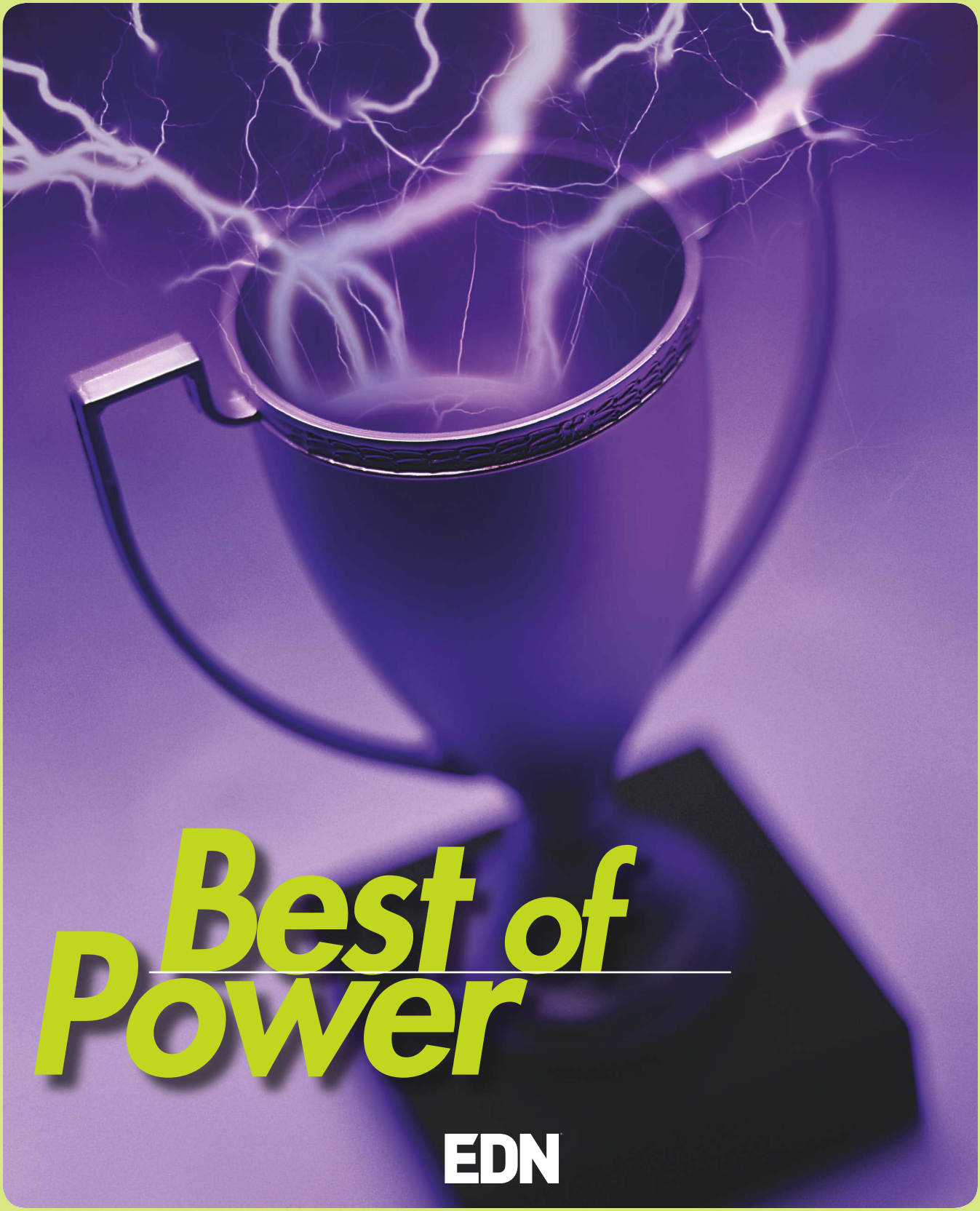
A SPECIAL SUPPLEMENT TO *EDN*

MAY 2008

POWER TECHNOLOGY



Best of Power

EDN

High-Brightness LED Driver

38-V, 1.2-A Switch Boost Converter

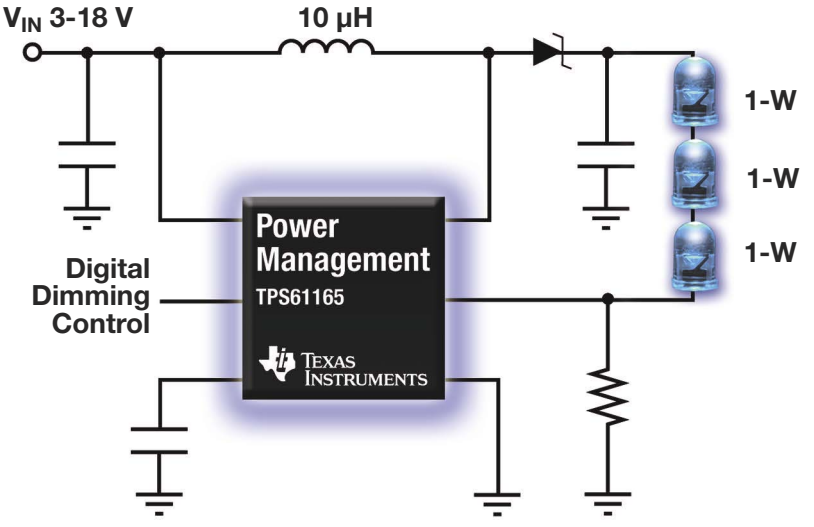
High-Performance Analog>>Your Way™

Applications

- High-power LEDs used in single-cell, battery-powered applications or point-of-load designs with a 9-V or 12-V bus
- White LED backlighting for media form factors up to 9”
  - Ultra-mobile PCs
  - LCD photo frames
  - Industrial laser diodes
  - Medical and industrial lighting

Features

- Wide input voltage range up to 18V
- Integrated 38-V, 1.2-A high-efficiency switching FET
- 1.2-MHz switching frequency
- 200-mV reference voltage with 2% accuracy
- 90% power efficiency
- 32-step, single-wire digital dimming or PWM dimming
- 2mm x 2mm x 0.8mm, 6-pin QFN with thermal pad



The **TPS61165** is the first high-output power boost converter that can drive up to three 1-watt LEDs in series. The tiny power circuit can manage backlight LEDs for media form factor displays up to 9 inches in diameter.

White LED Drivers that Support 3 to 12 LEDs

Device	Topology	# of LEDs	V_{IN} (V)	Switch Current Limit (A)	V_{OUT}	Efficiency (%)	Package	Price (1k)*
TPS61160	Boost	6	2.7 to 18	0.7	27	90	2 x 2 QFN	$0.85
TPS61161	Boost	10	2.7 to 18	0.7	38	90	2 x 2 QFN	$1.00
TPS61165	Boost	10	3.0 to 18	1.2	38	90	2 x 2 QFN	$1.45
TPS61081	Boost	7	2.5 to 6	1.6	27	87	3 x 3 QFN	$1.45
TPS61150A	Boost	6 x 2	2.5 to 6	0.7	27	85	3 x 3 QFN	$1.65
TPS60251	Charge Pump	5 + 2 + 1	2.7 to 6.5	–	6.5	90	4 x 4 QFN	$1.40
TPS40211	Boost	12 x 10	4.5 to 52	6.0	5 to 250	90	3 x 3 SON	$1.10

** Suggested resale price in U.S. dollars in quantities of 1,000.*

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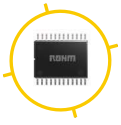
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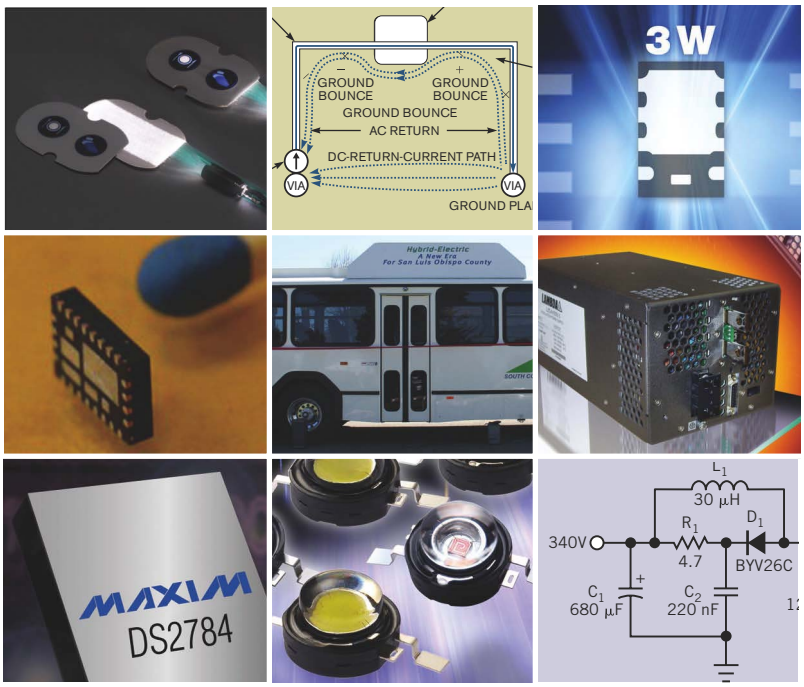


