

LT3303 3A, 0.95V to 10V, Very Low Dropout Linear Regulator with Programmable Current Limit

LTM8002 40V_{IN}, 2.5A Silent Switcher μ Module Regulator

LTC4041 2.5A Supercapacitor Backup Power Manager

ADP5138 Quad, 1A, 5.5V, Synchronous Step-Down Regulators with One RF LDO Regulator

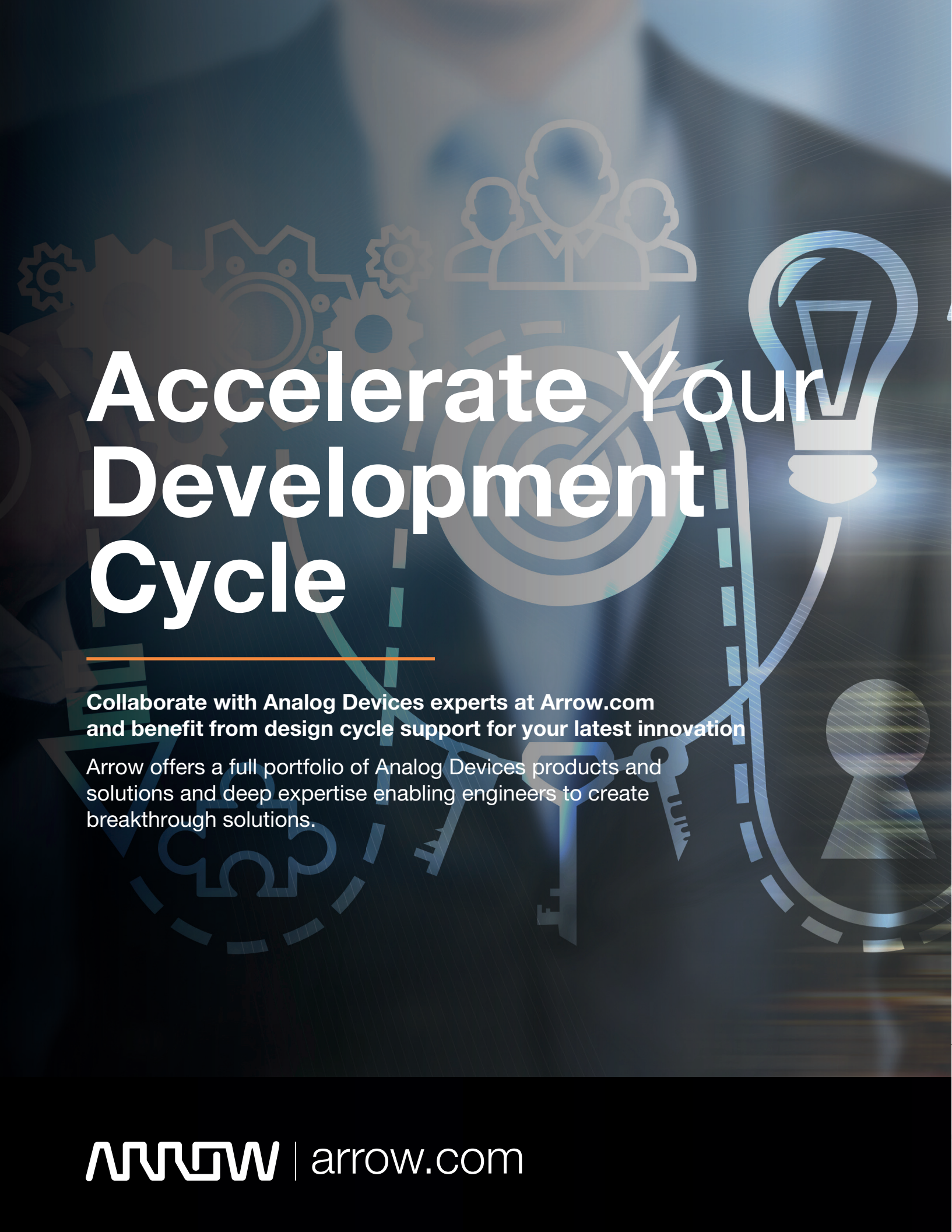
LT8708 80V Synchronous 4-Switch Buck-Boost DC/DC Controller with Flexible Bidirectional Capability

LTC2962/LTC2963/LTC2964 $\pm 0.5\%$ Accurate Quad Configurable Supervisor

NEW POWER MANAGEMENT PRODUCTS

November 2018





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LTC4162-F

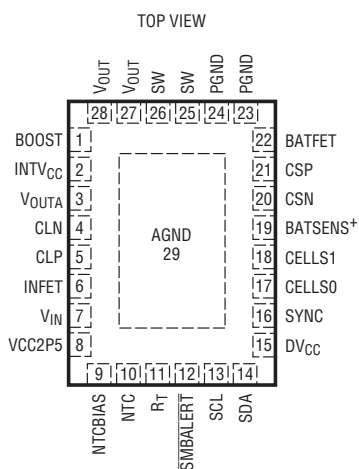
35V/3.2A Multicell LiFePO₄ Step-Down Battery Charger with PowerPath and I²C Telemetry

FEATURES

- LiFePO₄ Battery Charger with Termination
- Wide Charging Input Voltage Range: 4.5V to 35V
- High Efficiency Synchronous Operation
- 16-Bit Digital Telemetry System Monitors V_{BAT} , I_{BAT} , R_{BAT} , T_{BAT} , T_{DIE} , V_{IN} , I_{IN} , V_{OUT}
- Charges 1-9 Lithium-Iron Phosphate Cells
- Input Undervoltage Charge Current Limit Loop
- Input MPPT for Solar Panel Inputs
- Input Current Limit Prioritizes System Load Output
- Low Loss PowerPath
- Instant-On Operation with Discharged or Missing Battery
- JEITA Temperature Controlled Charging
- Pin Compatible with Li-Ion and SLA Versions

APPLICATIONS

- Medical Instruments
- USB-C Power Delivery
- Industrial Handhelds
- Ruggedized Notebooks
- Tablet Computers



UFD PACKAGE
28-LEAD (4mm × 5mm) PLASTIC QFN

LTC4162EUFDFAD	LTC4162IUFDFAD
LTC4162EUFDFST	LTC4162IUFDFST
LTC4162EUFDFFS	LTC4162IUFDFFS
LTC4162EUFDFADM	LTC4162IUFDFADM
LTC4162EUFDFSTM	LTC4162IUFDFSTM
LTC4162EUFDFFSM	LTC4162IUFDFFSM
LTC4162EUFDFAD	LTC4162IUFDFAD
LTC4162EUFDFST	LTC4162IUFDFST
LTC4162EUFDFFS	LTC4162IUFDFFS
LTC4162EUFDFADM	LTC4162IUFDFADM
LTC4162EUFDFSTM	LTC4162IUFDFSTM
LTC4162EUFDFFSM	LTC4162IUFDFFSM

DESCRIPTION

The LTC4162-F is an advanced monolithic synchronous step-down switching battery charger and PowerPath manager that seamlessly manages power distribution between input sources such as wall adapters, backplanes, solar panels, and a rechargeable lithium-iron phosphate battery.

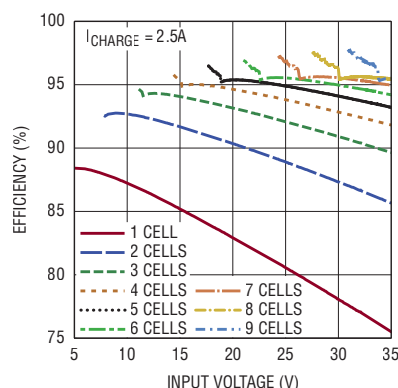
A high resolution measurement system provides extensive telemetry information for circuit voltages, currents, battery resistance and temperature which can all be read back over the I²C port. The I²C port can also be used to configure many charging parameters including charging voltages and currents, termination algorithms and numerous system status alerts.

The LTC4162-F can charge LiFePO₄ cell stacks from 1 cell to 9 cells with as much as 3.2A of charge current.

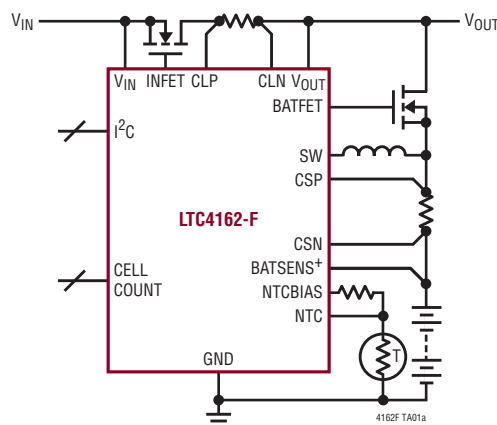
The power path topology decouples the output voltage from the battery allowing a portable product to start-up instantly under very low battery voltage conditions.

The LTC4162-F is available in a thermally enhanced 28-pin 4mm × 5mm × 0.75mm QFN surface mount package.

Charging Efficiency vs Input Voltage by Cell Count



1-9 Cell, 3.2A Step-Down Switching Battery Charger with PowerPath



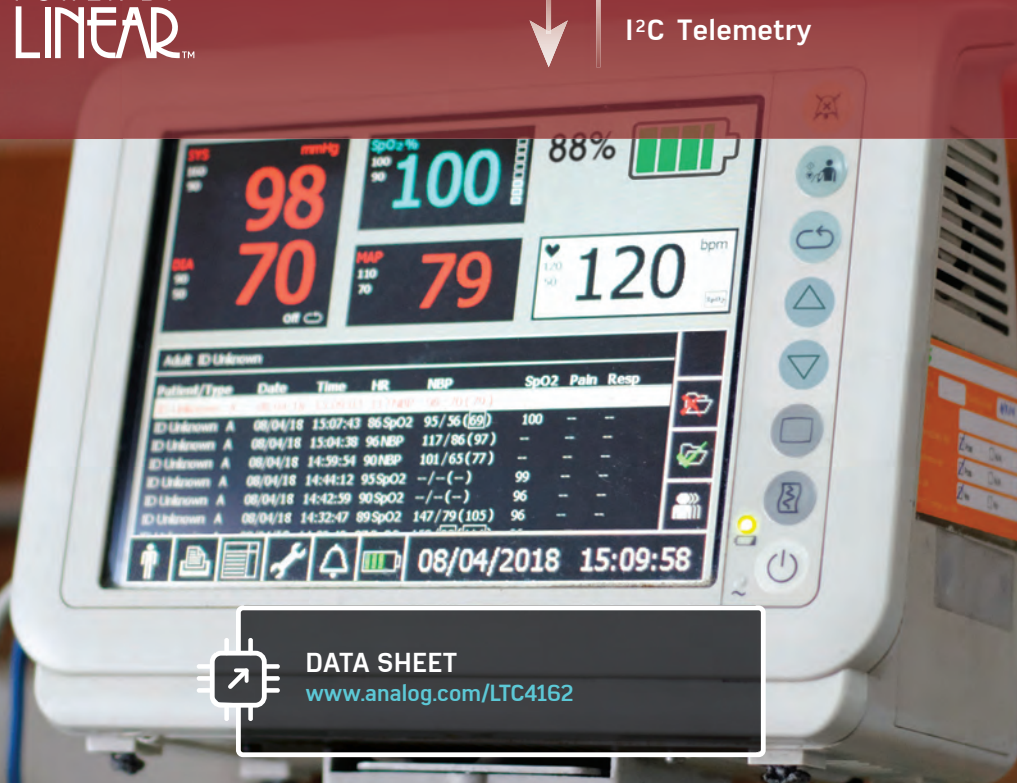
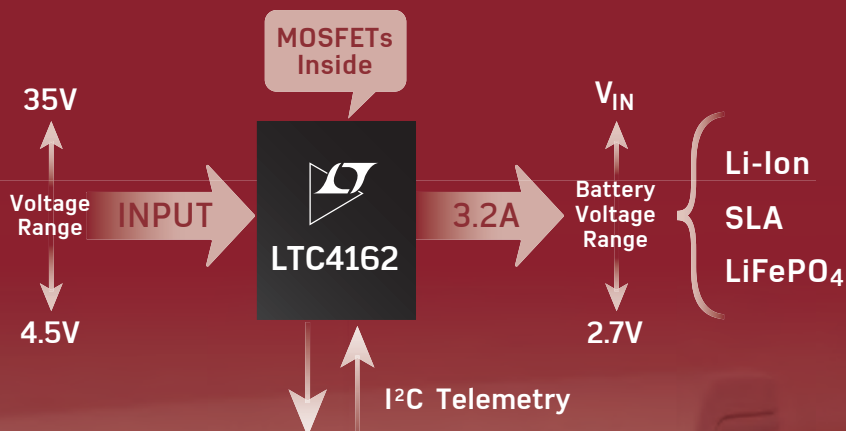


AHEAD OF WHAT'S POSSIBLE™

EASY TO USE MULTI- CHEMISTRY CHARGER

LTC4162 35V/3.2A MULTI-CELL STEP-DOWN BATTERY CHARGER

- ▶ Built-in Termination
- ▶ Wide Charging Input
Voltage Range: 4.5V to 35V
- ▶ 95% Charging Efficiency
- ▶ Advanced Solar Panel
MPPT Algorithm
- ▶ 16-Bit Digital Telemetry
Monitors V_{BAT} , I_{BAT} , R_{BAT} ,
 T_{BAT} , T_{DIE} , V_{IN} , I_{IN} , V_{OUT}



DATA SHEET
www.analog.com/LTC4162

LTC4162-L

35V/3.2A Multicell Lithium-Ion Step-Down Battery Charger with PowerPath and I²C Telemetry

FEATURES

- Li-Ion/Polymer Battery Charger with Termination
- Wide Charging Input Voltage Range: 4.5V to 35V
- High Efficiency Synchronous Operation
- 16-Bit Digital Telemetry System Monitors V_{BAT} , I_{BAT} , R_{BAT} , T_{BAT} , T_{DIE} , V_{IN} , I_{IN} , V_{OUT}
- Charges 1-8 Lithium-Ion/Polymer Cells
- Input Undervoltage Charge Current Limit Loop
- Input MPPT for Solar Panel Inputs
- Input Current Limit Prioritizes System Load Output
- Low Loss PowerPath
- Instant-On Operation with Discharged or Missing Battery
- JEITA Temperature Controlled Charging
- Pin Compatible with LiFePO₄ and SLA Versions

APPLICATIONS

- Medical Instruments
- USB-C Power Delivery
- Industrial Handhelds
- Ruggedized Notebooks
- Tablet Computers

DESCRIPTION

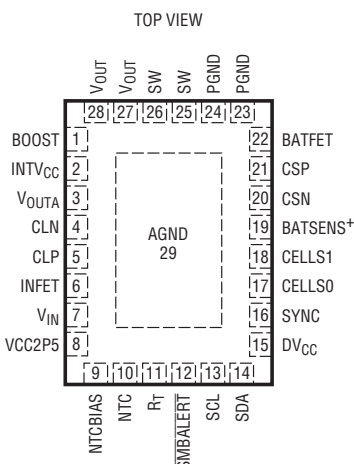
The LTC4162-L is an advanced monolithic synchronous step-down switching battery charger and PowerPath manager that seamlessly manages power distribution between input sources such as wall adapters, backplanes, solar panels, and a rechargeable Li-Ion/ Polymer battery.

