PRODUCT AND TECHNOLOGY NEWS FROM FUTURE ELECTRONICS

FTM

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AMERICAS' EDITION

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FUTURE ELECTRONICS

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APPLICATION SPOTLIGHT

High-Density AC/DC Power Supplies Housed in Low-Profile Open-Frame Packages

CUI INC

Featuring high power densities up to 30W/in³, the VOF series of AC/DC power supplies from CUI's Power Group offers efficiency up to 94% and supports loads of up to 550W continuous power.

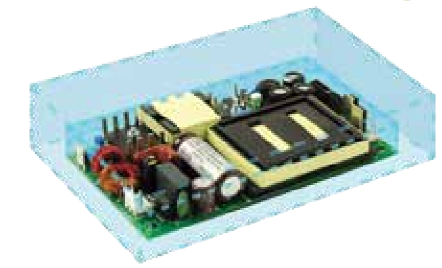
The VOF-180 series, rated for 180W, has an open-frame package with an industry-standard 2" x 4" footprint and is 0.75" high. The 2" x 4" VOF-225A with a 225W rating is 1" high.

The 275W, 300W, 350W and 550W models, the VOF-275, VOF-300, VOF-350 and VOF-550 series, are housed in 3" x 5" packages. The VOF-275 is 0.75" high, the VOF-300 1.18", the VOF-350 1", and the VOF-550 is 1.5" high.

The power supplies support efficient operation in standby mode, consuming no-load power as low as 0.5W.

Output-voltage options range from 12V to 58V DC. The power supplies handle a universal input-voltage range of 80V to 264V AC.

Certified compliant with the UL/EN 60950-1 safety standards, the VOF series parts also satisfy the requirements of the EN 55032 B specifications for conducted and radiated emissions.



FEATURES

- Power factor correction
- 12V DC/500mA fan output
- Over-voltage protection
- Overcurrent protection
- Short circuit protection
- 3.37 million hours MTBF calculated in accordance with Telcordia SR-332 issue 3
- Operating temperature range: -40°C to +50°C at full load with forced-air cooling

APPLICATIONS

- Industrial systems
- Telecoms equipment
- IT equipment
- Consumer electronics

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DC/DC Converters Ideal for Renewable Energy Applications

CUI INC

The AE series, available in board mount, chassis mount, and DIN rail mount configurations, offers power ratings of 5W, 10W, 15W and 40W with input voltages up to 1500Vdc and input ratio ranges up to 10:1.

Designed for reliable operation in renewable energy applications such as solar power equipment, wind turbines, and electric charging stations, the new models feature 4000 Vac input to output isolation and a wide operating temperature range of -40°C up to +70°C at full load. The series is also rated to operate at up to 5000 meters, allowing it to support remote, high altitude installations.

These new isolated DC/DC converters are housed in fully encapsulated packages for use in harsh environments with measurements beginning at 2.75 x 1.89 x 0.93 inches (70 x 48 x 23.50mm). Output voltage options of 5, 9, 12, 15, and 24Vdc are available, depending on the series, including efficiency ratings up to 84%. Standard is the protection for over-voltage and overcurrent, as well as continuous short circuit with automatic recovery.

The AE series further carries EN 62109 safety approvals and is rated to meet CISPR22/EN55022 Class A limits for conducted and radiated emissions, while the AE-UW series holds an additional UL 1741 safety approval.

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FEATURES

- Wide operating temperature
- 4kVac isolation
- Wide input voltage range

APPLICATIONS

- Solar power equipment
- Wind turbines
- Renewable energy applications

Altech® CBI All-in-One UPS Power Solutions

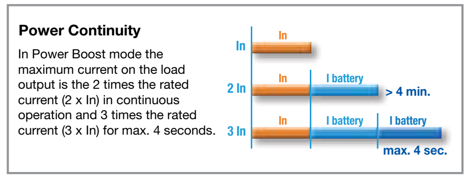
Altech Corp.®

Altech® CBI All-in-One UPS Power Solutions Combine Power Supply, Battery Charger, Battery Care Module, and Backup Module in Single Device

CBI all-in-one UPS power solutions from Altech Corp.® combine multiple functions in a single device for use as a power supply unit, battery charger, battery care module, or backup module. This "intelligent" device is compatible with a range of common battery types and is fully equipped with a real-time diagnostics system to continuously monitor battery status, charging levels, and potentially emerging battery faults. The CBI device ultimately will suit any battery-power application in any industry or setting where battery reliability is essential and the availability of backup power is critical.

The CBI DC-UPS (Uninterruptible Power Supply) device is available in $12V_{DC}$, $24V_{DC}$, and $48V_{DC}$ output versions for pairing with conventional battery types including open lead acid, sealed lead acid, lead gel, and Ni-Cd (as an option). The device features three charging levels (Recovery, Boost, or Trickle), allows for adjustment of charging current (from 20% to 100% of output current), and automatically and ideally distributes available power among load and battery. High efficiency up to 91% is achieved through switching technology.

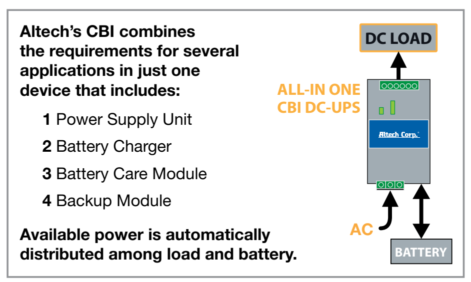
The device's battery-charging function is microprocessor-controlled and uses algorithms to detect a battery's condition and then choose the appropriate charging mode. Real-time diagnostics enable easy battery diagnosis and fault identification (displayed by LED) to protect against potentially occurring faults, such as short circuit, inverted polarity, overload, or disconnection of the battery. If the CBI device ever becomes disconnected from the main power source, the battery will serve to supply the load until battery voltage reaches 1.5V per cell, preventing deep battery discharge.



The CBI device performs over a wide temperature range from -40°C to +70°C (-40°F to +158°F) and is housed in a compact and rugged DIN rail mounted metal case offered in three sizes.

This power solution builds upon and expands Altech's extensive line of dedicated CB battery chargers, which feature the same advanced automatic diagnostics, charging level options, and protection against potential faults. All Altech power solutions meet relevant safety and EMC product standards.

The all-in-one device is covered by a three-year warranty and custom products can be developed to meet particular application requirements.



FEATURES

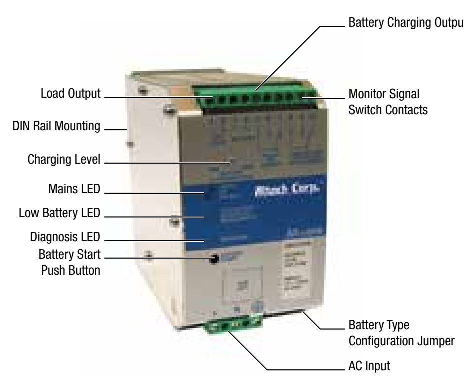
- Three charging modes
- Several output protection modes
- Compact, rugged metal case
- Available in $12V_{DC}$, $24V_{DC}$ and $48V_{DC}$
- Suitable for most common battery types
- Three charging modes
- Adjustable charging current
- Easy battery diagnosis and fault identification either by LED or external devices connected to fault
- Status contacts
- High efficiency up to 91% through switching technology
- Several output protection features such as short circuit, overload, deep battery discharge, etc.
- DIN rail mounting
- Deep discharge protection

BENEFITS

- Power supply, battery charger, battery care module and backup module in one device
- Universal input voltages upto 277V AC
- Large variety of output voltages and power options
- Small size
- 3-year warranty

APPLICATIONS

- Industrial water pumping
- Light security
- Marine applications
- Motorway light message boards
- Portable equipment
- Power supply continuity
- Remote measurement station
- Security doors for banks
- Security systems
- Security vision control
- Telecommunications
- Waterworks control
- Wireless control



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PMICs for Hearables: Lowest Standby Power and High Efficiency at Less Than Half the Size

maxim integrated™

Size is critical for hearables and wearables as they continue moving to smaller form factors. Most PMICs for these small, lithium-ion battery-operated devices require additional components, such as boost, buck, and low dropout (LDO) regulators; a charger; and current regulators for LED indicators.

Designers of Bluetooth® headphones, activity monitors, smart garments, smartwatches, and other size-constrained devices can now increase battery life and efficiency using the MAX77650/MAX77651 power management ICs (PMICs) from Maxim Integrated.

For space savings and efficiency, Maxim has integrated all these functions into a complete power solution that is only 19.2mm²—less than 1/2 the size of existing solutions.

The MAX77650 and MAX77651 feature single inductor multiple output (SIMO) buck-boost regulators that provide three independently programmable power rails using a single inductor, 150mA LDO, and three current sink drivers to reduce overall component count and maximize available board space. For design flexibility, the MAX77650 operates up to 3.3V and the MAX77651 operates up to 5V—both include an analog multiplexer output for safe battery monitoring, making them ideal for tiny, low-power designs.

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BENEFITS

- Ultra-low power: 0.3μA standby current, 5.6μA operating current
- High efficiency: 3-output SIMO channels plus LDO extend Li+ battery life
- Smallest solution size: multi-channel SIMO regulator significantly reduces component count and board space
- Available in a tiny 2.75 × 2.15 × 0.7mm wafer level package (WLP)

Read the Design Solution:
Hearables Get Longer Life with SIMO
at http://bit.ly/HEARABLES

Ultra-Low Dropout 150mA: Supports Wide Input Voltage Range with Fixed Output Voltages

DIODES INCORPORATED

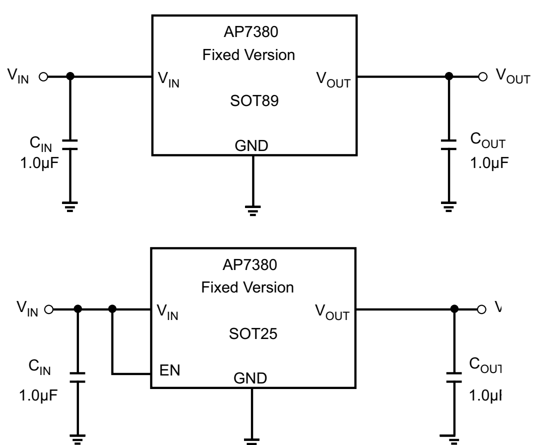
The AP7380 series of ultra-low dropout regulators introduced by Diodes Incorporated operates from a wide 24V input voltage range and offers various fixed output voltage options to address common system requirements. These features, combined with high accuracy and an ultra-low quiescent current, make this device well-suited for use in various USB power, portable equipment, consumer, instrumentation and metering applications.

The AP7380's wide 3.5V to 24V input voltage range enables operation from standard 5V, 9V and 12V system power rails with sufficient overhead to cope with supply transients. Regulated output voltage variants at 3.0V, 3.3V, 4.15V, 4.4V and 5.0V are offered, supporting common point-of-load requirements. The device provides excellent line/load regulation, maintaining a room temperature output accuracy of 1.0% under all I/O voltage conditions up to a maximum rated load current of 150mA.

The ultra-low dropout performance of the AP7380 is typified by a dropout voltage of just 250mV at an output voltage of 5V and load current of 50mA, while the device's low quiescent current of 1.8µA minimizes standby power and extends the operating life of battery-powered equipment. The AP7380 also integrates a thermal shutdown function to protect equipment from over-temperature conditions.

The AP7380 series is offered in SOT25 and SOT89 packages.

Typical Application Circuit



FEATURES

The AP7380 maximizes system run times with its extremely low quiescent current.