MARGERY CONNER,
TECHNICAL EDITOR,
POWER SYSTEMS AND
COMPONENTS, EDN

Letter from the editor

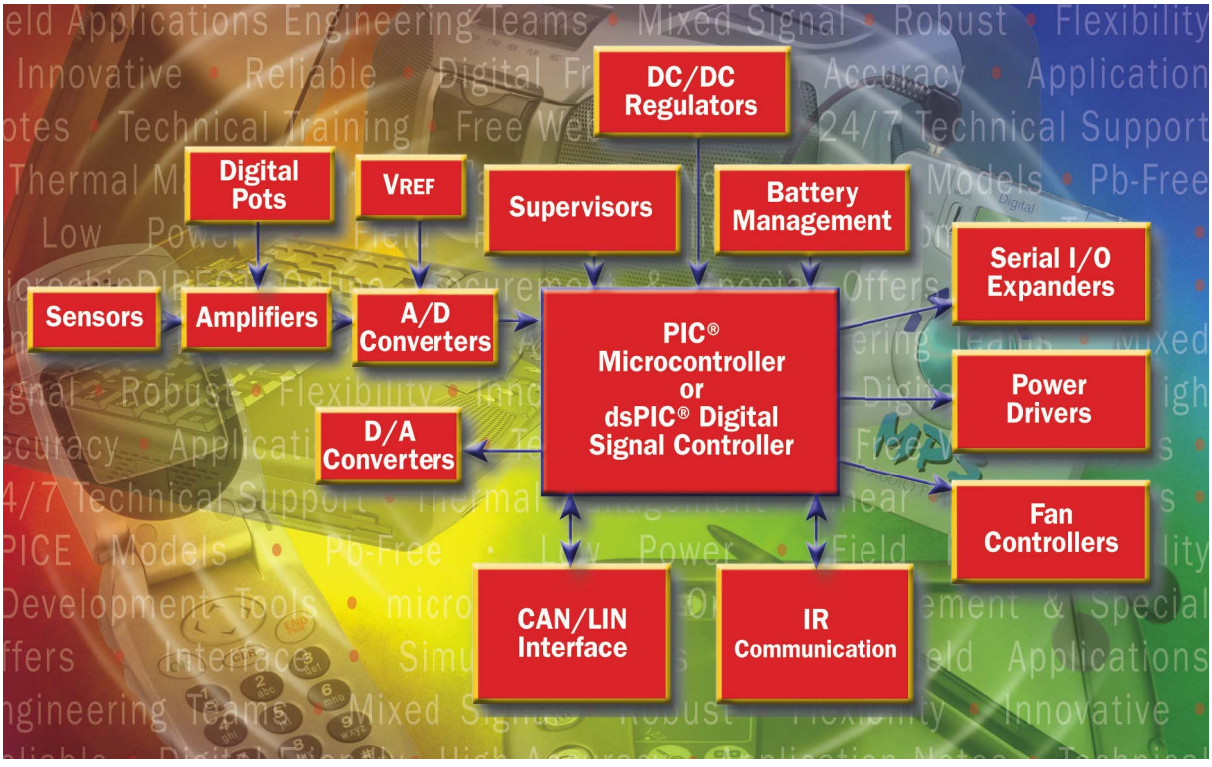
Power electronics continues to be a topic of vital interest to *EDN* readers, who include the most influential members of the power-design industry, so it's helpful to use *EDN*-readership patterns to draw some conclusions about trends in technology, products, and overall reader interest within the power-systems market. Just as popular-culture trend-watchers keep tabs on the hottest search terms on Google and Yahoo, it's also valuable to see what's of interest to power-system professionals.

EDN's "Best of Power" provides an overview of some of the topics that you, the power professionals, have ranked the best. We've broken down our findings into four basic categories: Features, Design Ideas, Community/Blog Posts, and Products, which we've further divided into subcategories. We've also provided a brief summary of trends, as well as pointers to more in-depth coverage that has appeared on the topic in *EDN* and EDN.com.

In addition, we've included one of the all-time-favorite power Design Ideas, "Circuit makes simple high-voltage inverter," and a sidebar from a power-related article, "PCB [printed-circuit-board]-layout configurations affect ground bounce." These tutorials continue to gain readers' interest because of their timely subjects: The simple inverter is relevant to today's interest in sustainable solar-energy sources, which often require inverters, and the effects of ground bounce are basic to understanding power-supply-design constraints.

We've pulled these numbers from *EDN*'s Website traffic reports from January—December 2007; hence, their credibility. *EDN* boasts more than a million page views and 100,000 unique visitors a month. More than half of those visitors say that concern about power is a big part of their jobs, and they come to *EDN* because its content helps them quickly solve their problems.

Low Power Analog
from Microchip



Microchip's low-power, stand-alone analog portfolio is engineered to meet today's demanding design requirements.

microchip DIRECT
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Microchip's broad portfolio of stand-alone analog and interface devices offers highly integrated solutions that combine various analog functions in space-saving packages and support a variety of bus interfaces. Many of these devices support functionality that enhances the analog features currently available on PIC® microcontrollers.

Power Management
- LDO & Switching Regulators
- Charge Pump DC/DC Converters
- Power MOSFET Drivers
- PWM Controllers
- System Supervisors
- Voltage Detectors
- Voltage References
- Li-Ion/Li-Polymer Battery Chargers

Mixed-Signal
- A/D Converter Families
- Digital Potentiometers
- D/A Converters
- V/F and F/V Converters
- Energy Measurement ICs

Linear
- Op Amps
- Programmable Gain Amplifiers
- Comparators
- Linear Integrated Devices

Interface
- CAN Peripherals
- Infrared Peripherals
- LIN Transceiver
- Serial Peripherals
- Ethernet Controller

Thermal Management
- Temperature Sensors
- Fan Speed Controllers/ Fan Fault Detectors

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EDN's Best of Power... PRODUCTS

Power systems include a wide-ranging group of products. Based on reader interest, *EDN*'s "Best of Power" breaks these products into six categories, including batteries and charging ICs, switching semiconductors, control ICs and modules, LED drivers, components, and supplies. Take a look at the top traffic-getters in each category, and check out the supporting editorial features that cover the product category and learn more about what's driving these design components and tools.

TOP OVERALL POWER PRODUCT

Cap-xx HS and HW supercapacitor line

As designers wrestle with the overcharging hazards of lithium-ion batteries as well as the batteries' finite charge/recharge cycle life, supercapacitors—with their virtually unlimited cycle lifetime, and nonexplosive chemistry—are gaining interest in the design community. This supercapacitor is for low-power consumer applications.

For more information on supercapacitors, read *EDN*'s feature article or access the Power Source blog:
"Hybrids mark the end of the stinky city bus"
www.edn.com/article/CA6437959
www.edn.com/blog/1560000156/post/1630017363.html

BATTERIES AND CHARGING ICs

Popular features that caught readers' eyes: the trend to speed up battery-recharge time through either supercapacitor usage or sophisticated charging algorithms, the move toward accurate fuel gauges for portable devices, and the integration of authentication circuits into charging ICs.

Cap-xx Ltd HS and HW: Supercapacitors deliver 100 times the power of batteries
www.edn.com/blog/1560000156/post/1630017363.html

Dallas Semiconductor DS2786: Stand-alone fuel gauge reports battery capacity without a full-charge cycle
www.edn.com/blog/1560000156/post/520007052.html

Advanced Analogic Technologies AAT4620: Integrated supercapacitor charger IC reduces charge time
www.edn.com/blog/1560000156/post/70010607.html

Advanced Analogic Technologies AAT3663: Battery-charger IC monitors internal die temperature
www.edn.com/blog/1560000156/post/1870020387.html

Maxim Integrated Products DS2784: Fuel gauge combines a lithium protector and SHA-1 authentication
www.edn.com/blog/1560000156/post/1510016351.html

Follow-on *EDN* feature article: "Friend or foe: Battery-authentication ICs separate the good guys from the bad"
www.edn.com/article/CA6301616

SWITCHING SEMICONDUCTORS

These switching semiconductors, which are mostly MOSFETs, boast two major sets of features: High switching speeds and low forward resistances. It used to be enough for a switching FET to switch large amounts of power at a fairly high speed; now, manufacturers offer higher performance FETs as a simple way to increase power-supply efficiency by using more efficient switching devices.

