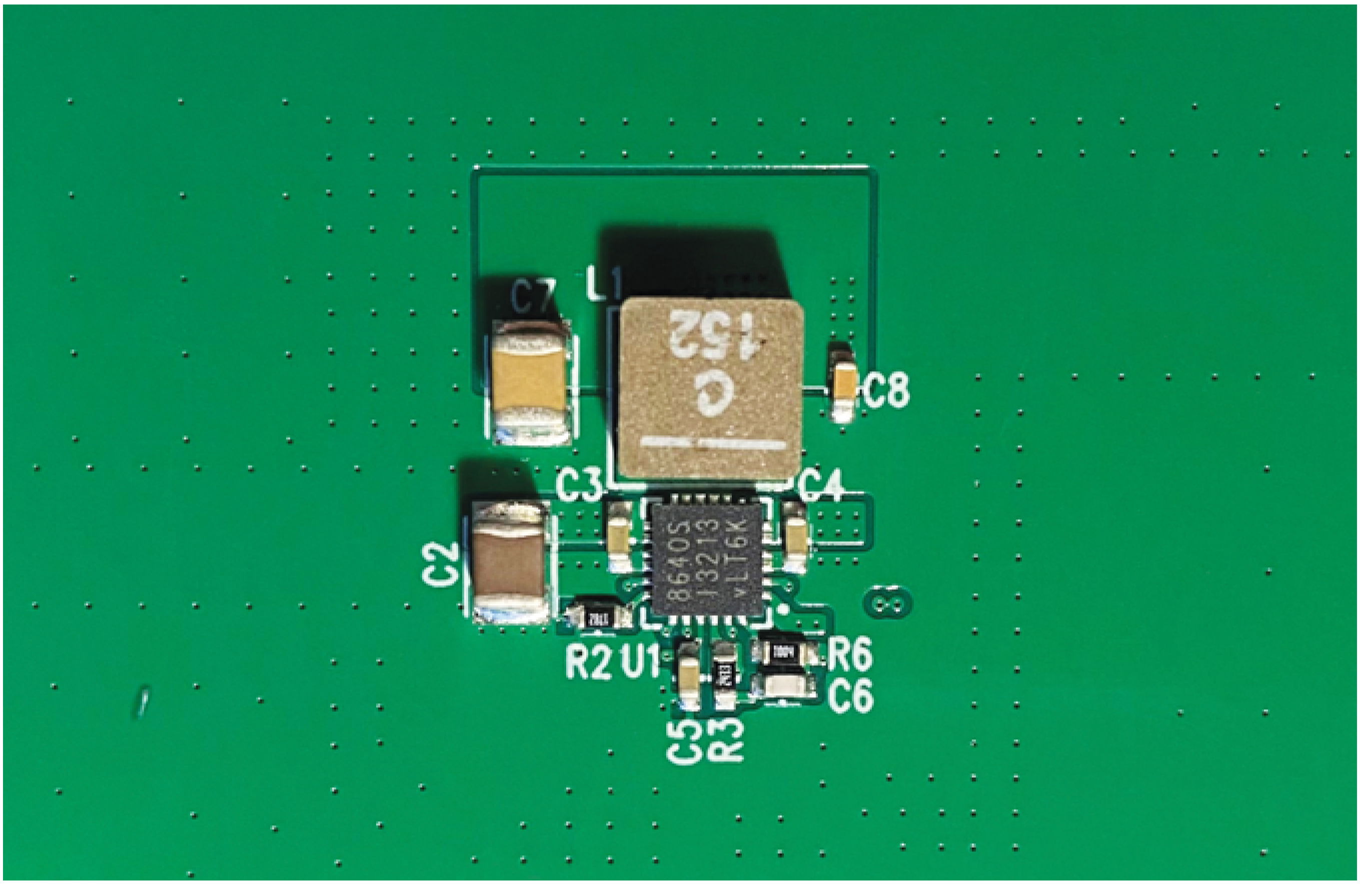

Figure 1: The board of an LT8640S switching regulator with closely spaced components and thus a compact board layout.

Which of these passive components have priority over the others in the placement and why?