- Wide input voltage: 3.5V to 24V
  - Covers 5V, 9V and 12V power rails with good transient withstand
- Wide fixed output voltage variants: 3.0V, 3.3V, 4.15V, 4.4V and 5.0V
  - Covers standard I/O voltage levels
- Low quiescent current at 1.8µA
  - Extends battery life battery operated products
  - Minimizes standby power in low-power systems
- Two pin-outs in SOT25
  - Matches industry standard footprints
  - Enable function on one extends battery life even further
- 1% output accuracy at room temperature
  - Maintains accuracy under all conditions
- Built-in over-temperature protection (OTP) function:
  - Protects system from over-temperature conditions

APPLICATIONS

- Battery-powered equipment
- Portable
- Instrumentation
- Ruggedized PC/tablets
- Notebook computers
- Home appliances
- eMeters

Product Portfolio

Part Number	V_{IN} (V)	V_{out} (V)	I_{out} (mA)	V_{DROP} at Full Load (mV)	I_Q (µA)	Output Accuracy (%)	Enable	BYPASS Cap	Package
AP7380-XXY-13	3.5 to 24	3.0, 3.3, 4.15, 4.4, 5.0	150	1,100	1.8	1	No	No	SOT89
AP7380-XXW5-7	3.5 to 24		150	1,100	1.8	1	Yes	No	SOT25
AP7380-XXWR-7	3.5 to 24		150	1,100	1.8	1	No	No	SOT25

Infineon's 1EDN/2EDN EiceDRIVER™ and CoolMOS™ P7 MOSFET Families

infineon

Rugged, Cool and Fast, 1- and 2- Channel Low-Side 4/8A and 5A Gate Driver ICs

1- and 2- channel MOSFET gate driver ICs are the crucial link between control ICs and powerful MOSFET and GaN switching devices. MOSFET Gate driver ICs enable high system level efficiencies, excellent power density and consistent system robustness.

Fast, Precise, Strong and Compatible

- Highly efficient SMPS enabled by 5ns short slew rates and ±5ns and 10ns propagation delay precision for fast MOSFET and GaN switching
- Industry standard packages and pinout ease system design upgrades
- 1EDN: Separate source and sink outputs simplify the application design
- 2EDN: Numerous deployment options due to two 5A channels; 1ns channel-to-channel accuracy to use two channels in parallel

The New Reference in Ruggedness and Low Power Dissipation

- 4V and 8V Under Voltage Lock Out (UVLO) options for instant MOSFET protection during start-up and under abnormal conditions
- Cool driver ICs from true rail-to-rail low impedance output stages
- -10V robustness of control and enable inputs provides crucial safety margin when driving pulse transformers or, in the case of the 2EDN, driving MOSFETs in TO-220 and TO-247 packages
- 5A reverse output current robustness eliminates the need for Schottky switching diodes when driving MOSFETs in TO-220 and TO-247 packages and reduces bill-of-material

APPLICATIONS

- PFC
- Synchronous rectification
- DC/DC converters
- Telecoms
- Power tools
- Industrial SMPS
- Motor control
- Wireless charging
- Servers
- Solar

Power MOSFET with Optimized Balance of Ease-of-Use and Highest Energy Efficiency

The 600V CoolMOS P7 is the successor of the 600V CoolMOS P6 series, targeting a broad range of applications ranging from low power SMPS up to highest power levels.

The 600V CoolMOS P7 is Infineon's most well-balanced CoolMOS technology in terms of combining ease-of-use (e.g. low ringing) with excellent efficiency performance and reasonable price.

600V CoolMOS P7 achieves up to 1.5% better efficiency and 4.2°C lower MOSFET temperature versus competitor offerings. Its gate charge Q_g and E_{oss} are 30% to 60% lower compared to previous CoolMOS families and competition, which leads to reduced driving and switching losses that allow high efficiency in various power classes. Furthermore, the optimized $R_{DS(on)}$ enables smaller footprints and higher power density.

	Product	Package Name	UVLO	Features
2EDN Gate Driver*	2EDN7524F	PG-DSO-8	4V	Non-inverting
	2EDN7523F		4V	Inverting
	2EDN7424F		4V	Non-inverting
	2EDN8524F		8V	Non-inverting
	2EDN8523F		8V	Inverting
	2EDN7524R	PG-TSSOP-8	4V	Non-inverting
	2EDN7523R		4V	Inverting
	2EDN7424R		4V	Non-inverting
	2EDN8523R		8V	Inverting
	2EDN8524R		8V	Non-inverting
	2EDN7524G	PG-WSON-8	4V	Non-inverting
	2EDN7523G		4V	Inverting
1EDN Gate Driver**	1EDN7512B	PG-SOT23-5	4V	–
	1EDN7511B	PG-SOT23-6	4V	–
	1EDN8511B		8V	–
	1EDN7512G	PG-WSON-6	4V	–

* 2EDN Topology = Low side (dual) ** 1EDN Topology = Low side (single)

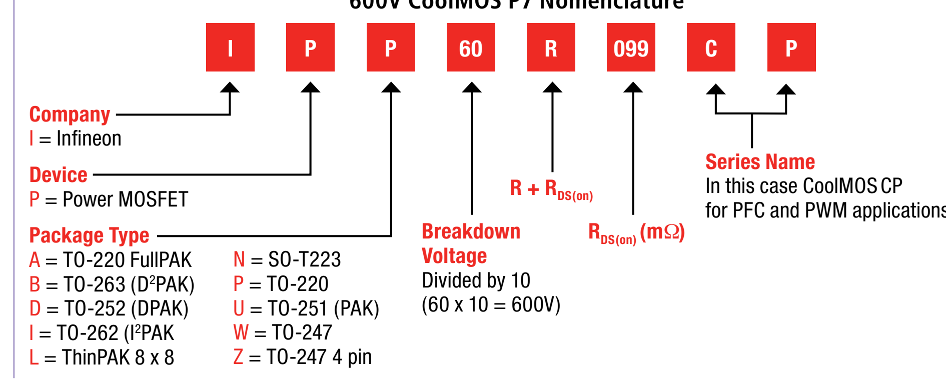
FEATURES

- Outstanding commutation ruggedness
- Optimized balance between efficiency and ease-of-use
- Significant reduction of switching and conduction losses
- Excellent ESD robustness >2kV (HBM) for all products
- Better $R_{DS(on)}$/package products compared to competition enabled by a low $R_{DS(on)}$ x A (below 1Ω x mm²)
- Large portfolio with granular $R_{DS(on)}$ selection qualified for a variety of industrial and consumer grade applications

BENEFITS

- Suitable for hard and soft switching (PFC and LLC)
- Ease-of-use and fast design-in through low ringing tendency and usage across PFC and PWM stages
- Simplified thermal management due to low switching and conduction losses
- Higher manufacturing quality due to >2kV ESD protection
- Increased power density solutions enabled by using products with smaller footprint
- Suitable for a wide variety of applications and power ranges

600V CoolMOS P7 Nomenclature



Superior Performance with ON Semiconductor's SuperFET® III MOSFET

NEW PRODUCT INTRODUCTION

ON Semiconductor®

SuperFET III MOSFET is ON Semiconductor's brand-new high voltage super-junction (SJ) MOSFET family that is utilizing charge balance technology for outstanding low on-resistance and lower gate charge performance. This advanced technology is tailored to minimize conduction loss, provide superior switching performance, and withstand extreme dv/dt rate.

Consequently, SuperFET III MOSFET is very suitable for the various power system for miniaturization and higher efficiency. SuperFET III FRFET® MOSFET's optimized reverse recovery performance of body diode can remove additional component and improve system reliability.

Check out ON Semiconductor's Power Supply Web Designer to get started with your power design.

FEATURES

- Higher system reliability in LLC and phase shift full bridge circuit
- Higher system reliability at low temperature operation
- Excellent body diode performance (robust body diode)
- Lower peak Vds and lower Vgs oscillation
- Low effective output capacitance
- Lower switching and conduction losses
- 100% Avalanche tested

APPLICATIONS

- Server and telecom power
- EV charging stations
- Solar/UPS
- LED lighting

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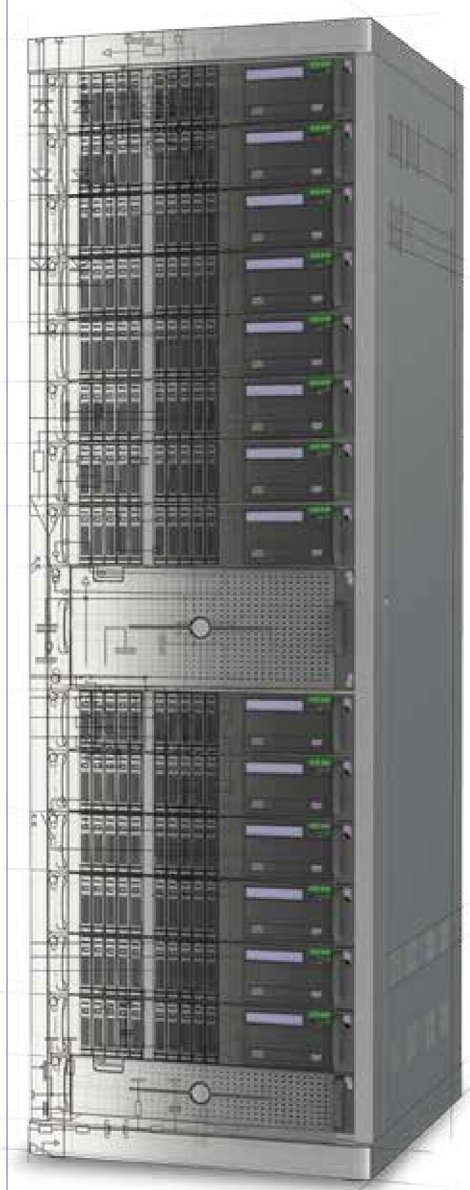
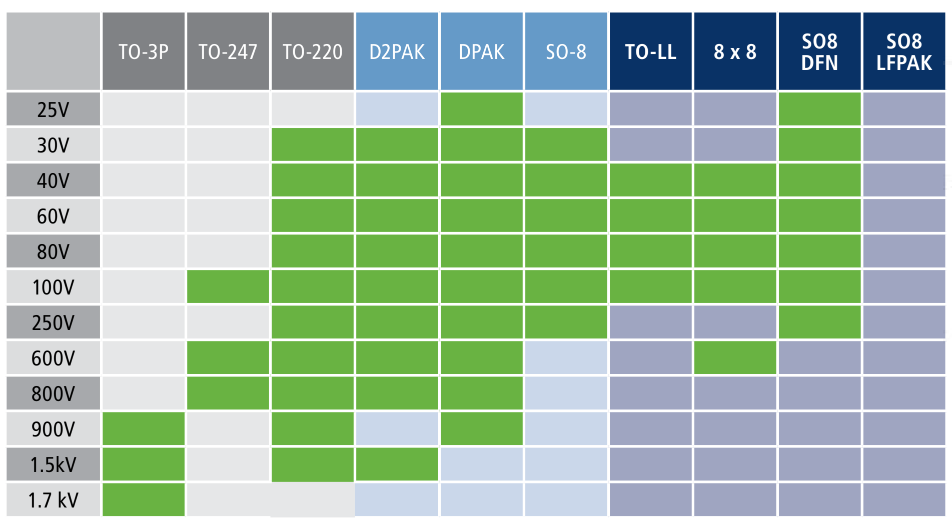
THINK ON.