"MOSFET/IGBT driver eliminates need for a negative-gate driver"
www.edn.com/blog/1560000156/post/450004645.html

"International Rectifier IRF6716M and IRF6712S: DirectFET MOSFET chip set has a low on-resistance"
www.edn.com/blog/1560000156/post/1970011197.html

"Vishay Intertechnology PolarPAK: Power MOSFETs feature double-sided cooling"
www.edn.com/blog/1560000156/post/1560007356.html

"Vishay Intertechnology Siliconix: P-channel MOSFETs have a low on-resistance"
www.edn.com/blog/1560000156/post/650018265.html

"Infineon Technologies CoolMOS CP 500V: MOSFET reduces switching losses"
www.edn.com/blog/1560000156/post/1090007309.html

"STMicroelectronics STD11NM60N: High-efficiency power MOSFET drives high currents at low V_{GS}"
www.edn.com/blog/1560000156/post/480005848.html

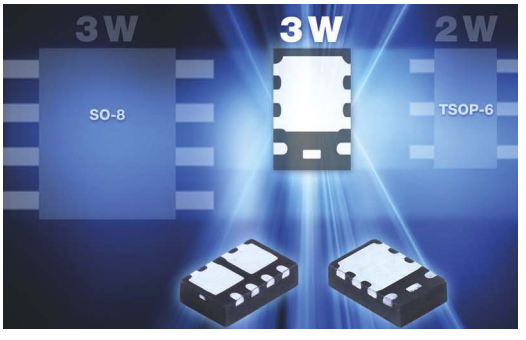
"Fairchild Semiconductor FOD3780 and FOD3181: Gate drivers switch MOSFET on and off to limit power dissipation"
www.edn.com/blog/1560000156/post/720007272.html

"STMicroelectronics STV300NH02L: Power MOSFET suits ORing applications"
www.edn.com/blog/1560000156/post/640018264.html

"On Semiconductor NSSxxx: PNP and NPN devices have low saturation voltage"
www.edn.com/blog/1560000156/post/700014470.html

"Vishay Intertechnology: P-channel power MOSFETs come in PowerPAK ChipFET packages"
www.edn.com/blog/1560000156/post/130014413.html

Blog post at *EDN*'s PowerSource:
"MOSFETs get their 15 minutes of fame at APEC"
www.edn.com/blog/1470000147/post/1350022935.html



PRODUCTS

POWER-CONTROL ICs AND MODULES

As with power supplies, readers' attention focused on highly efficient power regulators. In addition, regulators that take the work out of conditioning power for targeted portable systems—consumer, military, and automotive—are popular. In general, readers follow new products that continue the march of ICs that make power control and regulation simpler, smaller, more efficient, and less expensive.

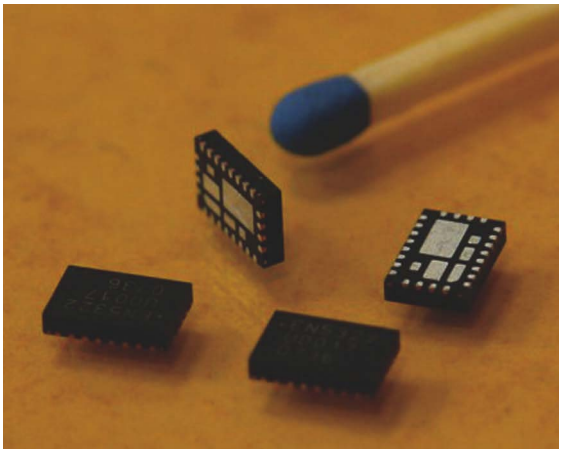
"Maxim Integrated Products MAX8901A and MAX8901B: Step-up dc/dc converters have 92% efficiency"
www.edn.com/blog/1560000156/post/740015074.html

"Enpirion EP53x2Q: Integrated buck converter targets low-power and portable applications"
www.edn.com/blog/1560000156/post/90005209.html

"International Rectifier IR33x: Current-sensing IPS targets automotive systems"
www.edn.com /blog/1560000156/post/900006490.html

"Linear Technology LTM4600HVMPV: Switch-mode regulator suits military applications"
www.edn.com/blog/1560000156/post/1520016352.html

"DS2 Montgo: Powerline-communications chip set has a 100-Mbps maximum data rate"
www.edn.com/blog/1560000156/post/540019854.html



Further *EDN* reading:
"Creating the power subsystem in modern design"
www.edn.com/article/CA6395488

LED DRIVERS

As LEDs increase in brightness and power, they are making their way into applications that no one thought of just a year or two ago. They are now commonplace in lighting areas, rather than just finding use as simple indicators. Designers are turning to high-brightness LEDs for automotive, architectural, signage, and portable lighting. As a result, ICs that take the challenge out of balancing and color-tweaking make life much easier for engineers.

"Endicott Research Group Smart Force: LED-driver boards feature full-function LED drivers"
www.edn.com/blog/1560000156/post/1040014104.html

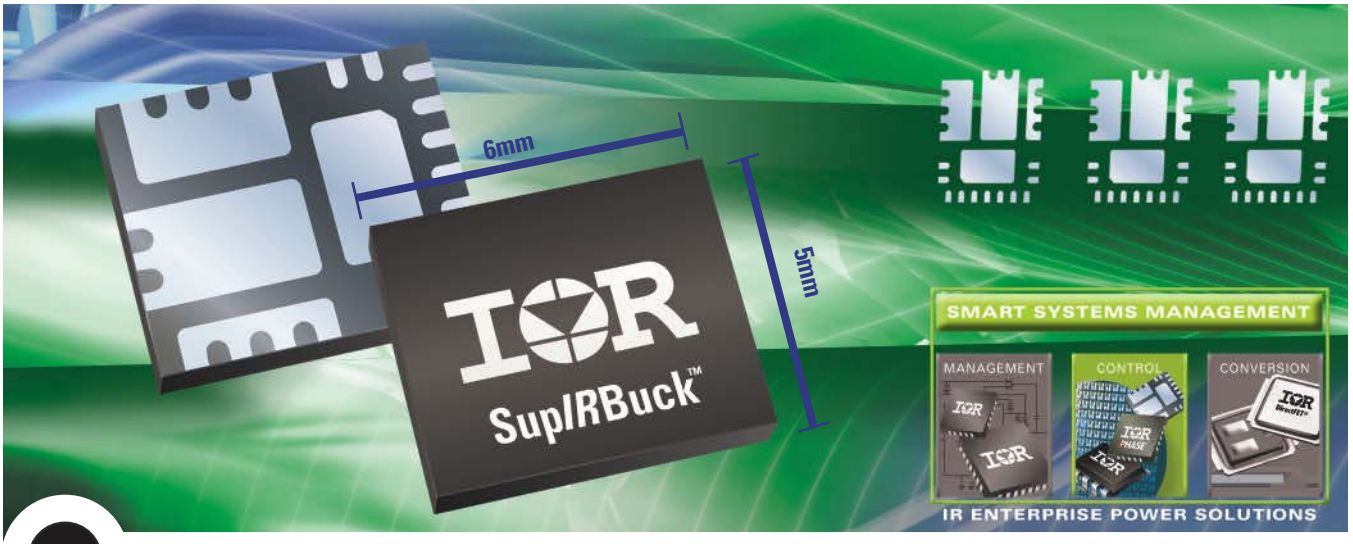
"Maxim Integrated Products MAX16831: High-voltage LED driver withstands harsh operating environments"
www.edn.com/blog/1560000156/post/540010054.html

"Maxim Integrated Products MAX16818: LED-driver controller targets rapid LED-current transients"
www.edn.com/blog/1560000156/post/1090006109.html

"Allegro Microsystems A6260: Constant-current LED driver targets automotive lighting"
www.edn.com/blog/1560000156/post/1970019197.html

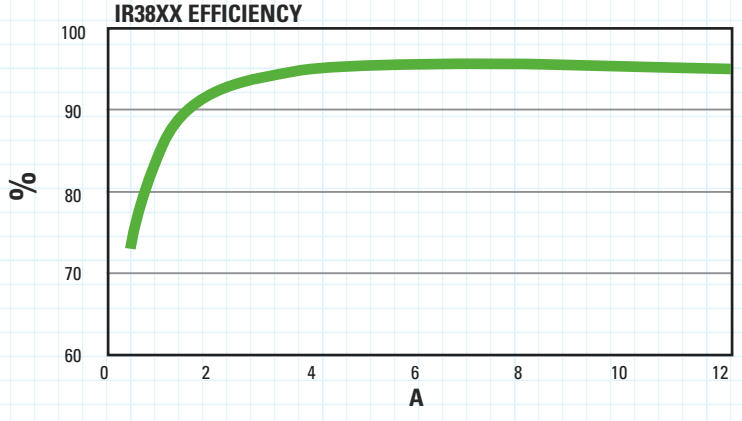
"Linear Technology LT3003: LED ballaster drives 24 LEDs"
www.edn.com/blog/1560000156/post/880006088.html