A high resolution measurement system provides extensive telemetry information for circuit voltages, currents, battery resistance and temperature which can all be read back over the I²C port. The I²C port can also be used to configure many charging parameters including charging voltages and currents, termination algorithms and numerous system status alerts.

The LTC4162-L can charge lithium-ion cell stacks from 1 cell to 8 cells with as much as 3.2A of charge current.

The power path topology decouples the output voltage from the battery allowing a portable product to start-up instantly under very low battery voltage conditions.

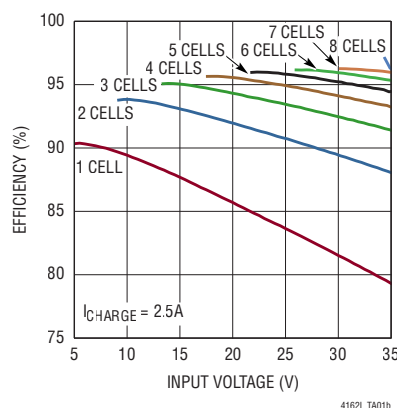
The LTC4162-L is available in a thermally enhanced 28-pin 4mm × 5mm × 0.75mm QFN surface mount package.



UFD PACKAGE
28-LEAD (4mm × 5mm) PLASTIC QFN

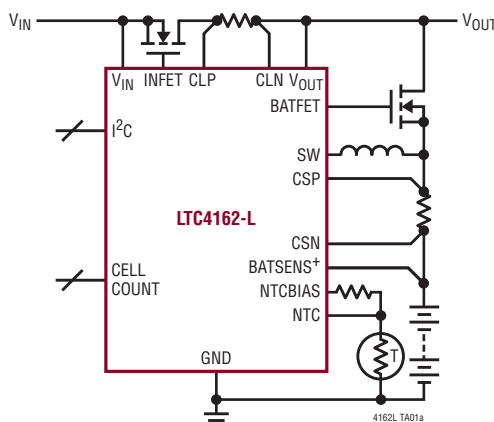
LTC4162EUFD-LAD	LTC4162IUFD-LAD
LTC4162EUFD-L40	LTC4162IUFD-L40
LTC4162EUFD-L41	LTC4162IUFD-L41
LTC4162EUFD-L42	LTC4162IUFD-L42
LTC4162EUFD-LADM	LTC4162IUFD-LADM
LTC4162EUFD-L40M	LTC4162IUFD-L40M
LTC4162EUFD-L41M	LTC4162IUFD-L41M
LTC4162EUFD-L42M	LTC4162IUFD-L42M
LTC4162EUFD-LAD	LTC4162IUFD-LAD
LTC4162EUFD-L40	LTC4162IUFD-L40
LTC4162EUFD-L41	LTC4162IUFD-L41
LTC4162EUFD-L42	LTC4162IUFD-L42
LTC4162EUFD-LADM	LTC4162IUFD-LADM
LTC4162EUFD-L40M	LTC4162IUFD-L40M
LTC4162EUFD-L41M	LTC4162IUFD-L41M
LTC4162EUFD-L42M	LTC4162IUFD-L42M

Charging Efficiency vs Input Voltage by Cell Count



4162L TA01b

1-8 Cell, 3.2A Step-Down Switching Battery Charger with PowerPath



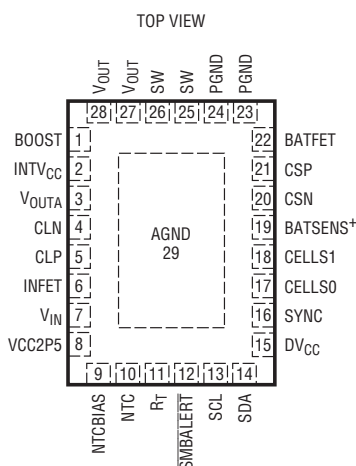
LTC4162-S 35V/3.2A Lead-Acid Step-Down Battery Charger with PowerPath and I²C Telemetry

FEATURES

- **Lead-Acid Battery Charger with Absorb and Equalize**
- **Wide Charging Input Voltage Range: 4.5V to 35V**
- **High Efficiency Synchronous Operation**
- **16-Bit Digital Telemetry System Monitors V_{BAT} , I_{BAT} , R_{BAT} , T_{BAT} , T_{DIE} , V_{IN} , I_{IN} , V_{OUT}**
- **Charges 6V, 12V, 18V and 24V Lead-Acid Batteries**
- Input Undervoltage Charge Current Limit Loop
- Input MPPT for Solar Panel Inputs
- Input Current Limit Prioritizes System Load Output
- Low Loss PowerPath
- Instant-On Operation with Discharged or Missing Battery
- Temperature Controlled Charging
- Pin Compatible with Li-Ion and LiFePO₄ Versions

APPLICATIONS

- Medical Instruments
- USB-C Power Delivery
- Industrial Handhelds
- Ruggedized Notebooks
- Tablet Computers



UFD PACKAGE
28-LEAD (4mm × 5mm) PLASTIC QFN

LTC4162EUFD-SAD
LTC4162EUFD-SST
LTC4162EUFD-SADM
LTC4162EUFD-SSTM
LTC4162EUFD-SAD
LTC4162EUFD-SST
LTC4162EUFD-SADM
LTC4162EUFD-SSTM
LTC4162IUFD-SAD
LTC4162IUFD-SST
LTC4162IUFD-SADM
LTC4162IUFD-SSTM
LTC4162IUFD-SAD
LTC4162IUFD-SST
LTC4162IUFD-SADM
LTC4162IUFD-SSTM

DESCRIPTION

The LTC4162-S is an advanced monolithic synchronous step-down switching battery charger and PowerPath manager that seamlessly manages power distribution between input sources such as wall adapters, backplanes, solar panels, and a lead-acid battery.

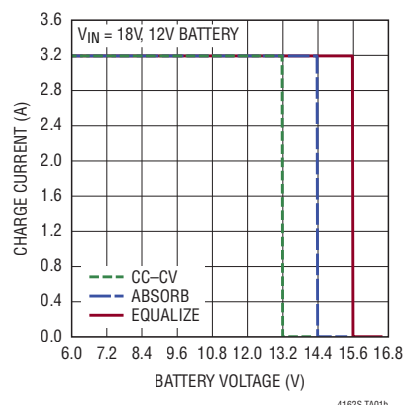
A high resolution measurement system provides extensive telemetry information for circuit voltages, currents, battery resistance and temperature which can all be read back over the I²C port. The I²C port can also be used to configure many charging parameters including charging voltages and currents, termination algorithms and numerous system status alerts.

The LTC4162-S can charge 6V, 12V, 18V and 24V lead-acid batteries with as much as 3.2A of charge current.

The power path topology decouples the output voltage from the battery allowing a portable product to start-up instantly under very low battery voltage conditions.

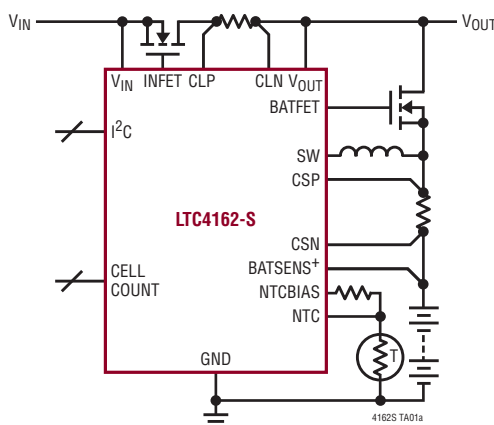
The LTC4162-S is available in a thermally enhanced 28-pin 4mm × 5mm × 0.75mm QFN surface mount package.

Charging Current vs Battery Voltage



4162S TA01b

9V to 35V, 3.2A Step-Down Switching Battery Charger with PowerPath



4162S TA01a

LT3922-1

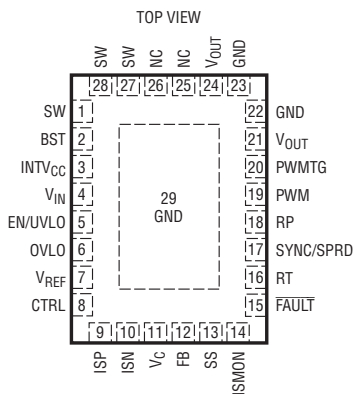
36V, 2.3A Synchronous Step-Up LED Driver with 25,000:1 PWM Dimming

FEATURES

- $\pm 2\%$ LED Current Regulation
- $\pm 2\%$ Output Voltage Regulation
- 25,000:1 PWM Dimming at 100Hz
- 128:1 Internal PWM Dimming
- Spread Spectrum Frequency Modulation
- Silent Switcher® Architecture for Low EMI
- Operates in Boost, Buck Mode and Buck-Boost Mode
- 2.8V to 36V Input Voltage Range
- Up to 34V LED String Voltage
- 2.3A, 40V Internal Switches
- 200kHz to 2MHz Switching Frequency with SYNC
- Analog or Duty Cycle LED Current Control
- Open/Short LED Protection and Fault Indication
- Thermally Enhanced 28-Lead (4mm × 5mm) QFN

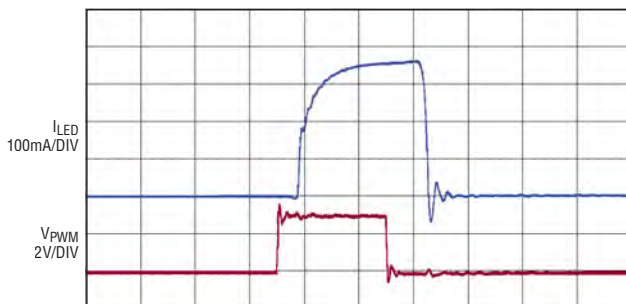
APPLICATIONS

- Automotive and Industrial Lighting
- Machine Vision



UFD PACKAGE
28-LEAD (4mm × 5mm) PLASTIC QFN

LT3922EUFD-1
LT3922IUFD-1
LT3922HUFD-1



INFINITE PERSISTENCE
 $V_{IN} = 12V$
 $f_{PWM} = 100Hz$

39221 TA01b

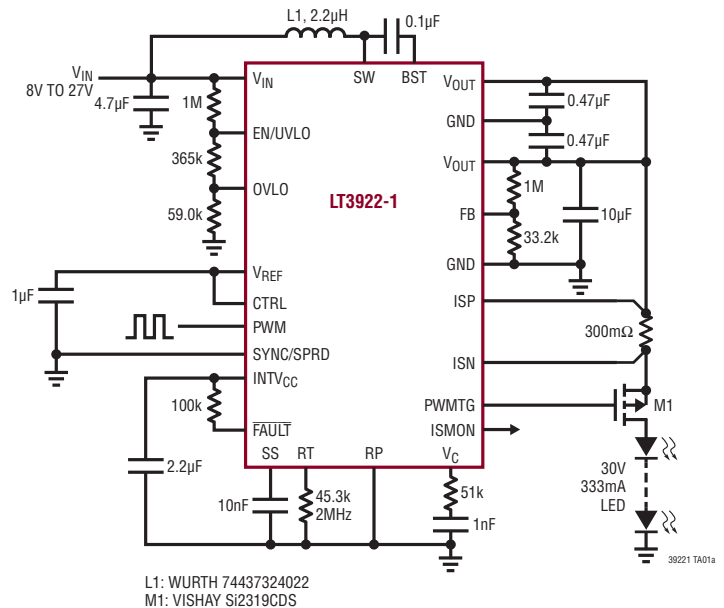
DESCRIPTION

The LT3922-1 is a monolithic, synchronous, step-up DC/DC converter that utilizes fixed-frequency, peak current control and provides PWM dimming for a string of LEDs. The LED current is programmed by an analog voltage or the duty cycle of pulses at the CTRL pin. The LT3922-1 will maintain $\pm 2\%$ current regulation through an external sense resistor over a wide range of output voltages.

The switching frequency is programmable from 200kHz to 2MHz by an external resistor at the RT pin or by an external clock applied at the SYNC/SPRD pin. With the optional spread spectrum frequency modulation enabled, the frequency varies from 100% to 125% to reduce EMI. The LT3922-1 also includes a driver for an external high side PMOS for PWM dimming and an internal PWM signal generator for analog control of PWM dimming. When an external signal is available, the LT3922-1 can perform 25,000:1 PWM dimming with 100Hz PWM pulses.

Additional features include an accurate external reference voltage for use with the CTRL and PWM pins, an LED current monitor, an accurate EN/UVLO pin threshold, open-drain fault reporting for open-circuit and short-circuit load conditions, and thermal shutdown.