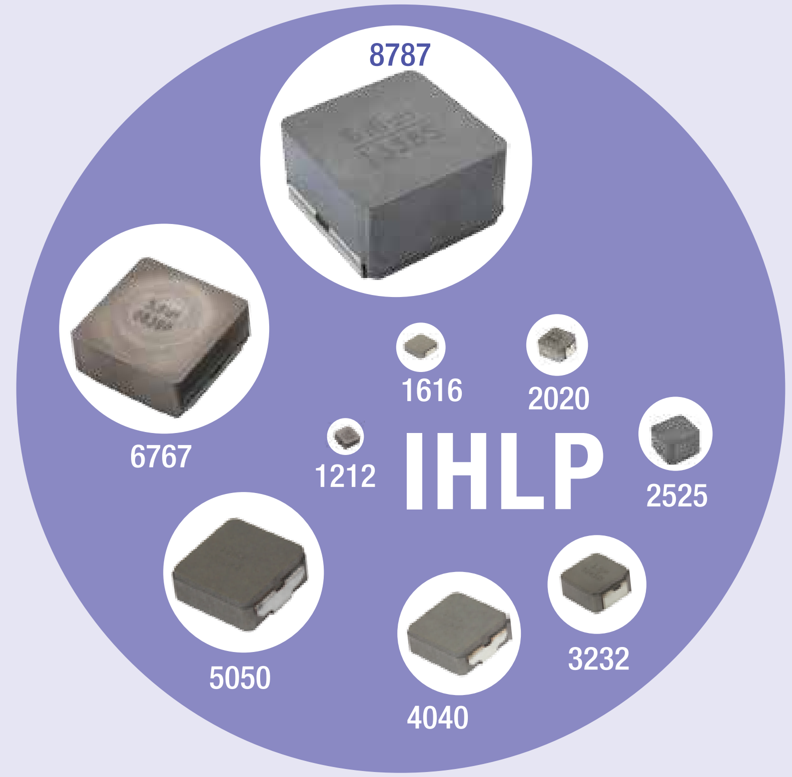
Product	Description	Voltage (V)	Current Ma (A)	$R_{DS(on)}$ (mΩ)
NTH027N65S3F	SuperFET III FRFET MOSFET	650	75	27.4
NTP082N65S3F	SuperFET III FRFET MOSFET	650	40	82



In addition to super-junction MOSFETs, ON Semiconductor also provides a comprehensive set of standard MOSFETs. This table shows the standard MOSFET portfolio as a result of organic growth and acquisitions. This coverage enables ON Semiconductor to compete directly against all voltages and packages.

VISHAY. IHLP® POWER INDUCTORS IN A NUTSHELL

LOW-PROFILE POWER INDUCTORS



NINE FOOTPRINTS AVAILABLE WITH A VARIETY OF HEIGHT OPTIONS

Size	Current rating for 1 µH (A)	Foot-print (mm)	Profile	Profile height (mm)
1212	4.5	3 x 3	AZ, AB, BZ	AZ = 1.0 AB = 1.2
1616	4.5	4 x 4	AB, BZ	AH = 1.8 BZ = 2.0
2020	9.2	5 x 5	AB, BZ, CZ	BD = 2.4
2525	13.0	6 x 6	AH, BD, CZ, EZ	CZ = 3.0 CE = 3.5
3232	18.0	8 x 8	CZ, DZ	DZ = 4.0
4040	20.0	10 x 10	DZ	EZ = 5.0
5050	32.0	13 x 13	CE, EZ, FD	FD = 6.4
6767	48.0	17 x 17	DZ, GZ	GZ = 7.0
8787	69.0	22 x 22	MZ	MZ =13.0

APPLICATIONS

DC/DC converters
- Power supplies for computers, notebooks, graphic cards, servers

Class "D" amplifiers
- LCD TVs and portable MP3 speakers

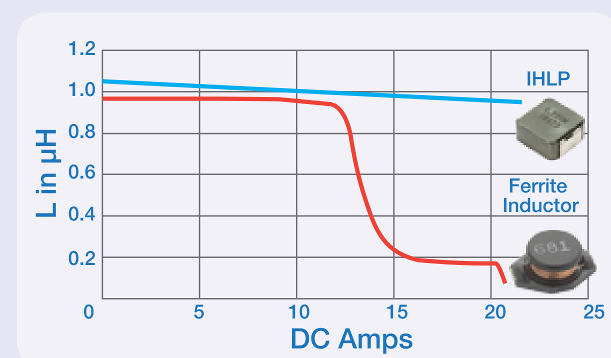
LED driver power
- Commercial LED lighting
- LCD display backlights

Automotive
- DC/DC converters
- Filters for noise suppression

All currently available IHLP footprints meet or exceed AEC-Q200 Grade 0 and Grade 1 requirements

For more information or to buy products, go to **www.FutureElectronics.com/FTM**

SATURATION – IHLP VS. FERRITE INDUCTOR



Four Different Material Types	Commercial Series	Automotive Grade Series
Original Series	IHLP - 01	IHLP - A1
Low DCR Series	IHLP - 11	IHLP - 1A
High Temp Series (+155°C)	IHLP - 51	IHLP - 5A
High Temp Series (+180°C)	IHLP - 81	IHLP - 8A

IHLP	2525	CZ	ER	1R0	M	01
Series	Footprint (in)	Profile (mm)	Pb free/ Packaging	L (µH)	L Tol	Material/Special

AEC-Q200 Certified Flyback Transformer Targets Demanding High Temperature Automotive and Industrial Applications

TT Electronics

The high isolation voltage HA00-10043ALFTR transformer provides reference design compatibility with Broadcom (Avago) ACPL-32JT and ACPL-302J optocoupler ICs

The HA00-10043ALFTR flyback transformer offers high voltage isolation between primary and secondary windings, coupled with AEC-Q200 Grade 0 automotive certification and an operating temperature specification of -40°C to +155°C; this transformer is ideal for use in harsh automotive and industrial environments, such as near a vehicle's powertrain.

The HA00-10043ALFTR is specifically designed to comply with the regulatory safety requirements stipulated for use with Broadcom (Avago) ACPL-32JT and ACPL-302J optocoupler ICs. Additionally, the superior quality of TT Electronics' magnetics products ensures a high saturation current capability and low leakage inductance performance. Together with the transformer's small 12.0 x 12.5mm footprint and low 6.3mm profile, these features provide the perfect solution for high efficiency DC/DC converter applications.

The miniature construction of the HA00-10043ALFTR uses a compact wound bobbin mounted on a 10-pin small-outline (SO) style IC package that enables convenient surface mount assembly. It is supplied in tape and reel packaging in reel quantities of 550 pieces.

FEATURES

- +155°C operation
- AEC-Q200 grade 0 certified
- Small 12.0 x 12.5mm footprint
- High voltage isolation
- Developed for use with Broadcom/Avago IGBT Chipset ACPL-32JT and ACPL-302J

APPLICATIONS

- Transportation – powertrain, isolation IGBT gate drive application
- Industrial – switch mode power supply, automation system, DC/DC converters

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Keystone Battery Holders with PCB Connectors

KEYSTONE®

A broad, new selection of Keystone's popular plastic battery holders now includes the option to have holders with a PCB connector plug pre-installed to the end of 6" wires for simplified installations.

These durable battery holders are molded from Polypropylene or ABS with polarity tabs and markings to ensure proper polarity and connectivity. Spring contacts are made from steel with nickel plating. The new PCB connector plug is made from Nylon 6/6 with UL 94V-0, flammability rating. A mating PC mountable jack is also available.

These new holder selections accommodate a wide range of cylindrical batteries from all the major manufacturers; sizes include AA, AAA, CR2, 12V, as well as N cells. This series of holders is available for 1 to 4 cell configurations for each cell size. For ordering products with this connector installed, add a CN suffix to the standard part number being requested. The connector is also available in the Densi-Pak covered holder series which accepts AA and AAA cells.

FEATURES

- PCB connector plug pre-installed to the end of 6" wires
- For AA, AAA, CR2, 12V, N cylindrical batteries
- Quick and easy battery installation/replacement
- Retains battery securely
- Multi-cell holders wired in series
- Suitable for industrial and consumer product applications
- Mating PC Jack available

To buy products or download data, go to **www.FutureElectronics.com/FTM**

APPLICATION SPOTLIGHT

Ready-to-Use Lithium Rechargeable Batteries

VARTA

The ready-to-use battery solutions allow design engineers to quickly and efficiently complete new product development. The VARTA Storage CellPac LITE product range is comprised of ready-to-use 3.7V Lithium Rechargeable batteries with capacities ranging from 595mAh to 2260mAh. Part of this offering is the EasyPack series of batteries that are comprised of Lithium Polymer cells which are the very latest in battery technology.

CellPac LITE: A Range of Standard Lithium-Ion Preconfigured Packs Available for Various Applications

These cylindrical and prismatic ready-to-use lithium rechargeable batteries incorporate cell protection features such as over-voltage, under-voltage and overcurrent. They comply with the requirements of battery safety standard IEC62133.

Designing a Customized Battery Has Never Been So Easy

CellPac BLOX is a design service that provides engineers the possibility to create a custom battery solution through the use of various standard battery cells and Protection Circuit Modules (PCMs). These combinations have been reviewed and safety tested by VARTA to ensure a good fit and function between the cells and electronics.

CellPac PLUS Custom Lithium Rechargeable Design Service

CellPac PLUS is VARTA Storage's core design-to-manufacture battery design service. It was created to provide customers with the highest quality custom battery solutions. CellPac PLUS fits ideally to long-term high value projects where customized batteries are a must.

- Minimal design costs and nominal NRE
- Quick samples of custom battery solution
- Reduced time to market

APPLICATIONS

VARTA CellPac LITE and CellPac BLOX Products

- Surgical lights
- Dental lights
- Blood pressure monitoring devices
- Recorders
- A variety of health monitoring devices
- Suction units (CellPac LITE)
- Nerve stimulation products for healing (CellPac BLOX)
- Satellite tracking
- Handheld and thermal imaging cameras
- eTransactions and point of sale
- Handheld communications and radios

CellPac PLUS: Custom Products

- Infusion pumps
- DVT pumps
- Respirators
- Blood pressure meters
- ECG monitors
- Recorders
- Suction units
- Ultrasound devices
- Medical drills and tools
- Monitors
- Portable lights
- Heat sensing devices
- Walky talkies

FEATURES/BENEFITS

CellPac LITE: Off the Shelf Products

- UNDOT 38.3 transportation compliant/tested
- IEC62133/UL2054 certified/tested
- Off the shelf/distribution

CellPac BLOX: Semi-Custom Products

- Building block utilization to assemble semi-custom packs
- For smaller/mid volume usage
- Multi options
- Smaller minimum requirements
- Certification eligible

CellPac PLUS: Custom Products

- Full custom design support
- Full certification compliance eligible
- Full program management

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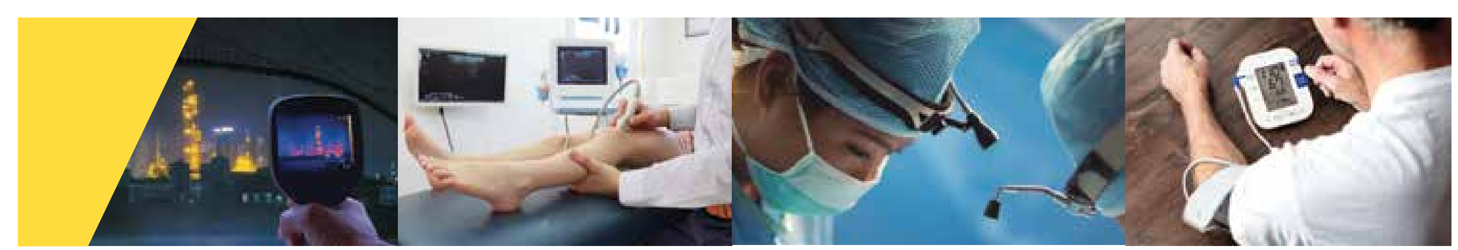


Microchip: Going to Extremes

MICROCHIP

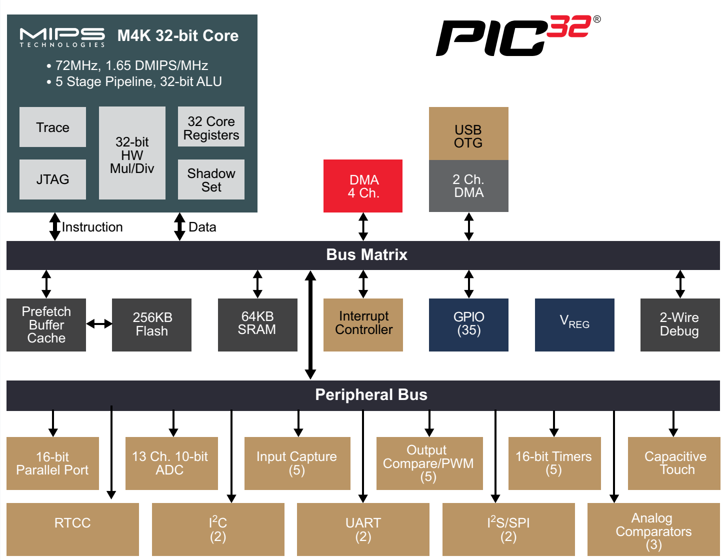
The high-performance PIC32MX family of microcontrollers from Microchip Technology now features eXtreme low-power technology. The low-cost PIC32MX1/2 XLP devices deliver increased performance at lower operating, Sleep and Deep-Sleep currents.

