



LTC2992 Dual Wide Range Power Monitor

LT3964 Dual 36V Synchronous 1.6A Buck LED Driver with I²C

LTM4651 EN55022B Compliant 58V, 24W Inverting-Output DC/DC μ Module Regulator

LT8362 Low I_Q Boost/SEPIC/Inverting Converter with 2A, 60V Switch

LT8650S Dual Channel 4A, 42V, Synchronous Step-Down Silent Switcher 2 with 6.2 μ A Quiescent Current

NEW POWER MANAGEMENT PRODUCTS

December 2017



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LTC4418

Dual Channel Prioritized PowerPath Controller

FEATURES

- Selects Highest Priority Supply from Two Inputs
- Blocks Reverse and Cross Conduction Currents
- Wide Operating Voltage Range: 2.5V to 40V
- -42V Protection Against Reverse Connection
- 60V Tolerant V1, V2 Inputs
- Adjustable Input Validation Time
- Fast Switchover Minimizes Output Voltage Droop
- Low 26µA Operating Current
- ±1.5% Input Overvoltage/Undervoltage Protection
- Adjustable Overvoltage/Undervoltage Hysteresis
- Cascadable for Additional Input Supplies
- 20-Lead 4mm × 4mm QFN Package

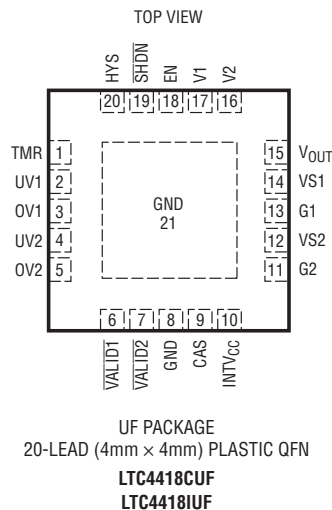
APPLICATIONS

- Industrial Handheld Instruments
- High Availability Systems
- Battery Backup Systems
- Servers and Computer Peripherals

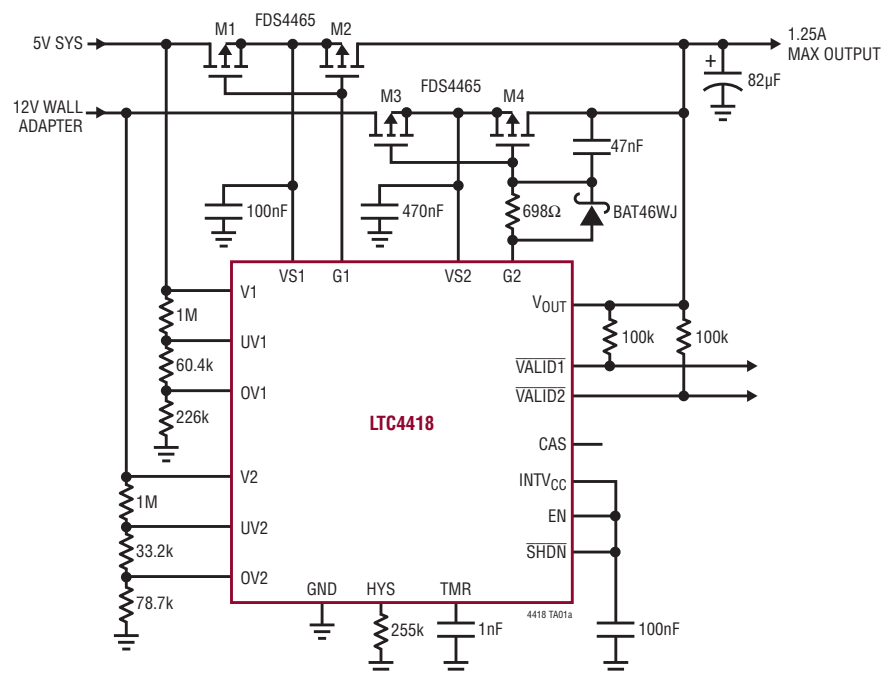
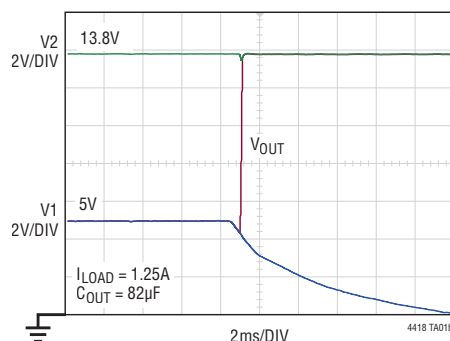
DESCRIPTION

The LTC4418 connects one of two valid power supplies to a common output based on priority and validity. Priority is defined by pin assignment, with V1 assigned the higher priority and V2 the lower priority. A power supply is defined as valid when its voltage has been within its overvoltage (OV) and undervoltage (UV) window continuously for at least the configured validation time. If the highest priority valid input falls out of the OV/UV window, the channel is immediately disconnected and the other valid input is connected to the common output. Multiple LTC4418s, as well as triple channel LTC4417s, can be cascaded to provide switchover between more than two inputs.

The LTC4418 incorporates fast non-overlap switching circuitry to prevent both reverse and cross conduction while minimizing output droop. The gate driver includes a 6V clamp to protect external MOSFETs. A controlled soft-start feature minimizes start-up inrush current. Open drain VALID outputs indicate the input supplies have been within their OV/UV window for the duration of the validation time. The validation time can be disabled or adjusted using an external capacitor.



Priority Switching from V1 to V2



LT8672

Active Rectifier Controller with Reverse Protection

FEATURES

- Reverse Input Protection to -40V
- Improved Performance Compared to a Schottky Diode:
 - Reduce Power Dissipation by $>90\%$
 - Reduce Drop to 20mV
- Ultrafast Transient Response
 - Rectifies $6\text{V}_{\text{p-p}}$ Up to 50kHz
 - Rectifies $2\text{V}_{\text{p-p}}$ Up to 100kHz
- Wide Operating Voltage Range: 3V to 42V
- Low $20\mu\text{A}$ Quiescent Current in Operation
- Low $3.5\mu\text{A}$ Shutdown Current
- Accurate 1.21V Enable Pin Threshold
- Available in Small 10-Lead MSOP

APPLICATIONS

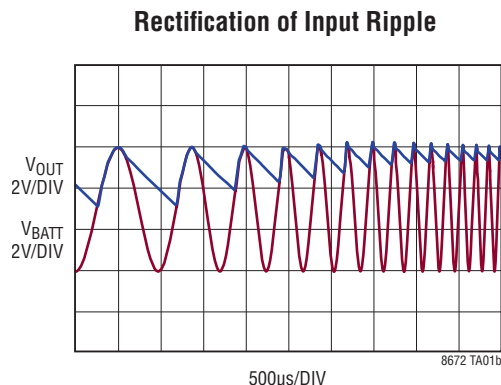
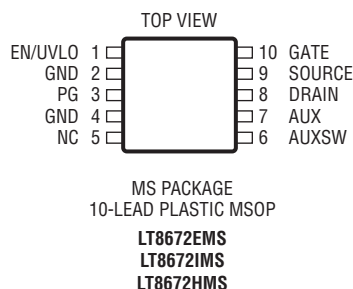
- Automotive Battery Protection
- Industrial Supplies
- Portable Instrumentation

DESCRIPTION

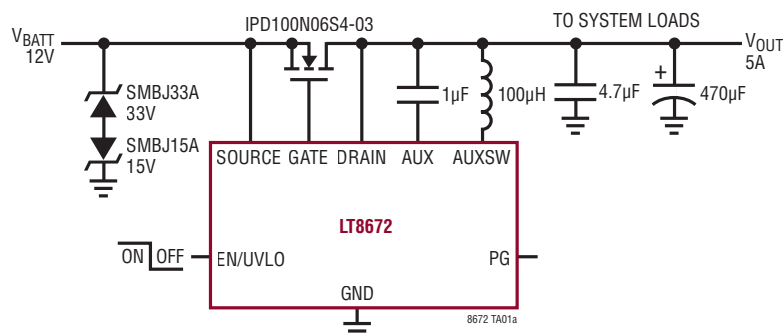
The LT8672 is an active rectifier controller for reverse input protection. It drives an external N-channel MOSFET to replace a power Schottky diode. Its very low quiescent current and fast transient response meet the tough requirements in automotive applications where AC input signals of up to 100kHz are present. These signals are rectified with minimum power dissipation on the external FET, simplifying thermal management on the PCB.

With a drop of only 20mV , the LT8672 solution eases the minimum input voltage requirement during cold crank and start-stop, allowing simpler and more efficient circuits. If the input power source fails or is shorted, a fast turn-off minimizes reverse current transients. An available shutdown mode reduces the quiescent current to $3.5\mu\text{A}$.

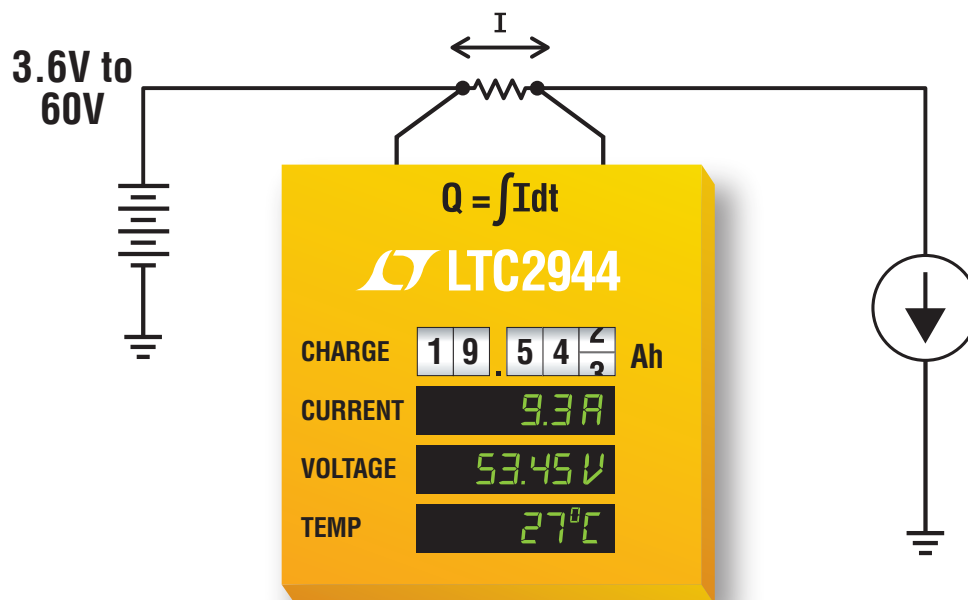
An integrated auxiliary boost regulator provides the required boost voltage to turn the external FET fully on. A power good pin signals when the external FET is ready to take load current.



12V, 5A Automotive Reverse Battery Protection



High Voltage Battery Monitor



Measure Charge, Voltage, Current and Temperature with 1% Accuracy

The LTC[®]2944 measures battery current, charge, voltage and internal temperature via an I²C interface. A precision coulomb counter integrates current to determine charge. Features include programmable limit thresholds and alerts. The LTC2944 provides useful measurements for any battery chemistry and capacity.

▼ Features

- Measures Accumulated Battery Charge
- 3.6V to 60V Operating Range for Multicell Applications
- 14-Bit ADC Measures Voltage, Current and Temperature
- 1% Charge, Voltage, Current Accuracy
- I²C/SMBus Interface
- Configurable Alert Output/Charge Complete Input
- Quiescent Current <150μA
- 8-Pin 3mm x 3mm DFN Package

▼ Battery Monitors

Part Number	Operating Range	Internal Sense Resistor	Measures:				Package
			Q	V	I	T	
LTC2941	2.7V to 5.5V		•				2mm x 3mm DFN-6
LTC2941-1	2.7V to 5.5V	1A	•				2mm x 3mm DFN-6
LTC2942	2.7V to 5.5V		•	•		•	2mm x 3mm DFN-6
LTC2942-1	2.7V to 5.5V	1A	•	•		•	2mm x 3mm DFN-6
LTC2943	3.6V to 20V		•	•	•	•	3mm x 3mm DFN-8
LTC2943-1	3.6V to 20V	1A	•	•	•	•	3mm x 3mm DFN-8
LTC2944	3.6V to 60V		•	•	•	•	3mm x 3mm DFN-8
LTC4150	2.7V to 8.5V		•				MSOP-10

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www.linear.com/product/LTC2944

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LTC2992

Dual Wide Range Power Monitor

FEATURES

- Rail-to-Rail Input Range: 0V to 100V
- Wide Input Supply Range: 2.7V to 100V
- Measures Current, Voltage and Power
- Shunt Regulator for Supplies >100V
- 8-/12-Bit ADCs with Less Than $\pm 0.3\%$ Total Unadjusted Error
- Four General Purpose Inputs/Outputs Configurable as ADC Inputs
- Continuous Scan and Snapshot Modes
- Stores Minimum and Maximum Measurements
- Alerts When Alarm Thresholds Exceeded
- Shutdown Mode with $I_Q < 50\mu A$
- Split SDA Pin Eases Opto-Isolation
- Available in 16-Lead 4mm $\times$ 3mm DFN and MSOP Packages

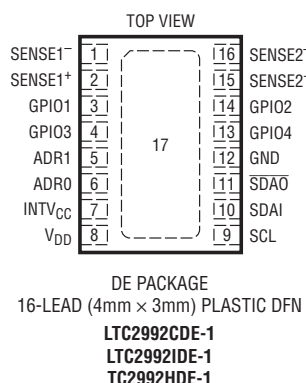
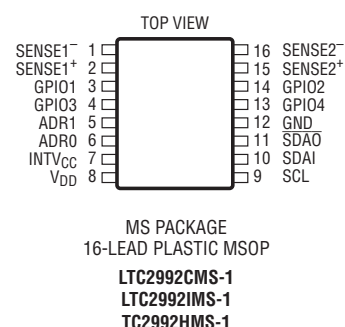
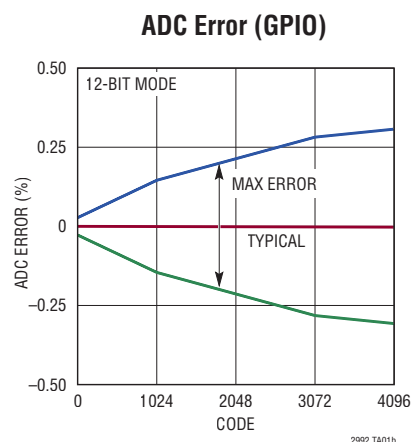
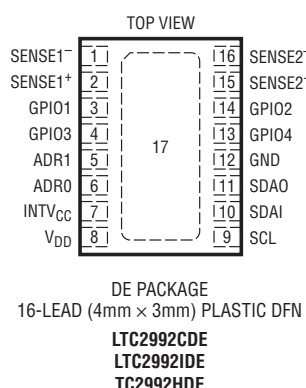
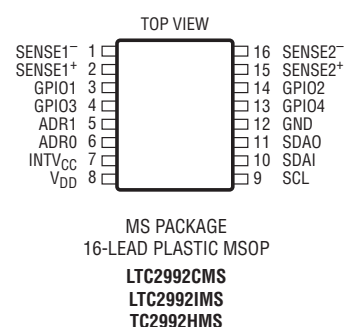
APPLICATIONS