30V, 333mA Boost LED Driver with 25,000:1 PWM Dimming



LT3033

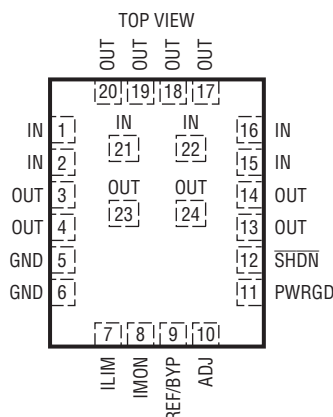
3A, 0.95V to 10V, Very Low Dropout Linear Regulator with Programmable Current Limit

FEATURES

- Single Supply V_{IN} Range: 0.95V to 10V
- Dropout Voltage: 95mV Typical
- Output Current: 3A
- Adjustable Output Voltage: 200mV to 9.7V
- Single Capacitor Soft-Starts Reference and Lowers Output Noise
- Stable with Low ESR, Ceramic Output Capacitors
- 0.075% Typical Load Regulation from 1mA to 3A
- Quiescent Current: 1.9mA Typical
- Quiescent Current in Shutdown: 22 μ A Typical
- Power Good (PWRGD) Flag (Status Valid in Shutdown)
- Current Limit Protection with Foldback
- Programmable Current Limit
- Output Current Monitor: $I_{OUT}/2650$
- Thermal Limiting with Hysteresis
- Reverse Battery, Reverse Output, and Reverse Current Protection
- 20-Lead 3mm $\times$ 4mm QFN Package

APPLICATIONS

- High Efficiency Linear Regulators
- Battery-Powered Systems
- Logic Supplies
- Post Regulator for Switching Supplies
- Wireless Modems
- FPGA Core Supplies



UDC PACKAGE
20-LEAD (3mm $\times$ 4mm) QFN, IN/OUT EXPOSED PADS

LT3033EUDC
LT3033IUDC

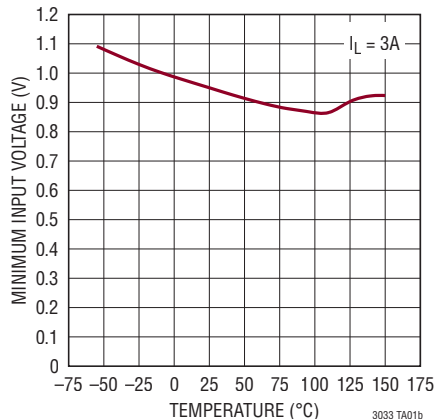
DESCRIPTION

The LT3033 is a very low dropout voltage (VLDO™) linear regulator that operates from a single input supply down to 0.95V. The device supplies 3A output current with 95mV typical dropout voltage. The LT3033 is ideal for low input voltage to low output voltage applications, providing comparable electrical efficiency to a switching regulator.

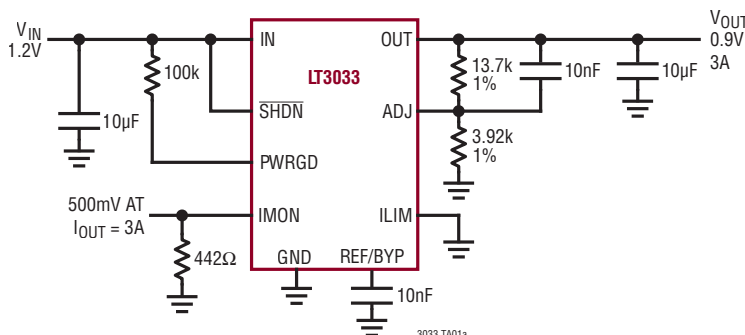
The LT3033 optimizes stability and transient response with low ESR ceramic output capacitors as small as 10 μ F. Other features include programmable current limit, an output current monitor and a power good flag to indicate output voltage regulation. In shutdown, quiescent current typically drops to 22 μ A. Internal protection circuitry includes reverse-battery protection, current limiting with foldback, thermal limiting with hysteresis and reverse-current protection.

The LT3033 is available as an adjustable device with an output voltage down to the 200mV reference. The device is available in a thermally enhanced, low profile 3mm $\times$ 4mm $\times$ 0.75mm QFN package.

Minimum Input Voltage vs Temperature



1.2V to 0.9V, 3A VLDO Regulator



LTM4678

Dual 25A or Single 50A µModule Regulator with Digital Power System Management

FEATURES

- Dual Digitally Adjustable Analog Loops with Digital Interface for Control and Monitoring
- Wide Input Voltage Range: 4.5V to 16V
- Output Voltage Range: 0.5V to 3.3V
- $\pm 0.5\%$ Maximum DC Output Error Over Temperature
- $\pm 5\%$ Current Readback Accuracy
- Sub-Milliohm DCR Current Sensing
- Integrated Input Current Sense Amplifier
- 400kHz PMBus-Compliant I²C Serial Interface
- Supports Telemetry Polling Rates up to 125Hz
- Integrated 16-Bit $\Delta\Sigma$ ADC
- Constant Frequency Current Mode Control
- Parallel and Current Share Up to 250A
- 16mm × 16mm × 5.86mm CoP-BGA Package

Readable Data:

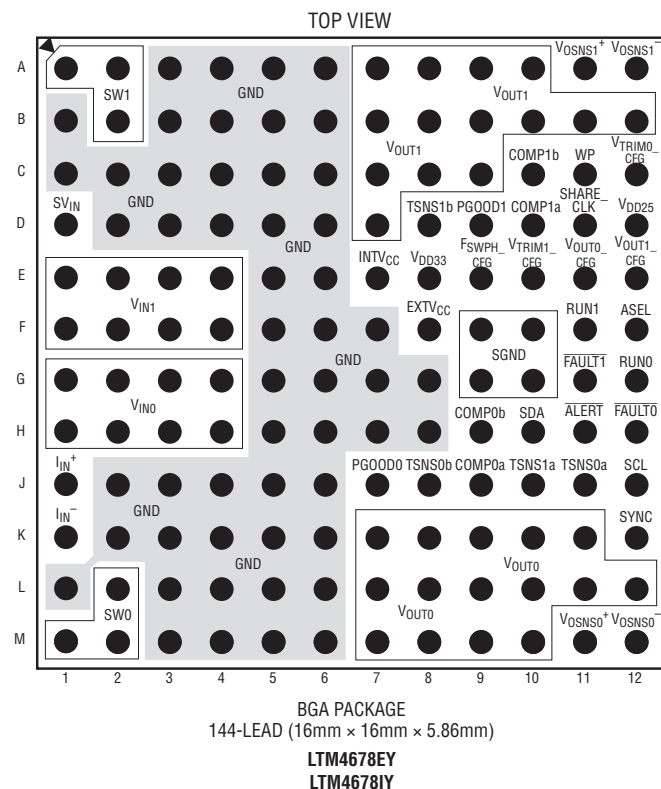
- Input and Output Voltages, Currents, and Temperatures
- Running Peak Values, Uptime, Faults and Warnings
- Onboard EEPROM Fault Log Record

Writable Data and Configurable Parameters:

- Output Voltage, Voltage Sequencing and Margining
- Digital Soft-Start/Stop Ramp, Program Analog Loop
- OV/UV/OT, UVLO, Frequency and Phasing

APPLICATIONS

- System Optimization, Characterization and Data Mining in Prototype, Production and Field Environments



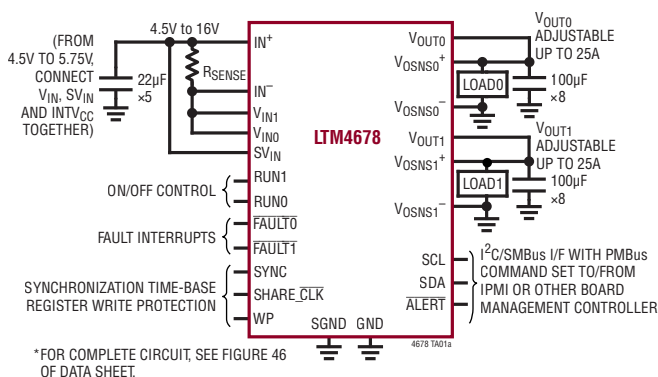
DESCRIPTION

The LTM4678 is a dual 25A or single 50A step-down µModule (power module) DC/DC regulator featuring remote configurability and telemetry-monitoring of power management parameters over PMBus—an open standard I²C-based digital interface protocol. The LTM4678 is comprised of digitally programmable analog control loops, precision mixed-signal circuitry, EEPROM, power MOSFETs, inductors and supporting components.

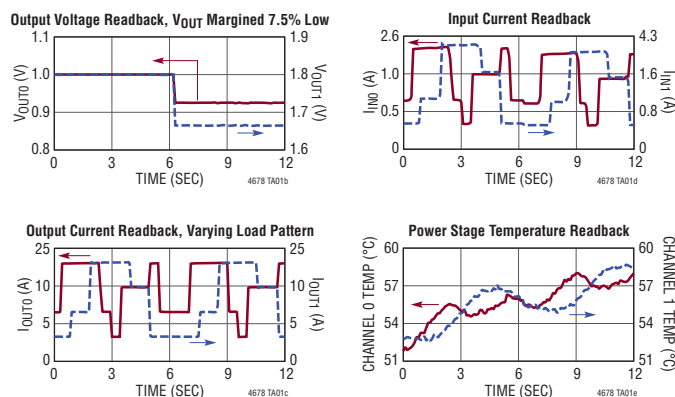
The LTM4678's 2-wire serial interface allows outputs to be margined, tuned and ramped up and down at programmable slew rates with sequencing delay times. True input current sense, output currents and voltages, output power, temperatures, uptime and peak values are readable. Custom configuration of the EEPROM contents is not required. At start-up, output voltages, switching frequency, and channel phase angle assignments can be set by pin-strapping resistors. The LTpowerPlay® GUI and DC1613 USB-to-PMBus converter and demo kits are available.

The LTM4678 is offered in a 16mm × 16mm × 5.86mm CoP-BGA package available with SnPb or RoHS compliant terminal finish.

Dual 25A µModule Regulator with Digital Interface for Control and Monitoring*



Using PMBus and LTpowerPlay to Monitor Telemetry and Margin V_{OUT0}/V_{OUT1} During Load Pattern Tests, 10Hz Polling Rate, 12V_{IN}



LTM4686/LTM4686-1

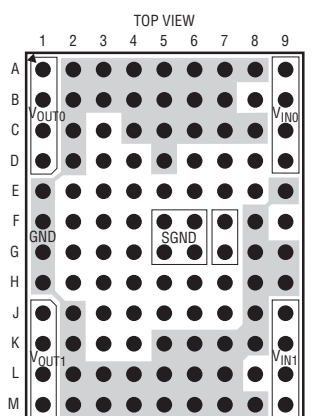
Ultrathin Dual 10A or Single 20A µModule Regulator with Digital Power System Management

FEATURES

- Dual, Fast, Analog Loops with Digital Interface for Control and Monitoring
- Wide Input Voltage Range: 4.5V to 17V Standalone, 2.375V to 17V with Aux 5V Bias (LTM4686-1)
- Output Voltage Range: 0.5V to 3.6V
- $\pm 0.5\%$ Maximum DC Output Error Over Temperature
- 10A DC Typical, 12A Peak Output Current, per Channel
- $\pm 5\%$ Current Readback Accuracy at 10A Load
- 400kHz PMBus-Compliant I²C Serial Interface
- Integrated 16-Bit $\Delta\Sigma$ ADC
- Supports Telemetry Polling Rates Up to 125Hz
- Constant Frequency Current Mode Control
- Parallel and Current Share Multiple Modules
- All 7-Bit Slave Addresses Supported
- Drop-In Pin-Compatible to Dual 9A LTM4675 and Dual 13A LTM4676A and Dual 18A LTM4677
- 16mm × 11.9mm × 1.82mm LGA Package
- **Readable Data:**
 - Input and Output Voltages, Currents, and Temperatures
 - Running Peak Values, Uptime, Faults and Warnings
 - Onboard EEPROM Fault Log Record with ECC
- **Writable Data and Configurable Parameters:**
 - Output Voltage, Voltage Sequencing and Margining
 - Digital Soft-Start/Stop Ramp
 - OV/UV/OT, UVLO, Frequency and Phasing

APPLICATIONS

- System Optimization, in Prototype and Production



LGA PACKAGE
108-LEAD (16mm × 11.9mm × 1.82mm)

LTM4686EV
LTM4686IV
LTM4686EV-1
LTM4686IV-1

DESCRIPTION

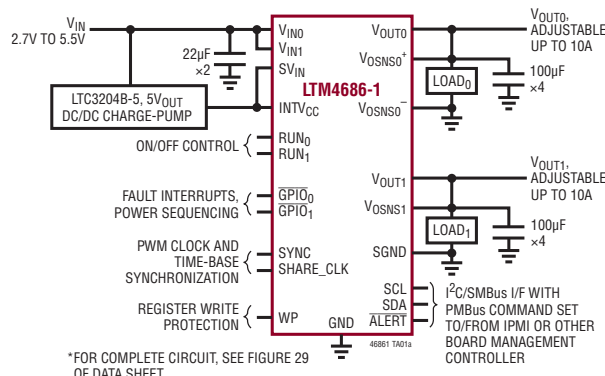
The LTM4686 is a dual 10A (12A Peak) or single 20A (24A Peak) step-down µModule (micromodule) DC/DC regulator with 39ms turn-on time. It features remote configurability and telemetry-monitoring of power management parameters over PMBus—an open standard I²C-based digital interface protocol. The LTM4686 is comprised of fast analog control loops, precision mixed-signal circuitry, EEPROM, power MOSFETs, inductors and supporting components. The LTM4686 product video is available on the website.