Energy conservation is a major concern to developers of today's connected applications. Wearable technology, wireless sensor networks and other smart connected devices need to consume as little power as possible and, in extreme cases, need to be able to run from a single battery for 20 years or longer. To enable these types of applications, Microchip offers a range of microcontrollers (MCUs) with eXtreme low-power (XLP) technology. These devices offer the industry's lowest currents for run and sleep, where extreme low-power applications spend 90% to 99% of their time.

If you have been successfully using Microchip's 32-bit PIC32MX family, you can now take advantage of XLP technology for your wearable and other low-power connected designs. The new PIC32MX1/2 XLP family offers you an easy migration path, with little code rework needed to achieve higher performance at much lower power. These MCUs deliver increased functionality as well as longer battery life in portable applications.

XLP technology enables Sleep and Deep Sleep shutdown states on the PIC32MX1/2 XLP MCUs, with Deep Sleep currents as low as 673nA. As a result, these new MCUs offer over 40% higher performance than devices in the existing PIC32MX1/2 portfolio, while reducing average run currents by 50%.

The low-cost family also offers a range of memory configurations with 128/256KB Flash and 32/64KB of RAM in packages ranging from 28 to 44-pins. They also include a diverse set of peripherals including I²S for digital audio, 116DMIPS performance for executing audio and advanced control applications, a 10-bit 1Msps 13-channel ADC, mTouch® capacitive touch-sensing and serial communications peripherals. The PIC32MX2 series also supports USB device, host and OTG functionality.



Block Diagram for PIC32MX Family with XLP Technology

Development Support

You can jump start your low-power application development with the PIC32MX XLP Starter Kit (DM320105). This fully integrated platform features a high-performance, 72MHz PIC32MX254F256 MCU with 256KB Flash, 64KB of RAM and Full Speed USB functionality. The PIC32MX XLP development board also includes an integrated programmer/debugger and is fully supported by MPLAB® X Integrated Development Environment (IDE). The starter kit also supports Bluetooth® Low Energy connectivity, and it comes with a 9-axis accelerometer, light sensor and barometric sensor to enable the development of a variety of Internet of Things (IoT) and other low power applications. The on-board mikroBUS™ expansion socket allows you to easily add a variety of click boards™ from MicroElektronika to expand the functionality of your design, while the Microchip X32 header will help accelerate your prototype development.

PIC32MX XLP Starter Kit (DM320105)

The PIC32MX1/MX2 XLP MCUs are also supported by the MPLAB Harmony Software Development Framework, which simplifies development cycles by integrating the license, resale and support of Microchip and third-party middleware, drivers, libraries and RTOSs. Microchip's readily available software packages, such as Bluetooth audio development suites, audio equalizer filter libraries, decoders (including AAC, MP3, SBC), sample rate conversion libraries and USB stacks, will significantly reduce your development time in creating digital audio, consumer, industrial and general-purpose embedded control applications.

The original article appeared in the Sept/Oct 2017 issue of Microchip's digital magazine, MicroSolutions.

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0.01%, 2ppm (TCR) and Unmatched Reliability

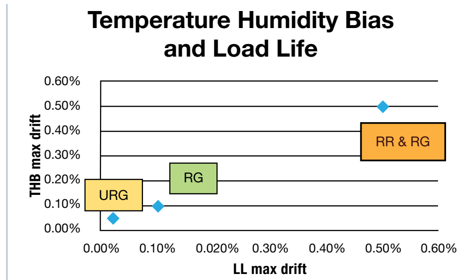
SSM SUSUMU
Thin Film Specialist and Innovator

Susumu's RG series, the best performing and most reliable thin film chip resistors in the market have gotten even better. The new URG series offers significant improvement in reliability as well as TCR linearity.

Electrical Characteristics

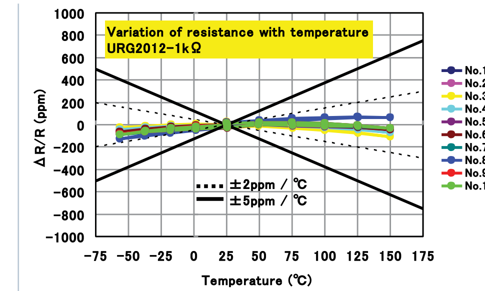
The URG series, like its cousin RGLL, boasts the industry's best absolute tolerance ±0.01%, and smallest TCR ±2ppm/°C, as thin film chip resistors. Because it is made of thin film, it maintains all the thin film advantages such as low noise (-25dB to -35dB) and frequency performance (up to 1GHz). In addition, the URG series shows superb linearity in TCR as shown.

Package size: EIA standard 0603, 0805 and 1206



Reliability

The RG series has excellent reliability and the URG's reliability is even better. For example, the maximum drift for load life (+70°C, 2000 hours) is specified as ±0.02% (RG ±0.05%), the humidity bias (85/85, 2000 hours) drift is specified as ±0.05% (RG ±0.1%, refer to the graph), the temperature cycle drift (-65°C/+150°C, 100 cycles) is specified as ±0.02% (RG ±0.1%), and the high temperature exposure (+155°C, 100 hours) drift is specified as ±0.02% (RG ±0.1%). The URG series is also highly stable under any environmental conditions including sulfuric atmosphere.



For applications that require extreme precision and reliability such as precision industrial instrumentation, test and measuring instrumentation, automotive electronics, and laboratory grade scales, now you have a choice among Susumu's highly precise and highly reliable resistor trio: RG-PV (0.02%, 5ppm), RG-LL (0.01% 2ppm), and the most advanced URG series (0.01%, 2ppm + ultra reliability).

To buy products or download data, go to **www.FutureElectronics.com/FTM**

New Design Support for USB Type-C Applications with ISL95338

RENESAS

The USB-C interface is revolutionizing the way we charge our electronic devices. Physically, the Type-C connector is both bidirectional (either end of the cable can be inserted into either device) and non-polarized (connector can go in either right side up or upside down). The connecting systems electrically figure out polarity as part of the connection process. In addition to data transfer, USB-C also supports bidirectional power flow at a much higher level. With a default 5V voltage, the USB-C port is capable of negotiating with a plugged-in device to raise the port voltage up to 20V, or another mutually agreed on voltage, and at an agreed to current level. The USB-C port's maximum power delivery is 100W (20V at 5A), which is more than adequate to charge most devices. With such appeal, it is easy to understand why electronics manufacturers are flocking to USB-C for their next generation products.

Compared to conventional USB Type-A and USB Type-B fixed voltages, USB Type-C is a bidirectional port featuring a variable input and 5V to 20V output voltage range. Its adjustable output voltage allows portable devices to use USB Type-C to replace the conventional AC/DC power adapter and USB Type-A and B terminals. Considering these advantages, some customers are designing in dual or multiple USB Type-C ports into their systems.

The current system architecture for dual or multiple USB Type-C ports is complicated and cannot meet many customer requirements. A new system architecture is now available using Intersil's ISL95338 buck-boost voltage regulator and ISL95521A combo battery charger. This architecture simplifies design and fully supports all USB-C functions.

A New Architecture for USB Type-C

Figure 1 shows a new USB Type-C architecture that consists of the ISL95338 bidirectional buck-boost (BB) voltage regulator and ISL95521A combo battery charger or ISL9238 BB battery charger. It allows a system to charge its battery through USB Type-C ports, and it supports the fast charge function when two PD chargers are plugged into USB-C_1 and USB-C_2. This new architecture also supports full USB 3.1 On-The-Go (OTG) for both ports without additional complex port-control logic circuits or ICs.

Comparing Figure 1 and Figure 2, it's easy to see that the current battery charger architecture requires more devices and complicated external circuitry to implement the same functions and performance level as Intersil's battery charger architecture. Obviously, with the current battery charger system, every individual charger path requires a USB-PD controller to control two ASGATE and perform the charge function, which increases the design's system cost. To implement 5V buck OTG, the OTG gate also needs a PD controller. Note that the current buck converter can only output a single fixed voltage. Figure 2 shows that if the 5V buck is adapted, designers can only output a fixed 5V, which doesn't match the adjustable 5V up to 20V OTG output voltage required by many USB Type-C applications.

Intersil product architecture overcomes all of these disadvantages. Figure 1 shows that two ISL95338 are in parallel to interface two USB Type-C ports to the ISL95521A battery charger. The system architecture is simplified, saving significant costs for customers because several components are eliminated, including individual PD controllers, ASGATE and OTG GATE. Most important, using fewer components does not degrade performance.

Programmable Power Supply Solution

In conventional USB Type-A and USB Type-B applications, the input voltage is a fixed value, which brings new challenges to USB Type-C because USB-C can also accept variable input voltages. The solution is the programmable power supply (PPS) function, which allows the power supply's output voltage and current to be programmed and adjusted in 20mV/50mA steps to optimize the power path. As shown in Figure 3, the ISL95338 buck-boost voltage regulator works well with PPS because it outputs an adjustable, bidirectional voltage using SMBus communication from the USB-PD controller.

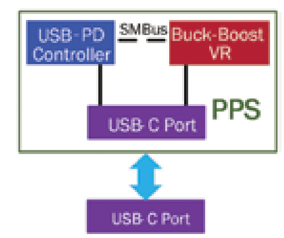


Figure 3: New Intersil PPS architecture

Applying the ISL95338 in a multiport USB Type-C battery charging system enables a new, easy to use charging architecture. Compared to today's currently available charging architecture, the Intersil product's new architecture can be implemented at much lower cost, and achieve higher performance, faster charging and longer battery life. Furthermore, all USB Type-C requirements are in full compliance, including the ability to address PPS, one of the key USB additions required for future applications.

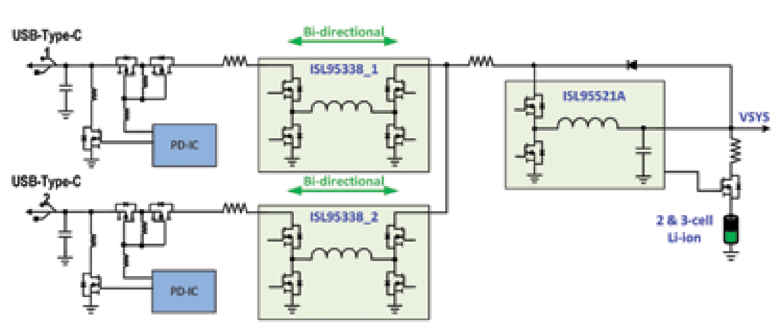


Figure 1: Intersil battery charger architecture–dual USB Type-C ports with 2x BB regulator + buck charger

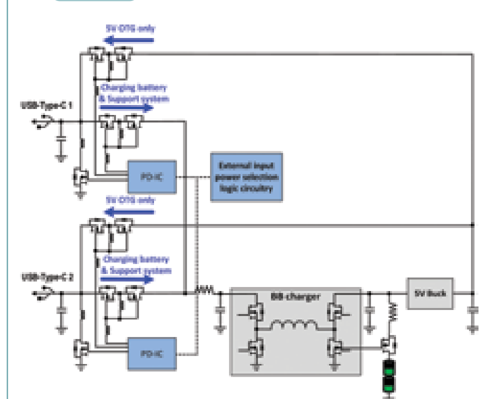


Figure 2: Current battery charger architecture–single BB charger + complicated external logic

Latest 15A, 42V Power Module Offers Highest Power Density POL Solution

RENESAS

The DC/DC buck converter is one of the most popular and widely used power supply topologies, finding applications in industrial, servers, telecom, and automotive sectors. The non-isolated buck converter also sees increasing use as a point-of-load (POL) solution to deliver power from a DC bus to individual POLs. It steps down the DC bus voltage to lower regulated output voltages. An ideal POL solution should be capable of supporting a wide range of input voltages while providing a stable operation at small duty cycles. For applications constrained by board space, a compact, higher power density design is required, and to minimize power losses and provide cost savings, high conversion efficiency is needed.