- Telecom Infrastructure
- Industrial Equipment
- Automotive
- Computer Systems and Servers

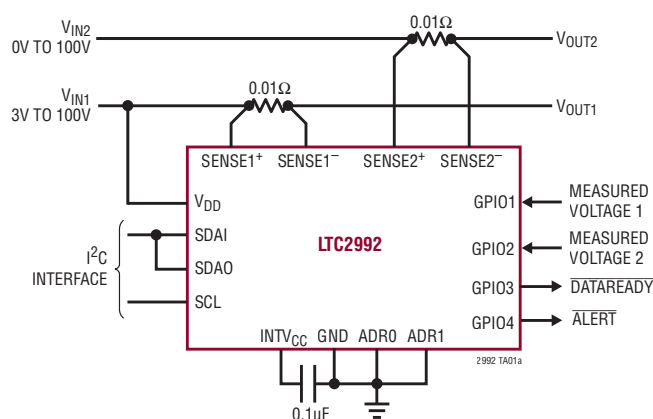
DESCRIPTION

The LTC2992 is a rail-to-rail system monitor that measures current, voltage and power of two supplies. It features an operating range of 2.7V to 100V and includes a shunt regulator for supplies above 100V. The voltage measurement range of 0V to 100V is independent of the input supply. Two ADCs simultaneously measure each supply's current. A third ADC monitors the input voltages and four auxiliary external voltages. Each supply's current and power is added for total system consumption. Minimum and maximum values are stored and an overrange alert with programmable thresholds minimizes the need for software polling. Data is reported via a standard I²C interface. Shutdown mode reduces current consumption to 25 μA typically.

The LTC2992 I²C interface includes separate data input and output pins for use with standard or opto-isolated I²C connections. The LTC2992-1 has an inverted data output for use with inverting opto-isolator configurations.



Dual Wide Range Power Monitor



LT3964

Dual 36V Synchronous 1.6A Buck LED Driver with I²C

FEATURES

- Wide Input Voltage Range: 4V to 36V
- Two Independent 1.6A/40V Synchronous Bucks
- I²C Interface for Internal True Color PWM™ Dimming (8192:1), Analog Dimming and Fault Reporting
- 1000:1 External True Color PWM Dimming and 10:1 External Analog Dimming
- PMOS Switch Driver for PWM and Output Disconnect
- ±3% Constant Current Regulation
- Adjustable Frequency: 200kHz to 2MHz
- Frequency Synchronization with Clock Output
- Programmable OPENLED Protection with Reporting
- Short-Circuit Protection with Reporting
- Programmable Undervoltage Lockout with Hysteresis
- Internal Compensation
- Nine Unique Device Addresses for I²C
- Available in 5mm × 6mm 36-Lead QFN Package

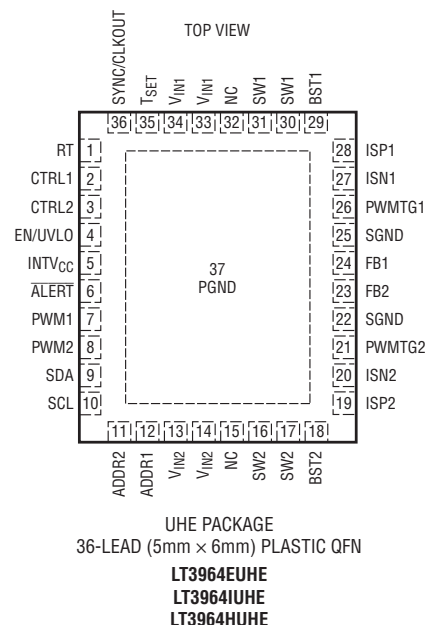
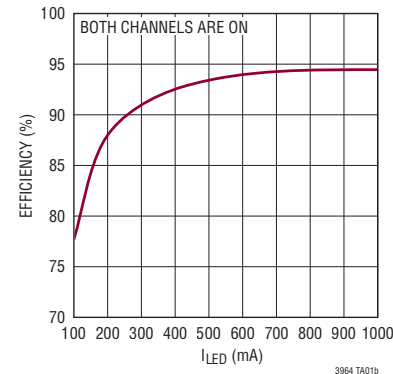
APPLICATIONS

- General Purpose, Industrial, Medical and Automotive Lighting
- Constant-Current, Constant-Voltage Source

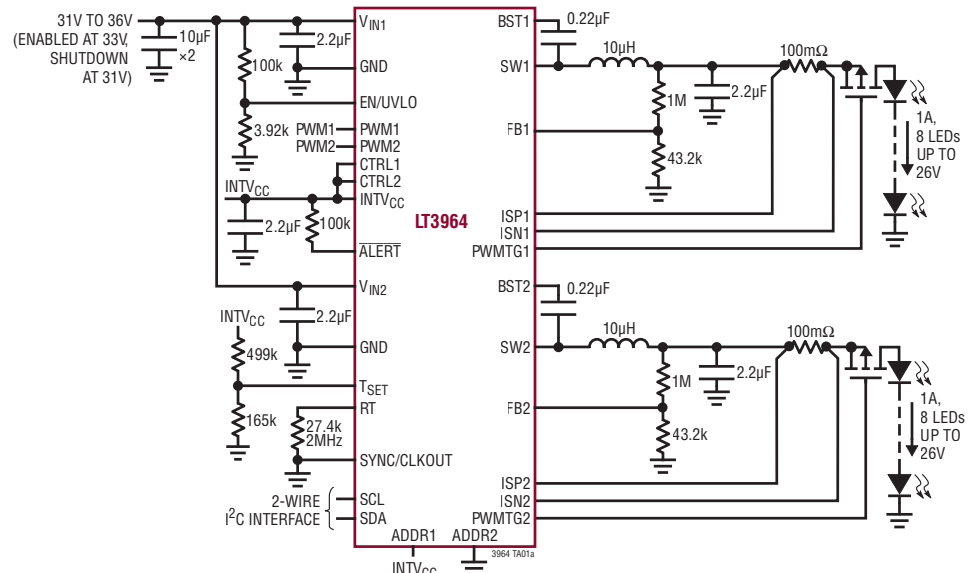
DESCRIPTION

The LT3964 is a dual synchronous step-down DC/DC converter with I²C interface designed to operate as a constant-current and constant-voltage source and is ideal for driving LEDs. The fixed frequency and peak current mode topology result in stable operation over a wide range of supply and output voltages. The ground referred voltage FB pin serves as the input for several LED protection features, and also allows the converter to operate as a constant-voltage source. The maximum output current is set by an external resistor, and the output current amplifier has a rail-to-rail common mode range. LT3964 uses an I²C interface to communicate with a microcontroller to read LED faults, write PWM and analog dimming registers and set fault masking. The I²C PWM input provides LED dimming ratios up to 8192:1. The I²C programmable CTRL register sets the gain of the external CTRL pin, and maximum current sense threshold, providing additional analog dimming capability.

Efficiency, V_{IN} = 34V



50W Dual Buck 1A LED Driver



LTM4645

25A DC/DC Step-Down µModule Regulator

FEATURES

- 4.7V to 15V Input Voltage Range
- 0.6V to 1.8V Output Voltage Range
- 25A DC Output Current
- $\pm 1.2\%$ Total DC Output Voltage Error (-40°C to 125°C)
- High Reliability N + 1 Phase Redundancy Supported
- Internal or External Control Loop Compensation
- Differential Remote Sense Amplifier for Precision Regulation
- Current Mode Control/Fast Transient Response
- Multiphase Current Sharing Up to 150A
- Built-In Temperature Monitoring
- Selectable Pulse-Skipping, Burst Mode® Operation
- Soft-Start/Voltage Tracking
- Frequency Synchronization
- Output Overvoltage Protection
- Output Overcurrent Foldback Protection
- 9mm × 15mm × 3.51mm BGA Package

APPLICATIONS

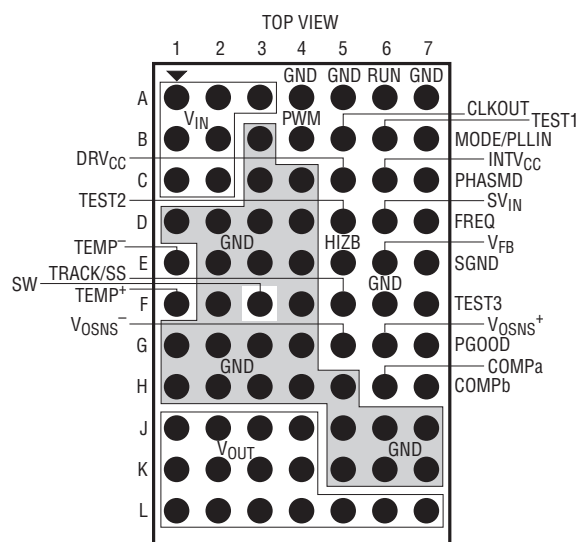
- Telecom, Networking and Industrial Equipment
- Point-of-Load Regulation

DESCRIPTION

The LTM4645 is a 25A output switching mode step-down DC/DC µModule (power module) regulator. Included in the package are the switching controller, power FETs, inductor and all supporting components. Operating over an input voltage range of 4.7V to 15V, the LTM4645 supports an output voltage range of 0.6V to 1.8V, set by a single external resistor. Only a few input and output capacitors are needed.

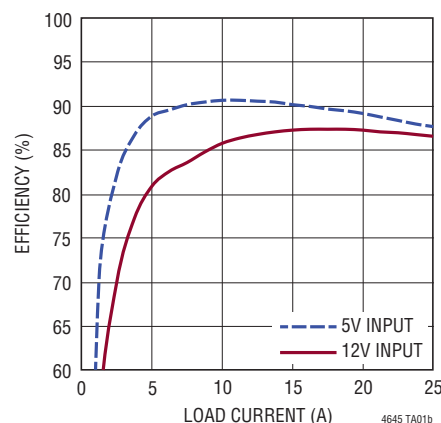
Its high efficiency design delivers about 86% efficiency from 12V input to 1.0V output with 25A continuous load current. High switching frequency and a current mode architecture enable a very fast transient response to line and load changes without sacrificing stability. The device supports frequency synchronization, programmable multiphase operation, N+1 phase redundancy, and output voltage tracking for supply rail sequencing.

Fault protection features include overvoltage and overcurrent protection. The power module is offered in a space saving 9mm × 15mm × 3.51mm BGA package. The LTM4645 is available with SnPb (BGA) or RoHS compliant terminal finish.

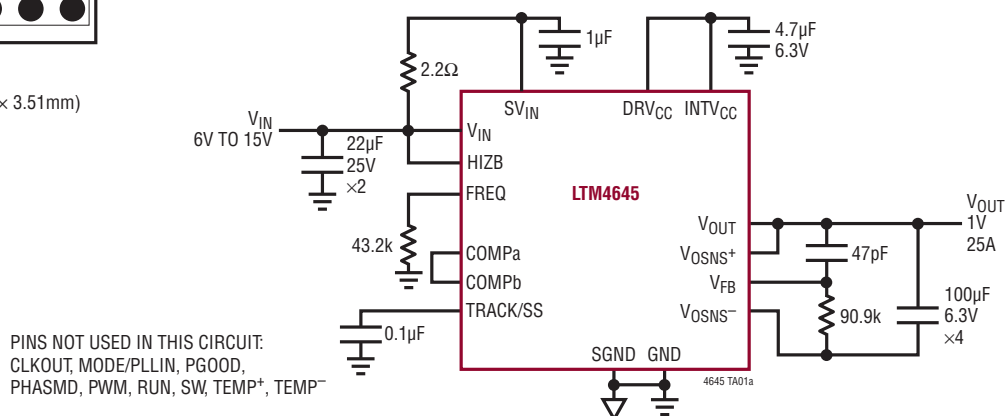


BGA PACKAGE
77-LEAD (9mm × 15mm × 3.51mm)
LTM4645EY
LTM4645IY

Efficiency vs Output Current at 1V Output



12V_{IN}, 1V_{OUT}, 25A DC/DC µModule Regulator



LTM4651

EN55022B Compliant 58V, 24W

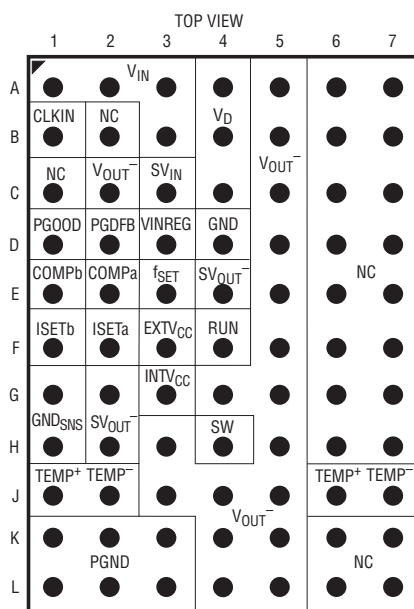
Inverting-Output DC/DC μ Module Regulator

FEATURES

- **Complete Low EMI Switch Mode Power Supply**
- **EN55022 Class B Compliant**
- **Wide Input Voltage Range: 3.6V to 58V**
- **Up to 4A Output Current**
 - **24W Output from 12V_{IN} to -24V_{OUT}, P_{LOSS} = 5W, T_A = 60°C, t_{RISE} = 60°C, 200LFM**
- **Output Voltage Range: -26.5V ≤ V_{OUT} ≤ -0.5V**
 - **Safe Operating Area: V_{IN} + |V_{OUT}| ≤ 58V**
- **±1.67% Total DC Output Voltage Error Over Line, Load and Temperature (-40°C to 125°C)**
- **Parallel and Current Share with Multiple LTM4651s**
- **Constant-Frequency Current Mode Control**
- **Frequency Synchronization Range: 250kHz to 3MHz**
- **Power Good Indicator and Programmable Soft-Start**
- **Overcurrent/Overvoltage/Overtemperature Protection**
- **15mm × 9mm × 5.01mm BGA Package**

APPLICATIONS

- Avionics, Industrial Control and Test Equipment
- Video, Imaging and Instrumentation
- 48V Telecom and Network Power Supplies
- RF Systems



BGA PACKAGE
 77-PIN (15mm × 9mm × 5.01mm)
LTM4651EY
LTM4651IY

DESCRIPTION

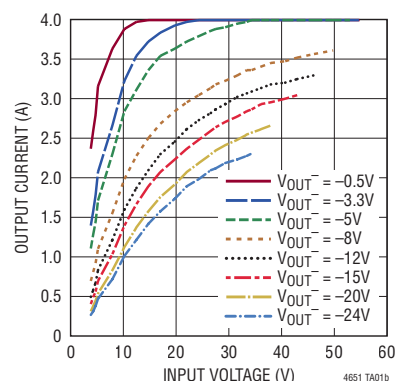
The LTM4651 is an ultralow noise, 58V, 24W DC/DC μ Module inverting topology regulator. It regulates a negative output voltage (V_{OUT-}) from a positive input supply voltage (V_{IN}), and is designed to meet the radiated emissions requirements of EN55022. Conducted emission requirements can be met by adding standard filter components. Included in the package are the switching controller, power MOSFETs, inductor, filters and support components.