Further *EDN* reading: Feature article, "High-brightness LEDs usher in new applications and standards"
www.edn.com/article/CA6512150



SupIRBuck™ Integrated Regulators: Simply Smaller, Cooler

Save Energy, Accelerate POL Design, Shrink Footprint 70%



Part Number	V_{IN} Max/Min	V_{OUT} Max/Min	Max Current	F_{SW}	Package	Features
IR3812MPBF	21 / 2.5	12 / 0.6	4A	600KHz	5mm x 6mm QFN	OCP; OTP; Tracking
IR3822MPBF	21 / 2.5	12 / 0.6	4A	600KHz	5mm x 6mm QFN	OCP; OTP; PGood
IR3822AMPBF	21 / 2.5	12 / 0.6	6A	300KHz	5mm x 6mm QFN	OCP; OTP; PGood
IR3811MPBF	21 / 2.5	12 / 0.6	7A	600KHz	5mm x 6mm QFN	OCP; OTP; Tracking
IR3821MPBF	21 / 2.5	12 / 0.6	7A	600KHz	5mm x 6mm QFN	OCP; OTP; PGood
IR3821AMPBF	21 / 2.5	12 / 0.6	9A	300KHz	5mm x 6mm QFN	OCP; OTP; PGood
IR3810MPBF	21 / 2.5	12 / 0.6	12A	600KHz	5mm x 6mm QFN	OCP; OTP; Tracking
IR3820MPBF	21 / 2.5	12 / 0.6	12A	600KHz	5mm x 6mm QFN	OCP; OTP; PGood
IR3820AMPBF	21 / 2.5	12 / 0.6	14A	300KHz	5mm x 6mm QFN	OCP; OTP; PGood

The SupIRBuck™ family of versatile point-of-load (POL) voltage regulators shrink silicon footprint 70% compared to discrete solutions and offer up to 10% higher full-load efficiency than monolithic power ICs.

Features

- 600kHz switching frequency
- 4A/7A/12A output options
- Programmable soft start with enable
- Programmable over-current protection
- 0.6V reference voltage with 1.5% accuracy
- 2.5V to 21V conversion Input
- Pre-Bias protection
- Integrates rugged control and sync FETs with control IC in one simple 5mm x 6mm power QFN package
- Optional 300kHz, DDR memory tracking, programmable PGOOD

Benefits

- Ease of implementation
- Enables single input voltage rail
- Wide input voltage range
- Common footprint for 4A, 7A and 12A power regulators
- Fewer discrete components

for more information call 1.800.981.8699 or visit us at www.irf.com/dcdc

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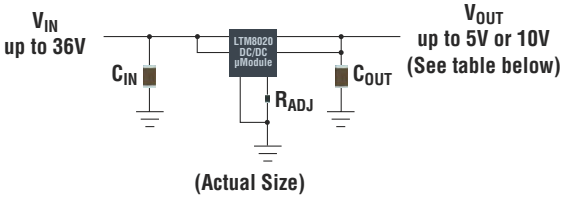

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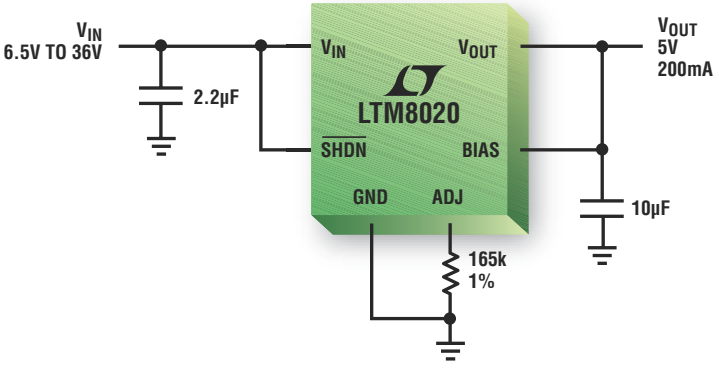

Compact, Low Profile & No Heat Sink

Our new DC/DC µModule™ regulators with up to 36V_{IN}, 200mA to 2A, operate cooler than linear regulators and are simpler than discrete switchmode DC/DC regulators. With onboard inductor, power switches and other circuitry, the LTM®8020, LTM8021, LTM8022 and LTM8023 are complete switchmode DC/DC regulator systems in an IC form factor. Low profile, thermally efficient and compact, they mount on either side of the board, leaving space for digital ICs.

Features

- Onboard inductor, power components, DC/DC regulator, input/output bypass capacitors and compensation circuitry
- Current mode operation for fast short-circuit response, accurate current limiting and precise line and load regulation
- LGA package with gold finished pads allow soldering with Pb and Pb-free solder pastes
- RoHS compliant
- Simple copy-and-paste layout

The New 200mA to 2A DC/DC µModule Family

	LTM8020	LTM8021	LTM8022	LTM8023
V_{IN}	4V to 36V	3V to 36V	3.6V to 36V	3.6V to 36V
V_{OUT}	1.25V to 5V	0.8V to 5V	0.8V to 10V	0.8V to 10V
I_{OUT}	200mA	500mA	1A	2A
Size (mm)	6.25 x 6.25 x 2.3	6.25 x 11.25 x 2.8	11.25 x 9 x 2.8 Pin Compatible	

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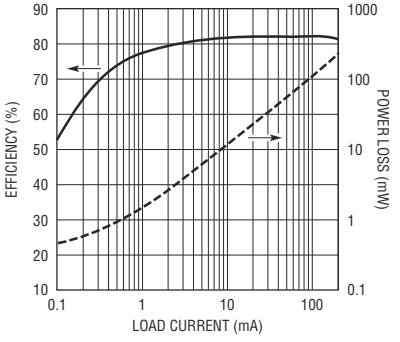
LINEAR TECHNOLOGY

An Alternate Option When Deciding between a Linear Regulator and a Switchmode DC/DC Regulator

Linear and Switchmode Regulators

If there is a concern for a DC/DC regulator's heat dissipation and temperature rise then one should consider the application and not just the efficiency number. For example, if a linear DC/DC regulator is used to convert 20V input to 3.3V output, its efficiency is approximately 17% (efficiency ≈ V_{OUT}/V_{IN}). Of course, this value is unacceptable if the power source has limited energy such as a battery or if the load current is so large that the regulator may be operating at or above its absolute maximum junction temperature. However, if the same linear regulator were to deliver 20mA of load current, even with a 17% efficiency, it will experience 42°C rise in junction temperature—a safe value (assume an 8-lead MSOP package, 125°C/W R_{JA}, 25°C ambient). On the other hand, if the load current increases to 50mA, the rise in junction temperature of the same linear regulator will be 104°C, which when added to a 25°C ambient temperature exceeds the safe operating temperature of the device (assuming 125°C absolute maximum junction). There are several remedies to safely operate a linear regulator in the latter application: use a heat sink, provide forced air flow, choose a larger package such as a TO-263 or a surface mount package with heat slug on the back to reduce the junction-to-air thermal impedance. The other option is to use a switchmode regulator.



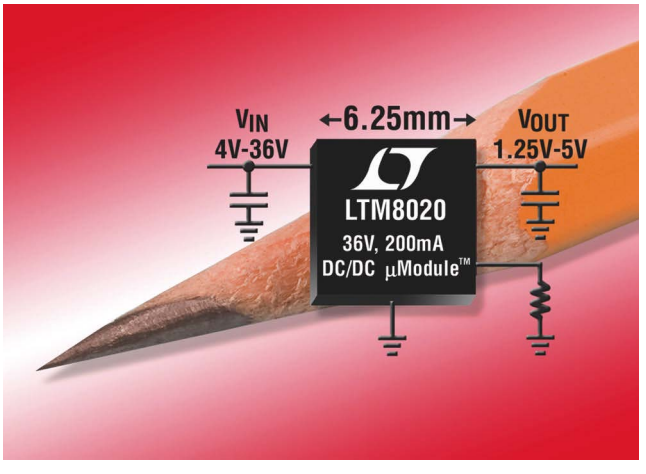
The LTM8020 low power loss eases thermal management of a DC/DC regulator circuit

The switchmode regulator topology offers higher operating efficiency and lower heat dissipation than the linear regulator in the pervious application. On average, a non-synchronous switchmode regulator can offer 70% to 90% efficiency. A synchronous topology bumps the efficiency by another 5 to 10 points to as high as 95% in some designs (depends on the choice of components and layout). However, a DC/DC switchmode regulator's circuit is more complex than a linear regulator's 3-terminal design. A switchmode regulator needs a magnetic component (inductor), capacitors, diode, compensation circuitry and sometimes external MOSFETs. Moreover, the layout plays a crucial role in its performance and taming voltage spikes and "noise" is a job of an experienced designer. And so the question arises: is there a third option besides a linear or switchmode regulator that has the simplicity of a linear regulator and low heat dissipation of a switchmode regulator?