Discrete POL solutions involve careful selection of components, including inductor, MOSFETs and capacitors, and that requires an experienced power supply designer. In addition, the placement of the components on the PCB is crucial since they have a direct correlation with efficiency, noise and thermal performance. Compensation elements must be carefully selected to keep the converter stable across all operating conditions. This is a cumbersome task, especially if the system has multiple POL power rails. All of these factors can lead to longer design cycles and increased cost of ownership.

Power Module: A Simplified Approach

Power modules provide an alternative to the lengthy and arduous process of discrete power supply design by integrating all of the key components inside the package. Figure 1 shows that a power module is a complete power supply in a condensed package that requires only a few external components to function.

A power module includes the high-side and low-side MOSFETs, inductor, controller, and the compensation network. The customer typically only needs to select the input and output capacitors, along with a few resistors to complete the power supply design. Power modules offer several advantages:

- Higher integration offers increased power density to occupy less board space
- Shorter development times lead to reduced cost of ownership
- Higher reliability due to detailed manufacturer characterization
- Efficient thermal management due to better packaging technology
- Simplified PCB layout and reduced design complexity due to fewer external components
- Easier manufacturing and assembly process with direct placement on application boards

Achieving High Power Density

The ISL8215M is a first of its class single-phase power module supporting a wide input/output voltage range, while delivering up to 180W output power from a small 13mm x 19mm thermally enhanced High Density Array (HDA) package. This makes it one of the highest power density POL solutions. The input voltage can vary from 7V to 42V and the output voltage is adjustable from 0.6V to 12V, while allowing a programmable switching frequency from 300kHz to 2MHz.

As seen in Figure 2, the ISL8215M requires only a few external resistors and capacitors to form a complete power supply solution. Internal compensation networks are implemented to stabilize the converter and achieve an optimal transient response across the full range of input and output operating conditions.

The ISL8215M is able to operate from a 42V input rail, providing customers with extra input voltage safety margin. This makes it ideal for industrial applications. It is able to achieve a high conversion ratio (42V input to 1.2V/3.3V output) by employing valley current mode control with an input voltage feedforward ramp. This eliminates the need for blanking time (as is the case with peak current mode), making it possible to control very narrow on-time pulses and provide excellent transient performance.

The ISL8215M is a highly characterized, reliable power module, which requires a minimal number of external components for developing a complete power supply solution. Its advanced packaging technology provides an excellent thermal performance over a wide range of operating temperatures. And, its high power density in a small footprint is made possible due to the high efficiency of the module, which reduces power dissipation and increases the current rating of the device. A wide output voltage range from 0.6V to 12V enables the module to be an efficient POL solution, while also allowing for an intermediate 12V/5V bus voltage generation.

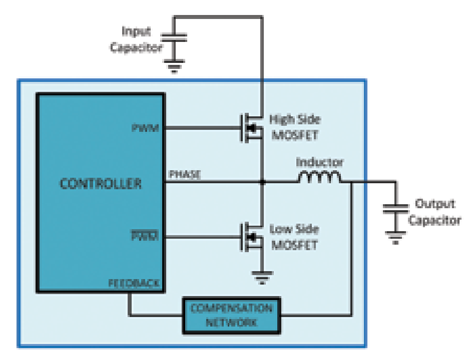


Figure 1: Inside the ISL8215M power module

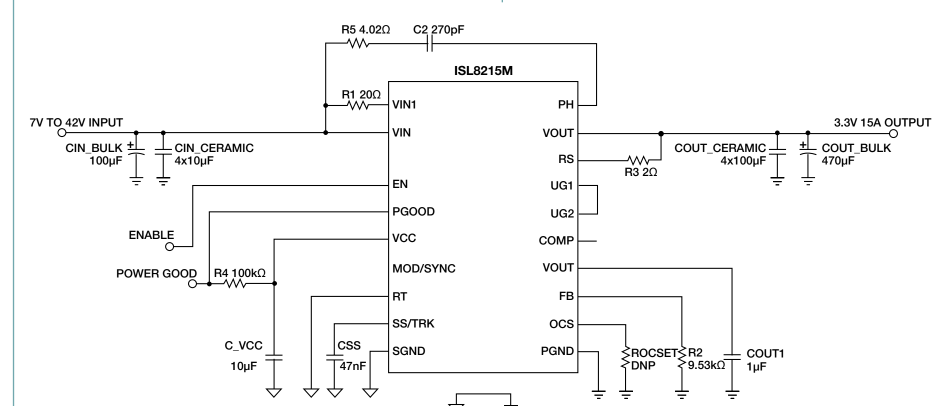


Figure 2: ISL8215M typical application circuit

DESIGN NOTE

Qrr – the Forgotten Parameter in Power Efficiency

By: Mike Becker, International Product and Marketing Manager, Power MOSFETs, Nexperia

nexperia

Low cost power supplies are used in abundance to power a wide range of consumer and industrial applications such as mobile phones, tablet computers, notebook computers, rechargeable power tools and LED lighting, to name just a few.

The efficiency of a power supply is often the most important major design factor, whether high efficiency is needed to meet legislative requirements, or also maybe to reduce the dissipated heat in order to facilitate a reduced form factor, e.g. size and weight. Choosing a synchronous MOSFET to meet all of the requirements can be a bewildering task.

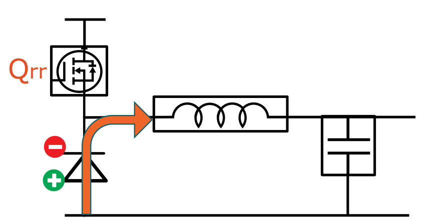
When selecting a MOSFET for a switching application, engineers often look at the obvious datasheet parameters first, e.g. what size and type of package is needed, what voltage is needed (don't ignore the spike!), and what is the maximum output current (determines the I²R losses at the rated load current, and hence the MOSFET's $R_{DS(on)}$ also).

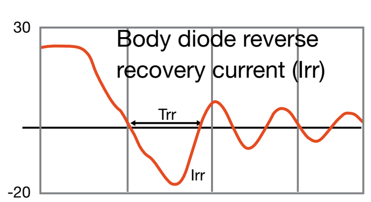
Maybe a few of the dynamic parameters will be considered also; for example, gate charge (Qg and Qgd) can be a good indicator of the expected gate losses. The Qg-FOM (figure of merit) is also a good indicator of a MOSFET's efficiency in a switching application, and the MOSFET's capacitance (Ciss, Coss, Crss) can help to indicate whether drain-source spiking and gate bounce will be an issue. Low capacitance can contribute to higher efficiency also.

There is another parameter, Qrr, which can generally be found lurking at the bottom of the datasheet and is often ignored. In applications where current flows through the MOSFET's body diode, for example, in a synchronous rectifier and in free-wheel applications, then the reverse recovery charge (Qrr) causes some significant issues as discussed below, which the design engineer needs to carefully address.

What is Qrr?

QRR is stored charge (measured in nC), and is caused by charge carriers accumulating in the body diode's PN junction when the diode is forward biased.



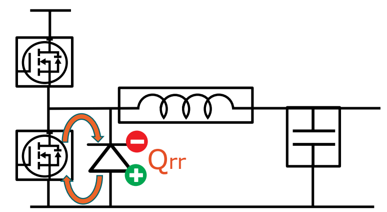


Beware of Qrr!

Due to the dead-time needed in most applications, current flows through the body diode twice for every switching cycle.

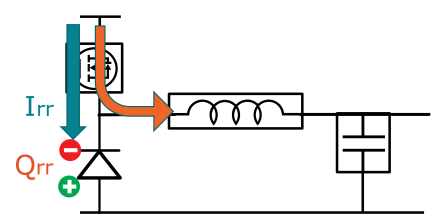
In the first instance, we can consider what happens just before the sync-fet is turned on. Since current will be flowing through the body diode during the dead-time, then some of the load current becomes trapped as stored charge (Qrr).

As the sync-fet is turned on, then the stored charge is dissipated internally within the MOSFET. Therefore, a proportion of the load current is lost due to the Qrr effect and becomes an I²R loss within the sync-fet.



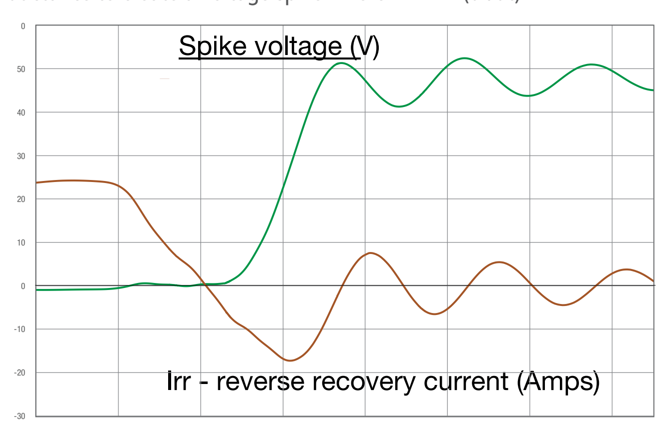
In the second instance, the MOSFET's body diode becomes reverse biased once again when the high-side MOSFET turns on. Additional current (Irr + load current) flows briefly through the high-side MOSFET until the stored charge (Qrr) is fully depleted. The charge depletion is not instantaneous, and the reverse recovery time (Trr) is also quoted on the datasheet.

Irr typically flows for a few tens of nS until Qrr is depleted. Irr results in additional I²R losses within the high-side MOSFET as per the following diagram:



VDS Spiking

Reverse recovery current (Irr) also interacts with the PCB's parasitic inductance to create a voltage spike where V = L x (di/dt).



The MOSFET should be suitably rated to ensure that the BVDS rating is higher than the maximum spike; typically an 80% derating is applied. An application with a measured 80V V-DS spike would typically require a MOSFET with BVDS of at least 100V.

Good PCB layout can reduce the parasitic inductance (L), and choosing a low Qrr MOSFET can help to reduce the di/dt also. If spiking is ignored, then this may result in a higher voltage grade MOSFET being required.

Gate Bounce

When VDS spiking occurs, then designers should also look for 'gate bounce' in their application. Since there is capacitance between all 3 terminals of a MOSFET, then any spiking at the drain pin will also be capacitively coupled to the MOSFET's gate pin. In extreme cases, if the 'gate bounce' exceeds the MOSFET's threshold voltage $V_{GS(th)}$ then the MOSFET can turn on.

Dead-time is usually applied in the gate drive circuits to ensure that the high-side and low-side MOSFET cannot be turned on at the same time. However, when gate-bounce occurs, then the low-side MOSFET is turned on at the same time as the high-side, causing 'shoot-through' current to flow between the power supply rails, resulting in excessive I²R losses and in extreme cases causing destruction of the MOSFET.