In a switching regulator PCB design, the most important rule is to route the traces that carry high switched currents to be as short as possible. If this rule is successfully implemented, a large part of the board layout for a switching regulator will be addressed properly.

What is the easiest way to implement this golden rule in the board layout?

Figure 3 shows a basic schematic diagram of a circuit with a boost topology. Here, a low voltage is converted to a higher voltage. Once again, the current paths in which the current flow changes with switching of the power switches are shown in red. Interestingly, the placement of the input capacitor is not critical at all. The most crucial is the placement of the output capacitor. It must be as close as possible to the flyback diode (or the high-side switch) as well as to the ground connection of the low-side switch.

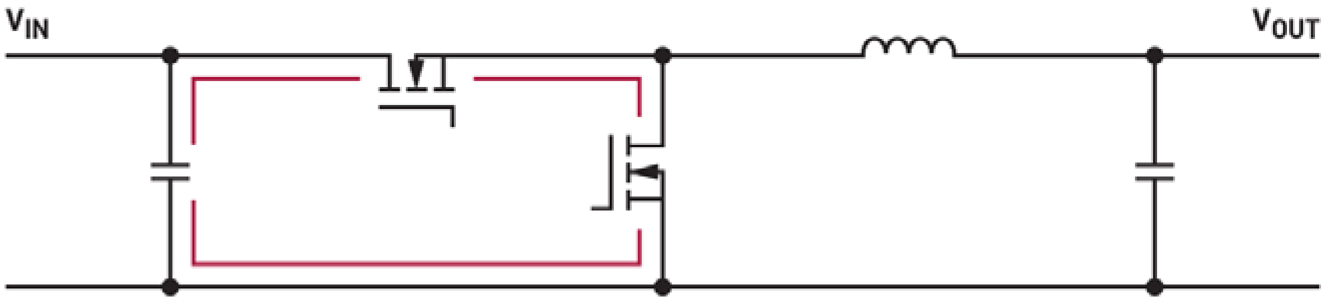

Figure 2: A schematic of a step-down switching regulator and paths with rapidly changing currents shown in red.

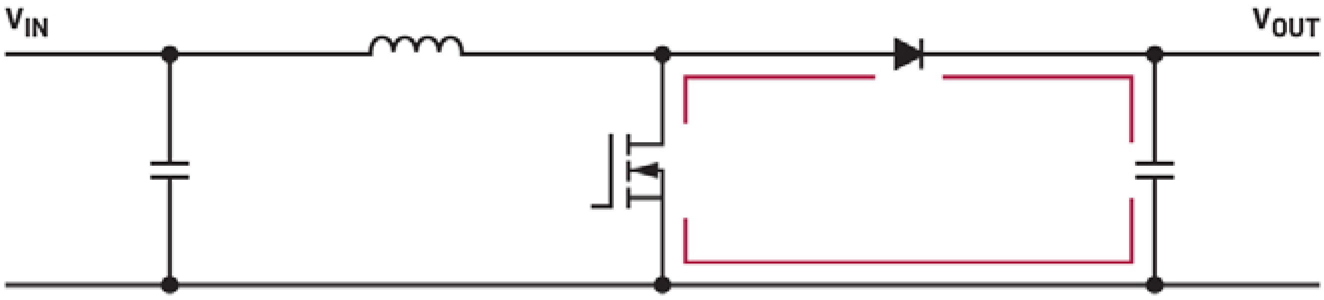

Figure 3: A schematic of a step-up switching regulator and paths with rapidly changing currents shown in red.

After that, any other switching regulator topology can be examined to yield information on how the current flow changes when the power switches are switched. The classic method involves printing out the circuit and drawing the current flow, using three differently colored pens. One color is used to indicate the current flow during the on-time - that is, when the power switch is conducting current. The second color shows the current flow during the off-time - that is, when the power switch is switched off. And finally, the third color is used for all paths marked either only in the first color or only in the second color. The critical path, in which the current flow changes with the switching of the power switches, can then be clearly identified.