The LTM4651 can regulate V_{OUT} to a value between $-0.5V$ and $-26.5V$, provided that its input and output voltages adhere to the safe operating area criteria of the LTM4651: $V_{IN} + |V_{OUT}| \leq 58V$. A switching frequency range of 250kHz to 3MHz is supported (400kHz default) and the module can synchronize to an external clock.

Despite being an inverting topology regulator, no level shift circuitry is needed to interface to the LTM4651's RUN, PGOOD or CLKIN pins; those pins are referenced to GND.

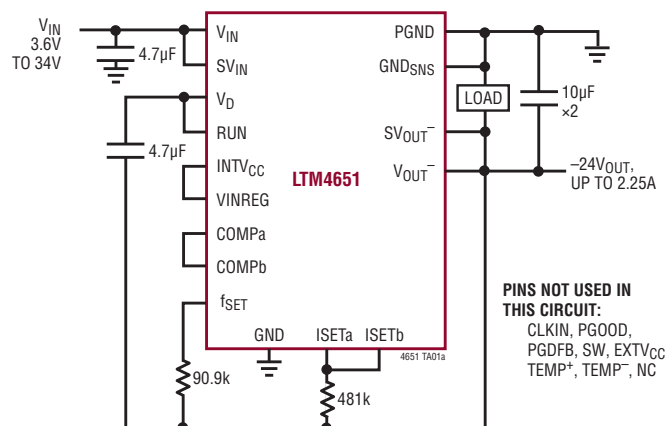
The LTM4651 is offered in a 15mm × 9mm × 5.01mm BGA package with SnPb or RoHS compliant terminal finish.

Output Current Capability*



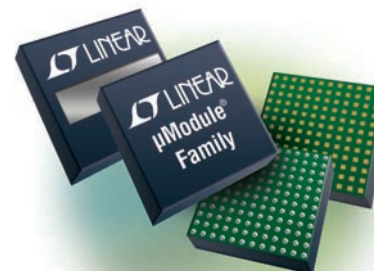
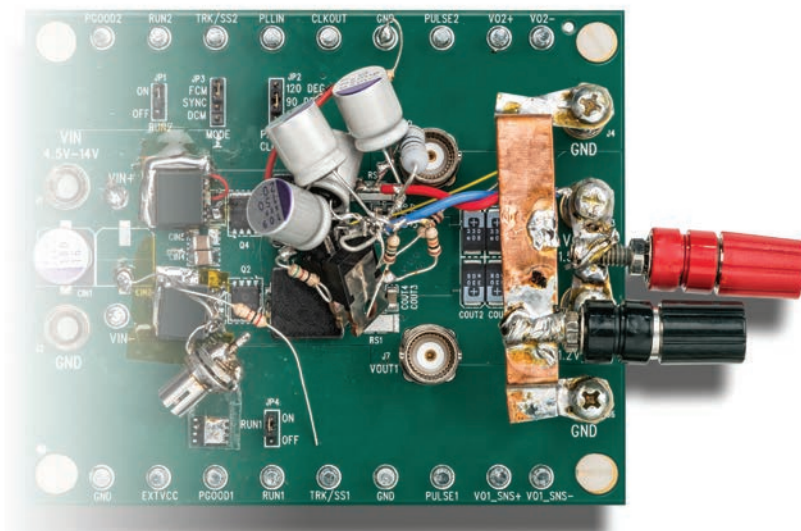
*Current limit frequency-foldback activates at load currents higher than indicated curves. Continuous output current capability subject to details of application implementation.

-24V, 2.25A* Ultralow Noise DC/DC μ Module Register



PINS NOT USED IN THIS CIRCUIT:
CLKIN, PGOOD,
PGDFB, SW, EXTV_{CC},
TEMP⁺, TEMP⁻, NC

Simple & Done



Complete Power System-in-a-Package

Over 100 μModule® Power Solutions

Our quickest, simplest and most integrated DC/DC power solutions are complete systems-in-a-package with integrated inductor, MOSFET, DC/DC regulator IC and supporting components. With over 100 power solutions available, each μModule product is qualified with Linear Technology's stringent electrical, package and thermal reliability tests. Simplify and speed your power system development with μModule power products. Our μModule products are available in both BGA and LGA packages.

▼ μModule Product Family Examples

Product Family	Key Features & Part Numbers
Ultrathin Buck Regulators	1.8mm Height: LTM®4622, LTM4623
Buck-Boost Regulators	LTM4607, LTM8055, LTM8056
Multiple Output Buck Regulators	Dual: LTM4616, 4620, 4628, 4630 Triple: LTM4615 Quad: LTM4644 Quint: LTM8001, LTM8008
High Power Buck Regulators	Up to 144A: Four in Parallel LTM4630
High Voltage Buck Regulators	Up to 60V: LTM8027, LTM8050
Digital Interface Buck Regulators	Dual Output: LTM4675, LTM4676, LTM4676A
Isolated Converters	Up to 1500VDC: LTM8048, LTM8057, LTM8058
Ultralow Noise	EN55022 Class B: LTM4606, LTM8033
LED Drivers	Up to 36V LED String: LTM8040, LTM8042, LTM8042A
Battery Chargers	Li-Ion, Li-Polymer, SLA, LiFePO4: LTM8061, LTM8062, LTM8062A

▼ For More Information

www.linear.com/uModulepower

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Linear's
μModule
Product
Brochure**

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LTM8063

40V_{IN} 2A Silent Switcher
μModule Regulator

FEATURES

- Low Noise Silent Switcher Architecture
- Wide Input Voltage Range: 3.2V to 40V
- Wide Output Voltage Range: 0.8V to 15V
- 2A Continuous Output Current at 12V_{IN}, 5V_{OUT}, T_A = 85°C
- 2.5A Peak Current
- Selectable Switching Frequency: 200kHz to 2.2MHz
- External Synchronization
- Configurable as an Inverter
- 6.25mm × 4mm × 2.22mm BGA Package

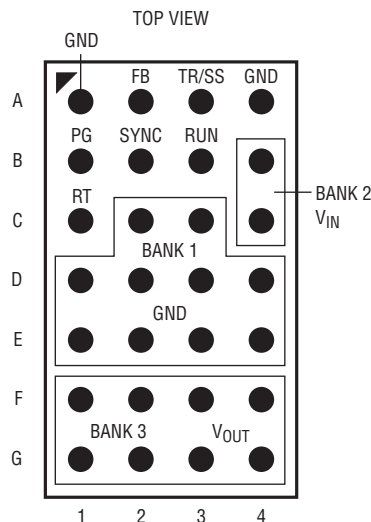
APPLICATIONS

- Automotive Battery Regulation
- Power for Portable Products
- Distributed Supply Regulation
- Industrial Supplies
- Wall Transformer Regulation

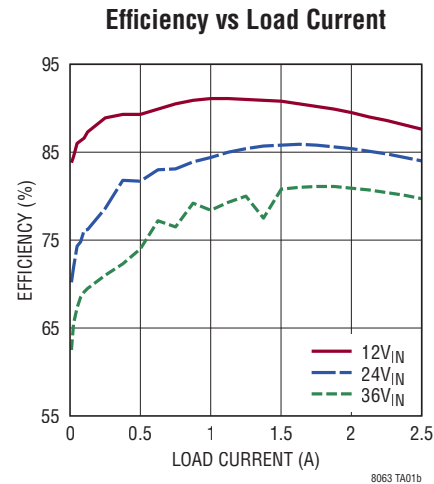
DESCRIPTION

The LTM8063 is a 40V_{IN}, 2A continuous, 2.5A peak, step-down μModule (power module) regulator. Included in the package are the switching controller, power switches, inductor and all support components. Operating over an input voltage range of 3.2V to 40V, the LTM8063 supports an output voltage range of 0.8V to 15V and a switching frequency range of 200kHz to 2.2MHz, each set by a single resistor. Only the input and output filter capacitors are needed to finish the design.

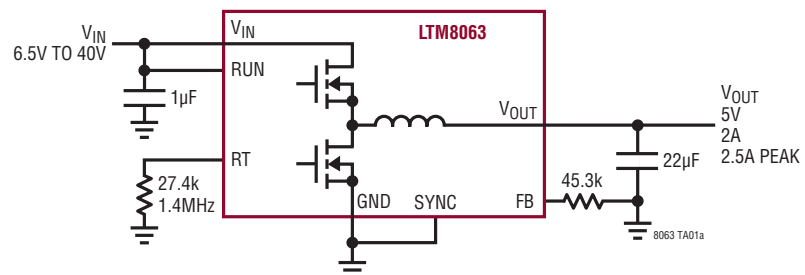
The low profile package enables utilization of unused space on the bottom of PC boards for high density point of load regulation. The LTM8063 is packaged in a thermally enhanced, compact overmolded ball grid array (BGA) package suitable for automated assembly by standard surface mount equipment. The LTM8063 is RoHS compliant.



BGA PACKAGE
28-LEAD (6.25mm × 4mm × 2.22mm)
LTM8063EY
LTM8063IY



5V_{OUT} from 6.5V_{IN} to 40V_{IN} Step-Down Converter



PINS NOT USED IN THIS CIRCUIT: TR/SS, PG

LTM8065

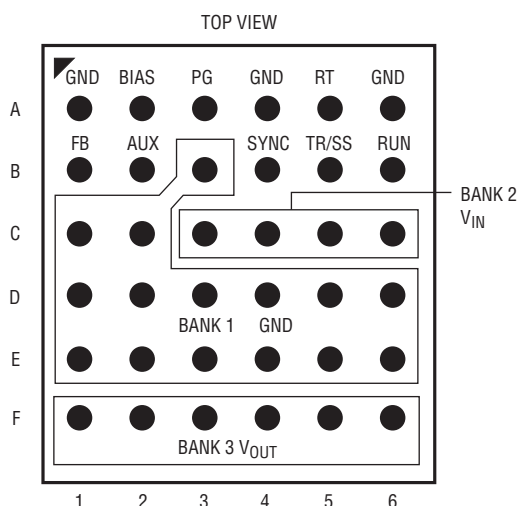
40V_{IN}, 2.5A Silent Switcher
µModule Regulator

FEATURES

- Complete Step-Down Switch Mode Power Supply
- Low Noise Silent Switcher Architecture
- Wide Input Voltage Range: 3.4V to 40V
- Wide Output Voltage Range: 0.97V to 18V
- 2.5A Continuous Output Current, 3.5A Peak
- Selectable Switching Frequency: 200kHz to 3MHz
- External Synchronization
- Programmable Soft-Start
- Tiny, Low Profile 6.25mm × 6.25mm × 2.32mm RoHS Compliant BGA Package

APPLICATIONS

- Automotive Battery Regulation
- Power for Portable Products
- Distributed Supply Regulation
- Industrial Supplies
- Wall Transformer Regulation



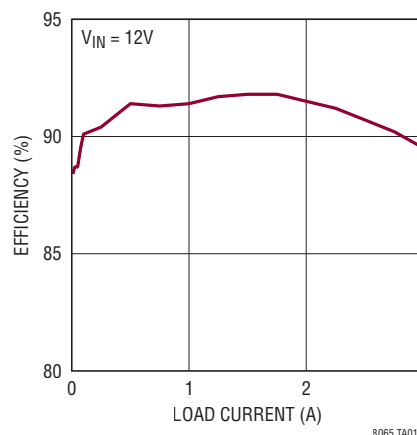
BGA PACKAGE
36-LEAD (6.25mm × 6.25mm × 2.32mm)
LTM8065EY
LTM8065IY

DESCRIPTION

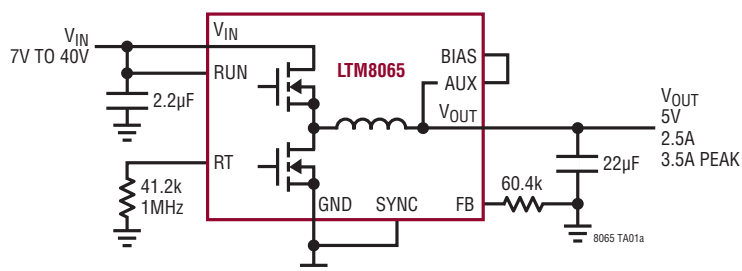
The LTM8065 is a 40V_{IN}, 3.5A peak, 2.5A continuous step-down µModule (power module) regulator. Included in the package are the switching controller, power switches, inductor and all support components. Operating over an input voltage range of 3.4V to 40V, the LTM8065 supports an output voltage range of 0.97V to 18V and a switching frequency range of 200kHz to 3MHz, each set by a single resistor. Only the input and output filter capacitors are needed to finish the design.

The low profile package enables utilization of unused space on the bottom of PC boards for high density point of load regulation. The LTM8065 is packaged in a thermally enhanced, compact overmolded ball grid array (BGA) package suitable for automated assembly by standard surface mount equipment. The LTM8065 is RoHS compliant.