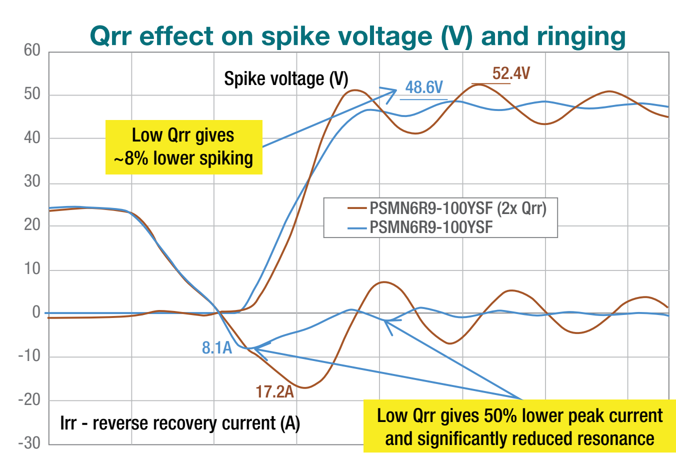
Benefits of Low Qrr MOSFETs

MOSFETs are not all the same! A quick comparison of MOSFET vendors' datasheet parameters for 100V MOSFETs with 4~8mΩ $R_{DS(on)}$ shows that there are dramatic differences in Qrr between different vendors.

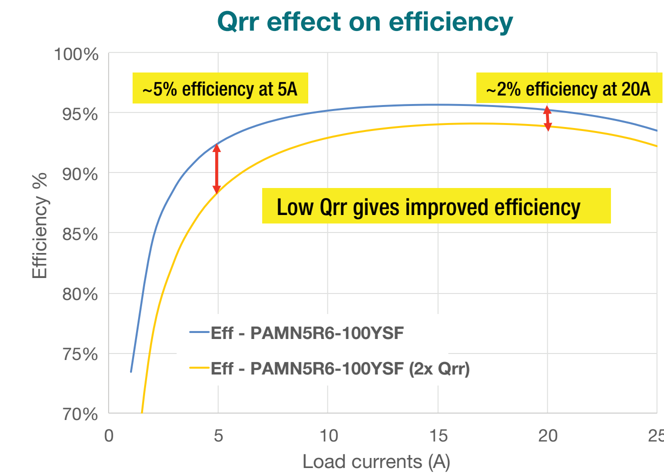
Other vendors are typically 130% to 300% higher Qrr than similar $R_{DS(on)}$ types with NextPower 100V technology.

Since it is difficult to measure the individual Qrr effects in a typical application, then we rely on simulations to model the effects instead.

Spice simulations for a 7mR MOSFET (PSMN6R9-100YSF) show that when Qrr is increased by 2x, the resultant spike voltage can increase by around 8%.



Choosing a MOSFET with low Qrr can also significantly improve the efficiency. Especially at low load current (<5 Amps), choosing a low Qrr MOSFET gives significant efficiency gains, since the dynamic losses are more significant than I2R losses in this portion of the efficiency curve.



Conclusion

In low-power chargers and adapters, where load currents are typically less than 5A, then there is less emphasis on I²R losses, and design engineers should pay more attention to the dynamic losses also.

In conclusion, choosing a MOSFET with low Qrr can result in lower spiking, improved efficiency and reduced EMI emissions.

NextPower 100V MOSFETs offer very low Qrr as well as competitive $R_{DS(on)}$, and are ideally suited to power supply applications.

Choose from:

LFPAK56	TO220	I2PAK
PSMN5R6-100YSF	PSMN8R5-100PSF	PSMN8R5-100ESF
PSMN6R9-100YSF	PSMN018-100YSF	PSMN018-100ESF
PSMN8R7-100YSF		

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Why are Power Designs Moving to 48V?

What you need to know

VICOR

Today's applications are increasing performance by adding:

- More processing capability
- Higher communication rates
- Longer run rates
- Added peripherals
- More torque
- Brighter LEDs

To deliver "more" requires more power to be delivered. More power typically is constrained by size and/or weight restrictions. This is why a growing number of industries are moving to higher voltage, 48V distribution versus conventional 12V distribution.

Why 48V?

I^2R losses in a system can be detrimental to system efficiency and can reduce the power flow to the load effectively given cable, connector, and/or PCB limitations.

As an example, processor power in servers has increased from sub-100W to 200W, 300W, and even higher. Distributing this increased power to multiple server processors creates more losses unless mitigated by higher voltage distribution or larger copper bus bars if possible. Not just servers, but any design with increased power will have increased losses to the square of the current.

Higher voltage distribution of power reduces the I^2R losses. For example, a 48V vs 12V power distribution scheme creates a 16X in power loss reduction. With such a reduction in loss, why would anyone use a low voltage (like 12V) power distribution scheme?

The answer is a higher voltage distribution scheme that can actually lower overall efficiency, create a higher cost, and increase size/weight when the higher voltage converters are compared to the lower voltage ones.

But these drawbacks in the converters are largely historical. Today, engineers can reduce I^2R losses and utilize higher voltage converters that enable efficiency, cost, and size/weight metrics comparable to or superior to those of lower voltage converters.

Telephony Started it All…

We can thank the development of the modern telephone and telephone exchanges for the earliest use of 48V. As you would expect, the communication industry standardized to, and still uses 48V today.

Why? It was more efficient because of lower voltage loss over distance (as a % of the operational voltage), smaller gauge wire requirements, simple battery backup (also the reason for negative reference 48V), and a voltage level considered to be safe.

What is the New 48V and is it Safe?

Many consider the usage of 48V outside the communication space as the "new 48V" since it is positive referenced, has no lightning or surge requirements, and has a more limited range of 30V to 60V typically.

Voltages below a 60V DC limit are considered Safety Extra Low Voltage or SELV, referring to their handling requirements compared to 12V usage. The 48V distribution scheme minimizes I^2R losses without creating SELV issues.

Where is 48V Being Used Today?

Today, it is widely documented that 48V is used in such areas as data centers, automobiles, LED lighting, industrial equipment, and even power tools. It is impossible to go through a typical day and not see/use several 48V applications; 48V is the new 12V.

Data Centers Blazing the "New 48" Path

Data centers and supercomputers are demanding power at the levels of small countries and efficiency is critical to these high performance computing centers. With surging interest in artificial intelligence, computing solutions are requiring processors that can keep pace with the increasing power requirements.

However, delivering the higher processor power presents physical challenges to power delivery and in trying to maintain efficiency using traditional 12V. Therefore, engineers have turned to 48V distribution to enable the higher levels of power distribution and overcome these challenges.

Google Adopts 48V

One example of 48V usage is by Google. Google engineers openly discussed the merits and cost savings of 48V within their data centers at APEC2017 (Applied Power Electronics Conference, 2017) and OCP2017 (Open Compute Project, 2017).

Another example of 48V adoption was highlighted at Supercomputing 2017, when the recent Green500 ranking was announced.

The Green500 ranks the most-efficient high performance computer systems. This year, four of the top five rankings were systems designed by PEZY, a Japanese company that deployed 48V distribution throughout their computer systems.

Commercial LED Panels Get Brighter, Cost Less

Ever wonder how much it costs to illuminate Times Square for a night? The size and power demands of those enormous, outdoor LED screens have grown exponentially in the last decade.

LED panels continue to increase in performance, delivering higher LED pixel density and brightness. Engineers designing these new panels are moving to 48V distribution, reducing the power cable size and weight while also increasing the efficiency.

In addition to enhanced efficiency, these larger installations are benefiting from reduced weight and ease of installation. Today a matrix of smaller panels are assembled together to create a single brighter, longer lasting display — which is easier to transport and install.

48V power distribution also provides lower cost and a safer alternative to AC distribution schemes used in retail store wall displays and transportation-hub informational displays.

Power Tools Clamor for More Torque

Consumer and professional battery-powered tools are following a similar trend, moving to higher voltages for more power. More power enables longer run times and higher torque for tools. Cordless tool batteries have progressed from ~9V to ~12V to ~18V to ~20V to ~24V, to now 48V and 60V.

Walk into any home center and you will find 60V battery tools from such well-known companies as DeWalt to lesser known newcomers like Greenworks. Likewise, you will also find lighter weight yard tools like Snapper's high performance 60V chainsaws and mowers.

Automotive is Driven to Adopt 48V

Mild hybrids are increasing fuel efficiency by 10% or more in vehicles with a modest addition to existing combustion-based vehicles. Automotive engineers, like those at Delphi, are using 48V power distribution schemes for mild hybrids to take some load off an internal-combustion engine by powering accessories during the "stop" phase of start/stop operation. Initial designs deployed a 12V only battery scheme, but the system couldn't adequately power all the cabin features during the stop phase. 48V has proven to be the most efficient alternative.

Powering Robotics and Industrial Equipment

Industrial equipment covers a wide range of products and 48V is being leveraged here for the same reason — more power.

- Kiva Systems, a robotic fulfillment system for large warehouses, is using 48V to support Amazon's warehouses.
- Advantest uses 48V to minimize wire size (more power through a smaller wire) within their ATE products.
- CAT offers 48V warehouse lift trucks. Process control, manufacturing equipment, and factory automation equipment are additional examples of 48V applications.

48V is the New 12V

If more power is needed, consider 48V. Engineers are finding the losses attributed by simply increasing power with 12V distribution are limiting their systems. Enhanced 48V converters/regulators today enable efficiencies, cost, and size/weight performance comparable to 12V counterparts. Many power designs are capitalizing on the additional benefits of replacing intermediate stage regulators with a single regulator that converts directly from 48V to the load voltage instead of first regulating to 12V.

48V DC/DC has increased over the past few years with several component suppliers offering 48V solutions. Vicor enables 48V DC/DC regulators and isolated converters pushing efficiency, density, and cost performance through several design assets including:

- High-efficiency switching topologies like zero-voltage switching
- 3D-packaging technology enabling high-density power packing like the SM-ChiP package

In addition, engineers designing their 48V systems have access to Vicor online selection/design tools, reducing design time and ensuring an optimized solution.

Generating Isolated Supplies for Industrial Applications Using the SiC462 in an Isolated Buck Topology

By: Ron Vinsant, Vishay Intertechnology, Inc.

Introduction

Industrial power applications typically require a high input voltage. Standard voltage rails are 24V, 36V, and 48V. The DC/DC step-down (buck) switching regulators and controllers used to power circuitry in industrial applications are required to provide the solid, reliable performance needed for environments subject to noise, power surges, and outages.

It's common for the power supply requirements in industrial systems to be quite complex. Galvanic isolation is often needed to meet safety standards, as well as to break ground loop interference for noise-sensitive applications.

For example, in new factory automation systems such as PLCs and I/O modules, an increasing number of I/O channels is driving higher sensing accuracy. As a result, isolation between different voltages is preferred for digital/analog signal isolation or channel-to-channel isolation to prevent noise interference from a common ground (see Figure 1).

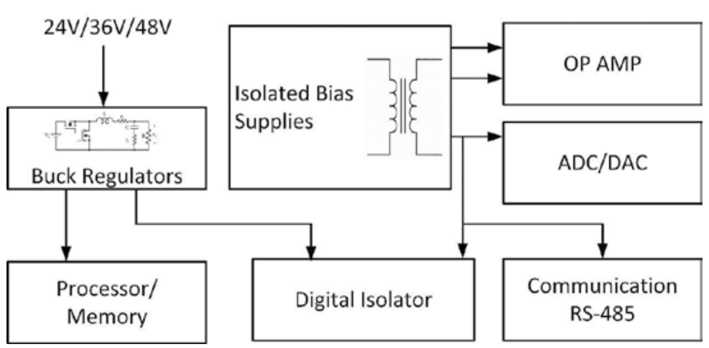


Figure 1

The traditional way to achieve these isolated supplies would be to use a flyback converter of the main supply to generate the various voltages needed by the bias supply. Flyback designs typically utilize asymmetric transformer turn ratios for primary and secondary power windings, with an optocoupler and reference, or an auxiliary winding for feedback regulation. Additionally, flyback converters need an elaborate compensation design for stability. This results in a tedious design process and a bulky solution with a higher component count and cost.