Inexperienced circuit designers often consider the board layout for a switching regulator to be black magic. The most important rule is to design the traces, in which the current flow changes with the switch transitions, to be as short and compact as possible. This can be explained easily, follows logical relationships, and is the basis for an optimized board layout in a switch-mode power supply design.

About the Author

Frederik Dostal is a power management expert with more than 20 years of experience in this industry. After his studies of microelectronics at the University of Erlangen, Germany, he joined National Semiconductor in 2001, where he worked as a field applications engineer, gaining a lot of experience in implementing power management solutions in customer projects. During his time at National, he also spent four years in Phoenix, Arizona (USA), working on switch mode power supplies as an applications engineer. In 2009, he joined Analog Devices, where since then he held a variety of positions working for the product line and European technical support, and currently brings in his broad design and application knowledge as a power management expert. Frederik works in the ADI office in Munich, Germany.a

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Battery Cell and Pack Monitors

Texas Instruments introduced automotive battery cell and pack monitors, maximizing electric vehicle (EV) drive time and enabling safer operation. As EVs grow in popularity, advanced battery management systems (BMS) are helping overcome critical barriers to widespread adoption. With a focus on solving complex system design challenges, TI provides a comprehensive portfolio of BMS devices, enabling automakers to create a safer, more reliable driving experience and accelerate EV adoption. The BQ79731-Q1 battery cell monitor and BQ79718-Q1 battery pack monitor provide an accuracy and precision in measuring battery voltage, current and temperature to effectively determine the true range of a vehicle and increase the overall life and safety of the battery pack. "Automakers aim to get the most range possible out of their EVs, and accurate state-of-charge estimations are vital to achieve this," said Sam Wong, general manager for BMS at TI. "Our new devices bring substantially higher precision to voltage and current measurement, giving automakers confidence to accurately measure an EV's true range."

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Three-Level Configurable Slew-Rate Controlled Power Switch

Diodes has introduced a versatile single-channel high-side power switch. The DIODES™ AP22980 features three different selectable slew rates, so that wider capacitance loads can be handled while keeping inrush currents down, ensuring system stability. This power switch is targeted at the solid-state data storage systems used in portable electronic equipment, computer hardware, and edge-based data center deployments.

The N-channel MOSFET, with a built-in charge pump inside the AP22980, has an extremely low Rds(ON) of 5.1mΩ enabling loads reaching 6A while minimizing voltage drops and power losses in high current loading applications. By having a separate VBIAS pin, the minimum input voltage that it is capable of supporting is significantly lower, resulting in a wider input voltage range that can be covered - from 0.285V to 5.5V - enabling greater application flexibility.

With 60µA (typical) quiescent supply current, the AP22980 is highly optimized for situations where keeping standby power consumption down is a priority. This device has an operational temperature range of -40°C to 105°C. If the junction temperature exceeds 150°C, an overtemperature protection mechanism is triggered. The AP22980 three-level selectable slew rate power switches are supplied in the compact W-QFN1520 package that takes up little board space and eases integration.

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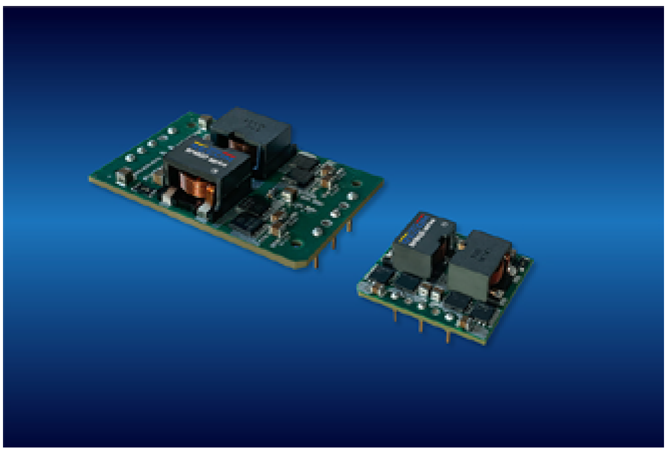
Point of Load DC/DCs with High-Efficiency Suit Distributed Power

RECOM Power announces two ranges of cost-effective switching regulators - the RPMGQ-20 and RPMGS-20 open-frame, through-hole, non-isolated DC/DC buck converters with 20A output rating.