Efficiency vs Load Current



5V_{OUT} from 7V_{IN} to 40V_{IN} Step-Down Converter



PINS NOT USED IN THIS CIRCUIT: TR/SS, PG

LT8362

Low I_Q Boost/SEPIC/ Inverting Converter
with 2A, 60V Switch

FEATURES

- Wide Input Voltage Range: 2.8V to 60V
- Ultralow Quiescent Current and Low Ripple Burst Mode Operation: $I_Q = 9\mu A$
- 2A, 60V Power Switch
- Positive or Negative Output Voltage Programming with a Single Feedback Pin
- Programmable Frequency (300kHz to 2MHz)
- Synchronizable to an External Clock
- Spread Spectrum Frequency Modulation for Low EMI
- BIAS Pin for Higher Efficiency
- Programmable Undervoltage Lockout (UVLO)
- Thermally Enhanced 10-Lead 3mm × 3mm DFN and 16-Lead MSOP Packages

APPLICATIONS

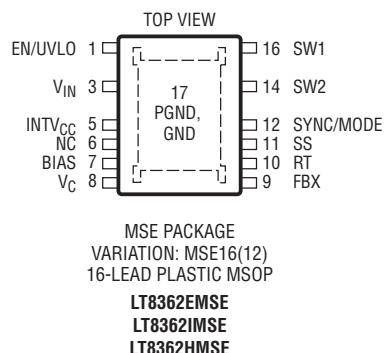
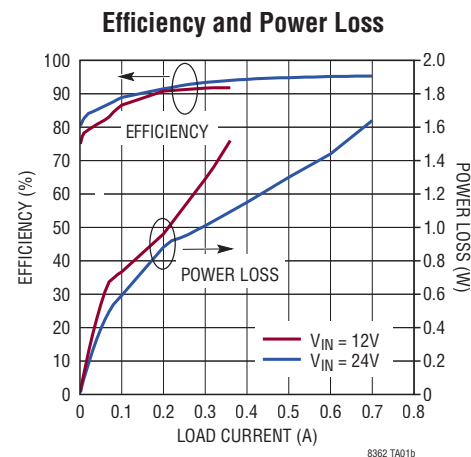
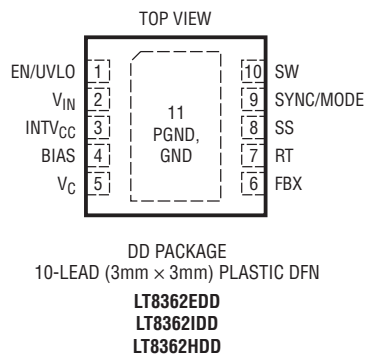
- Industrial and Automotive
- Telecom
- Medical Diagnostic Equipment
- Portable Electronics

DESCRIPTION

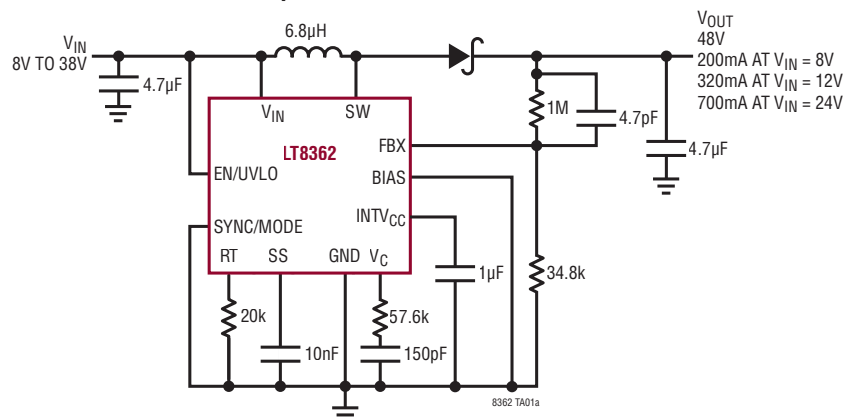
The LT8362 is a current mode DC/DC converter with a 60V, 2A switch operating from a 2.8V to 60V input. With a unique single feedback pin architecture it is capable of boost, SEPIC or inverting configurations. Burst Mode operation consumes as low as 9μA quiescent current to maintain high efficiency at very low output currents, while keeping typical output ripple below 15mV.

An external compensation pin allows optimization of loop bandwidth over a wide range of input and output voltages and programmable switching frequencies between 300kHz and 2MHz. A SYNC/MODE pin allows synchronization to an external clock. It can also be used to select between burst or pulse-skipping modes of operation with or without Spread Spectrum Frequency Modulation for low EMI. For increased efficiency, a BIAS pin can accept a second input to supply the INTV_{CC} regulator. Additional features include frequency foldback and programmable soft-start to control inductor current during start-up.

The LT8362 is available in a thermally enhanced 10-lead 3mm × 3mm DFN package or a thermally enhanced 16-lead MSOP package with four pins removed.



2MHz, 48V Output Boost Converter



LT8603

42V, Low I_Q, Quad Output Triple Monolithic Buck Converter and Boost Controller

FEATURES

- **Flexible Power Supply System Capable of Four Regulated Outputs with $V_{BATT} \ll V_{OUT}$**
- **Two High Voltage Synchronous Buck Regulators**
 - **3V to 42V Input Voltage Range**
 - **Output Currents Up to 2.5A and 1.5A**
- **One Low Voltage Synchronous Buck Regulator**
 - **2.6V to 5.5V Input Voltage Range**
 - **Output Currents Up to 1.8A**
- **One Boost Controller Allows Buck Converters to Regulate with $V_{BATT} \ll V_{OUT}$**
- **Selectable Burst Mode Operation Allows Low 28μA I_Q with High Voltage Channels Active**
- **Programmable Power-On Reset**
- **Individual Channel Power Good Indicators**
- **Step-Down Switching Frequency: 250kHz to 2.2MHz**
- **Available in 40-Lead QFN (6mm × 6mm) Package**

APPLICATIONS

- Automotive Stop-Start and Cold Crank Ride Through
- Last-Gasp CPU Power Hold-Up
- Industrial Controls and Power Supplies

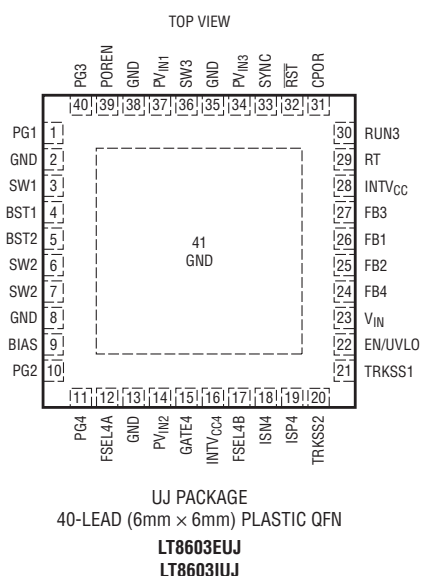
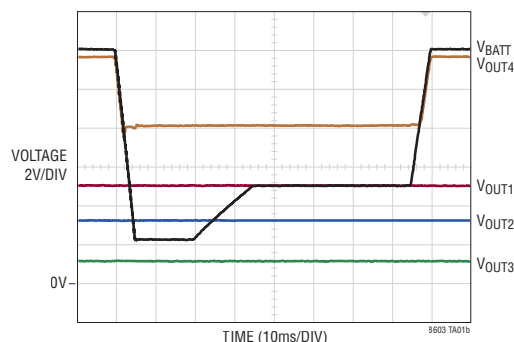
DESCRIPTION

The LT8603 is a highly flexible, quad output regulator combining two high input voltage capable monolithic step-down switching regulators, one low input voltage capable monolithic step-down regulator, and a boost controller to satisfy a wide range of applications while occupying minimal board space.

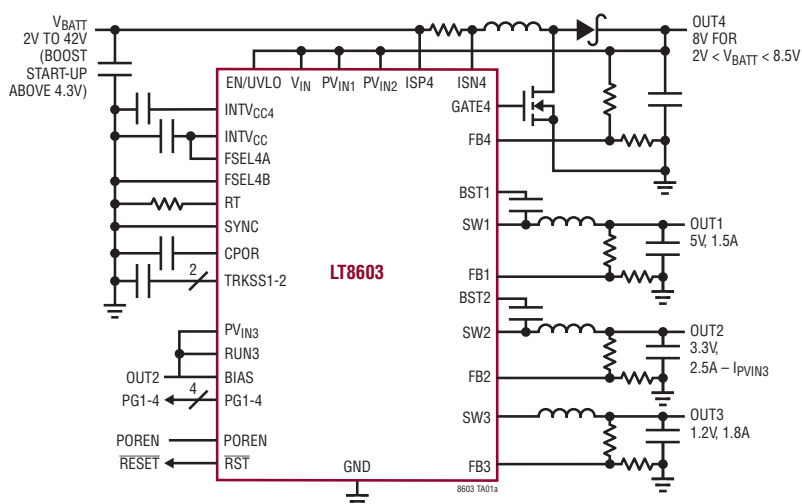
With the boost controller configured to supply the chip V_{IN} supply, the LT8603 produces three precisely regulated outputs even when the boost input voltage falls significantly below the regulated output voltages, such as during an automotive cold crank scenario. Alternatively, with the boost controller driven from one of the step-down regulator outputs or configured as a SEPIC, the LT8603 provides four precisely regulated outputs over a wide input voltage range.

The LT8603 provides robust regulation by including a cycle-by-cycle current limit for all step-down regulators, thermal shutdown, and a boost controller that can tolerate reverse battery connections and negative transient input voltages down to -42V .

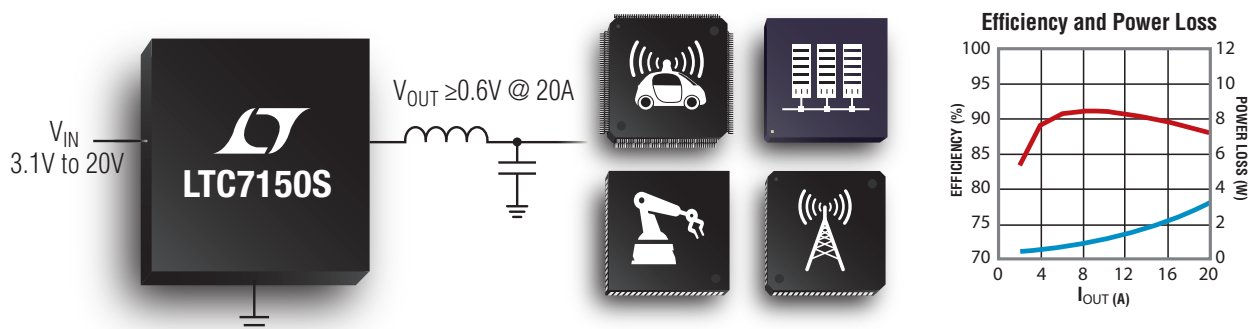
LT8603 Response to a Cold Crank Automotive Input Waveform



Cold Crank Tolerant Automotive Triple Output Supply



20V_{IN} & 20A_{OUT} Silent Switcher[®] 2



12V_{IN} to 1.2V_{OUT}, 92% Efficient Monolithic Buck

Need a high performance, high power point-of-load power supply for your digital IC (FPGA, uP, uC, DSP, GPU, PLD, ASIC)? The LTC7150S is a 20A, high efficiency monolithic synchronous buck regulator that incorporates Silent Switcher 2 technology, delivering excellent EMI performance while easing board layout. Its phase-lockable controlled on-time current mode architecture enables large step-down ratios at high switching frequencies to deliver high power density solutions. PolyPhase operation allows multiple LTC7150S regulators to run in parallel out-of-phase, reducing the amount of required input and output capacitance. Its operating supply voltage range is 3.1V to 20V, with an output voltage range of 0.6V to V_{IN} . With an operating frequency programmable from 400kHz to 3MHz, it can use physically smaller inductor and capacitor sizes, and can be externally synchronized over the same range for noise sensitive applications.

Selected Monolithic Single & Dual Buck Regulators

Part Number	I_{OUT}	V_{IN} Range	V_{OUT} Range	Freq (Max)	Differential Remote Sense	Silent Switcher	Package
LTC7150S	20A	3.1V to 20V	0.6V to V_{IN}	3MHz	Yes	SS 2 ^{^^}	5 x 6 x 1.3mm BGA
LTC7151S*	15A	3.1V to 20V	0.5V to V_{IN}	3MHz	Yes	SS 2 ^{^^}	4 x 5 x 0.75mm LQFN
LT8642S*	10A	3V to 18V	0.6V to V_{IN}	3MHz	No	SS 2 ^{^^}	4 x 4 x 0.94mm LQFN
LT8652S*	8.5A/8.5A	3V to 18V	0.6V to V_{IN}	3MHz	Yes	SS 2 ^{^^}	4 x 7 x 0.94mm LQFN
LTC3636	6A/6A	3.1V to 20V	0.6V to 12V	4MHz	No	No	4 x 5 x 0.75mm QFN
LTC7124	3.5A/3.5A	3.1V to 17V	0.6V to V_{IN}	4MHz	No	No	3 x 5 x 0.75mm QFN

* Future product, please contact for more information. ^^ SS 2 = noise-cancelling hot loops and integrated capacitors

Info & Free Samples

www.linear.com/product/LTC7150S
1-800-4-LINEAR

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Find your local sales office: www.linear.com/contact

LT8650S

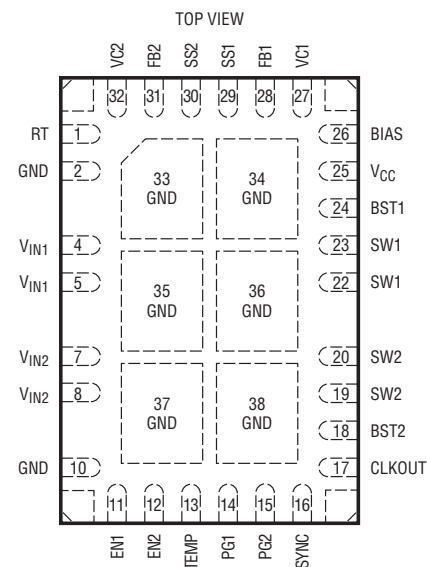
Dual Channel 4A, 42V, Synchronous Step-Down Silent Switcher 2 with 6.2μA Quiescent Current