The Alternative

Linear Technology offers a solution which comes in a surface mount package and is extremely compact. It occupies only 6.25mm x 6.25mm of area and has a thin 2.3mm of height (profile). The device is just as simple to use as a linear regulator circuit but is also more efficient because of its switchmode topology. It also provides cooler operation by dissipating 98% less heat and allows for smaller circuit by occupying 90% less volume (area x height) with its compact package and no-heat sink requirement (comparison conditions: 36V_{IN}, 1.5V_{OUT}, 200mA, T_A=25°C). Unlike a switchmode regulator circuit, it requires no external inductor, MOSFET or compensation circuitry. All are included in the device.

The LTM8020 is a complete 200mA, current mode, switching DC/DC point-of-load regulator system in a 6.25mm x 6.25mm x 2.3mm LGA (Land Grid Array) surface mount package. The package can be mounted on the back side of a PCB to provide room for digital ICs on the top. Its input voltage range is from 4V to 36V and output can be adjusted with only one resistor from 1.25V to 5V. Encapsulated packaging protects the circuit components against mechanical, chemical and ambient factors thus improving the reliability of the solution. The LTM8020 is rated for operation from −40°C to 85°C and is RoHS compliant, although with its gold-plated pads both Pb- and Pb-free solder can be used during board assembly. Applications include systems with 24V and 28V input supply rails in medical, industrial, avionics and after-market automotive. For a complete listing of Linear Technology's family of DC/DC µModule™ regulators, visit www.linear.com/micromodule.



LTM8020: as simple as a linear regulator and has low heat dissipation of a switchmode regulator

LINEAR TECHNOLOGY

Thermal Considerations for High Current LDOs:

Microchip Technology's MCP1727 and MCP1827/S 1.5A, 6V LDOs

Battery-operated equipment has created a strong demand for integrated circuits in smaller packages. While such packages save space, they also have poor heat transfer characteristics. To minimize power dissipation, linear regulators are designed to work with very low input/output voltage differentials – hence the name Low Dropout Regulators or LDOs. LDOs specify maximum output current and input voltage limits. For example, Microchip's MCP1727 and MCP1827 have a maximum output current of 1.5A with an input voltage limit of 6V. However, blindly operating these LDOs to their limits without understanding their power dissipation capabilities can lead to trouble. Even though data sheets and package manufacturers provide power-handling data for packages, it is impossible to specify the true capability for specific applications when power handling can vary significantly due to design and layout.

Heat is removed from the dissipating energy source by three means: conduction, convection and radiation.

Conduction

Heat is conducted from the junction of the power dissipating device through the silicon, package material, lead frame, and printed circuit board. Increasing copper trace size and improving thermal interface (using thermal grease or films) can significantly improve conduction cooling efficiency. The table to the right shows the effects of the material used, as thermal conductivity varies widely and should not be overlooked. It should also be noted that the metal slabs associated with DFN packages, in which the MCP1727 is available, and DDPAK packages, which the MCP1827 is available, improves heat dissipation through conduction.

Material	k (cal/m*C*s)
Silver	98
Copper	83
Fiber Glass	0.011
Air (dry)	0.006

Convection

Convection is the transfer of energy (heat) through a fluid or medium (air), and is determined by the thermal resistance of the junction to ambient from the die. For natural convection, air currents are set up by the rising of heated air and the falling of cooling air. Heat sinks and/or forced air techniques may be used to drastically decrease this thermal resistance significantly, but not without impacting system size and cost. The MCP1827 is available in the TO-220 package, which integrates a metal tab for easily mounting a heatsink.

Radiation

Radiation is another method of heat transfer that is applicable to the surface mount environment. A material whose temperature is elevated will emit more energy than the same material with a cooler temperature. In an application, if there is a large component dissipating a significant amount of heat, it will elevate the temperature of adjacent smaller components. Thus, it is best to be careful with the layout of the board.

Considering all of the methods of heat transfer and mounting variations, it is difficult to accurately determine the power dissipation capability for small surface mount packages in system level applications.

Microchip's **MCP1727**, **MCP1827** and **MCP1827S** Low-Dropout Regulators (LDOs) support input voltages ranging from 2.3V to 6.0V and output voltages from 0.8V to 5.0V, while having a full-current dropout voltage of only 330 mV (typical). The devices feature a quiescent current of 120 µA for low-power consumption during regulation and are ceramic output-capacitor stable to help reduce design costs and size.

The full-featured MCP1727 incorporates shutdown, power good, programmable power good delay and bond-wire compensation, all on a single chip. The mainstream 5-pin MCP1827 LDO includes power-good and shutdown functions, while the 3-pin MCP1827S is a more cost-effective alternative, for those applications that do not require power good and shutdown.

Product	Features	Output Voltage	Active Current	Dropout Voltage @1.5A	Output Voltage Accuracy	Package	Volume Pricing
MCP1727	Shutdown, Power Good, Delay, Sense	0.8V-5.0V	140 µA	330 mV	0.50%	8-DFN, 8-SOIC	$1.09
MCP1827	Shutdown, Power Good	0.8V-5.0V	120 µA	330 mV	2%	5-DDPAK, 5-TO-220	$1.11
MCP1827S	3-pin	0.8V-5.0V	120 µA	330 mV	2%	3-DDPAK, 3-TO-220	$1.03

MICROCHIP

www.microchip.com/analog

PRODUCTS

COMPONENTS

Switching devices and power-control ICs and architectures are the glamour parts for power-supply subsystems, but components, including passives, switches, and isolators, are vital parts, and *EDN* readers know that they can make or break a power supply. Switches are particularly popular as companies continue to come up with novel approaches to turning power on and off.

"Optek Technology OPI7000 Series: Optically coupled isolators suit 6-kV isolation"
www.edn.com/blog/1560000156/post/1840009984.html

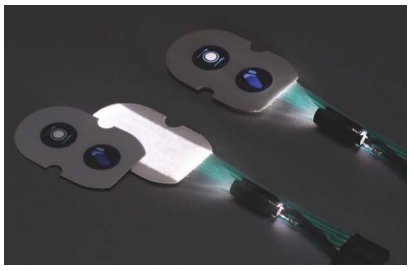
"BI Technologies HM62: Surface-mount power inductors have low profiles"
www.edn.com/blog/1560000156/post/1430010543.html

"Omron Electronic Components LLC G9E: Power-relay series switches 200A at 400V dc"
www.edn.com/blog/1560000156/post/1080020708.html

"International Rectifier IPS6011: Intelligent power switch features reverse-battery protection"
www.edn.com/blog/1560000156/post/1410007541.html

"Fairchild Semiconductor Green FPS e-Series: Power switch conserves energy using valley-switching technique"
www.edn.com/blog/1560000156/post/730011273.html

More on switches in *EDN*'s PowerSource blog: "Optical fibers light up flat switches in tight spaces"
www.edn.com/blog/1470000147/post/3100017431.html



POWER SUPPLIES

As usual, the broad field of power supplies features a variety of products. Some standout features in this product list are supplies that work with alternative energy sources; small, high-density, and energy-efficient sources; and specialty applications, such as automotive and military applications. The supplies that made this list tend to be highly specialized.

"Power-One Aurora PVI-6000: Photovoltaic and wind converters use two MPPT channels"
www.edn.com/blog/1560000156/post/1800008780.html

"XP Power MFA350: 350W power supply comes in a small U-bracket package"
www.edn.com/blog/1560000156/post/420008842.html

"Power-One SSQE48T20033: 16th-brick converter claims efficiency boost to more than 90%"
www.edn.com/blog/1560000156/post/100006810.html

"Lambda NV-175M: Power supplies target medical applications"
www.edn.com/blog/1560000156/post/50012605.html

"MicroPower Direct D200E: Single- and dual-output dc/dc converters have UL approval"
www.edn.com/blog/1560000156/post/450012645.html

"Astrodyne ECA Series: Switching power supplies provide EMC performance"
www.edn.com/blog/1560000156/post/410008841.html

"Power Sources Unlimited Tracopower TSP: 14 DIN-rail power supplies have regulated, adjustable output voltages"
www.edn.com/blog/1560000156/post/1200006720.html

"MicroPower Direct HF60W-SL: 60W, single-output power supplies are CE-certified"
www.edn.com/blog/1560000156/post/1210006721.html

"VPT VPTPCM-12: Power module targets military dc/dc systems"
www.edn.com/blog/1560000156/post/290016429.html