The RPMGQ-20 is in an industry-standard quarter-brick format while the RPMGS-20 is in the emerging standard package size of 36.83 x 34.04mm with a standard sixteenth brick pin-out. Both products have a maximum height of 15mm from their mounting surface. The parts operate from an 18V-75V input and optional nominal outputs are 5V or 12V, trimmable over a wide range, 3.3V to 8V and 8V to 24V respectively. The efficiency of the RPMGQ-20 and RPMGS-20 parts is very high, peaking at 98% for the 12V output versions and 94% for 5V output, with a nearly-flat efficiency curve down to around 10% load. Due to the low losses and advanced thermal design, full load is available with air-flow to an ambient temperature of more than 90°C for all variants with derating to 120°C.

The products feature comprehensive protection against input undervoltage, output over-current, short circuits, and over-temperature. Remote sense and control input is also provided.

www.recom-power.com

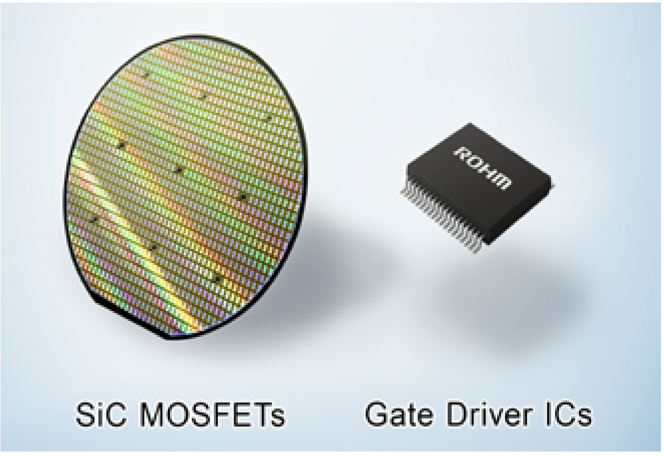
Polymer Chip Capacitor Series Offers Voltage Ratings up to 35 VDC

Cornell Dubilier's XMPL polymer chip capacitor series has been expanded to match applications with higher voltage and capacitance requirements. Their capacitance and voltage stability with temperature and frequency make these conductive polymer capacitors ideal for applications where bulk storage and high ripple current filtering are needed. Possessing much lower ESR and a shorter height profile than SMT aluminum electrolytics, XMPLs offer designers the opportunity to reduce the size and cost of their high-frequency/high-ripple applications by using fewer components. Standard capacitance values now range from 6.8µF to 470µF, with a maximum working voltage of 35VDC in a molded package measuring 7.3x4.3x1.9 mm. The operating temperature is -55°C to 105°C with a load life of 2,000 hours at 105°C with rated voltage applied. XMPLs are halogen-free and RoHS-compliant. Applications include high-frequency compact power supplies, DC-to-DC converters, LED lighting, industrial instrumentation, and automation.

www.cde.com

SiC MOSFETs to be Used in Inverters for Electric Vehicles

ROHM has recently announced the adoption of its 4th Generation SiC MOSFETs and gate driver ICs in electric vehicle inverters from Hitachi Astemo, a Japanese automotive parts manufacturer. Especially for EVs, the inverter, which plays a central role in the drive system, needs to be made more efficient to extend the cruising range and reduce the size of the onboard battery, increasing the expectations for SiC power devices. ROHM's latest 4th Generation SiC MOSFETs deliver improved short-circuit withstand time along with the low ON-resistance, making it possible to extend the cruising range of electric vehicles by reducing power consumption 6% vs IGBTs (as calculated by the international standard WLTC fuel efficiency test) when installed in the main inverter. At the same time, Hitachi Astemo, which has been developing advanced technologies for vehicle motors and inverters for a number of years, already enjoys a considerable track record in the increasingly popular EV market. However, this marks the first time SiC devices will be adopted for the main inverter circuit to further improve performance. The inverters are slated to be supplied to automakers from 2025, starting in Japan then expanding overseas.