FEATURES

- Silent Switcher 2 Architecture:
 - Ultralow EMI on Any PCB
 - Eliminates PCB Layout Sensitivity
 - Internal Bypass Capacitors Reduce Radiated EMI
 - Optional Spread Spectrum Modulation
- 4A DC from Each Channel Simultaneously
- Up to 6A on Either Channel
- Ultralow Quiescent Current Burst Mode Operation:
 - 6.2μA I_Q Regulating 12V_{IN} to 5V_{OUT1} and 3.3V_{OUT2}
 - Output Ripple <10mV_{P-P}
- Optional External VC Pin: Fast Transient Response and Current Sharing (Extra 50μA I_Q /Channel)
- Forced Continuous Mode
- High Efficiency at High Frequency
 - 94.6% Efficiency at 2A, 5V_{OUT} from 12V_{IN} at 2MHz
 - 93.3% Efficiency at 4A, 5V_{OUT} from 12V_{IN} at 2MHz
- Fast Minimum Switch-On Time: 40ns
- Wide Input Voltage Range: 3.0V to 42V
- Adjustable and Synchronizable: 300kHz to 3MHz
- Small 4mm × 6mm 32-Lead LQFN Package

APPLICATIONS

- General Purpose Step-Down
- Automotive and Industrial Supplies



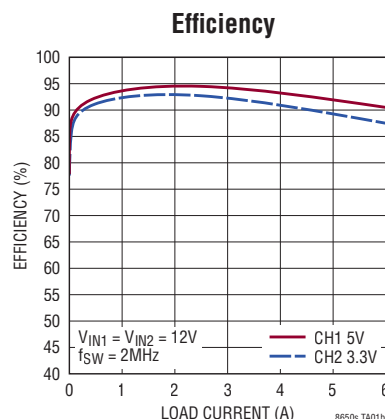
LQFN PACKAGE
32-LEAD (6mm × 4mm × 0.94mm)
LT8650SEV
LT8650SIV

DESCRIPTION

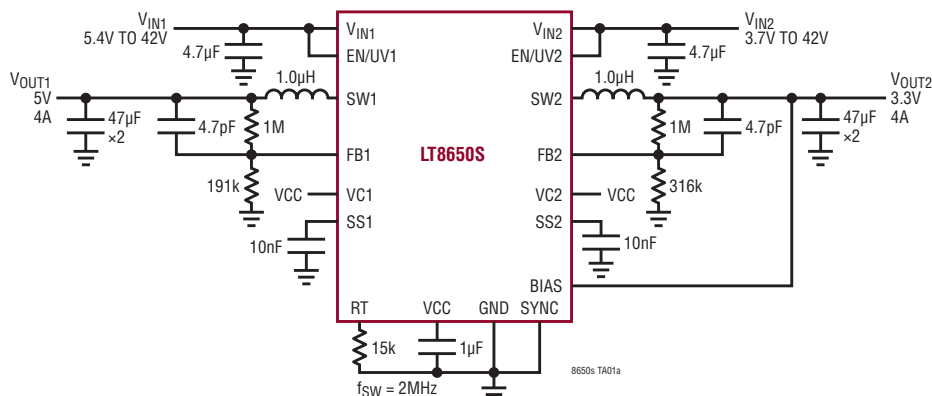
The LT8650S is a dual step-down regulator that delivers up to 4A of continuous current from both channels and supports loads up to 6A from each channel. The LT8650S features the second generation Silent Switcher architecture to minimize EMI emissions while delivering high efficiency at high switching frequencies. This includes integration of bypass capacitors to optimize high frequency current loops and make it easy to achieve advertised EMI performance by eliminating layout sensitivity.

The fast, clean, low overshoot switching edges enable high efficiency operation even at high switching frequencies, leading to a small overall solution size. Peak current mode control with a 40ns minimum on-time allows high step down ratios at high switching frequencies.

Burst Mode operation features a 6.2μA quiescent current resulting in high efficiency at low output currents, forced continuous mode allows fixed switching frequency operation over the entire output load range, and spread spectrum operation can further reduce EMI emissions. External VC pins allow optimal loop compensation for fast transient response. The VC pins can also be used for current sharing and the CLKOUT pin enables synchronizing two LT8650S chips to generate a 4-phase, 16A supply.



5V/4A, 3.3V/4A 2MHz Step-Down Converter



LTC3779

150V V_{IN} and V_{OUT} Synchronous 4-Switch Buck-Boost Controller

FEATURES

- **4-Switch Current Mode Single Inductor Architecture Allows V_{IN} Above, Below or Equal to V_{OUT}**
- **Wide V_{IN} Range: 4.5V to 150V**
- **Wide Output Voltage Range: $1.2V \leq V_{OUT} \leq 150V$**
- **Synchronous Rectification: Up to 99% Efficiency**
- **$\pm 1\%$ 1.2V Voltage Reference**
- **Input or Output Average Current Limit**
- **Onboard LDO or External NMOS LDO for DRV_{CC}**
- **36V $EXTV_{CC}$ LDO Powers Drivers**
- **Programmable 6V to 10V DRV_{CC} Optimizes Efficiency**
- **No Top FET Refresh Noise in Boost or Buck Mode**
- **V_{OUT} Disconnected from V_{IN} During Shutdown**
- **Phase-Lockable Fixed Frequency (50kHz to 600kHz)**
- **No Reverse Current During Start-Up**
- **Power Good Output Voltage Monitor**
- **150V Rated RUN Pin with Accurate Turn-On Threshold**
- **Programmable Input Overvoltage Lockout**
- **Thermally Enhanced FE38 TSSOP Package Modified for High Voltage Operation**

APPLICATIONS

- Industrial, Automotive, Medical, Military, Avionics

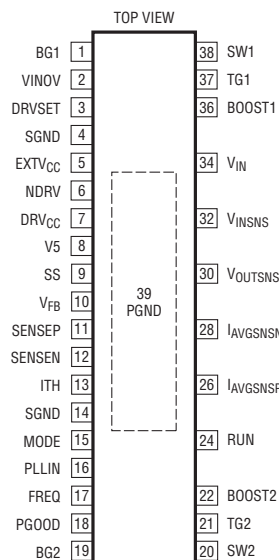
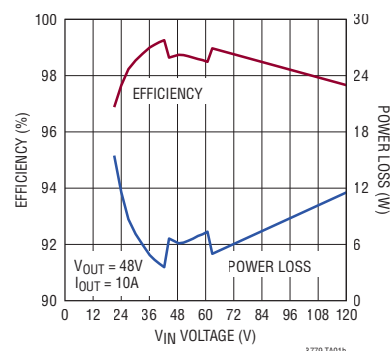
DESCRIPTION

The LTC3779 is a high performance buck-boost switching regulator controller that operates from input voltages above, below or equal to the output voltage. The constant frequency current mode architecture allows a phase-lockable frequency of up to 600kHz, while an input/output constant current loop provides support for battery charging.

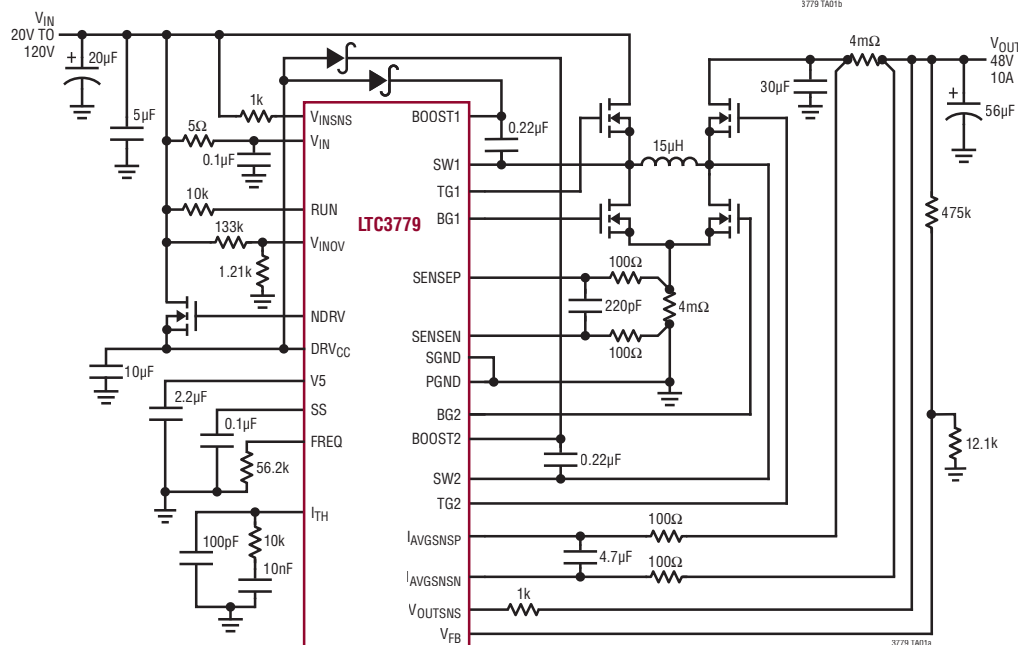
With a wide 4.5V to 150V input and output range and seamless transfers between operating regions, the LTC3779 is ideal for automotive, telecom and battery-powered systems.

The LTC3779 features a precision 1.2V reference and power good output indicator. The MODE pin can select between pulse-skipping mode or forced continuous mode of operation. Pulse-skipping mode offers high efficiency at light load while forced continuous mode operates at a constant frequency for noise sensitive applications. The PLLIN pin allows the IC to be synchronized to an external clock. The SS pin ramps the output voltage during start-up. Current feedback limits MOSFET heat dissipation during short-circuit conditions.

Efficiency and Power Loss vs Input Voltage



FE PACKAGE
VARIATION: FE38(31)
38-LEAD PLASTIC TSSOP
LTC3779EFE
LTC3779IFE
LTC3779HFE



LTC3874-1

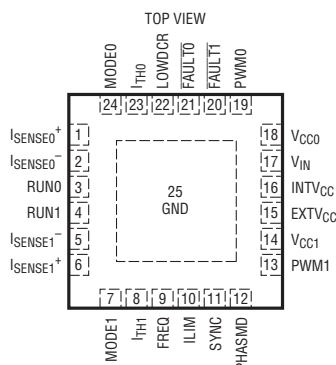
PolyPhase Step-Down Synchronous Slave Controller with Sub-Milliohm DCR Sensing

FEATURES

- Phase Extender for High Phase Count Voltage Rails
- Operates with Power Blocks, DrMOS or External Gate Drivers and MOSFETs
- Accurate Phase-to-Phase Current Sharing
- Sub-Milliohm DCR Current Sensing
- Phase-Lockable Fixed Frequency 250kHz to 1MHz
- Immediate Response to Master IC's Fault
- Up to 12-Phase Operation
- Wide V_{IN} Range: 4.5 to 38V
- V_{OUT} Range: Up to 3.5V (LOWDCR Pin High)
Up to 5.5V (LOWDCR Pin Low)
- Proprietary Current Mode Control Loop
- Programmable CCM/DCM Operation
- Programmable Phase Shift Control
- 24-Lead (4mm × 4mm) QFN Package

APPLICATIONS

- High Current Distributed Power Systems
- Telecom, Datacom and Storage Systems
- Intelligent Energy Efficient Power Regulation



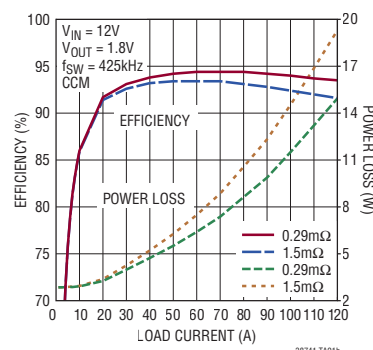
UF PACKAGE
24-LEAD (4mm × 4mm) PLASTIC QFN
LTC3874EUF-1
LTC3874IUF-1

DESCRIPTION

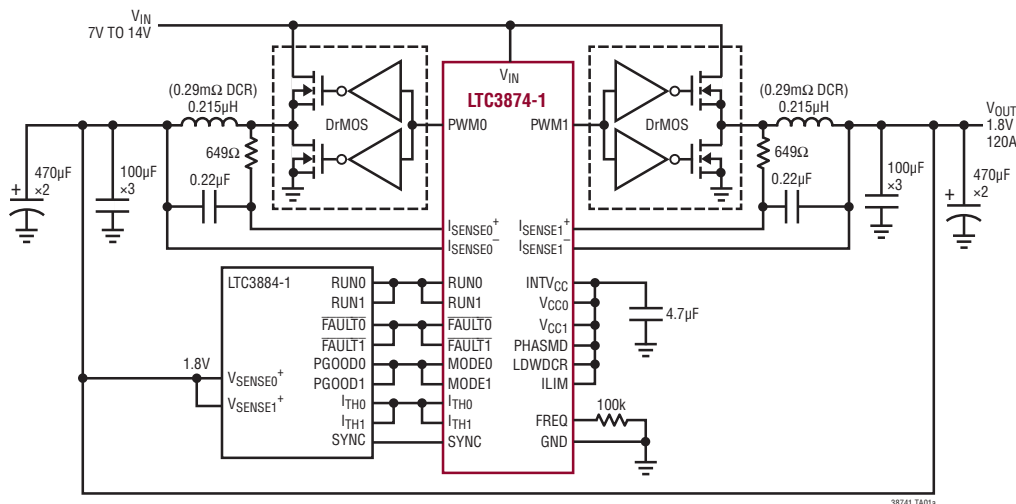
The LTC3874-1 is a dual PolyPhase current mode synchronous step-down slave controller. It enables high current, multiphase applications when paired with a companion master controller by extending the phase count. Compatible master controllers include the LTC3884-1, LTC3774, LTC3875, LTC3877 and LTC3866. The LTC3874-1 employs a unique architecture that enhances the signal-to-noise ratio of the current sense signal, allowing the use of sub-milliohm DC resistance power inductors to maximize efficiency while reducing switching jitter. Its peak current mode architecture allows for accurate phase-to-phase current sharing even for dynamic loads.

Effectively working with a master controller, the LTC3874-1 supports all the programmable features as well as fault protection.