The LTM4686's 2-wire serial interface enables voltage margining and sequencing, and telemetry readback of currents, voltages, power, temperature, uptime and peak values. Pin-strap resistors configure start-up settings. The LTpowerPlay GUI, DC1613 USB-to-PMBus converter, DC2086 programming adapter and demo kits are available. Applications running from 5V_{IN} or supplying 5V_{AUX} to SV_{IN} should use LTM4686-1. Otherwise, use LTM4686:

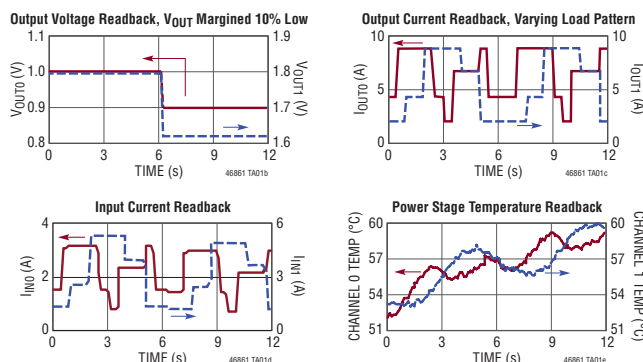
MODULE PMBus COMMAND CODE	LTM4686	LTM4686-1
0x35, VIN_ON (SV _{IN} UVLO-Rising)	5.50V	4.25V
0x36, VIN_OFF (SV _{IN} UVLO-Falling)	5.25V	4.00V
0x58, VIN_UV_WARN_LIMIT	5.30V	4.09V

Pb-free and RoHS compliant, the LTM4686 is available in a 16mm × 11.9mm × 1.82mm LGA package.

Dual 10A µModule Regulator with Digital Interface for Control and Monitoring*



Using PMBus and LTpowerPlay to Monitor Telemetry and Margin V_{OUT0}/V_{OUT1} During Load Pattern Tests. 10Hz Polling Rate. 3.3V_{IN}



LTM8002

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

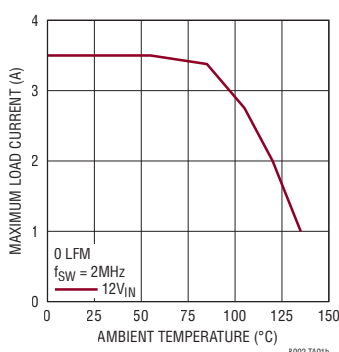
FEATURES

- 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
- Wide Temperature Range: -40°C to 150°C (H-Grade)
- 2.8A Continuous for 5V_{OUT}, 12V_{IN}, 2MHz at 105°C (H-Grade)
- 3.5A Peak
- FMEA Compliant Pinout
- Output Stays at or Below Regulation Voltage During Adjacent Pin Short or if a Pin Is Left Floating
- Selectable Switching Frequency: 200kHz to 3MHz
- External Synchronization
- Low Quiescent Current: 25µA (5V_{OUT})
- Programmable Soft-Start
- Tiny, Low Profile 6.25mm × 6.25mm × 2.22mm BGA Package

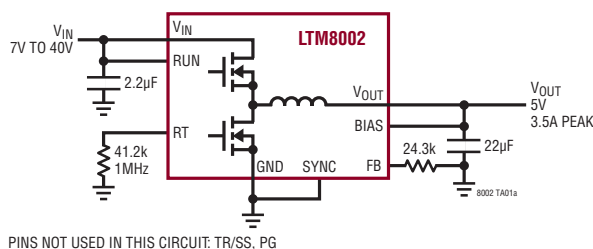
APPLICATIONS

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

Derating, H-Grade, BIAS = 5V,
DC2501A Demo Board



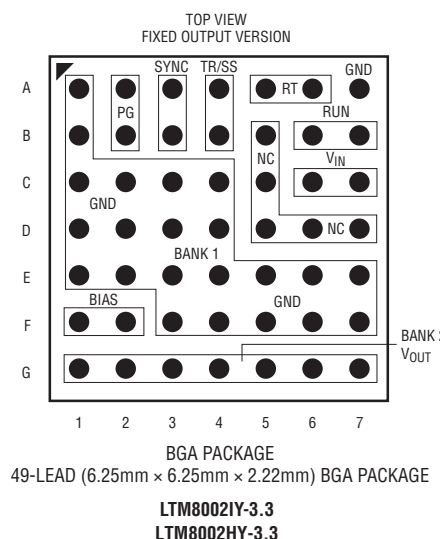
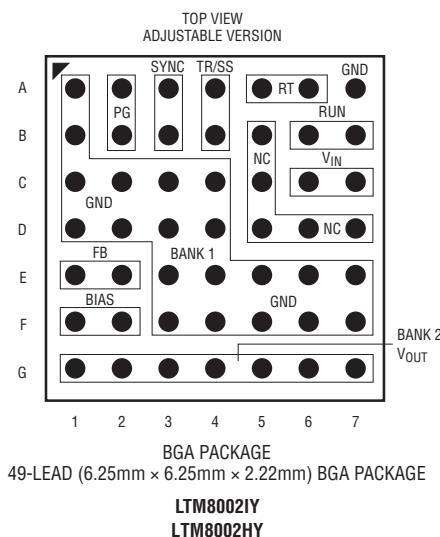
5V_{OUT} from 7V_{IN} to 40V_{IN} Step-Down Converter



DESCRIPTION

The LTM8002 is a 40V_{IN}, 2.5A 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 LTM8002 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 LTM8002 is packaged in a thermally enhanced, compact over-molded ball grid array (BGA) package suitable for automated assembly by standard surface mount equipment. The LTM8002 is available with SnPb or RoHS compliant terminal finish.



LTM8074 40V_{IN}, 1.2A Silent Switcher µModule Regulator

FEATURES

- Low Noise Silent Switcher Architecture
- CISPR 22 Class B Compliance
- Wide Input Voltage Range: 3.2V to 40V
- Wide Output Voltage Range: 0.8V to 12V
- 1.2A Continuous Output Current at 24V_{IN}, 5V_{OUT}, T_A = 85°C
- 1.75A Peak Output Current at 3.3V_{OUT}
- Selectable Switching Frequency: 200kHz to 2.2MHz
- External Synchronization
- Configurable as an Inverter
- 4mm × 4mm × 1.82mm BGA Package

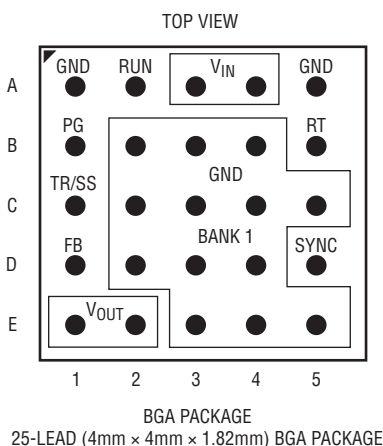
APPLICATIONS

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

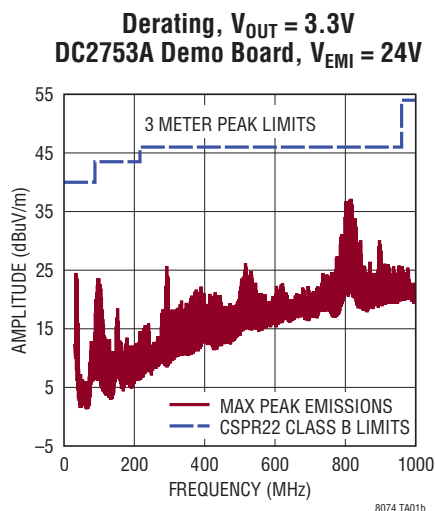
DESCRIPTION

The LTM8074 is a 40V_{IN}, 1.2A continuous, 1.75A peak, step-down µModule (power module) regulator. The Silent Switcher architecture minimizes EMI while delivering high efficiency at frequencies up to 2.2MHz. 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 LTM8074 supports an output voltage range of 0.8V to 12V 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.

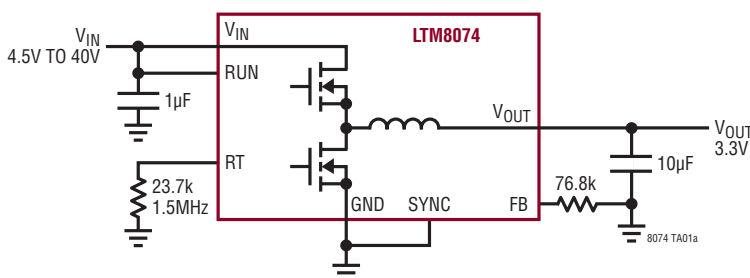
The low profile package enables utilization of unused space on the bottom of PC boards for high density point of load regulation. The LTM8074 is packaged in a thermally enhanced, compact over-molded ball grid array (BGA) package suitable for automated assembly by standard surface mount equipment. The LTM8074 is RoHS compliant.



LTM8074EY
LTM8074IY



3.3V_{OUT} from 4.5V_{IN} to 40V_{IN} Step-Down Converter



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

LTC4292/LTC4291 4-Port IEEE 802.3bt PoE PSE Controller

FEATURES

- Four PSE Ports
 - Two Power Channels Per Port
- Fully Compliant IEEE 802.3bt Type 3 and 4 PSE
 - Compliant Support for Type 1, 2, 3, and 4 PDs
- Low Power Path Dissipation per Channel
 - 150mΩ Sense Resistance
 - 30mΩ or Lower MOSFET $R_{DS(ON)}$
- Chipset Provides Electrical Isolation
 - Eliminates Optos and Isolated 3.3V Supply
- Very High Reliability Multipoint PD Detection
 - Connection Check Distinguishes Single-Signature and Dual-Signature PDs
- Continuous, Dedicated Per-Port Power and Current Monitoring
 - Per-Port Power Policing
- 1MHz I²C Compatible Serial Control Interface
- Pin or I²C Programmable PD Power Up to 71.3W
- Available in a 40-Lead 6mm × 6mm (LTC4292) and 24-Lead 4mm × 4mm (LTC4291) QFN Package

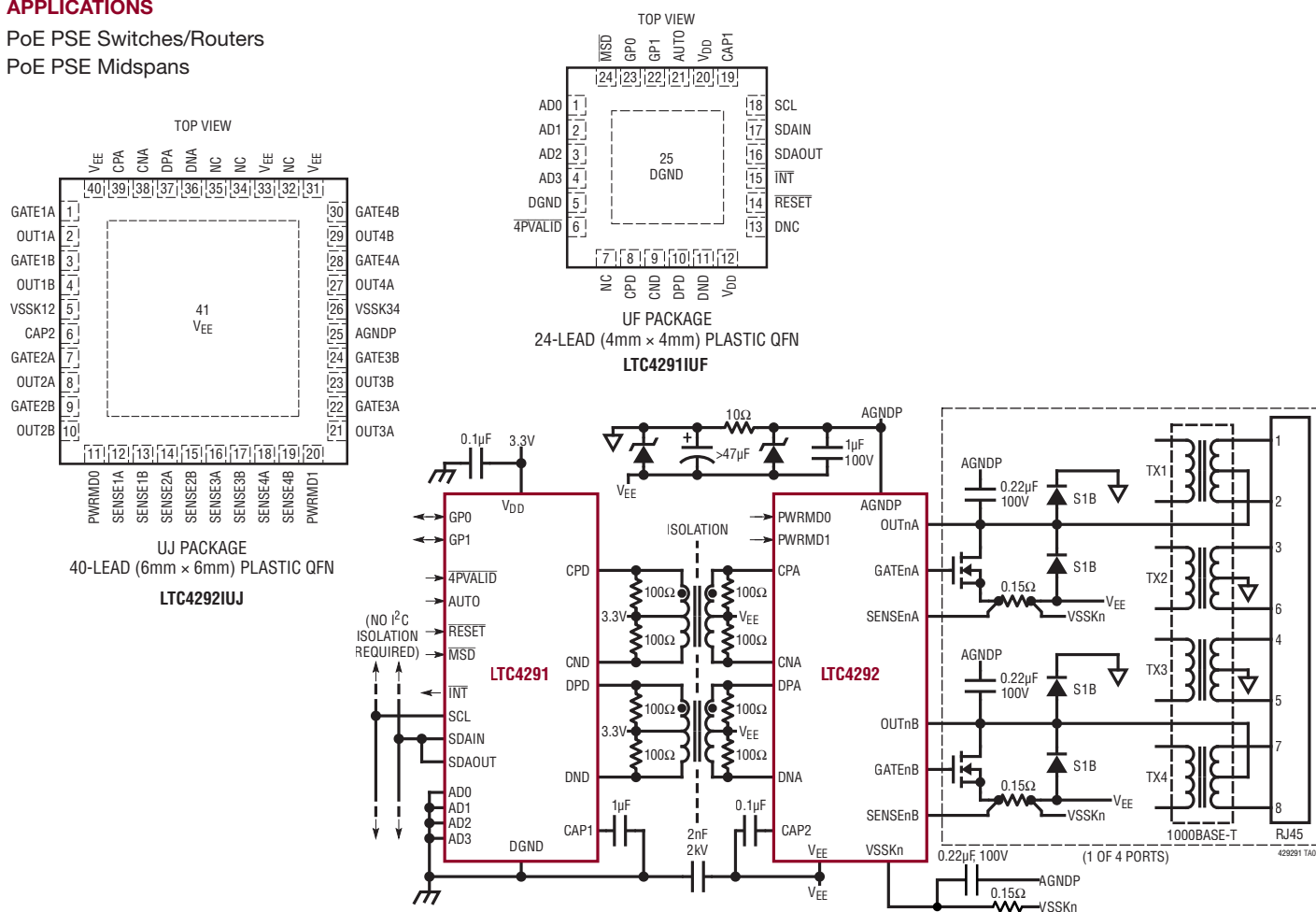
APPLICATIONS

- PoE PSE Switches/Routers
- PoE PSE Midspans

DESCRIPTION

The LTC4292/LTC4291 chipset is a 4-port power sourcing equipment (PSE) controller designed for use in IEEE 802.3bt Type 3 and 4 compliant Power over Ethernet (PoE) systems. The LTC4292/LTC4291 is designed to power compliant 802.3af, 802.3at, and 802.3bt PDs. The LTC4292/LTC4291 chipset delivers lowest-in-industry heat dissipation by utilizing low $R_{DS(ON)}$ external MOSFETs and 0.15Ω sense resistance per power channel. A transformer-isolated communication protocol replaces expensive opto-couplers and complex isolated 3.3V supply, resulting in significant BOM cost savings.