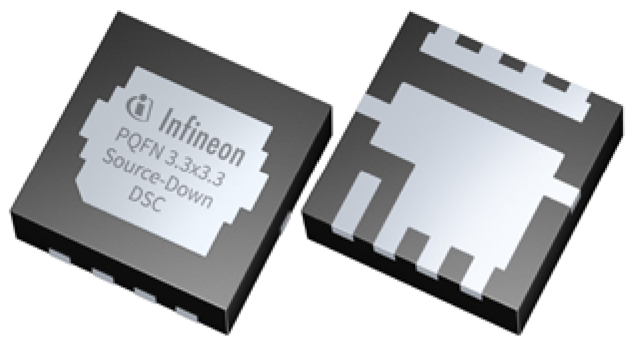
Going forward, as a leading supplier of SiC power devices, ROHM will continue to strengthen its lineup and provide power solutions that contribute to technical innovation in vehicles by combining peripheral device technologies such as control ICs designed to maximize performance.

www.rohm.com

Addition to Source-Down Power MOSFET Family

Infineon Technologies launches a Source-Down 3.3 x 3.3 mm² PQFN product family in the 25-150 V classes with Bottom-Side (BSC) and Dual-Side Cooling (DSC) variants. The product family provides significant enhancements on the component level to offer attractive solutions in DC-DC power conversion, opening up new possibilities for system innovation in server, telecom, OR-ing, battery protection, power tools, and charger applications. In the Source-Down (SD) concept, the MOSFET die source contact is flipped toward the footprint side of the package, which is then soldered to the PCB. In addition, the concept comprises an improved clip design on top of the chip for the drain contact and market-leading chip-to-package area ratio.

As system form factors continuously shrink, two key aspects are essential: reduction of power losses and optimal thermal management. Compared to best-in-class PQFN 3.3 x 3.3 m² Drain-Down devices, the family improves the on-resistance (R DS(on)) by up to 35 percent. Infineon's OptiMOS Source-Down PQFN with Dual-Side Cooling provides an enhanced thermal interface to redirect power



losses from the switch towards the heatsink. Dual-Side Cooling variants offer the most direct way to connect a power switch to a heatsink, increasing power dissipation capability by a factor of up to three compared to the corresponding Bottom-Side Cooled Source-Down variant.

www.infineon.com

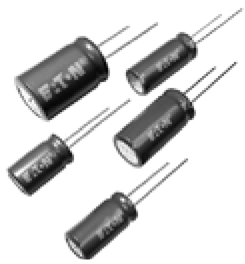
Battery Protector Series to Include 60 A Rating to Prevent Battery Pack Damage

Littelfuse announced the extension of its ITV9550 surface-mountable Li-ion battery protector series. These fuses safeguard battery packs against overcurrent and overcharging (overvoltage) conditions. The latest ITV9550 addition provides a 60 amp, three-terminal fuse in a 9.5 x 5.0 mm footprint. The innovative design incorporates an embedded fuse and heater elements that provide fast response and reliable performance to interrupt the battery pack's charging or discharging circuit before an overcharge or overheating condition occurs. "These new released parts are 60-amp rated devices, which extend our ITV line of li-ion battery pack protection fuses to provide more options for electronics designers," said Stephen Li, Global Product Manager at Littelfuse. "Expanding our portfolio of surface-mountable, three-terminal battery pack protectors enables us to provide this innovative solution to an even broader range of consumer and industry applications."

www.littelfuse.com

Hybrid Supercapacitors Available with Capacitances of 10 F, 25 F and 150 F

EATON offers energy storage devices with particularly high capacity for reliable use in emergency power supply, pulse power and hybrid energy systems with the HS / HSL hybrid supercapacitors, available at Rutronik24. Their flexibility is particularly impressive: they can be used as a stand-alone energy storage device or in combination with batteries to optimize costs, service life and operating time. System requirements can range from a few microwatts to hundreds of watts. Their operating voltage of 3.8 V provides high energy, while the low ESR ensures high power density. Low self-discharge makes them ideal for use in combination with batteries. Low temperatures down to -25 °C are part of the application range of the HSL supercapacitors. On the other hand, the HS variant has an extended temperature range of up to +85 °C. The capacitors are also lead-free, halogen-free and RoHS-compliant.