"Emerson Network Power IBC32 and IBC60: Quarter-brick and eighth-brick IBCs feature a driven-synchronous system"
www.edn.com/blog/1560000156/post/1120008712.html

For more on general trends in the power-supply industry, including efficiencies over wide load ranges, see "Tightened power-efficiency regulations force power supplies to keep up"
www.edn.com/article/CA6531582

Excellence in Electronics

ROHM

Pb Free

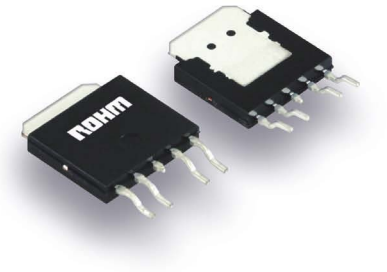
ROHM Electronic Components

RoHS

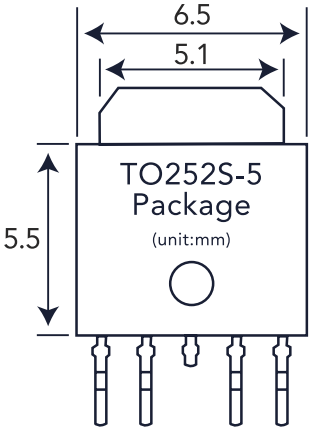
Directive Compliance

900 kHz Single-Channel Step-Down Switching Regulator Delivers Space Savings and High Efficiency

BD9870FPS



ROHM's BD9870's integrated protection and compensation circuitry, smaller external components and ceramic input/output capacitor compatibility result in space savings of up to 60%.

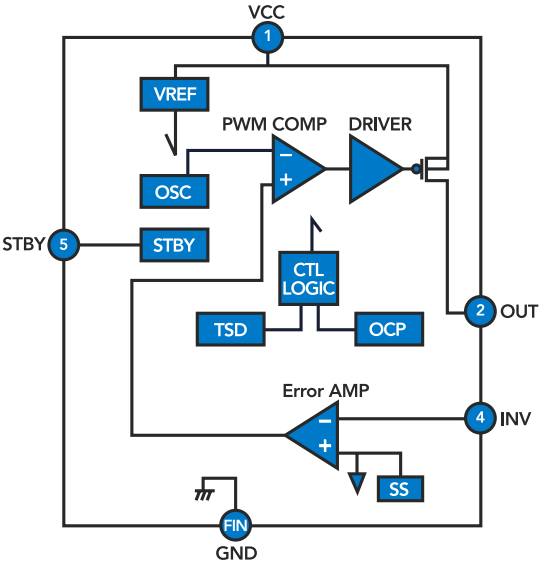


Features

- 900kHz oscillation frequency reduces external coil size (10µH).
- Compatible with ceramic capacitors at output LC filter.
- Built-in Pch MOSFET (diode rectification).
- Only 3 external components required: coil, diode, output capacitor (no feedback compensation).
- Integrated Overcurrent Protection (OCP) and Thermal Shutdown (TSD) circuits.

Applications

- TVs
- Printers
- Gaming consoles
- Car audio and navigation
- Communication devices
- A/V equipment
- Office and industrial equipment



For catalog and product information: www.rohmelectronics.com | 1.888.775.ROHM

EDN's Best of Power... FEATURE ARTICLES

These articles are in-depth looks at a targeted area of power-system design from both *EDN* technical editors and contributing experts in the field.

"Wireless power transmission: no strings attached"
Receiving electrical power without the use of wires has long been an ideal for electronic devices. How feasible is it, and what are some of the other options?
www.edn.com/article/CA6455599

"Portable power: New lithium-ion-battery chemistries allow designers to trade off energy capacity and power"
As recently as two years ago, lithium-ion cells might not have met your system's power requirements. But take another look: With new batteries featuring iron-phosphate cathodes, you might be pleasantly surprised by what's available now.
www.edn.com/article/CA6501082

"Permanent-magnet motors boost efficiency and power density"
Sensorless versions of these highly efficient motors reduce cost and parts count, but the motors still require complex control algorithms. Match the right motor type and controller to your application for the best performance and cost.
www.edn.com/article/CA6475007

"Stealing USB-port power"
With a design that conserves current drain, you can power your peripheral device directly from the host computer's USB port.
www.edn.com/article/CA220400

"Reducing ground bounce in dc/dc-converter applications"
Electrical ground, which looks simple on a schematic, can become complex depending on how you lay out the PCB (printed-circuit board). Unfortunately, ground-node analysis is difficult. However, understanding the physics of ground noise helps to reduce the problem.
www.edn.com/article/CA6347258

This sidebar originally appeared in "Reducing ground bounce in dc/dc-converter applications," and provides an intuitive understanding of how current moves within a PCB (printed-circuit-board) as well as the effect the PCB layout has on the current. To see the figures in this sidebar, go to www.edn.com/article/CA634258.

PCB-LAYOUT CONFIGURATIONS AFFECT GROUND BOUNCE

Conductors that cross at right angles do not interact magnetically: The magnetic field from the vertical trace induces positive and negative voltages that cancel in the horizontal trace (**Figure A**).

Magnetic-field lines around parallel wires with equal currents cancel everywhere between the wires, so the total stored energy is less than what you would find for the individual wires. Wide PCB (printed-circuit-board) traces have less inductance than narrow traces (**Figure B**).

Magnetic-field lines around parallel conductors with opposite current flow cancel everywhere outside the conductors and add everywhere inside. If you make the inside loop area small, then the total magnetic flux and, therefore, the inductance will also be small (**Figure C**). This behavior is the reason that the ac ground-plane return current always flows under the top-trace conductor.

Corners have more inductance because both the vertical and the horizontal traces see a magnetic field from themselves as well as from the perpendicular trace (**Figure D**). A current flows into a top trace, down a via, into a ground plane, and back up a via to the bottom of the source (**Figure E**). The return current flows, with dc current taking the path of least resistance and ac current taking the path of least impedance. Because top-trace corners and ground-plane cuts increase impedance, you can expect ground bounce. The change in magnetic flux at those points induces the bounce.

The upper trace in **Figure F** shows good layout practice; the capacitor is in line with the current flow, creating a minimal loop size. The bottom trace, with the capacitor at right angles to the current flow, creates an unnecessarily large loop, resulting in ground bounce.

EDN's Best of Power...
POWER DESIGN IDEAS

Long before anyone invented social Web sites, such as Facebook and MySpace, *EDN*'s Design Ideas provided a true community for exchanging circuit designs with other electronic-design engineers. Design Ideas are an early and valuable example of user-generated content. They are one of *EDN*'s best-read sections and continue to provide a forum for what is the essence of a hardware designer's job. The largest category within Design Ideas is power-related designs.

All of the Design Ideas that made this list are popular, but the Design Idea below has been popular since its publication in 2004. This edition of *EDN*'s "What's Tops in Power" is reprinting this Design Idea to make it easily available to all power designers.

"Use a 555 timer as a switch-mode power supply"
www.edn.com/article/CA257052

"Analog switch converts 555 timer into pulse-width modulator"
www.edn.com/article/CA6413787

"1.5V battery powers white-LED driver"
www.edn.com/article/CA454645

"Triac lighting and heating controller uses few parts"
www.edn.com/article/CA446989

"Build a transformerless 12- to 180V-dc/dc converter"
www.edn.com/article/CA431146

"Circuit provides bidirectional, variable-speed motor control"
www.edn.com/article/CA216168

"Power inverter is bidirectional"
www.edn.com/article/CA149121

"Designing instrumentation circuitry with rms/dc converters"
www.edn.com/article/CA6409624

"Constant-current, constant-voltage converter drives white LEDs"
www.edn.com/article/CA446990

"Supply derives 5 and 3.3V from USB port"
www.edn.com/article/CA185954

Circuit makes simple high-voltage inverter

FRANCESC CASANELLAS, AIGUAFREDA, SPAIN

A simple high-voltage MOSFET inverter solves the problem of driving a high-side MOSFET, using a low-voltage transistor, Q_1, and a special arrangement involving D_6 (**Figure 1**). This inverter is much faster than those that optocouplers drive, so dead-time problems are minimal. The inverter has the usual blocking diodes, D_4 and D_6, and the parallel diodes, D_5 and D_8. Q_3 provides the turn-off signal to Q_2. When Q_3 turns on, Q_2's gate short-circuits to ground through R_4. R_4 limits current and dampens oscillations. Q_2's gate discharges quickly; only the value of R_4 limits discharge time. Q_1 stays off, thanks to R_2, and C_3 charges to 12V through D_2. The gate pulse creates a current through C_4, and D_3 protects the base-emitter junction of Q_1.