This article explores a simpler way to achieve isolated voltages without the use of a flyback topology.

Isolated Synchronous Buck Converter

An isolated buck converter uses a synchronous buck converter with coupled inductor windings to create isolated outputs (see Figure 2). Isolated converters utilizing this topology use a smaller transformer for an equivalent power transfer, as the transformer's primary and secondary turn ratios are better matched. There is no need for an optocoupler or auxiliary winding, as the secondary output closely tracks the primary regulated output voltage, resulting in a smaller solution size and lower cost.

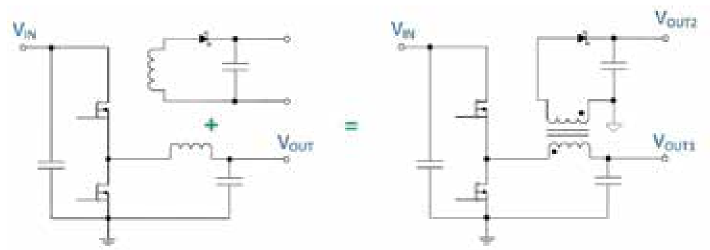


Figure 2: An isolated synchronous buck converter generating two outputs

This topology has several advantages including:

- Easy to generate, isolated positive and negative supplies
- The primary side supply is available to power loads that don't require isolation from V_{IN}
- Simplified design compared with the traditional flyback approach
- Fewer components and a smaller solution size compared to a flyback topology

To showcase the ease of designing such a power supply, we will use as an example the SiC462, which is the 6A member of a family of fully integrated synchronous buck regulators. These devices offer high power conversion efficiency and high power density with low electrical parasitics due to both excellent silicon (MOSFETs and drivers) and packaging design techniques.

The power stages used in this family can supply 3A to 10A of continuous current, depending on the model number. Their output voltage is adjustable from 0.8V to up to $0.9*V_{IN}$, with an input range from 4.5V to 60V. These devices offer such features as multiple power saving modes for very low output current operation, adjustable operating frequency, fast transient response, cycle by cycle current limiting, adjustable current limit, OVP, OTP, UVP, Power Good and enable signals, tracking, sequencing, an ultra-sonic mode for a minimum operating frequency of 25kHz to avoid audible noise, soft start, and the use of an all-ceramic capacitor solution for both input and output. This flexibility allows us to create a design that generates two outputs, one isolated, with well-regulated outputs.

The basic requirements for this design are:

- V_{IN}: 32V to 56V
- V_{OUT}: 12V at 2A and an isolated 5V at 1A (referred to as Iso +5)
- Min. load: 10% of full load values

The design is based on a buck regulator with a dual winding inductor. The "flyback" aspect of the inductor is used to generate another output. This is a continuous flyback design, as the SiC462 is always operating in full synchronous mode, even under no-load conditions. This is possible due to the "mode" feature of the regulator. This feature allows operation in different modes, depending on requirements. There are two modes: "power save," where the regulator can go into deep discontinuous operation with energy being transferred to the output only a few times per second, and "continuous mode," where energy transfer occurs in every switching cycle. The continuous operation is not as efficient at light loads; however, this mode of operation allows for an improved transient response and the ability to add flyback windings that are suitable at light or zero loads.

In Figure 3, the inductor, L1, consists of a high temperature powder toroidal core with 24-turn "primary" and 16-turn "secondary" bifilar windings. The design of this inductor was done specifically for this project (non-standard) and was built in our lab. Since the main regulator loop controls the voltage during the time the low side switch is on, the flyback voltage remains constant by virtue of the main control loop. With 24 turns on the primary, there are 12V/24 turns = 0.5V per turn. On the flyback winding then, 16 turns x 0.5V per turn = 8V. Taking into account the drop of the diode, D1, of 0.65V, we wind up with 7.35V. In addition, there is drop in the winding DCR and the coupling coefficient of the inductor. This gets us to about 6.5V or so. Note the "blue dots" next to L1 indicating phasing of the windings.

As can be observed in the performance charac-terization below, input capacitor stress is greatly increased in this type of design. A snubber consisting of C27 and R17 will be needed across the diode, D1, used in the flyback output due to leakage inductance. There will need to be a snubber consisting of C17 and R8 from the LX node to the power ground to limit the peak value of the voltage that the SiC462 is subjected to due to device parasitics.

The effect of the flyback winding on circuit operation is to make the inductor look like less than its nominal value. In all oscillographs below, the trace legend is as follows (refer to Figure 3 for circuit nets):

- Ch1, yellow: inductor current in the Lx node
- Ch2, blue: voltage at Lx node
- Ch4, green: flyback winding voltage between 5V return and the anode of D1

Here is a map of the legend (Figure 3):

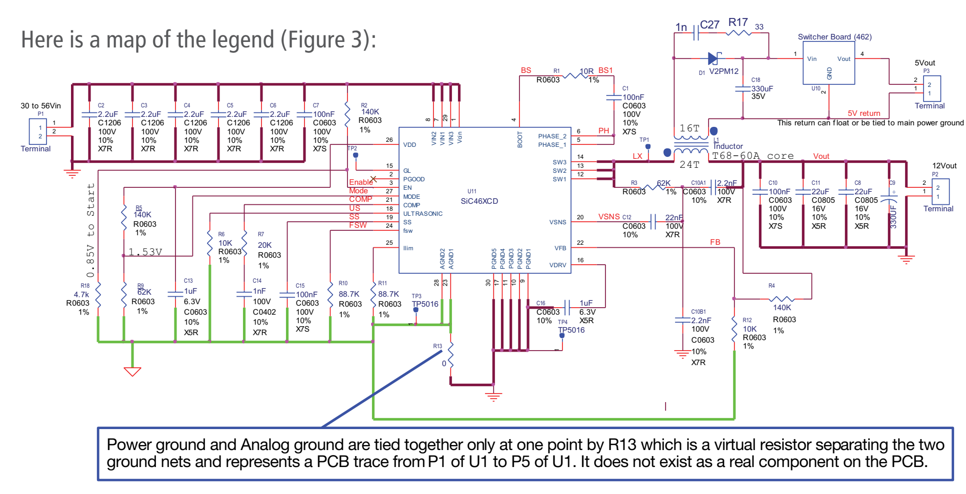


Figure 3. Schematic dual output regulator

Here are some example waveforms showing operation of the circuit:

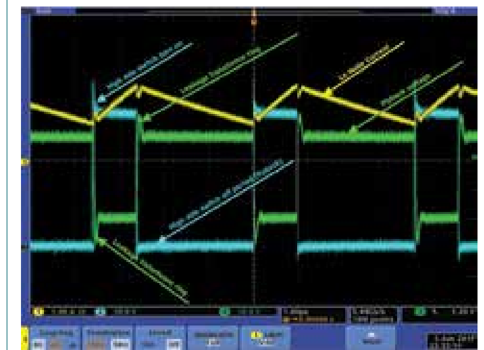


Figure 4: Waveform legend map

Figure 6: Waveform with no load on ISO +5 and 2A on main +12 at 45 V_{IN}

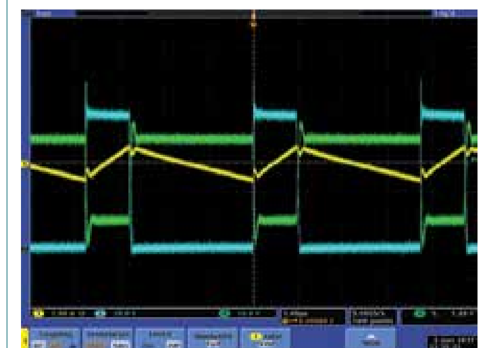


Figure 5: Waveform with no load on ISO +5 and 0A on main +12 45 V_{IN}

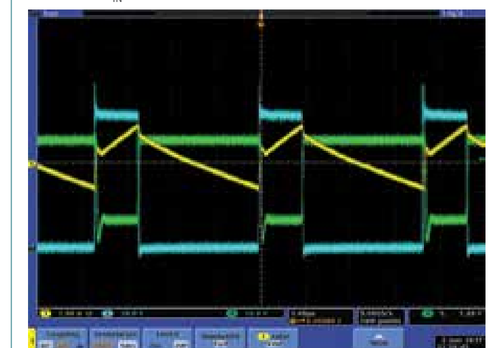


Figure 7. Waveform with a full load (1 A) on ISO +5 and 0A on main +12 at 45 V_{IN}

In Figure 6, the peak to peak current in the main winding of L1 remains constant, but the average current increases.

Now we will add current to the flyback winding by increasing the load on the +5 IS) but lowering the main current to zero:

Compare Figure 7 to Figure 6 and notice the increase in peak to peak current.

The next oscillograph shows both outputs at full load. Notice that the peak to peak current is about the same as Figure 6, but now the average value of the current has increased.

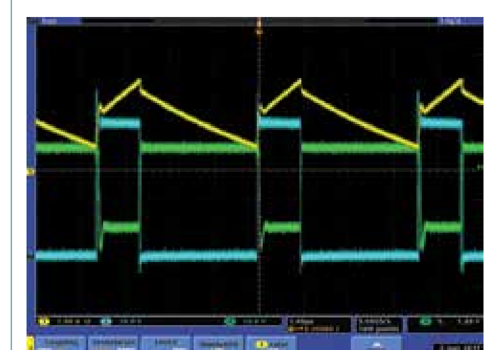


Figure 8: Waveform with a full load (1 A) on Iso +5 and 2A on main +12 45 V_{IN}

As can be observed in Figures 5 through 8 above, the flyback voltage does not substantially change over all of the required operating conditions.

Efficiency over the input voltage range is quite flat.

Generating Isolated Supplies for Industrial Applications Using the SiC462 in an Isolated Buck Topology (cont'd)

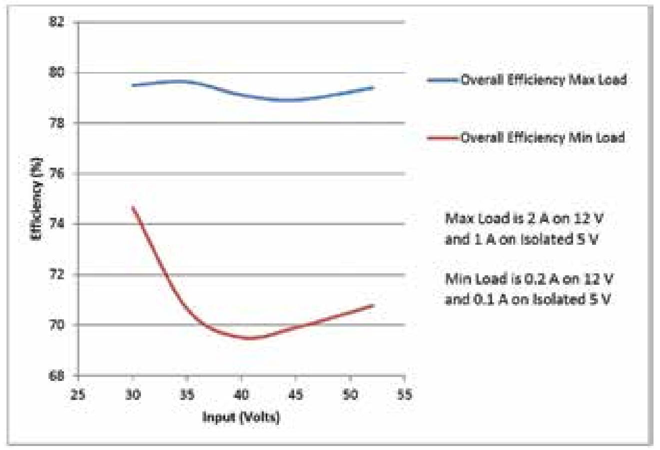


Figure 9. Efficiency over the input voltage range and load range (includes secondary switching regulator, U10)

Line regulation is excellent with a minimum load on the main +12V output.

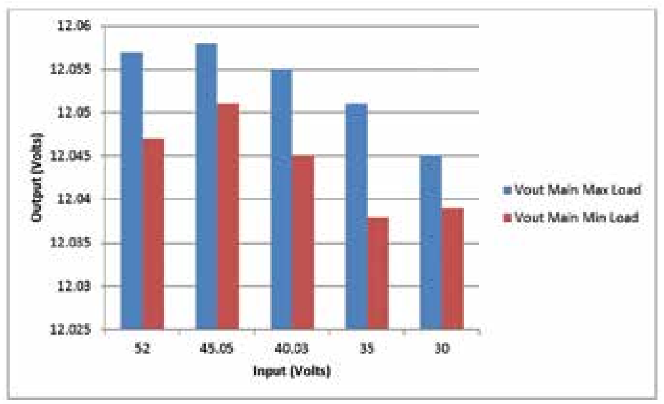


Figure 10: Main +12V output voltage regulation over loading on all outputs and line voltage

The DC output voltage from the flyback winding across C18 is not as well regulated as shown in Figure 11. However, if the Vin range of the input bus is not as wide as in this design, better regulation can be achieved. If a lower cost solution is needed, a linear regulator can be used in place of U10 to post regulate the ISO +5V rail.