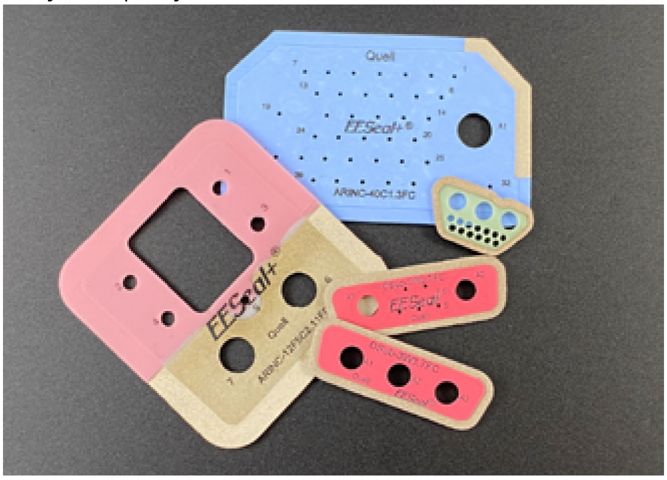


Further fields of application include industrial backup / ride-through, backup for IT server, smart water and gas meters, IoT energy storage, medical emergency power supply / alarm systems and truck / container asset tracking.

www.rutronik24.com

EMC Filters Offer Attenuation and Simple Grounding

Powell Electronics is stocking Quell's EESeal+ EMI filter inserts with improved attenuation and frequency mitigation. The inserts are easily and quickly inserted into standard connectors in seconds without the need for any special tooling or soldering, forming an effective EMI filter and maintaining the environmental seal. Customized samples are available at very short lead times.



The products benefit from Quell's patented EESeal+ technology which uses EMC filter components embedded into a silicone rubber insert that matches the size, shape and pin configuration of the connector to be filtered. Transient suppressors can also be included. Users can specify which filter elements are required for each pin, allowing for the creation of a completely custom filter insert with widely varying capacitor values, shorts and opens as desired.

The EESeal+ technology benefits from lower contact resistance and lower inductance than standard EESeals due to the improved ground plane. Peak attenuation is around 45-50dB and customers have seen frequency mitigation as high as 100GHz. In addition to EMI filters the EESeal+ filters make it easy to ground pins to the shell such as the coaxial shields in Combo D-Sub connectors as well as ARINC and coaxial circular connections.

www.powell.com

GaN FETs for DC-DC Conversion, AC/DC SMPS and Chargers

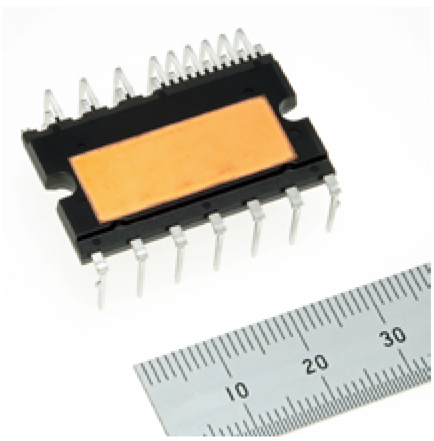
EPC introduces the 150 V, 3 mΩ EPC2305 and the 200 V, 5 mΩ EPC2304 GaN FETs in a thermally enhanced QFN package with exposed top and tiny 3 mm x 5 mm footprint. These devices are the lowest on-resistance (RDS(on)) FETs in the market at 150 V and 200 V in a size that is fifteen times smaller than alternative Si MOSFETs. In addition to offering devices with half the on-resistance and fifteen times smaller, QG, QGD, QOSS are more than three times smaller than Si MOSFETs and the reverse recovery charge (QRR), is zero. These characteristics result in switching losses that are six times smaller in both hard switching and soft switching applications. The driver losses are three times less than silicon solutions and ringing and overshoot are both significantly reduced.