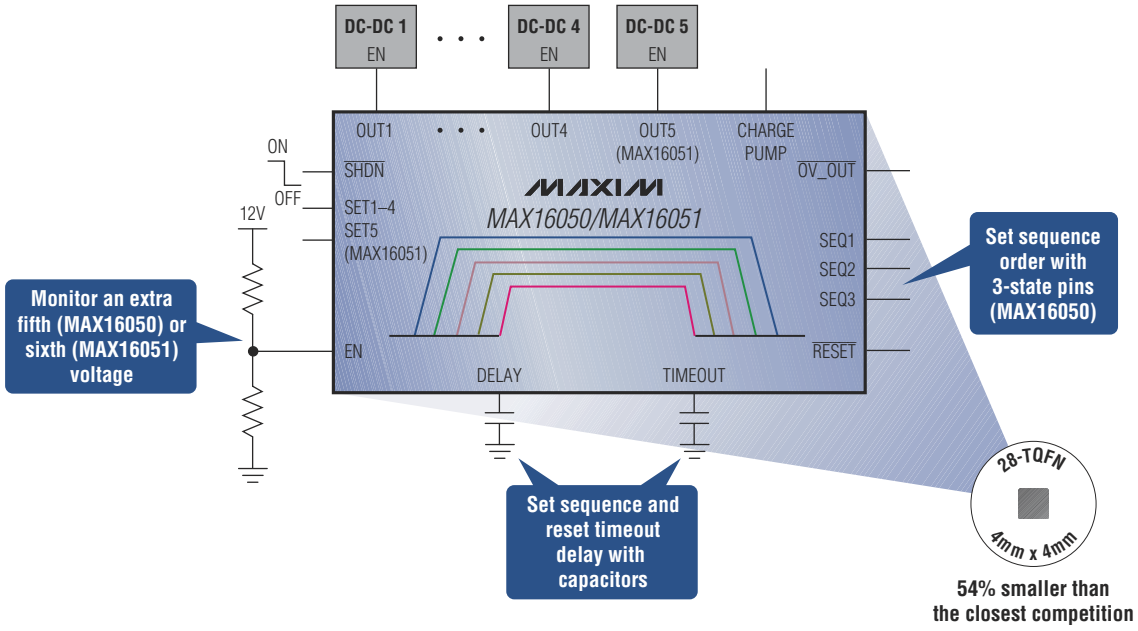
(Continued on page 21)

MAXIM 1983 • 2008 25 YEARS OF ENGINEERING SUCCESS

Sequencing made simple

Key advantages

1) Highest integration in its class 2) No software required 3) Smallest solution



54% smaller than the closest competition

Sequence more channels than the competition

- Sequence five and monitor six channels for overvoltage and undervoltage
- Daisy-chain multiple devices for sequencing additional channels
- Reverse sequencing

Additional benefits

- Wide, 2.7V to 13.2V operating range
- Discharge output capacitors on shutdown with 85mA internal pulldowns
- Pin-configurable sequencing controlled through three 3-state pins (MAX16050)

Part	No. of voltages monitored	No. of outputs/FET drivers	Reverse sequencing	Overvoltage monitoring	Operates off of intermediate bus voltage	Package (mm x mm)
MAX16050	5	4/1	✓	✓	✓	28-TQFN (4 x 4)
MAX16051	6	5/1				

Technical Support
www.maxim-ic.com/support

MAXIM DIRECT
www.maxim-ic.com/shop

AVNET electronics marketing
www.avnet.com

MAXIM
www.maxim-ic.com/MAX16050-info

For a free sample, visit www.maxim-ic.com/samples or call 1-800-998-8800

First in Power Management; First in Innovation

For over 60 years, IR's industry-leading power management technology has helped to transform crude electricity into clean efficient power. Today, IR's mission is twofold: to enable energy-saving solutions that squeeze more efficiency from everyday products; and tackling tough technology roadblocks by delivering high power density that extends the performance of next-generation computing and communications equipment with less wasted energy.

IR's latest product introductions include the versatile IR3721 output power monitor IC for low-voltage DC-DC converters used in notebook, desktop computers, and energy-efficient server applications. These new devices utilize IR's patent-pending TruePower™ technology to accurately capture highly dynamic power information with 2.5 percent accuracy at 65°C.

The IR3721 measures dynamic power at the output/load side of voltage regulators to deliver a significant improvement in dynamic power measurement accuracy compared to competing power monitor ICs. TruePower™ technology addresses dynamic errors which can account for more than a 30 percent error in competing solutions which monitor voltage and current separately in dynamic conditions with independent A/D conversion.

The IR3721 IC monitors the output filter inductor current in buck or multiphase converters from 0.5V to 1.8V and provides the options of using resistive sensing or inductor DCR current sensing with an internal thermal compensation feature to achieve one percent higher efficiency compared to existing solutions while reducing bill of materials and board size requirements.

Another recent innovation from IR is the iP2005A, a fully optimized power stage solution for high current synchronous buck multi-phase converters used in gaming, computing and communications applications.

The iP2005A is 40 percent smaller in size compared to the previous generation device while its efficient operation up to 1.5MHz allows designers to further reduce board space by minimizing the value of output

capacitors and inductors. The iP2005A is optimized for very low EMI, eliminating the need for external snubber circuits in EMI-sensitive designs such as consumer game consoles. By eliminating external snubbers, the iP2005A reduces per phase power loss by up to 2.3W compared to the previous generation device that required an external resistor and capacitor snubber with values of 2.2 Ohms and 10nF respectively.

Available in a 7.7mm x 7.7mm x 1.7mm LGA package, each iP2005A building block is capable of delivering up to 40 amps at 0.8V to 5.5V output. By using these building blocks in a multi-phase system, currents up to 160 amps can be achieved with an industry standard four-phase controller. In addition to an external PWM controller, only input and output capacitors and an output inductor at each phase are required.

Expanding its energy saving product portfolio, IR has recently introduced a family of 600V insulated gate bipolar transistors (IGBTs) that reduces power dissipation by up to 30 percent in uninterruptible power supply (UPS) and solar inverter applications up to 3 kW.

The new application-specific devices use IR's latest-generation field stop trench technology to reduce conduction and switching losses, and are optimized for switching at 20 kHz with low short circuit requirements, enabling higher efficiency power conversion in UPS and solar inverter applications.

Traditionally, IGBT devices have excessive switching losses at the frequencies used in UPS and solar inverters. IR's new Trench IGBT devices have lower switching energy coupled with low conduction losses. These lower losses provide higher efficiency, reducing the size of the unit and the cost of power generation to the end user.

Co-packaged with ultrafast soft recovery diodes, the new family of IGBTs has lower collector-to-emitter saturation voltage (VCE(on)) and total switching energy (ETS) than punch-through (PT) and non-punch-through (NPT) type IGBTs. In addition, the internal ultrafast soft recovery diode improves efficiency and reduces EMI.

For more information visit www.irf.com.

International
IOR Rectifier

POWER DESIGN IDEAS

(Continued from page 18)

In the turn-on of Q_2, the following scenario occurs: When the control input, PWM, goes low, Q_3 quickly turns off, thanks to D_7. A displacement current, $C_4 \times dV/dt$, flows through C_4 to the base of Q_1. Q_1 charges the output capacitance of Q_3 and the gate capacitance of Q_2, and Q_2 turns on. C_3 supplies the collector current. If the period is long, Q_1 keeps conducting and compensating the leakage of Q_3. If D_6 were a Schottky diode, which is leaky, you would have to reduce the value of R_1. A short cross-conduction period exists between the two MOSFETs, a phenomenon that is more apparent when Q_3 turns off and Q_2 turns on. A small inductor, L_1, in series with the main supply limits the current spikes. The inductor needs a snubber comprising D_1, R_1, and C_2. Note that the inductor value is conservative and can be smaller.

The values are for a 370W, three-phase inverter with 150% overload capacity. If you change the MOSFET, the value of C_4 has to change according to the total gate charge plus the output capacitance of Q_3, which is much lower and, in fact, negligible. Q_1 amplifies the capacitor current, so C_4 is proportional to $QG2 \times hFE1$. Make C_4's value no higher than necessary, because the base current in Q_1 would be too high. To obtain all the speed advantages of the circuit, the PWM signal should be able to quickly drive Q_3. If necessary, you can use a buffer circuit (**Figure 2**). You can drive the circuit with a single CMOS gate. The circuit in **Figure 1** is probably the simplest high-voltage inverter you can design. It has served in thousands of three-phase motor drives from 0.37 to 0.75 kW. To reference **Figure 2** or to access this Design Idea online, go to www.edn.com/article/CA419572.