**4-Phase Efficiency and Power Loss
vs Output Current, Sub-Milliohm DCR
vs Traditional DCR**



High Efficiency, 4-Phase 1.8V/120A Step-Down Supply



REFER TO LTC3884-1 DATA SHEET
FOR MASTER SETUP

PIN NOT USED IN THIS CIRCUIT: EXTVCC

LT8391A 60V 2MHz Synchronous 4-Switch Buck-Boost LED Driver Controller

FEATURES

- 4-Switch Single Inductor Architecture Allows V_{IN} Above, Below or Equal to V_{OUT}
- Up to 95% Efficiency at 2MHz
- Proprietary Peak-Buck Peak-Boost Current Mode
- Wide V_{IN} Range: 4V to 60V
- Wide V_{OUT} Range: 0V to 60V (51V LED)
- $\pm 3\%$ LED Current Accuracy
- 2000:1 External and 128:1 Internal PWM Dimming
- High Side PMOS PWM Switch Driver
- No Top MOSFET Refresh Noise in Buck or Boost
- Adjustable and Synchronizable: 600kHz to 2MHz
- Flicker-Free Spread Spectrum for Low EMI
- Open and Short LED Protection with Fault Reporting
- Available in 28-Lead TSSOP with Exposed Pad and 28-Lead QFN (4mm $\times$ 5mm)

APPLICATIONS

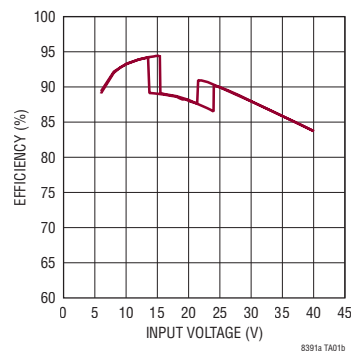
- Automotive Head Lamps/Running Lamps
- High Frequency LED Lighting

DESCRIPTION

The LT8391A is a synchronous 4-switch buck-boost LED controller that regulates LED current from input voltage above, below or equal to the output voltage. The proprietary peak-buck peak-boost current mode control scheme allows adjustable and synchronizable 600kHz to 2MHz fixed frequency operation, or internal 25% triangle spread spectrum operation for low EMI. With 4V to 60V input, 0V to 60V output, and seamless low noise transitions between operation regions, the LT8391A is ideal for LED driver and battery charger applications in automotive, industrial and battery-powered systems.

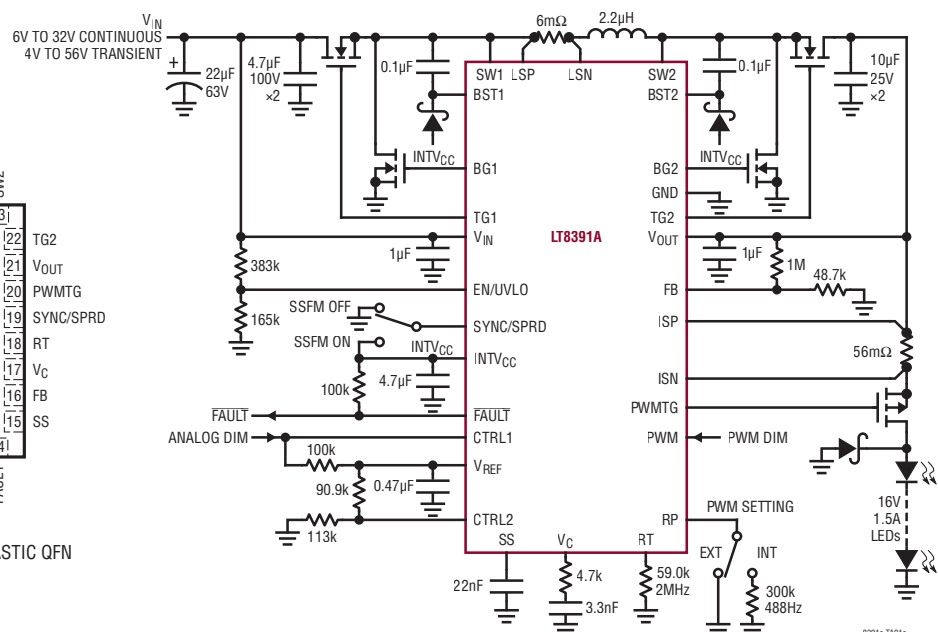
The LT8391A provides both internal (up to 128:1) and external (up to 2000:1) LED current PWM dimming with a high side PMOS switch. Two CTRL pins provide flexible 20:1 analog dimming with $\pm 3\%$ LED current accuracy at 100mV full scale. Fault protection is provided to detect an open or short LED condition, during which the LT8391A retries, latches off or keeps running.

Efficiency vs V_{IN}

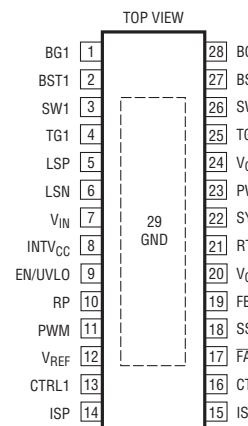


8391a TA01b

94% Efficiency 24W (16V, 1.5A) 2MHz Buck-Boost LED Driver

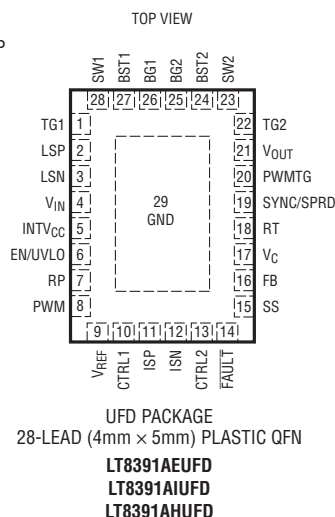


8391a TA01a



FE PACKAGE
28-LEAD PLASTIC TSSOP

LT8391AEFE
LT8391AIFE
LT8391AHFE



UFD PACKAGE
28-LEAD (4mm $\times$ 5mm) PLASTIC QFN

LT8391AEUFD
LT8391AIUFD
LT8391AHUFD

LT8711

Micropower Synchronous Multitopology Controller with 42V Input Capability

FEATURES

- Easily Configurable as a Synchronous Buck, Boost, SEPIC, ZETA or Nonsynchronous Buck-Boost Converter
- Wide Input Range: 4.5V to 42V (V_{IN} Can Operate to 0V, when $EXTV_{CC} > 4.5V$)
- Automatic Low Noise Burst Mode Operation
- Low I_Q in Burst Mode Operation (15 μ A Operating)
- Input Voltage Regulation for High Impedance Source
- 100% Duty Cycle in Dropout (Buck Mode)
- 2A Gate Drivers (BG and TG)
- Adjustable Soft-Start with One Capacitor
- Frequency Programmable from 100kHz to 750kHz
- Can Be Synchronized to External Clock
- Available in 20-Lead TSSOP and 20-Lead 3mm $\times$ 4mm QFN Packages

APPLICATIONS

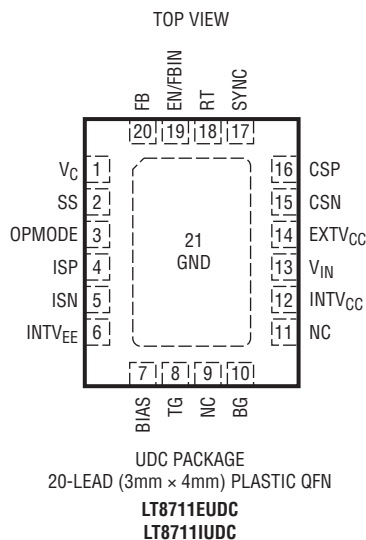
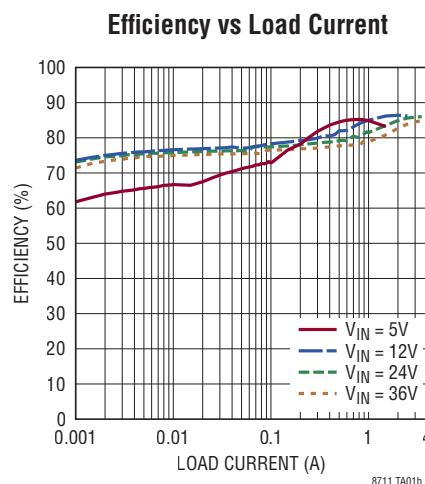
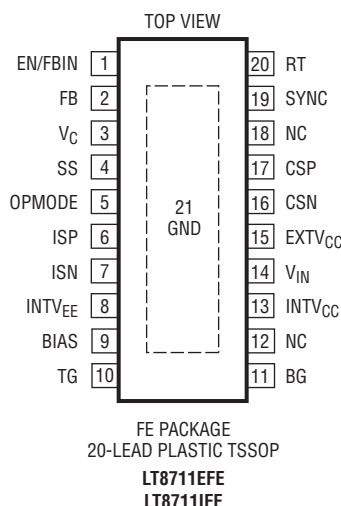
- General Purpose DC/DC Conversion
- Automotive Systems
- Industrial Supplies
- Solar Panel Power Converter

DESCRIPTION

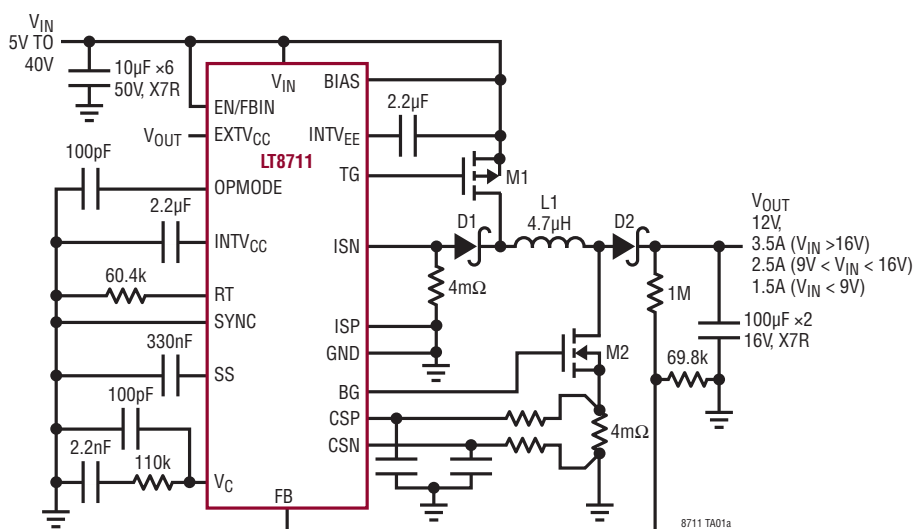
The LT8711 is a multitopology current mode PWM controller that can easily be configured as a synchronous buck, boost, SEPIC, ZETA or as a nonsynchronous buck-boost converter. Its dual gate drive voltage inputs optimize gate driver efficiency.

The 15 μ A no-load quiescent current with the output voltage in regulation extends operating run time in battery powered systems. Low ripple Burst Mode operation enables high efficiency at very light loads while maintaining low output voltage ripple. The LT8711's fixed switching frequency can be set from 100kHz to 750kHz or can be synchronized to an external clock.

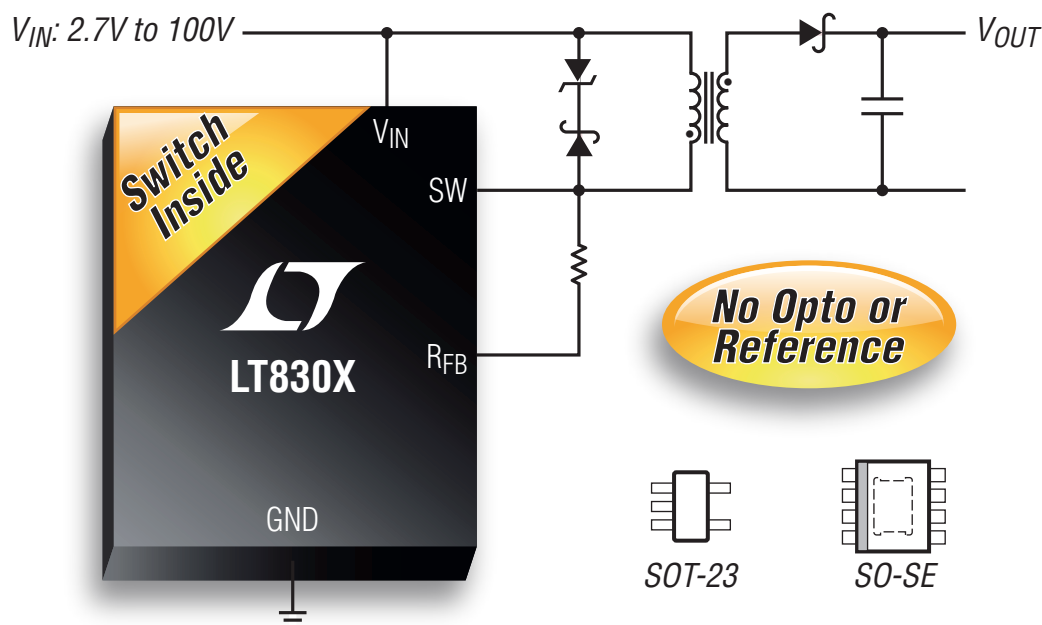
The additional features include 100% duty cycle capability when in buck mode, a topology selection pin and adjustable soft-start. LT8711 is available in the 20-lead TSSOP and 20-lead 3mm $\times$ 4mm QFN packages.



400kHz 5V to 40V Input/12V Output Nonsynchronous Buck-Boost



No-Opto Isolated Flyback Converters



Our No-Opto isolated flyback devices need no opto-coupler or LT1431 for regulation. The devices sense the reflected isolated output voltage from the primary-side waveform, resulting in better than $\pm 1\%$ load and line regulation. This simplifies the design, enables a smaller solution size and only requires one component crossing the isolation barrier. Several off-the-shelf transformers are shown in the data sheets, making it easy to complete the design.