Advanced power management features include per-port 14-bit current monitoring, programmable current limit, and versatile fast shut-down of preselected ports. Advanced power management host software is available under a no-cost license. PD detection uses a proprietary multipoint detection mechanism ensuring excellent immunity from false PD identification. Autoclass and 5-event physical classification are supported. The LTC4292/LTC4291 includes an I²C serial interface operable up to 1MHz. The LTC4292/LTC4291 is pin or I²C programmable to negotiate PD delivered power up to 71.3W.



LTC4041

2.5A Supercapacitor Backup Power Manager

FEATURES

- **2.5A Step-Down Supercapacitor Charger and 2.5A Step-Up Backup Supply**
- **6.5A Switches for 2.5A Backup from One Supercapacitor or Two in Series**
- **Input Current Limit Prioritizes Load over Charge Current**
- **Input Disconnect Switch Isolates Input During Backup**
- **Automatic Seamless Switch-Over to Backup Mode**
- Internal Supercapacitor Balancer (No External Resistors)
- Programmable Charge Current and Charge Voltage
- Input Power Fail Indicator
- System Power Good Indicator
- Optional OVP Circuitry Protects Device to >60V
- Constant Frequency Operation
- Thermally Enhanced 24-Lead 4mm × 5mm QFN Package

APPLICATIONS

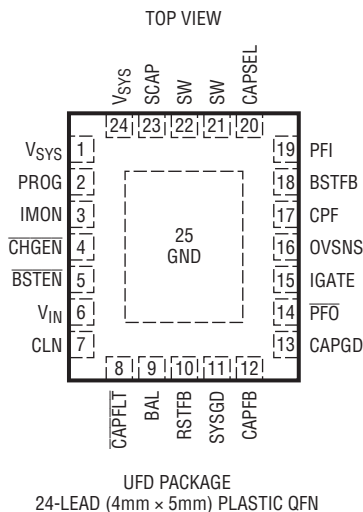
- Ride-Through “Dying Gasp” Supplies
- High Current Ride-Through 3V to 5V UPS
- Power Meters/Industrial Alarms
- Servers/Solid State Drives

DESCRIPTION

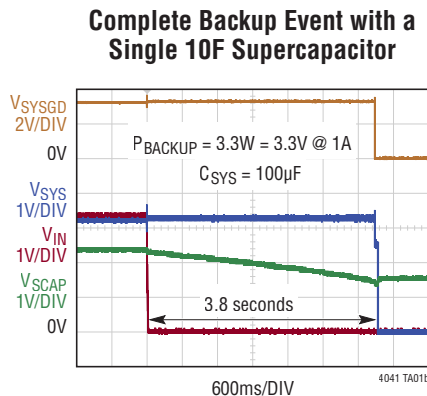
The LTC4041 is a complete supercapacitor backup system for 2.9V to 5.5V supply rails. It contains a high current step-down DC/DC converter to charge a single supercapacitor or two supercapacitors in series. When input power is unavailable, the step-down regulator operates in reverse as a step-up regulator to backup the system output from the supercapacitor(s).

The LTC4041's adjustable input current limit function reduces charge current to protect the input supply from overload while an external disconnect switch isolates the input supply during backup. When the input supply drops below the adjustable PFI threshold, the 2.5A boost regulator delivers power from the supercapacitor to the system output.

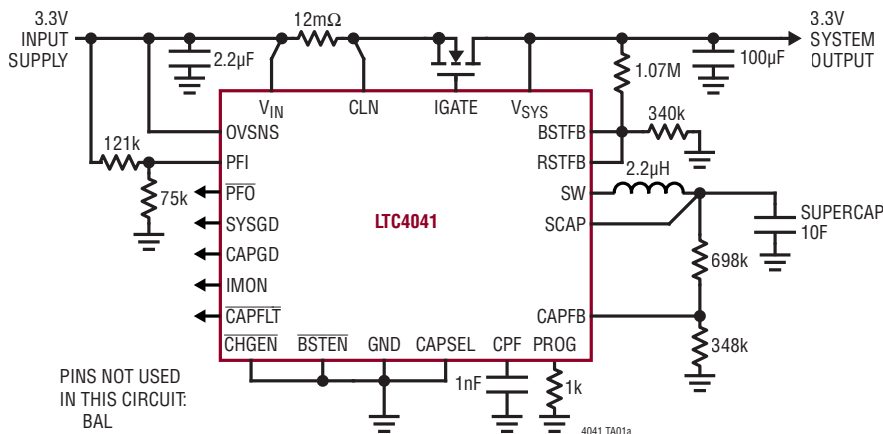
An optional input overvoltage protection (OVP) circuit protects the LTC4041 from high voltage damage at the V_{IN} pin. An internal supercapacitor balancing circuit maintains equal voltages across each supercapacitor and limits the maximum voltage of each supercapacitor to a pre-determined value. The LTC4041 is available in a low profile (0.75mm) 24-lead 4mm × 5mm QFN package.



LTC4041EUFD
LTC4041IUFD



Single Supercapacitor 3.3V Backup Application



LTC7862 140V High Efficiency Switching Surge Stopper

FEATURES

- **V_{OUT} Clamp Stops High Voltage Input Surges**
- **100% Duty Cycle Pass-Through Mode During Normal Operation**
- **Switches During Overvoltage or Overcurrent Transients and Faults and During Start-Up**
- **High Efficiency Switching Enables Long Duration Surge Protection and High Output Currents**
- **Wide V_{IN} Range: 4V to 140V (150V Abs Max)**
- **Adjustable Output Voltage Clamp Up to 60V**
- **Adjustable Output Overcurrent Protection**
- **R_{SENSE} or Inductor DCR Current Sensing**
- Power Inductor Reduces Input EMI in Normal Mode
- Adjustable Soft-Start for Inrush Current Limiting
- Programmable Fault Timer
- Open-Drain Fault Warning Indicator
- 2.7% Retry Duty Cycle During Faults
- Adjustable Switching Frequency: 50kHz to 900kHz
- Adjustable Input Voltage Turn-On Threshold
- Adjustable Input Overvoltage Lockout Threshold
- 20-Pin 4mm × 5mm QFN and TSSOP Packages

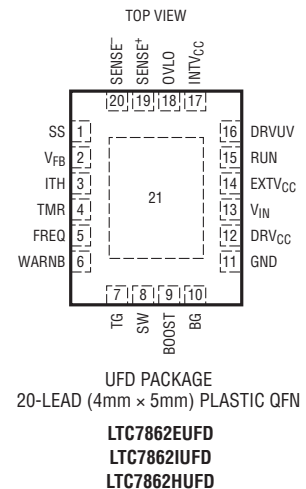
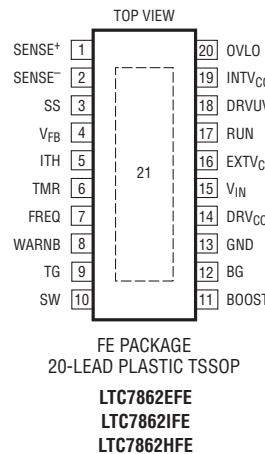
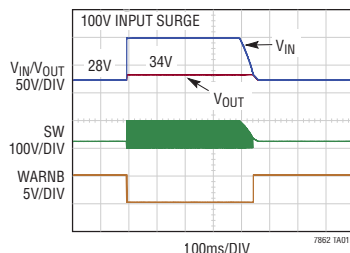
APPLICATIONS

- Automotive/Avionic/Industrial Surge Protection
- Automotive Load Dump Protection
- Vehicle Power Including ISO7637
- Military Power Including MIL1275

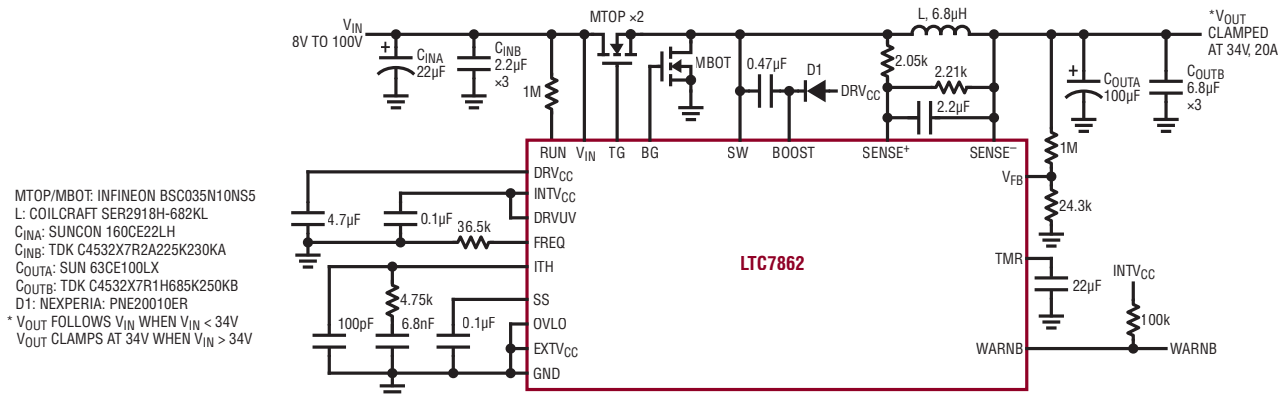
DESCRIPTION

The LTC7862 high efficiency switching surge stopper protects loads from high voltage transients. High efficiency switching allows high output currents, small solution sizes, and high reliability. During an input overvoltage event, the LTC7862 controls the gates of two external N-channel MOSFETs to act as a switching DC/DC step-down regulator. This maintains the output voltage at a safe value, allowing the loads to continue to operate through the input overvoltage event. During normal operation, the LTC7862 turns on the top external N-channel MOSFET continuously, passing the input voltage through to the output, with minimal voltage drop. Using a fast peak current comparator, the LTC7862 also limits the maximum output current to protect against overcurrent and short-circuit faults. An adjustable timer limits the time that the LTC7862 can spend switching during an overvoltage, overcurrent, or start-up condition. When the timer expires, the external MOSFETs are turned off for a cooldown period and then the LTC7862 restarts. By strictly limiting how long the LTC7862 can switch, when the power loss is relatively high, the components and thermal design can be optimized for normal pass-through operation while still safely operating through high voltage input surges and/or overcurrent events.

Overvoltage Protector Regulates Output at 28V During V_{IN} Transient



28V, 20A with 100V Overvoltage Protection



ADP5138

Quad, 1 A, 5.5 V, Synchronous Step-Down Regulators with One RF LDO Regulator

FEATURES

- PVINx Voltage Range: 3 V to 5.5 V
- Continuous Output Current
 - Channel 1 to Channel 4 (buck): 1 A
 - Channel 5 (LDO): 250 mA
- 3.2 MHz Fixed PWM Switching Frequency
- Synchronization Input Function
- Buck Regulators Run at 90° Out-of-Phase
- Individual Precision Enable Input
- Power-On Reset Output
- Integrated Compensation
- Soft-Start and Power-Up Sequencing Reduce Inrush Current
- Active Output Discharge Switch Function
- Stable with Low ESR Output Ceramic Capacitors
- OVLO, UVM, and UVLO
- TSD Protection
- Qualified for Automotive Applications

APPLICATIONS

- Automotive
- Industrial and Instrumentation
- DC to DC Point-of-Load Applications

DESCRIPTION

The ADP5138 integrates four high performance synchronous step-down regulators and one low noise radio frequency (RF) low dropout (LDO) regulator. The device runs from PVINx input voltages of 3 V to 5.5 V. The output voltage of each channel is factory set or can be programmed down to 0.8 V with a resistor. Each step-down regulator can provide up to 1 A of continuous output current and the LDO can provide 250 mA of output current.

The ADP5138 runs at the fixed PWM switching frequency, 3.2 MHz, or can be synchronized to the external clock from 2.8 MHz to 3.5 MHz, which is outside the amplitude modulation (AM) band. The four buck regulators run at 90° out of phase to reduce the input ripple current and the input capacitor size, thereby helping to lower system electromagnetic interference (EMI).

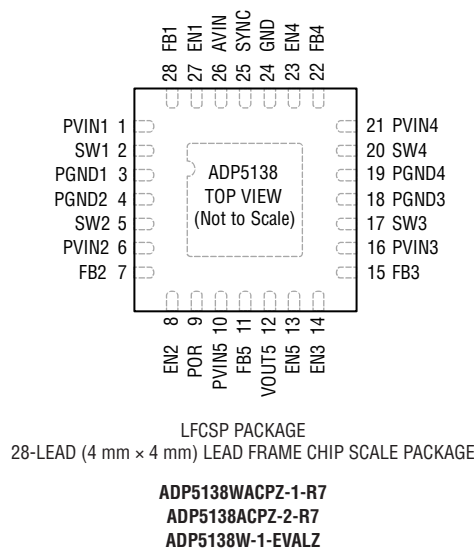
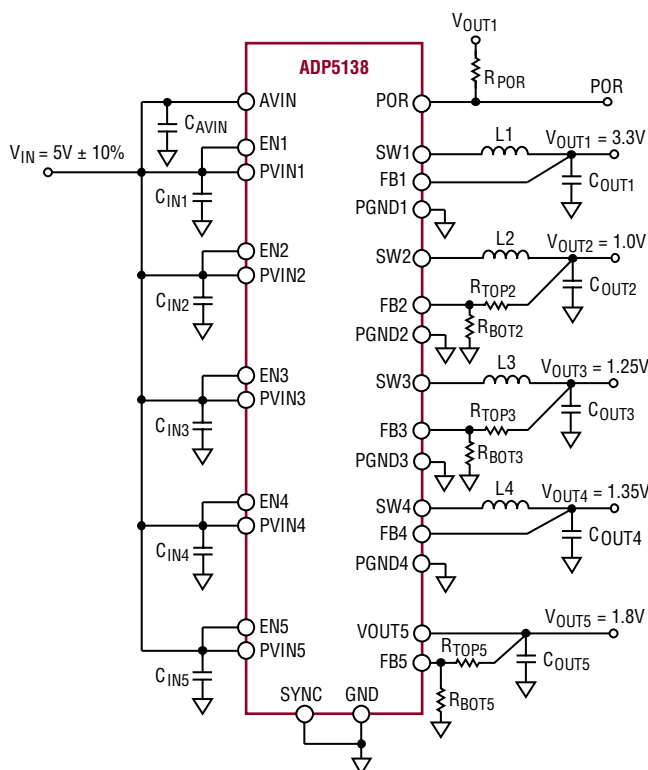
The ADP5138 integrates internal compensation to simplify the design. The internal soft start circuitry and power-up sequencing help reduce the input inrush current.