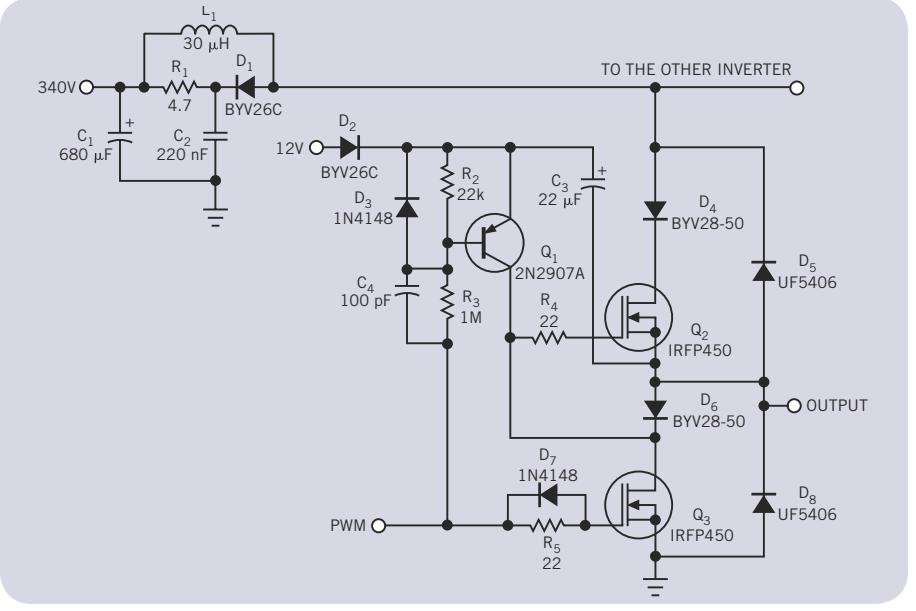


Figure 1 This circuit is probably the simplest high-voltage inverter you can build.

EDN's Best of Power...

COMMUNITY/BLOG POSTS

These posts speak for themselves: Design engineers are an outspoken bunch, with strong opinions on topics within their community.

"'Green' marketing hype turning off consumers"
www.edn.com/blog/1700000170/post/1860018986.html

"What's inside a 9V battery? More batteries! (…and why you never see a AAAA)"
www.edn.com/blog/1470000147/post/910006291.html

"China enters the golf-cart, er, electric-vehicle market"
www.edn.com/log/1470000147/post/1510007951.html

"Freezing temps affect lithium-ion-battery charging"
www.edn.com/log/1470000147/post/940006494.html

"Rave review for free PCB-layout manual"
www.edn.com/blog/1470000147/post/1490010149.html

"$1000 light packs seven LEDs, puts out 1400 lumen—for a bike?"
www.edn.com/blog/1470000147/post/1250015125.html

"Rogowski coils simplify current, power measurement"
www.edn.com/blog/1470000147/post/1740011574.html

"Electric car: Tesla's use of PTC and CID protection in its lithium-ion-battery pack"
www.edn.com/blog/1470000147/post/430007443.html

"Lusting after 100% energy efficiency? Photosynthesis' quantum secret may hold key"
www.edn.com/blog/1470000147/post/590008459.html

"Electric-car batteries might serve as reservoirs of green power?"
www.edn.com/blog/1470000147/post/1170007917.html

READER RESPONSES TO "'GREEN' MARKETING HYPE TURNING OFF CONSUMERS"

Read the original blog on Anablog at www.edn.com/blog/1700000170/post/1860018986.html

on 12/18/2007 at 8:22 am, bluelair said:
Your math is correct, but you're giving it purely from the POV [point-of-view] of the "selfish" buyer who considers only [his] economic well-being. Others may view this differently to take into account resource use in general, not just what hits them in the pocketbook. At this point in time, there is no direct tax on spewing carbon emissions into the atmosphere; it is a cost borne by the entire populace.

on 12/18/2007 at 8:45 am, Economics 101 said:
Economics 101 dude ... something called 'externalities.' These are things that the buyer/seller market relationship does not price, and they explain why libertarian types completely miss the point of the environment. For example, let's say we have a simple economic transaction: You hunt whales in the ocean; I eat whales. I pay you for your labor. Simple, right? The problem is the loss to the world of the whales. Market economics simply breaks down in these situations, just as you are describing in your article. This is why government regulation is 100% appropriate, and I don't say this as a bleeding-heart hippie. I say this as a trained economist who recognizes this at a very fundamental level. In technical terms, regulation is needed because of 'market failure' with regard to the environment.

on 12/18/2007 at 8:54 am, grayscale said:
Sure, there's something wrong about trashing a perfectly good washing machine just to go out and buy a greener version. The point is not to do that. The point is, when your old machine is dead, buy the greenest one you can afford. Just like the point of CF [compact-fluorescent] light bulbs. When an old incandescent one burns out, replace it with a better model. And, with regard to the dead birds around the windmills, that's only one particular site that has that major of a problem. The others are placed with bird-migration patterns taken into account and birdkill is much less at those sites. Is it perfect? No, but the alternative is even more dead birds/animals/people. It doesn't have to be an all-or-nothing situation, just better than before.

Energy-Efficient Power Solutions

High-Performance Analog >>Your Way™

At TI, we've been helping our customers design high-performance power conversion products that meet strict efficiency regulations for over 20 years. TI can help you get to market fast with a winning, energy-saving design. **That's High-Performance Analog >>Your Way.**

UCC28600	Green Mode PWM Controller	Enables off-line power supplies to meet light-load efficiency standards
TPS40140	Stackable Multiphase Controller	Improves point-of-load efficiency in power-hungry data centers and telecom equipment
TPS2410	ORing FET Power Rail Controller	Replaces low-efficiency diodes with high-efficiency, high-reliability control and protection solutions
UCC28060 **UCC28070**	Industry's First Single-Chip Interleaved PFC Controller	Dual phase for high-efficiency, high-power density and easy phase management for light-load efficiency
UCD9112 **UCD9240**	Digital Controller w/Configurable GUI	Easy-to-use, flexible point-of-load solution for multi-phase power topologies
PTH08T250W	50-A Non-Isolated Power Module w/TurboTrans™ Technology	96%-efficient, stackable, and easy-to-use point-of-load module for servers, wireless infrastructure, datacom and telecom equipment
TMS320F28335	Digital Signal Controller	Highly integrated digital controller improves efficiency of renewable energy systems

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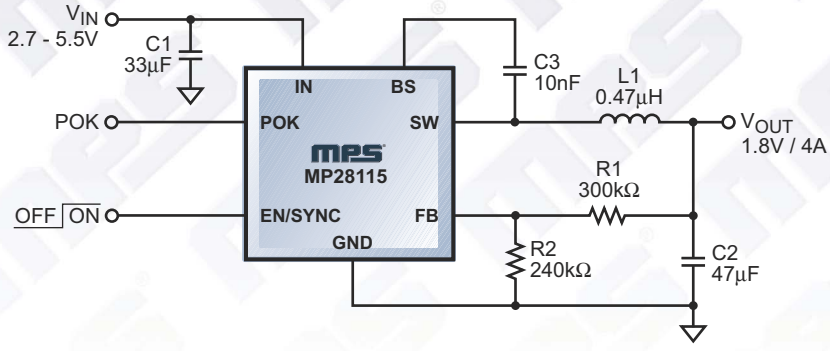
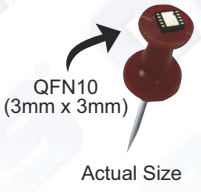
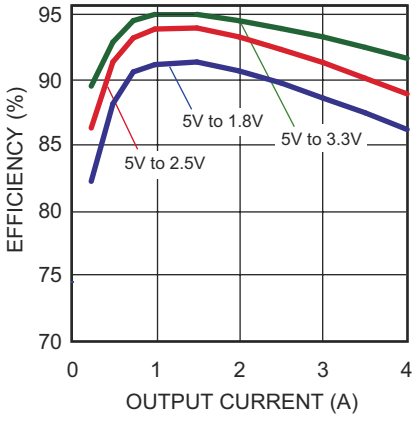
Highest Efficiency 4A Step-Down Switching Regulators

93% Efficient at 3A, up to 70% Smaller Footprint





Efficiency vs Output Current



- *Smallest 4A Solution Available!*
- *3mm x 3mm 10-lead QFN Package*
- *93% Efficient @ 3A*
- *All Ceramic Capacitor Design*
- *Internal Soft-Start and Compensation*

Power Your Designs with Greater Efficiency!

Part	Switch Frequency	Efficiency	$R_{DS(ON)}$	V_{IN} (V)	V_{OUT} (V)	I_{OUT} (A)	Package Footprint
MP28115	1.5MHz	93% @ 3A	60mΩ	2.7 - 6.0	0.8 - 0.9 x V_{IN}	4	3mm x 3mm QFN 10-Pin
MP28128	1.5MHz	95% @ 1.5A	60mΩ	2.7 - 6.0	0.8 - 0.9 x V_{IN}	2.5	3mm x 3mm QFN 10-Pin

DC to DC Converters CCFL / LED Drivers Class D Audio Amplifiers Linear ICs

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