No-Opto Monolithic Devices (Internal Switch)

Part Number	V_{IN} Range (V)	Max P_{OUT} (W)	Power Switch Rating	Package
LT8300	6-100	2	0.23A/150V	SOT-23
LT8303	5.5-100	5	0.5A/150V	SOT-23
LT8301	2.7-42	6	1.2A/65V	SOT-23
LT8302	2.8-42	18	3.6A/65V	SO-8E
LT8304/LT8304-1	3-100	24	2A/150V	SO-8E
LT8315	18-560	15	0.3A/630V	TSSOP-20 (16)

No-Opto Controller Devices (External Switch)

Part Number	V_{IN} Range	Max P_{OUT} (W)	Description	Package
LT3748	5VDC-100VDC	80-100	No-Opto Flyback Controller	MSOP-16 (12)
LT8309	4.5VDC-40VDC	80-100	Flyback Synchronous Rectifier Driver	SOT-23
LT3798	20-400VDC/90-264VAC	80-100	No-Opto Flyback Controller with PFC	MSOP-16E

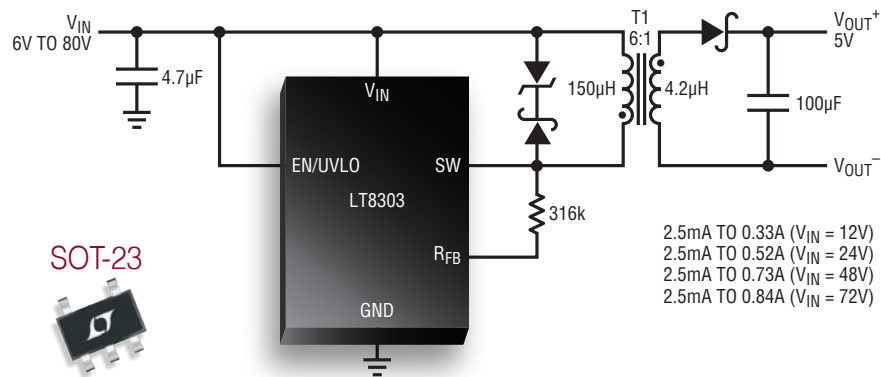
Features

- Input Voltage Ranging from 2.7V to 400V
- No Opto-Coupler Required
- Primary-Side V_{OUT} Sensing
- Only One Part Crossing the Isolation Barrier
- Internal Loop Compensation for Monolithic Required Devices
- Compact Packages
- Off-the-Shelf Transformers from Wurth, Sumida and Pulse Engineering

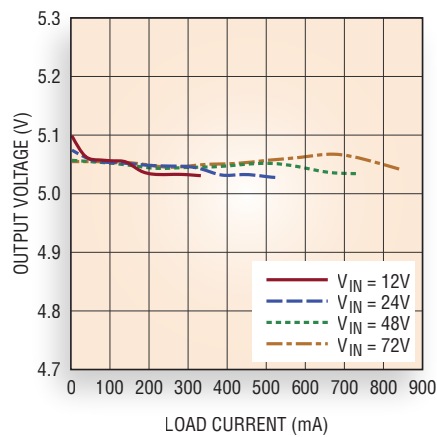
Applications

- Telecom/Datacom
- Industrial Controls
- Automotive
- Factory Automation
- Heavy Equipment
- Medical
- Robotics and Aviation
- Housekeeping Supplies

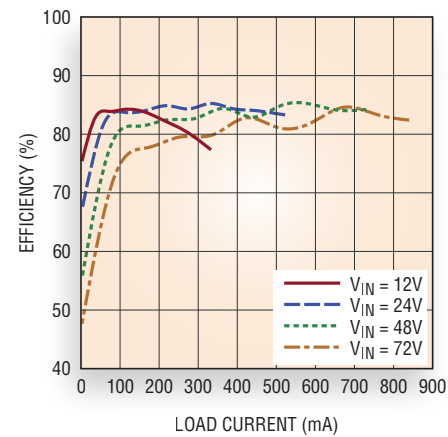
LT8303 Telecom/Datacom Isolated Schematic



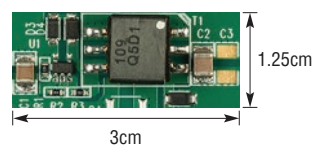
Output Load and Line Regulation



Efficiency vs Load Current

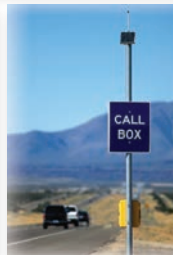


LT8303 Demo Board Photo

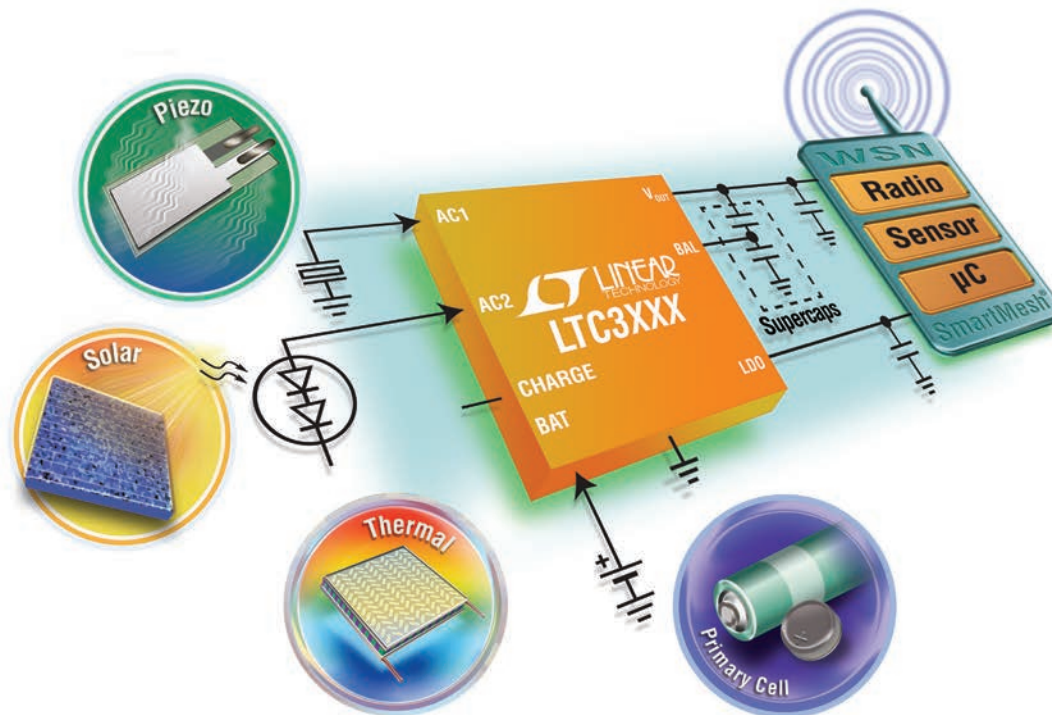


Practical Ambient Energy Harvesting for WSNs

Part Number	Energy Source	Description
LTC®3105	 	400mA boost converter with MPP control and 250mV start-up
LTC3106	 	300mA buck-boost converter and power manager with MPPC
LTC3107	 	Ultralow voltage converter and primary battery life extender
LTC3108	 	Ultralow voltage boost converter and system manager
LTC3109	 	Auto-polarity version of LTC3108
LTC3330/31	   	Energy harvesting DC/DC converter with battery life extender
LTC3588	 	Piezoelectric energy harvesting power supply
LT®3652/HV		Power tracking 2A solar battery charger
LTC4070/71	   	Nanoamp operating current shunt Li-Ion battery charger



Single Nanopower ICs Manage Multiple Input Sources



Energy Harvesting

We offer a wide range of ultralow power products targeted for Energy Harvesting applications. Power management products that convert energy from Vibration (Piezo), PhotoVoltaic (Solar) and Thermal (TEC, TEG, Thermopiles, Thermocouples) sources provide high efficiency conversion to regulated voltages and charge batteries and/or super capacitor storage elements. These Energy Harvesting ICs automatically manage ambient and battery energy to dramatically extend the run time of a primary battery. Boost converters that operate from as little as 20mV or battery chargers with Maximum Power Point capability expand the possibilities for a wide variety of industrial automation and control, wireless sensor, transportation, automotive and building management applications.

Ultralow quiescent current linear regulators, op amps, comparators, voltage supervisors, analog-to-digital converters, digital-to-analog converters and micropower voltage references provide additional fundamental building blocks required for autonomous systems.

Energy Harvesting ICs with Battery Life Extenders

Part Number	Description	Output Power Level	Number of Outputs	Energy Source	Packages	Topology	I _q	V _{IN} MIN (V)	V _{IN} MAX (V)
LTC3330	Nanopower Buck-Boost DC/DC with Energy Harvesting Battery Life Extender	0.1mW to 50mW	2	Vibration, Solar (AC or DC)	5mm × 5mm QFN-32	Full Bridge Rectifier, Buck	750nA	3.0V(EH) 1.8V(V _{BATT})	19V(EH) 5V(V _{BATT})
LTC3331	Nanopower Buck-Boost DC/DC with Energy Harvesting Battery Charger	0.1mW to 50mW	1	Vibration, Solar (AC or DC)	5mm × 5mm QFN-32	Full Bridge Rectifier, Buck	950nA	3.0V	19V
LTC3107	Ultralow Voltage Energy Harvester and Primary Battery Life Extender	0.01mW to 5mW	2	Thermal	3mm × 3mm DFN-10	Boost	80nA	20mV	500mV
LTC3106	300mA Ultralow I _q Step-Up Converter and Power Manager with MPPC	0.1mW to 160mW	2	Solar	3mm × 4mm QFN-20, TSSOP-20E	Buck-Boost	1.5μA	330mV	5.5V

Energy Harvesting ICs

LTC4071	Li-Ion/Polymer Shunt Battery Charger System with Low Battery Disconnect	0.1mW to 250mW	1	–	DFN-8, MSOP-8	Shunt Battery Charger	550nA		None
LTC4070	Li-Ion/Polymer Shunt Battery Charger System	0.1mW to 250mW	1	–	DFN-8, MSOP-8E	Shunt Battery Charger	450nA		None
LTC3588-1/ LTC3588-2/ LTC3588-3	Piezoelectric Energy Harvesting Power Supply	0.1mW to 50mW	1	Piezoelectric	MS-10, DFN-10	Buck	450nA	14	20
LTC3388-1/ LTC3388-3	20V, High Efficiency Nano Step-Down Regulator	0.1mW to 250mW	1	All	DFN-10, MS-10	Buck	400nA	2.7	20
LTC3526L	550mA 1MHz Synchronous Step-Up DC/DC Converters in 2mm × 2mm DFN	0.1mW to 650mW	1	Solar	DFN-6	Boost	9μA	0.5	5
LTC3109	Auto-Polarity, Ultralow Voltage Step-Up Converter and Power Manager	0.1mW to 50mW	3	Thermoelectric	QFN-20, SSOP-20	Boost	200nA	0.02	0.5
LTC3108/ LTC3108-1	Ultralow Voltage Step-Up Converter and Power Manager	0.1mW to 50mW	3	Thermoelectric	DFN-12, SSOP-16	Boost	200nA	0.02	0.5
LTC3105	400mA Step-Up DC/DC Converter with Maximum Power Point Control and 250mV Start-Up	0.1mW to 1100mW	1	Solar	DFN-10, MS-12	Boost	24μA	0.2	5
LT3652HV	Power Tracking 2A Battery Charger	1W to 30W	1	Solar	DFN-12, MS-12	Buck	19μA	4.95	34
LT3652	Power Tracking 2A Battery Charger for Solar Power	1W to 30W	1	Solar	DFN-12, MS-12	Battery Charger	19μA	4.95	32

Design Note

60V 2MHz Buck-Boost Controllers Regulate High Power Voltage and Current with High Efficiency and Low EMI

Keith Szolusha

Synchronous buck-boost controllers are versatile and highly efficient. They can produce high power as both a boost and a buck with a single inductor, keeping power supply design simple. Normally, a buck-boost controller in a high power application is operated at a standard or low switching frequency, this maximizes efficiency and avoids complications related to shoot-through and switch blanking time, which can arise in synchronous rectification at high frequencies. Nevertheless, a high frequency 2MHz buck-boost controller with a smaller inductor ensures that the EMI content resides above the AM frequency band.

The LT8390A and LT8391A buck-boost controllers are unique in that they operate at 2MHz. The high switching speed enables use of a small inductor for a compact solution size, even in high power applications.

Unlike monolithic converters, which save space with power switches inside the IC package, controllers can drive external power switches with much higher peak currents.

such as 10A. Such high peak currents would burn up the small IC packages of typical integrated converters, but external 3mm × 3mm synchronous MOSFETs can handle this power. The MOSFETs can be arranged in tight quarters with hot-loop capacitors for very low EMI. The unique peak switch current sense amplifier architecture places the sense resistor next to the power inductor, outside the critical input and output hot loops, also reducing EMI.

2MHz, 95% Efficiency, 12V, 4A Buck-Boost

The 2MHz, 12V, 4A buck-boost regulator in Figure 1 boasts efficiency to 95%. This relatively compact design uses 3mm × 3mm MOSFETs and a single high power inductor. The temperature rise for this converter is low, even at 48W. At 12V input, no component rises more than 45°C above room temperature. At 7V input, the hottest component rises less than 55°C with a standard 4-layer PCB and no heat sink or airflow. This converter handles short input transients down to 4V at 4A load, or runs continuously at 4V input with 2A of load (~25W).