The ADP5138 monitors the input voltage and provides input overvoltage lockout (OVLO), undervoltage monitor (UVM), and undervoltage lockout (UVLO) features. It also monitors the undervoltage and overvoltage of the outputs. The power-on reset (POR) signal is asserted when the input or output voltage fault occurs.

Additional protection includes overcurrent protection (OCP) and thermal shutdown (TSD).

The ADP5138 operates over the -40°C to $+125^{\circ}\text{C}$ operating temperature range (junction), and is available in a 28-lead LFCSP package.

Typical Application Circuit



LTC3372

60V Low I_Q Buck Controller Plus 4-Channel 8A Configurable Buck DC/DCs

FEATURES

- **HV Buck Controller:** $V_{IN} = 4.5V$ to $60V$, $V_{OUT} = 5V/3.3V$
- **LV Buck Regulators:** $V_{INA-H} = 2.25V$ to $5.5V$, $V_{OUT1-4} \geq 0.8V$
- **8x1A LV Buck Integrated Power Stages, Configurable as 2, 3 or 4 Output Channels**
- **8 Unique Output Configurations (1A to 4A Per Channel)**
- **Low Total No-Load Input Supply Current (I_Q)**
 - **15 μ A HV Controller Only ($5V_{OUT}$)**
 - **23 μ A HV Controller Only ($3.3V_{OUT}$)**
 - **33 μ A HV Controller ($3.3V_{OUT}$) Plus One LV Regulator**
 - **9 μ A Per Additional LV Regulator Channel**
- 1MHz to 3MHz Operation (HV Runs at 1/6 Frequency)
- Programmable or Synchronizable to External Clock
- Programmable Watchdog and Power-On Reset Delay
- IC Die Temperature Monitor Output
- Thermally Enhanced 48-pin 7mm x 7mm QFN Package

APPLICATIONS

- Automotive and Industrial Always-On Systems
- General Purpose Multi-Channel Power Supplies

DESCRIPTION

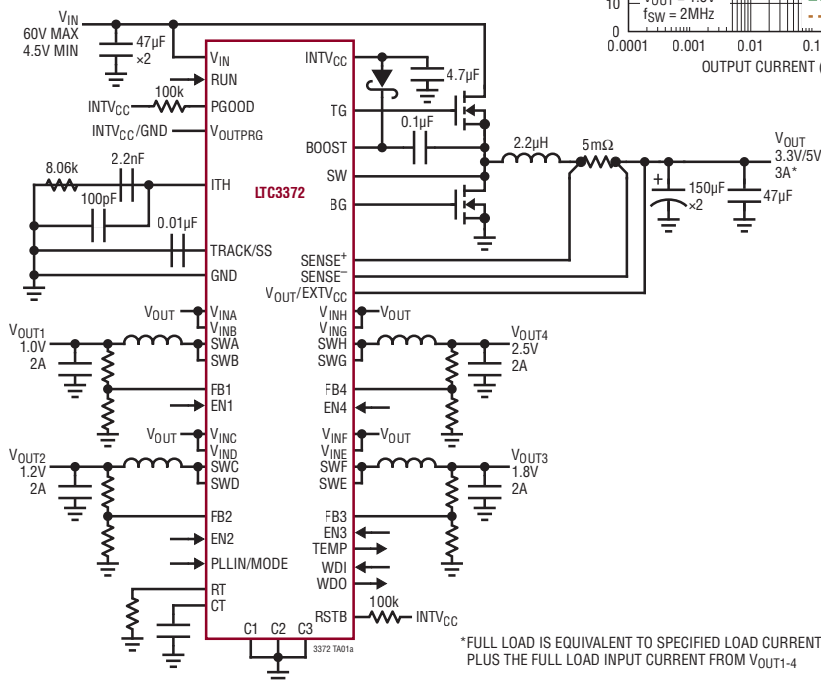
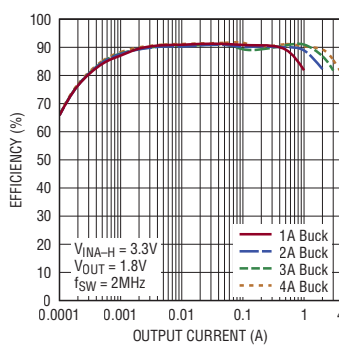
The LTC3372 is a highly flexible multioutput power supply IC. The device includes a high performance, high voltage (HV) step-down DC/DC switching regulator controller that drives an all N-channel synchronous power FET stage from a 4.5V to 60V input.

The LTC3372 also includes four low voltage (LV) synchronous buck regulators that can be programmed by the C1-C3 pins to share eight 1A integrated power stages in one of eight possible configurations. Each power stage is powered from independent inputs which may be connected to the HV buck's V_{OUT} or to other 2.25V to 5.5V supplies.

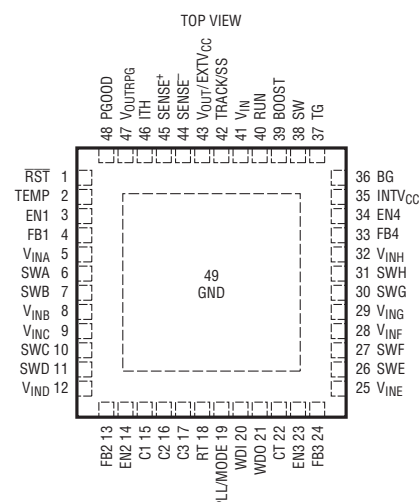
The CT pin programs timing parameters of the watchdog timer and LV outputs' Power-On Reset (RST). Precision enable thresholds facilitate reliable power-up sequencing.

The LTC3372 is available in a 48-pin 7mm x 7mm QFN package.

LV Efficiency vs Output Current



*FULL LOAD IS EQUIVALENT TO SPECIFIED LOAD CURRENT PLUS THE FULL LOAD INPUT CURRENT FROM V_{OUT1-4}



UK PACKAGE
48-LEAD (7mm x 7mm) PLASTIC QFN

LTC3372EUK
LTC3372IUK
LTC3372HUK

Low Voltage Buck Regulator Configurations

C3	C2	C1	BUCK1	BUCK2	BUCK3	BUCK4
0	0	0	2A	2A	2A	2A
0	0	1	3A	1A	2A	2A
0	1	0	3A	1A	1A	3A
0	1	1	4A	1A	1A	2A
1	0	0	3A	2A	—	3A
1	0	1	4A	—	2A	2A
1	1	0	4A	—	1A	3A
1	1	1	4A	—	—	4A

LTC3894

150V Low I_Q Step-Down DC/DC Controller with 100% Duty Cycle Capability

FEATURES

- Wide Operating V_{IN} Range: 4.5V to 150V
- Wide V_{OUT} Range: 0.8V to 60V
- 9 μ A I_Q When Regulating 48V_{IN} to 3.3V_{OUT}
- 16 μ A I_Q When Regulating 12V_{IN} to 3.3V_{OUT}
- Very Low Dropout Operation: 100% Duty Cycle
- Adjustable Input Overvoltage Lockout
- Programmable PGOOD Undervoltage Monitor
- R_{SENSE} or Inductor DCR Current Sensing
- Selectable High Efficiency Burst Mode® Operation or Pulse-Skipping Mode at Light Loads
- Programmable Fixed Frequency: 50kHz to 850kHz
- Phase-Lockable Frequency: 75kHz to 800kHz
- Internal Fixed Soft-Start and External Programmable Soft-Start or Voltage Tracking
- Strong MOSFET Gate Driver with Selectable Undervoltage Lockout Thresholds
- Optional External NMOS for Gate Driver Bias in High Power Applications

APPLICATIONS

- Automotive and Industrial Power Systems
- Telecommunication Power Systems
- Distributed Power Systems

DESCRIPTION

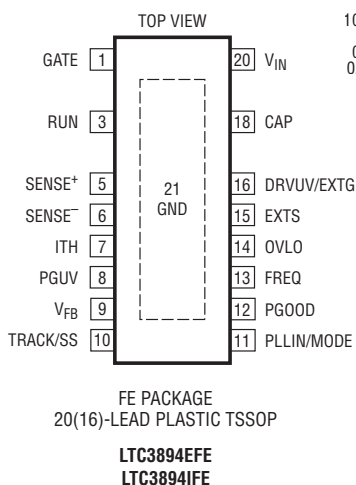
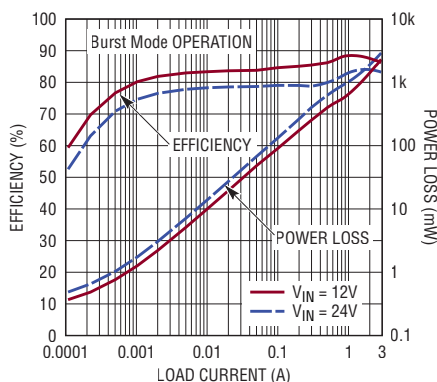
The LTC3894 is a high voltage step-down DC/DC switching regulator controller. It drives a P-channel power MOSFET switch allowing 100% duty cycle operation. It enables a low part count, simple, and robust solution for high reliability, high voltage applications.

The LTC3894 operates over a wide input voltage range from 4.5V to 150V and can regulate output voltages from 0.8V to 60V. It offers excellent light load efficiency, drawing only 9 μ A quiescent current while regulating the output voltage with no load. Its peak current mode, constant frequency architecture provides for good control of switching frequency and output current limit. The switching frequency can be programmed from 50kHz to 850kHz with an external resistor and can be synchronized to an external clock from 75kHz to 800kHz.

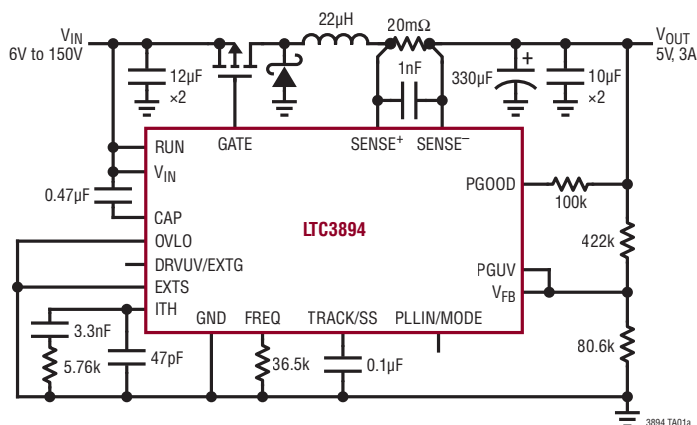
The LTC3894 offers programmable output voltage soft-start or tracking. Safety features include overvoltage, overcurrent and overtemperature protection with a power good output monitor with adjustable threshold.

The LTC3894 is available in a thermally enhanced 20-pin TSSOP package with leads removed to accommodate high voltage creepage and clearance requirements.

Efficiency and Power Loss vs Load Current



High Efficiency 150V to 5V Step-Down Regulator



LTC7840

2-Phase Dual Output Nonsynchronous Boost Controller with Hiccup Mode

FEATURES

- Wide V_{IN} Range: 5.5V to 60V
- Configurable for Dual Phase Single/Dual Output Operation
- Peak Current Mode Control with Smooth Quadratic Slope Compensation and Dynamic Slope Recovery
- Adjustable Max Duty Cycle
- Adjustable Min On-Time
- Hiccup Mode for Overcurrent Protection
- Adjustable Current Sense Limit
- Output Overvoltage Protection
- Programmable and Phase-Lockable Operating Frequency (from 50kHz to 425kHz)
- Adjustable Soft-Start Current Ramping
- $\pm 1\%$ Internal Voltage Reference
- Internal 10V LDO Regulator for Gate Driver
- Two RUN Pins and Dual Power Good Monitors
- Flexible Topology for Boost, SEPIC and Flyback

APPLICATIONS

- Automotive System, Telecom System and Industrial Power Supplies

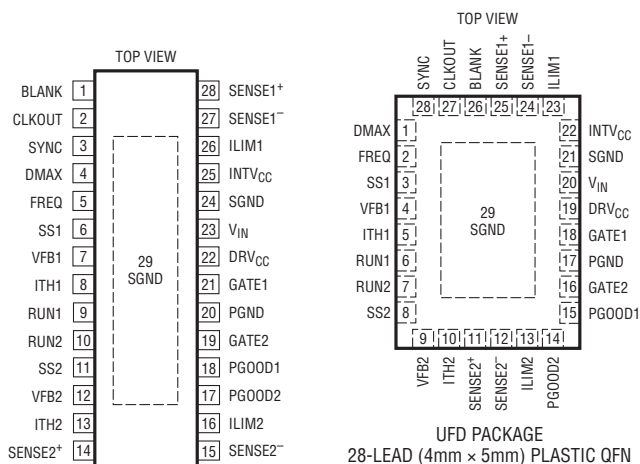
DESCRIPTION

The LTC7840 is a dual phase dual output, constant frequency current mode, nonsynchronous boost controller that drives N-channel power MOSFETs. The nonsynchronous topology makes the output voltage dependent on the choice of external components.

A wide 5.5V to 60V input supply range can accommodate high input voltage surges. The LTC7840 can be configured as a dual phase single output or dual output controller. It can be also configured for the SEPIC and flyback topologies. The switching frequency is programmed by the voltage on the FREQ pin or synchronized to an external clock. The LTC7840 features a precise 1.2V internal reference. It has two RUN pins and two power good output indicators.