For sinusoidal BLDC motor drives, these devices enable < 20 ns deadtime and higher frequency to reduce noise, minimize size to allow for integration with the motor, reduce the input filter and eliminate the electrolytic capacitors, and increase motor + driver efficiency more than 8% by eliminating vibrations and distortions. This makes them ideal for forklift, escooter, eMobility, robots, and power tool motor drives.

www.epc-co.com

Power Semiconductor Module Will Help to Simplify and Downsize Inverter Systems

Mitsubishi Electric Corporation announced that its SLIMDIP-Z power semiconductor module, featuring an extra-high 30A rated current for use in inverter systems of home appliances, will be released in February 2023. The compact module will enable the SLIMDIP™ series to meet a wider range of power and size needs for inverter units, specifically by simplifying and downsizing systems for multifunctional and sophisticated products such as air conditioners, washing machines and refrigerators.



The demand is growing for power semiconductors capable of efficiently converting electric power to help realize a low-carbon world. In 1997, Mitsubishi Electric commercialized its first DIPIPM™ as a high-performance intelligent power module with a transfer-mold structure incorporating a switching device and a control IC to drive and protect the switching element. Since then, DIPIPMs have been widely adapted for use in large appliances and inverters for industrial motors, contributing to the downsizing and energy-efficiency of inverter boards.

www.mitsubishielectric.com

Medical and Industrial Power Conversion Platforms

Advanced Energy Industries introduced two ranges of AC-DC power supplies for critical medical and industrial equipment. The SL Power™ NGB800 800 W and NGB1200 1200 W families are optimized to address the performance, power, size, reliability and compliance requirements of medical and industrial applications.

The power supplies combine compact form factors and typical efficiencies above 90%. With full medical and industrial safety and EMC approvals, they comply with IEC 60601-1-2 4th edition covering medical equipment and applications operating in heavy industrial areas.

"Medical and industrial OEMs want to reduce the size, improve the performance and extend the operating life of their equipment while minimizing time-to-market," said Conor Duffy, vice president of marketing, medical power products at Advanced Energy. "With their high efficiencies, small form factors, compliance with all relevant standards and long operating lives, the NGB family of power supplies enable equipment designers to address these challenging requirements. Deep engineering and integration support from Advanced Energy's technical teams further speed development cycles."

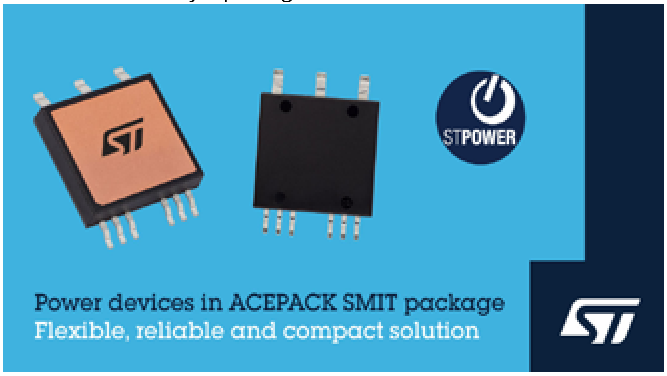
Designed to meet the lifetime reliability requirements of equipment ranging from medical imaging and patient monitoring to industrial automation, the NGB families offer an MTBF in excess of 500,000 hours and come with a three-year warranty. Long-term reliability is further supported by the specification of high-quality electrolytic capacitors with operating lives over seven years.

These power supplies can accommodate a wide 85 – 264 VAC input range and offer output voltages from 12 Vdc to 48 Vdc. Power supplies in the NGB800 family are convection cooled, while the NGB1200 units feature an integrated, low-noise fan.

www.advancedenergy.com

Automotive-Grade Devices Run Cooler in Surface-Mount SMIT Package

STMicroelectronics has introduced five power-semiconductor bridges in popular configurations, housed in ST's ACEPACK™ SMIT package that eases assembly and enhances power density over conventional TO-style packages.



Engineers can choose from two STPOWER 650V MOSFET half bridges, a 600V ultrafast diode bridge, a 1200V half-controlled full-wave rectifier, and a 1200V thyristor-controlled bridge leg. All devices meet automotive-industry requirements and are suitable for electric vehicle on-board chargers (OBC) and DC/DC converters, as well as industrial power conversion.