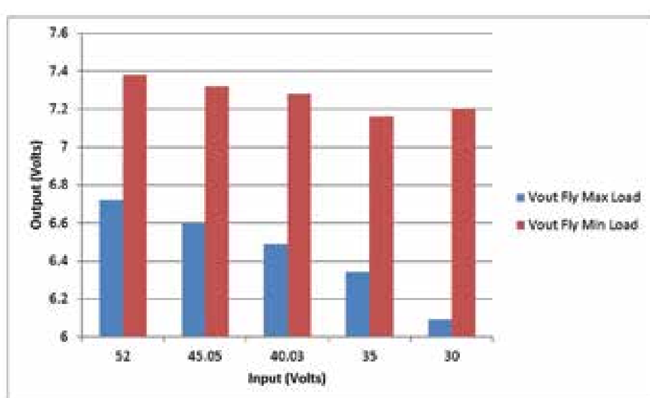


Figure 11: Flyback output voltage regulation on C18 over loading on all outputs and line voltage

Figure 12 is a thermal image of the breadboard operating at a full load and a 55V input:

Figure 12: Thermal image at 55V input and a full load on both outputs

- HSW is the high side switch in the SiC462, U1
- L is the inductor temperature of L1
- SD is the temperature of the Schottky diode, D1
- RSNB is the temperature of the snubber resistor, R17
- CSNB is the temperature of the snubber capacitor, C27

Conclusion

PLCs and I/O module power supply designs have become quite complex with the need for multiple isolated voltages, floating bias voltages, and negative output voltages. PLCs are used extensively in factory automation, building automation, and process control. The need to supply various isolated rails for gate drivers, op-amps, and isolated communication interfaces such as RS-485, RS-232, etc. results in the need for a simpler way to achieve these voltages that also meets the requirements of low component count, small PCB size, and a compact, low profile design.

This breadboard design is an example of the new possibilities afforded by the introduction of higher voltage families of buck regulators, such as the SiC462.

Dual-Mode Choke Addresses Differential and Common Mode Noise

By: Lazaro Rodriguez, Standard Product Engineering Manager, Triad Magnetics

Circuit designers must deal with many types of noise: internal, external, RF, line frequency and more. Noise can be a limiting factor in system performance and so must be addressed and minimized. The challenge is "at what effort and cost?"

Even the ubiquitous switched-mode power supply (SMPS) has noise issues. Due to its efficiency and small size, this device is used in applications including LED drivers and electronic ballasts, etc. Unfortunately, SMPS units also are subject to differential mode (DM) noise and common mode (CM) noise, both of which must be suppressed.

Noise Mechanisms and Solutions

Differential mode and common mode noise have different causes and thus different solutions. Differential mode noise is noise that is conducted on the line and neutral in opposite directions (Figure 1). Common mode noise is conducted on the line and neutral in the same direction returning through ground (Figure 1).

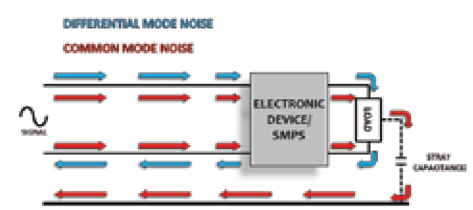


Figure 1

The basic DM filter uses a single-winding choke (inductor) inserted in series with the line path, along with a capacitor from line to neutral, thus blocking noise propagation through the system.

Since the DM inductor is in series with the line path, it handles the noise and DC offset current being supplied to load. Therefore, it must be designed to provide the needed inductance, but do so with low DC resistance to handle the RMS current and peak line current without saturating (Figure 2).

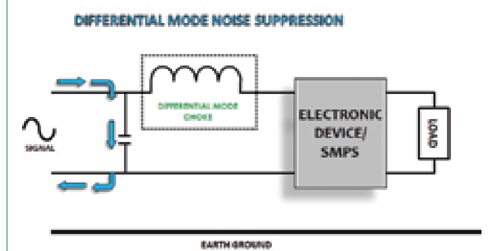


Figure 2

The basic CM filter uses a dual-winding inductor in both the line and neutral paths, plus a capacitor from line to ground (Figure 3).

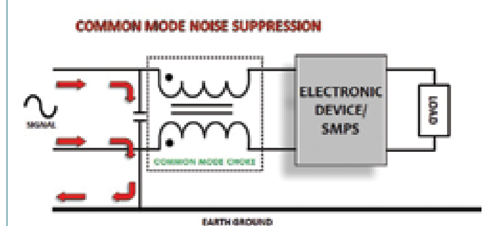


Figure 3

Since the line and neutral currents pass through the CM windings in opposite directions, there is no net magnetic flux and therefore no possibility of saturating the CM choke. The CM filter choke only needs to have the required inductance along with sufficiently low DCR for the RMS current.

A Better Idea from Triad Magnetics

Since the DM and CM noise mechanisms are largely unrelated, their solutions require two different chokes. It would be fortunate if the two noise-suppressing approaches could be implemented by one choke — saving space, simplifying the bill of materials (BOM) and reducing cost.

Fortunately, a new solution from Triad Magnetics combines both chokes into a dual-function, open-frame design that provides the features of both chokes in a single, smaller, more cost-effective package. CMF Series Dual Mode Chokes (Figure 4) are more than a simplistic co-packaging of two distinct devices into a single component. Instead, their design enhances the electrical performance, while yielding savings in size and cost.

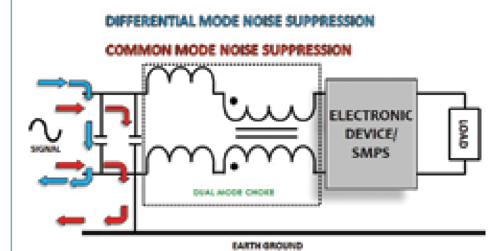
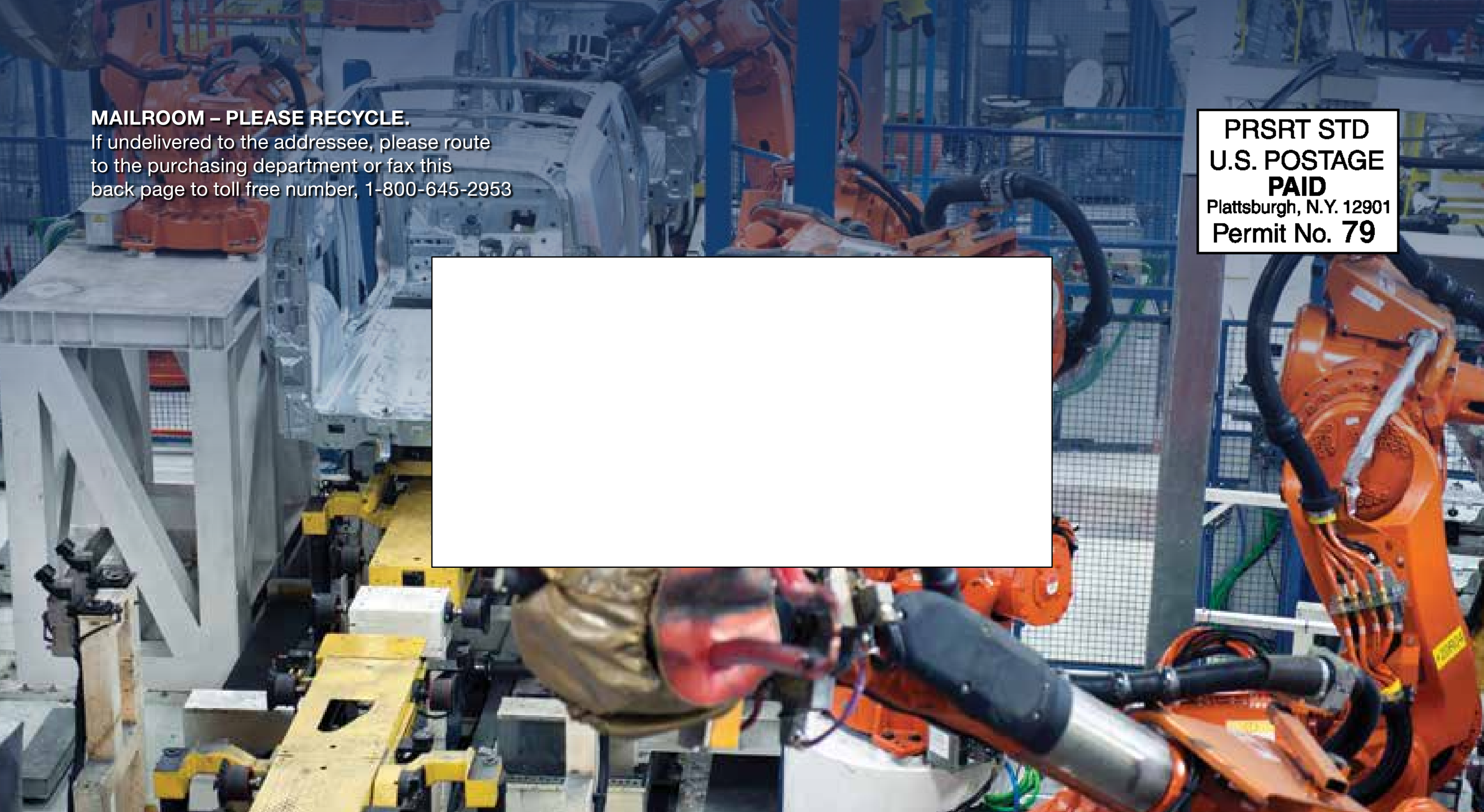


Figure 4

There are 21 CMF models with current ratings from 0.45 to 2.3A; inductances from 10 to 100mH; stray inductances from 200 to 2100mH. DC resistances are 188 to 2930mΩ, depending on model. They're available in horizontal packages (13.5h × 15 × 24.5mm to 14h × 25 × 29mm) and vertical packages (27h × 15 × 29mm) to fit tight clearance situations.

Despite their small size, the creepage and clearance parameter is greater than 3mm and they are rated for 300VAC operation. They're an excellent solution for most designs.



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The IRF200P222 is the latest flagship product. It is optimized for both high current carrying capability and low $R_{DS(on)}$ making it the ideal solution for industrial applications. When compared to previous generation devices, it offers a 40% increase in current carrying capability and 32% lower $R_{DS(on)}$ leading to increased power density and reduction in I^2R losses.

Voltage (V)	Part Number	$R_{DS(on)}$ max. (mΩ)	ID (A)
200	IRF200P222	6.6	182
	IRFP4668	9.7	130
	IRF200P223	11.5	100
	IRFP4127	21.0	75
	IRFP4227	25.0	65
250	IRF250P224	12.0	96
	IRFP4768	17.5	93
	IRF250P225	22.0	69
	IRFP4332	33.0	57
	IRFP4229	46.0	44
300	IRF300P226	19.0	75
	IRFP4868	32.0	70
	IRF300P227	40.0	50
	IRFP4137	69.0	38

Key Features and Benefits

- Designed for industrial applications
- Low $R_{DS(on)}$ for reduced conduction losses
  - 6.6 mΩ at 200V
  - 32% improvement versus previous generations
- High-current carrying capability
  - 182A at 200V
  - 40% improvement versus previous generations
- 175°C junction temperature rated
- Gate, avalanche, and dynamic dV/dT ruggedness
- Fully characterized capacitance and avalanche SOA
- Wide portfolio supports best in class and cost optimized designs
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Applications

- Uninterruptible power supply (UPS)
- Solar power inverter
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