The LTC7840 has an internal 10V LDO with undervoltage lockout protection for its on-chip gate driver. The maximum duty cycle and blanking time can be programmed by the voltage on DMAX and BLANK pins, respectively. The hiccup mode protects the system in the event of faults.

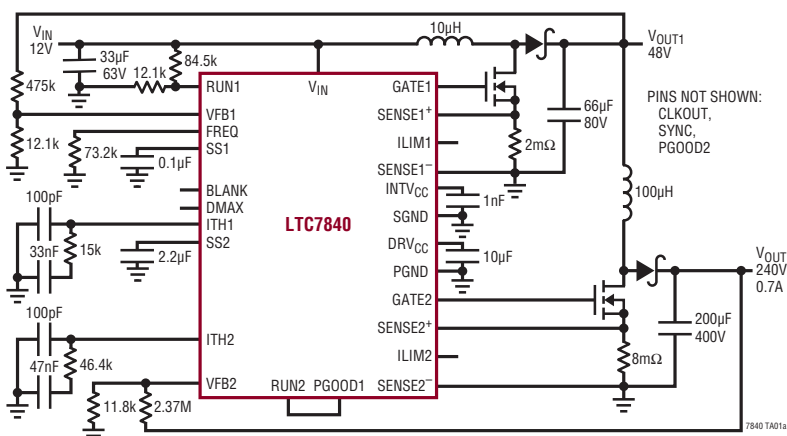
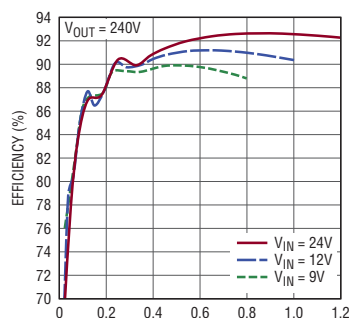
The LTC7840 is available in a 28-lead thermally enhanced TSSOP package (FE28) or a 28-lead QFN package (UFD28).



LTC7840UFD
LTC7840IUF
LTC7840HUF

LTC7840EFE
LTC7840IFE
LTC7840HFE

Efficiency vs Output Current





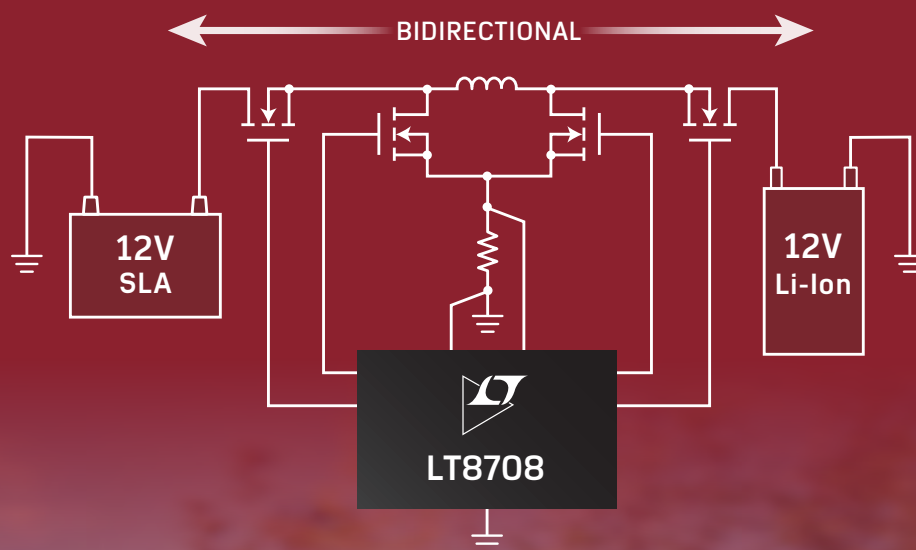
AHEAD OF WHAT'S POSSIBLE™

DUAL BATTERY CONTROL FOR AUTONOMOUS VEHICLES

LT8708

80V BIDIRECTIONAL DC/DC
BUCK-BOOST CONTROLLER
FOR EV/HEV

- ▶ Dual Voltage Redundancy:
12V/12V, 24V/24V, 48V/48V
48V/12V, 48V/24V
- ▶ LT8708-1: Multiphase
Operation for Several Kilowatts
- ▶ Six Forms of Regulation:
Voltages & Currents
- ▶ Up to 98% Efficiency



POWER BY
LINEAR™



DATA SHEET
www.analog.com/LT8708

LT8708

80V Synchronous 4-Switch Buck-Boost DC/DC Controller with Flexible Bidirectional Capability

FEATURES

- Single Inductor Allows V_{IN} Above, Below or Equal to V_{OUT}
- Six Independent Forms of Regulation
 - V_{IN} Current (Forward and Reverse)
 - V_{OUT} Current (Forward and Reverse)
 - V_{IN} and V_{OUT} Voltage
- Forward and Reverse Discontinuous Conduction Mode Supported
- Supports MODE and DIR Pin Changes While Switching
- V_{INCHIP} Range 2.8V (Need $EXTV_{CC} > 6.4V$) to 80V
- V_{OUT} Range: 1.3V to 80V
- Synchronous Rectification: Up to 99% Efficiency
- Available in 40-Lead (5mm × 8mm) QFN with High Voltage Pin Spacing

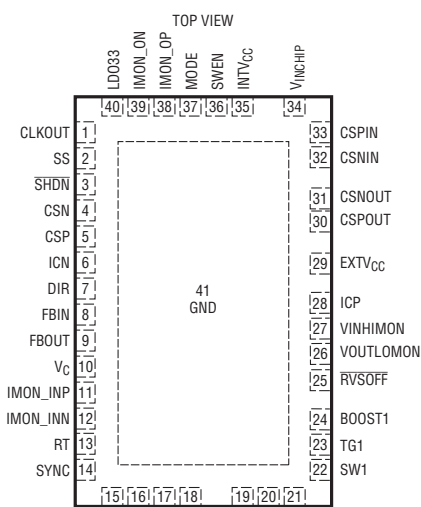
APPLICATIONS

- High Voltage Buck-Boost Converters
- Bidirectional Charging System
- Automotive 48V Systems

DESCRIPTION

The LT8708 is a high performance buck-boost switching regulator controller that operates from an input voltage that can be above, below or equal to the output voltage. Features are included to simplify bidirectional power conversion in battery/capacitor backup systems and other applications that may need regulation of V_{OUT} , V_{IN} , I_{OUT} , and/or I_{IN} . Forward and reverse current can be monitored and limited for the input and output sides of the converter. All four current limits (forward input, reverse input, forward output and reverse output) can be set independently using four resistors on the PCB.

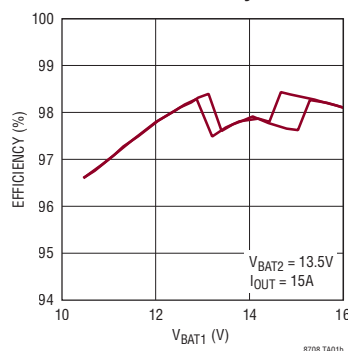
The MODE pin can select between discontinuous conduction mode (DCM), continuous conduction mode (CCM), hybrid conduction mode (HCM) and Burst Mode operation. In combination with the DIR (direction) pin, the chip can be configured to process power only from V_{IN} to V_{OUT} or only from V_{OUT} to V_{IN} . With a wide 2.8V to 80V input and 1.3V to 80V output range, the LT8708 is compatible with most solar, automotive, telecom and battery-powered systems.



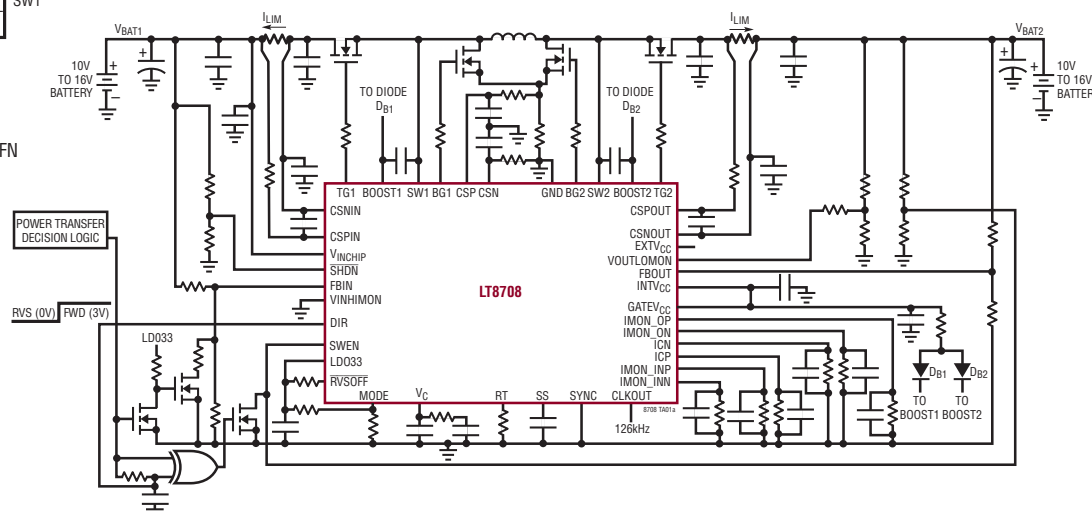
UHG PACKAGE
40-LEAD (5mm × 8mm) PLASTIC QFN

LT8708EUHG
LT8708IUHG
LT8708HUHG

Efficiency



12V Bidirectional Dual Battery System with FHCM and RHCM



LT8701-1

80V Synchronous 4-Switch Buck-Boost DC/DC Slave Controller for LT8708 Multiphase System

FEATURES

- Slave Chip of LT8708 to Deliver Additional Power
- Good Current Matching to the Average Output Current of LT8708 Through Current Regulation
- Easily Paralleled with LT8708 Through Four Pins
- Synchronized Start-Up with LT8708
- Same Conduction Modes as LT8708
- Synchronous Rectification: Up to 98% Efficiency
- Frequency Range: 100kHz to 400kHz
- Available in 40-Lead (5mm × 8mm) QFN with High Voltage Pin Spacing

APPLICATIONS

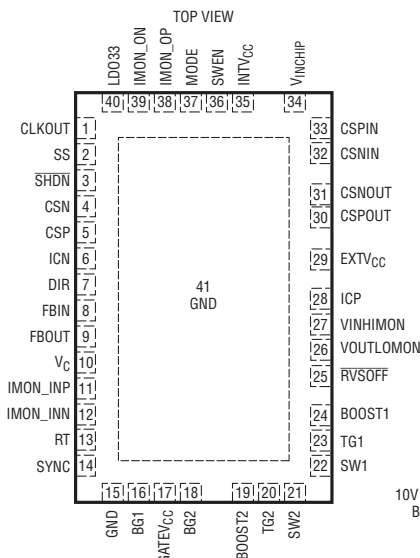
- High Voltage Buck-Boost Converters
- Bidirectional Charging Systems
- Automotive 48V Systems

DESCRIPTION

The LT8708-1 is a high performance buck-boost switching regulator controller that is paralleled with the LT8708 to add power and phases to an LT8708 system. The LT8708-1 always operates as a slave to the master LT8708 and has the capability of delivering as much current or power as the master. One or more slaves can be connected to a single master, proportionally increasing power and current capability of the system.

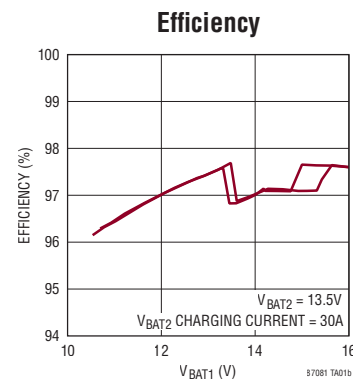
The LT8708-1 has the same conduction modes as LT8708, allowing the LT8708-1 to conduct current and power in the same direction(s) as the master. The master controls the overall current and voltage limits for an LT8708 multiphase system, and the slaves comply with these limits.

LT8708-1s can be easily paralleled with the LT8708 by connecting four signals together. Two additional current limits (forward V_{IN} current and reverse V_{IN} current) are available on each slave that can be set independently.