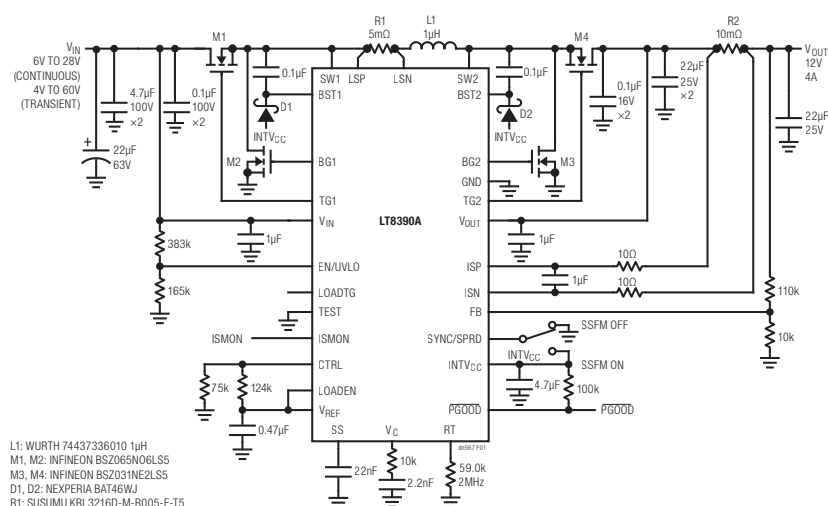


Figure 1. 2MHz 12V, 4A Buck-Boost Voltage Regulator with High Efficiency

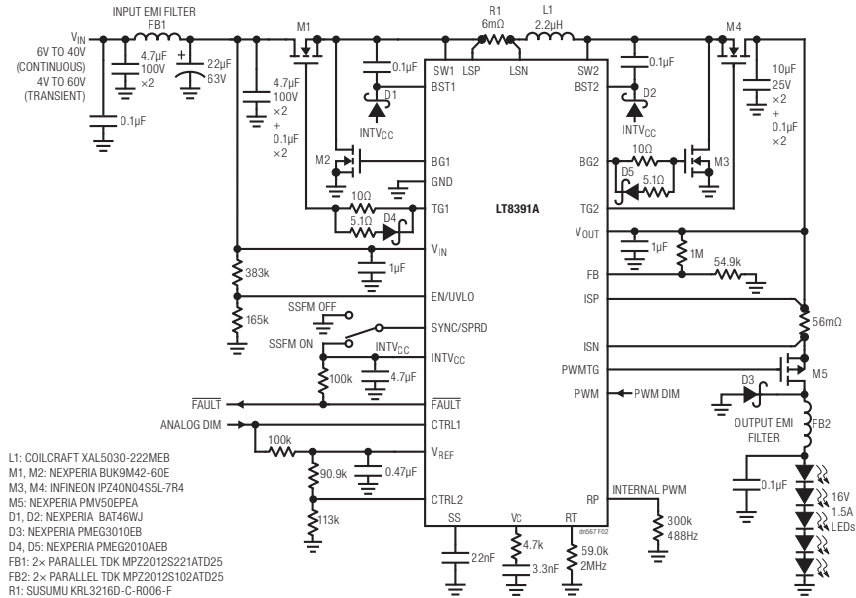


Figure 2. Low EMI 16V, 1.5A Automotive Buck-Boost LED Driver Passes CISPR 25 Class 5 EMI

The LT8390A's high switching frequency (600kHz to 2MHz) distinguishes it from the field of 4-switch controllers. It also has a variety of notable features like its lower frequency cousin, the LT8390. It has a PGOOD flag, short-circuit protection, and a flexible current-limiting sense resistor for output or inrush current restrictions. Its spread spectrum frequency modulation (SSFM) for low EMI makes it ideal for automotive applications.

2MHz Low EMI Automotive Buck-Boost LED Driver

The LT8391A is a 2MHz LED driver counterpart of the LT8390A. The main difference is that LT8391A includes LED driver PWM dimming features and open LED fault protection. The output sense resistor controls current through a string of LEDs whose voltage may lie within the input voltage range, such as the 9V to 16V car battery. It can run down to 4V cold crank and can withstand up to 60V input transients. LT8391A provides up to 2000:1 PWM dimming ratio at 120Hz and it can use its internal PWM dimming generator (no external clock required) for up to 128:1 accurate dimming.

The 2MHz LT8391A LED driver shown in Figure 1 is optimized for automotive headlights. It uses AEC-Q100 components and meets CISPR 25 Class 5 radiated EMI standards. SSFM reduces EMI, and also runs flicker-free simultaneously with PWM dimming.

Data Sheet Download
www.linear.com/LT8390A

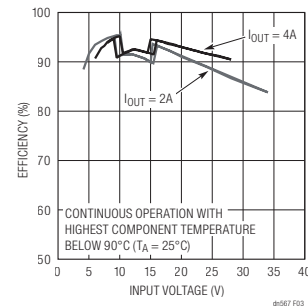


Figure 3. LT8390A Efficiency of Figure 1

This compact design features a small inductor and especially small input and output EMI filters. It can run down to 4V and up to 60V. The four synchronous MOSFETs shown can be replaced with two dual MOSFETs for reduced component count when needed. It reaches 93% efficiency. The FAULT flag reports short-circuit and open LED conditions, which are handled with ease.

Conclusion

The LT8390A and LT8391A 2MHz 60V buck-boost controllers can regulate high power voltage and current in compact spaces. The low EMI architecture and SSFM feature make these ideal for low EMI applications.

For applications help, call (408) 432-1900

Design Note

Cool Running, 144W, 4 × 40A μ Module POL Regulator

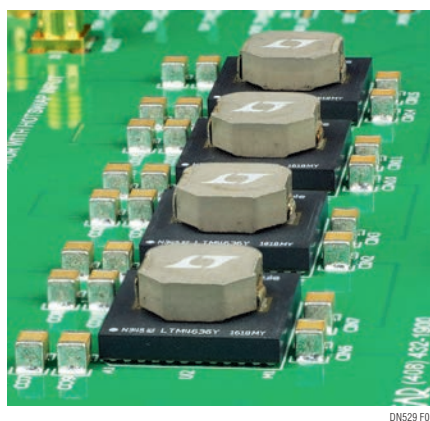
Afshin Odabae and Yan Liang

Introduction

The LTM[®]4636 is a 40A-capable μ Module[®] regulator featuring 3D packaging technology, or component-on-package (CoP) to keep it cool—see Figure 1. The body of the device is an overmolded 16mm × 16mm × 1.91mm BGA package with an inductor stacked on top to expose it to cooling airflow. The total package height is 7.16mm.

In addition to dissipating heat from the top through the exposed inductor, the LTM4636 efficiently disperses heat to the PCB via 144 BGA solder balls dedicated to GND, V_{IN} and V_{OUT} —where high current flows.

A single LTM4636 is rated for 40A loads; two parallel converters can support 80A; four support 160A. Upscaling a power supply by paralleling LTM4636s is easy: simply copy and paste the single-regulator footprint, as shown in Figure 1.



DN529 F01

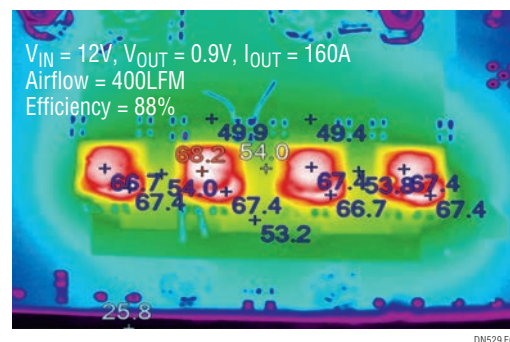
Figure 1. 3D Packaging of the LTM4636 Puts One of the Hottest Components, the Inductor, on Top, Where Significant Surface Area Is Exposed to Airflow. It Is Easy to Lay Out Parallel LTM4636s to Scale Power Capability—Simply Duplicate the Layout of One Channel and Multiply. The Clean Layout Here Shows Four Channels at 40A Each.

The current mode architecture of the LTM4636 enables precision current sharing among the 40A blocks. Precise current sharing, in turn, produces a power supply that spreads the heat evenly between devices. Figure 2 shows that all devices in the 4- μ Module 160A regulator operate within 1°C of each other, ensuring that no individual device is overloaded or overheated. This greatly simplifies heat mitigation.

Figure 3 shows the complete 160A design. Note that no clock device is required for the LTM4636s to operate out-of-phase to each other—clocking and phase control is included. Multiphase operation reduces input and output ripple current, reducing the number of required input and output capacitors. Here, the four LTM4636s run 90° out-of-phase.

Conclusion

Choosing a POL regulator for a densely populated system requires scrutiny beyond voltage and amperage ratings of the device. Evaluation of package thermal characteristics is essential, as it determines the cost of cooling, the cost of the PCB and final product size.



DN529 F02

Figure 2. Precision Current Sharing Among Four LTM4636s Running in Parallel, Resulting in Only 40°C Rise in Temperature for 160A Application.

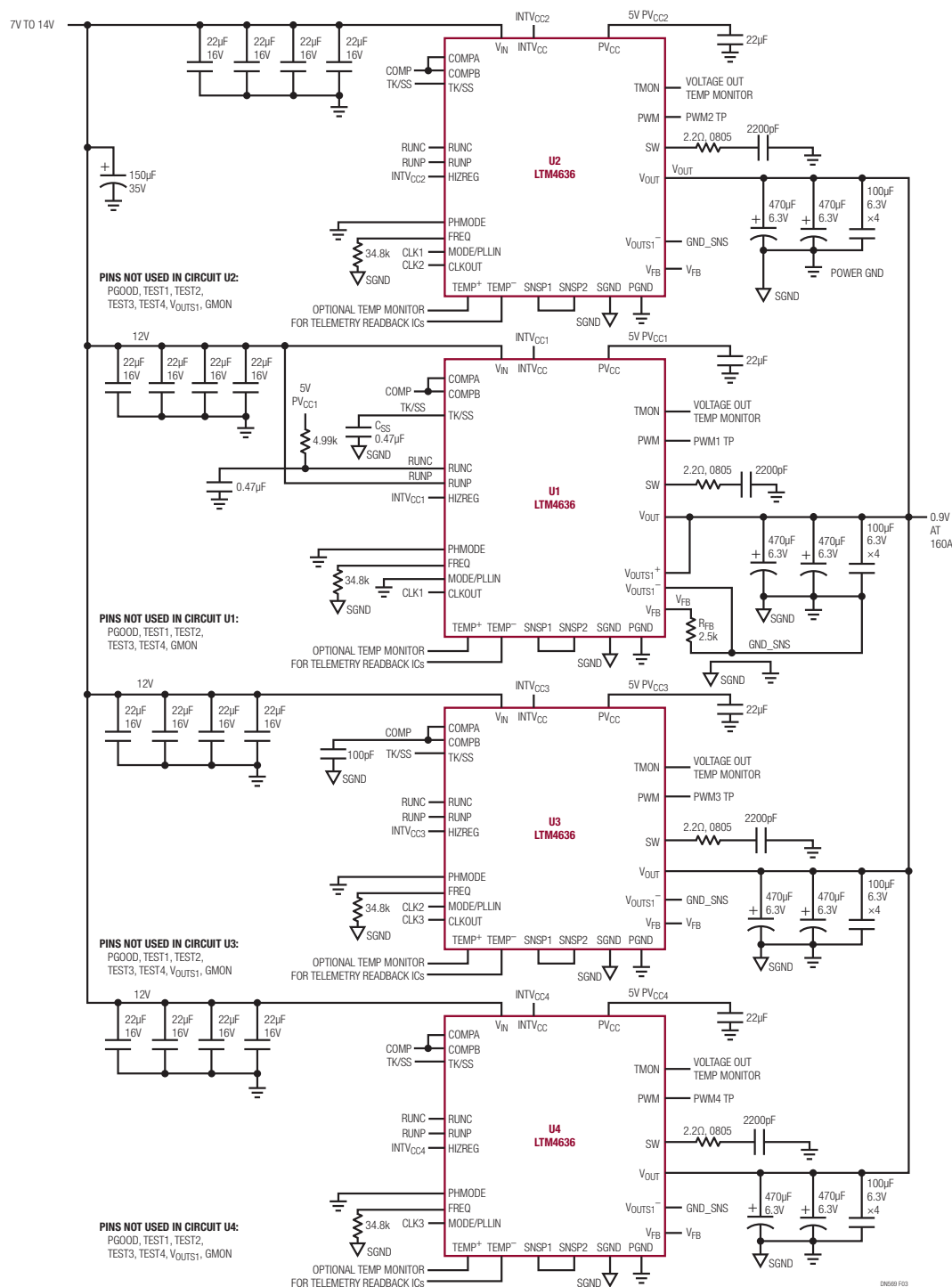


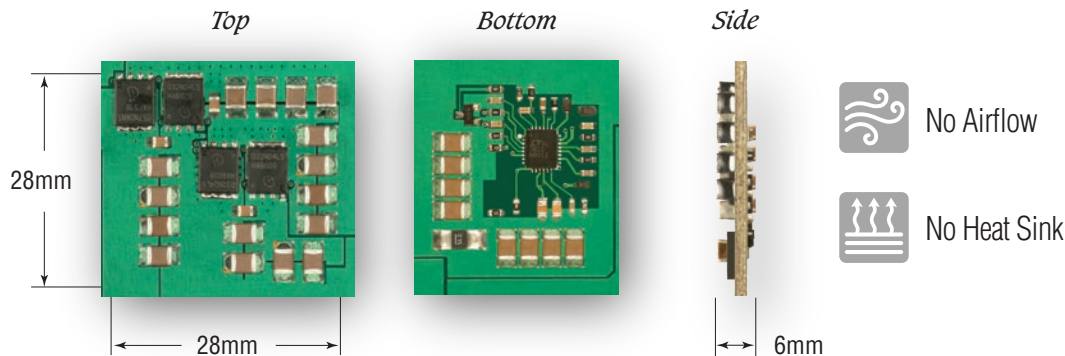
Figure 3. 140W Regulator Features Four LTM4636s Running in Parallel with Precision Current Sharing and High Efficiency 12V Input to 0.9V Output at 160A

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500W

Inductorless Bus Converter



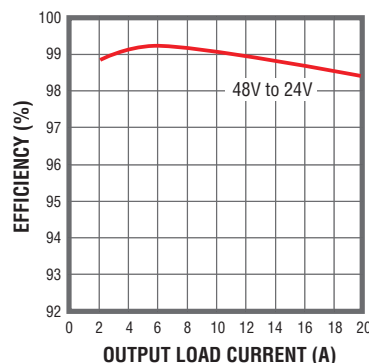
99% Efficient Step-Down, Step-Up or Invert

The LTC7820 brings a new level of performance and simplicity to fixed ratio non-isolated bus converters by eliminating the power inductor, providing a 50% reduction in circuit size compared to alternative solutions. It drives external MOSFETs in either a voltage divider (2:1), doubler (1:2) or inverter (1:-1) configuration with up to 99% efficiency and a power density of up to 4000W/in³. Multiple LTC7820s can be cascaded for higher conversion ratios. Its open loop fixed duty cycle is ideal for non-isolated intermediate bus applications commonly found in power distribution, datacom, telecom, computing and industrial systems.

Features

- V_{IN} Range: 6V to 72V, 80V abs max
- Voltage Divider (2:1)/Doubler (1:2)/Inverter (1:-1)
- High Power Density: Up to 4000W/in³
- Capable of 500W+
- Soft Switching – Low EMI
- Overload, OV/UV Protection
- Fault Protection/Programmable Timer
- Operating Frequency: 100kHz to 1MHz
- 4mm x 5mm QFN-28 Package

Efficiency vs Load Current



More Info

www.linear.com/product/LTC7820
1-800-4-LINEAR

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