ST's ACEPACK SMIT surface mounted package delivers the easy handling of an insulated package with the thermal efficiency of an exposed drain. It allows direct-bonded copper (DBC) die attachment for efficient top-side cooling. The 4.6 cm^2 exposed metal topside of the ACEPACK SMIT permits easy attachment of a planar heatsink. This creates a space-saving low profile that maximizes thermal dissipation for greater reliability at high power. The module and heatsink can be placed using automated inline equipment, which saves manual processes and boosts productivity.

While minimizing the stack height and enhancing power density, the topside cooling design and 32.7mm x 22.5mm package footprint allow 6.6mm lead-to-lead creepage distance. The tab-to-lead insulation is 4500Vrms. The package also has low parasitic inductance and capacitance.

The SH68N65DM6AG and SH32N65DM6AG 650V-MDmesh DM6 MOSFET half bridges now available in ACEPACK SMIT are AQG-324 qualified. Their Rds(on) (max) of 41mΩ in the SH68N65DM6AG and 97mΩ in the SH32N65DM6AG ensures high electrical efficiency and low thermal dissipation. They can be used in DC/DC converters for both OBC and high voltage to low voltage section. Their multi-role flexibility helps streamline inventory and simplify procurement.

www.st.com

MOSFET for Light Electric Vehicles

Magnachip Semiconductor Corporation ("Magnachip") announced that the company has launched its eighth-generation 150V MXT Metal-Oxide-Semiconductor Field-Effect Transistor (MOSFET) optimized for Light Electric Vehicle (LEV) motor controllers and battery management systems (BMSs). This MOSFET (MDT15N054PTRH) features Magnachip's eighth-generation trench MOSFET technology to lower RDS(on) by 28%, as compared to the previous generation. Based on the enhanced design of the core cell and termination, a high figure of merit can be achieved and an increase in the total gate charge can be avoided. MDT15N054PTRH is available in a surface mount device TO-Leadless (TOLL) package to reduce product size and improve heat dissipation. The energy efficiency is also significantly enhanced by fast switching, while enabling high power density. In addition, a guaranteed operating junction temperature from -55°C up to 175°C and a high level of avalanche ruggedness help the new MXT MOSFET to exceed the performance requirements of LEV motor controllers and BMSs.

"Beginning in 2008 we have released more than 40 MOSFET products for motor controllers and battery management systems and, since 2017, most of them have been made for LEV applications," said YJ Kim, CEO of Magnachip. "As a provider of high-performance MOSFETs, Magnachip will continue to deliver innovative solutions that meet the sophisticated requirements of the market."

www.magnachip.com

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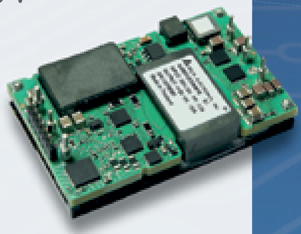

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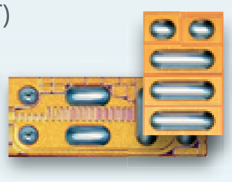
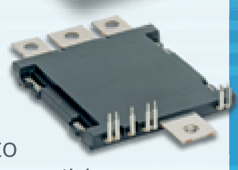
  - Bipolar Snubber and Welding diodes
  - Thyristors
  - Automotive modules (SiC + IGBT)





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September 4th - 8th , 2023
Aalborg, Denmark

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The European Power Electronics and Drives Association, in collaboration with its co-sponsor IEEE-PELS, is proud to announce that EPE’23 ECCE Europe will take place in the AKKC – the Aalborg Congress and Culture Center from September 4th to 8th, 2023. In addition to the regular topics, EPE’23 ECCE Europe will highlight six Focus Topics, with dedicated lectures and dialogue sessions, keynotes, exhibition, panel discussions, tutorials and technical visits.

Paper submissions in line with these Focus Topics are highly encouraged.

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Important dates

March 2nd, 2023: Provisional Paper Submission
April 26th, 2023: Acceptance Notification
June 1st, 2023: Final Paper Submission

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