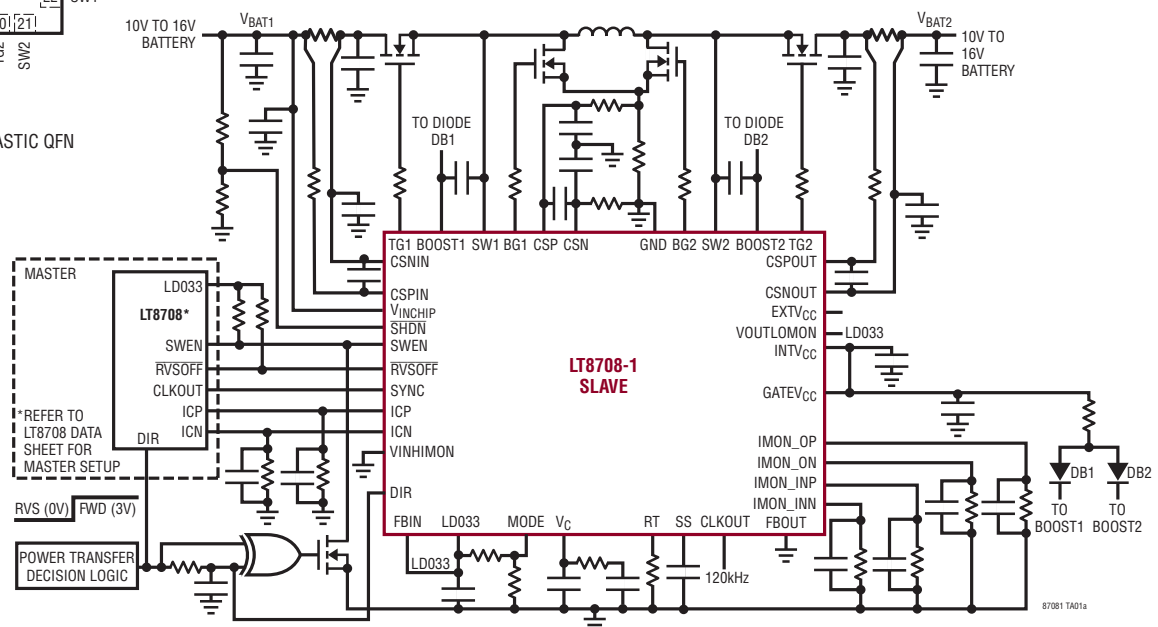


UHG PACKAGE
40-LEAD (5mm × 8mm) PLASTIC QFN

LT8708EUHG-1
LT8708IUHG-1
LT8708HUHG-1



The LT8708-1 2-Phase 12V Bidirectional Dual Battery System with FHCM and RHCM



ADM1266 Cascadable Super Sequencer with Margin Control and Fault Recording

FEATURES

- Complete Supervisory and Sequencing Solution for Up to 17 Supplies
 - Expandable to 257 Supplies with Additional ADM1266 ICs Connected to the 2-Wire Interdevice Bus
 - Fully Programmable Sequencing Engine
- 17 Supply Fault Detectors Enable Real Time Supervision of Supplies
 - 0.4 V to 15 V on VH1 to VH4 (VHx)
 - 0.4 V to 5 V on VP1 to VP13 (VPx)
 - Device Powered by the Higher of VH1 and VH2 Inputs for Improved Operating Redundancy
 - 12-Bit ADC for Readback of all Supervised Voltages
- Black Box Nonvolatile Fault Recording
- 16 PDIOs
- 9 GPIOs
- 9 Voltage Output 8-Bit DACs Allow Voltage Margining Adjustment via DC-to-DC Converter Trim/Feedback Node
- Main and Backup Memory Industry Standard PMBus Interface Compliant
- Available in a 9 mm × 9 mm, 64-Lead Package

APPLICATIONS

- Communications Infrastructure
- Industrial Test and Measurement

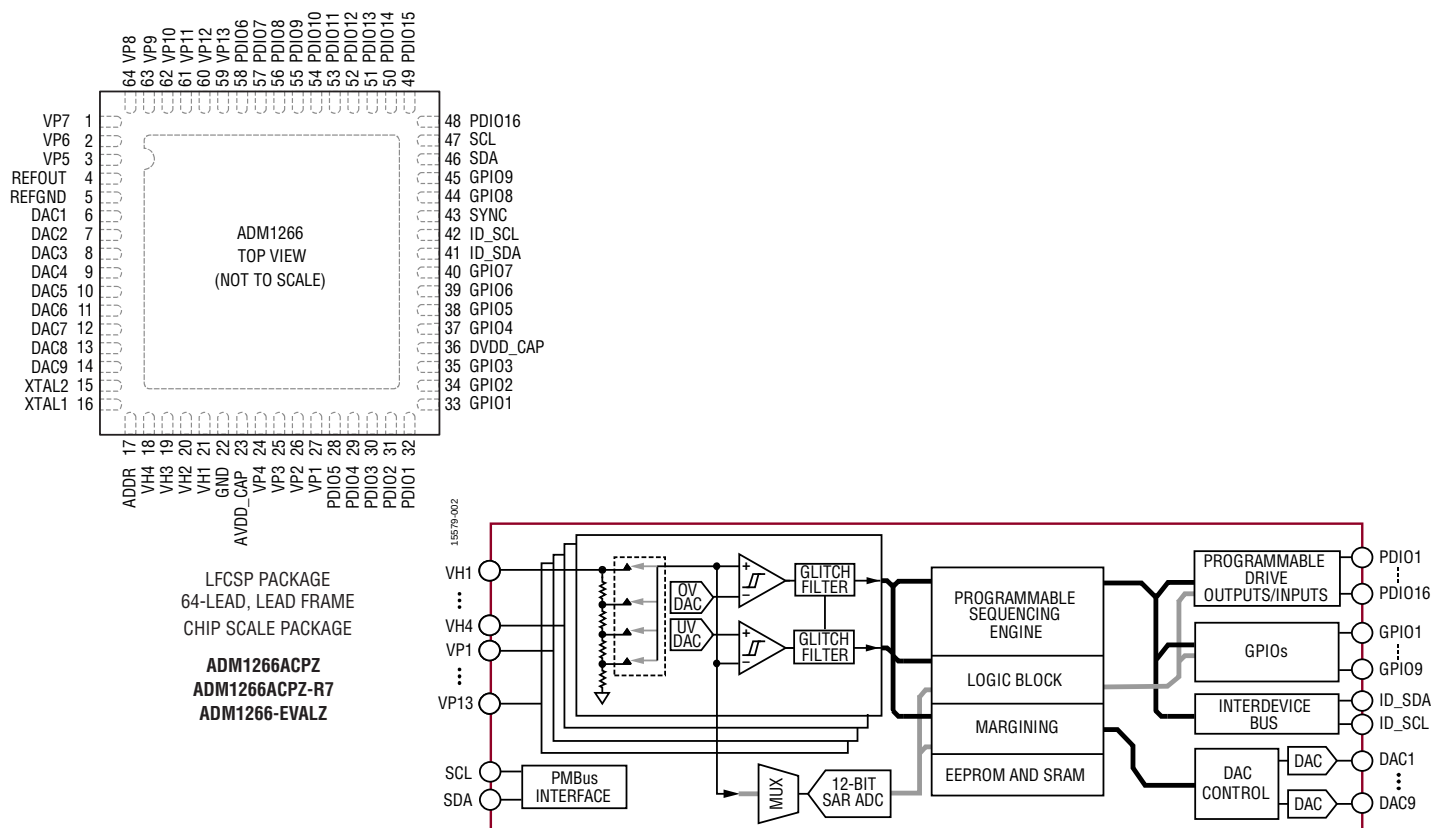
DESCRIPTION

The ADM1266 Super Sequencer® is a configurable supervisory/sequencing device that offers a single-chip solution for supply monitoring and sequencing in systems with up to 17 supplies. For systems with more supplies (up to 257), the operation of up to 16 ADM1266 devices can be synchronized through a proprietary 2-wire interface (interdevice bus).

The sequencing engine (SE) monitors the supply fault detectors (SFDs), programmable driver input/outputs (PDIOs), general-purpose inputs/outputs (GPIOs), and timers, and controls the PDIOs and GPIOs to sequence the supplies up and down as required. The logical core of the device is an ARM® Cortex-M3 microcontroller. The firmware is supplied by Analog Devices, Inc., and all configuration is performed through an intuitive graphic user interface (GUI).

Additionally, the ADM1266 integrates an analog-to-digital converter (ADC) and voltage output digital-to-analog converters (DACs) that can be used to adjust either the feedback node or reference of a DC-to-DC converter to implement a closed-loop, autonomous, margining system.

A block of nonvolatile EEPROM is available to record voltage, time, and fault information when instructed to by the sequencing engine configuration.



LTC2962/LTC2963/LTC2964

±0.5% Accurate Quad Configurable Supervisor

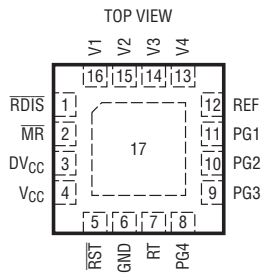
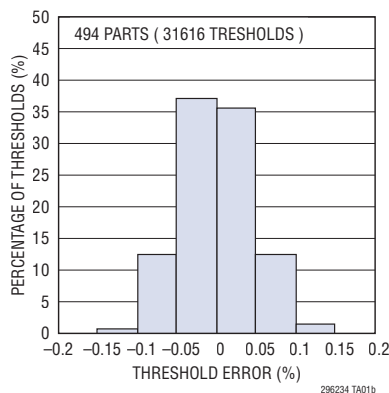
FEATURES

- **Simultaneously Monitor Four Power Supplies**
- **±0.5% Threshold Accuracy Over Temperature**
- **Selectable –4% and –6% Thresholds per Supply: 5V, 3.3V, 2.5V, 1.8V, 1.5V, 1.2V, 1V and ±ADJ**
- Adjustable Reset ($\overline{\text{RST}}$) Timeout
- Overvoltage and Negative Voltage Monitoring
- Push-Pull or Open-Drain $\overline{\text{RST}}$ Output
- Margin Pin RDIS for Reset Disable
- H-Grade Temperature Range
- LTC2963
 - Non-Windowed (-1) Watchdog
 - Adjustable Watchdog Timer
 - Watchdog Status Output WDO
 - Selectable Initial Watchdog Timeout
- LTC2964
 - Individual Comparator Open-Drain Outputs
- 16-Lead 3mm × 3mm QFN (LTC2962)
- 20-Lead 3mm × 4mm QFN (LTC2963, LTC2964)

APPLICATIONS

- High Reliability Systems
- Network, Telecom and Server Systems
- Automotive Control Systems

Typical Distribution of Monitor Threshold Error



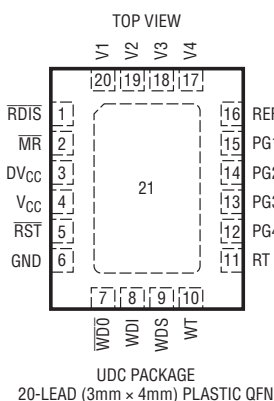
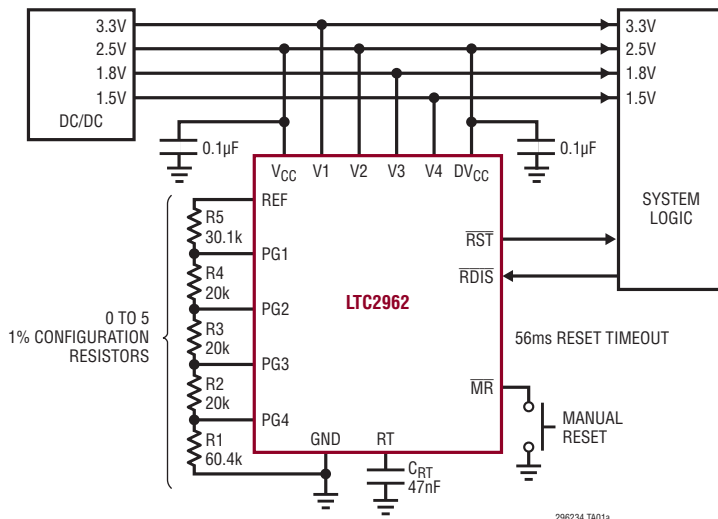
LTC2962CUD
LTC2962IUD
LTC2962HUD

DESCRIPTION

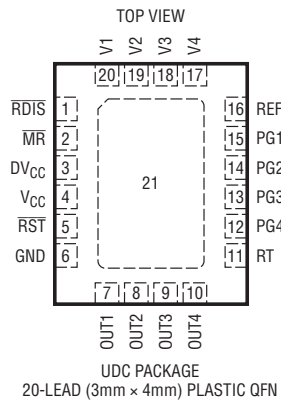
The LTC2962 series of configurable power supply monitors can supervise systems with up to four supply voltages. One of 16 preset or adjustable voltage monitor thresholds per channel can be selected using external 1% resistors connected to the programming (PG) inputs. The preset voltage thresholds are accurate to ±0.5% over temperature. Positive (+ADJ) and negative (–ADJ) adjustable inputs with a 0.5V threshold allow undervoltage, negative voltage and overvoltage monitoring.

The watchdog (LTC2963 only) and reset timeout periods are adjustable using external capacitors. Accurate voltage thresholds and comparator glitch immunity ensure reliable reset operation without false triggering. The $\overline{\text{RST}}$ output is guaranteed to be in the correct state for V_{CC} input voltage down to 1V.

The flexibility of the LTC2962 family provides the ability to monitor a wide variety of power supply combinations, including multiple supplies of the same voltage, with ±0.5% accuracy.



LTC2963CUDC-1
LTC2963IUDC-1
LTC2963HUDC-1



LTC2964CUDC
LTC2964IUDC
LTC2964HUDC

Design Note

High Efficiency 20A Monolithic Silent Switcher®2 Regulator for SoC and μ P Applications

Zhongming Ye

Power budgets continually rise for advanced SoC (system on chip) solutions used in industrial and automotive systems. Each successive SoC generation adds power hungry devices and increases data processing speed. These devices require reliable power, including 0.8V for cores, 1.2V and 1.1V for DDR3 and LPDDR4, and 5V, 3.3V and 1.8V for peripheral and auxiliary components. Moreover, advanced SoCs require higher performance than traditional PWM controllers and MOSFETs can provide. As a result, the solutions necessary must be more compact, with higher current capability, higher efficiency, and more importantly, superior EMI performance. This is where our Power by Linear™ Monolithic Silent Switcher 2 buck regulators can satisfy advanced SoC power budgets while meeting SoC size and thermal constraints.

20A Solution from 20V Input for an SoC

The LTC®7150S raises the bar for high performance in industrial and automotive power supplies. It features high efficiency, small form factor and low EMI. Integrated high performance MOSFETs and thermal management features enable reliable and continuous delivery of currents up to 20A from input voltages up to 20V without heat sinking or airflow, making it ideal for SoCs, FPGA, DSP, GPU and μ Ps in industrial, transportation and automotive applications.

Figure 1 shows a 1.2V output at 20A solution for SoC and CPU power using the LTC7150S switching at 1MHz. This circuit can be easily modified to accommodate other output combinations, including 3.3V, 1.8V, 1.1V and 0.6V to take advantage of the wide input range of the LTC7150S. The LTC7150S has the output current capability to act as a first stage 5V supply, which can be followed by a number of downstream second-stage switching or LDO regulators at various outputs.

Silent Switcher 2 with Excellent EMI Performance

Passing EMI regulations at high currents typically involves a complicated design and test challenge, including numerous trade-offs in solution size, efficiency, reliability and complexity. Traditional approaches control EMI by slowing down the MOSFET switching edge rates and/or lowering switching frequency. Both of these strategies come with trade-offs, such as reduced efficiency, increased minimum on- and off-times and larger solution size. Alternative mitigation techniques, such as a complicated bulky EMI filter or metal shielding, add significant costs in board space, components and assembly, while complicating thermal management and testing.

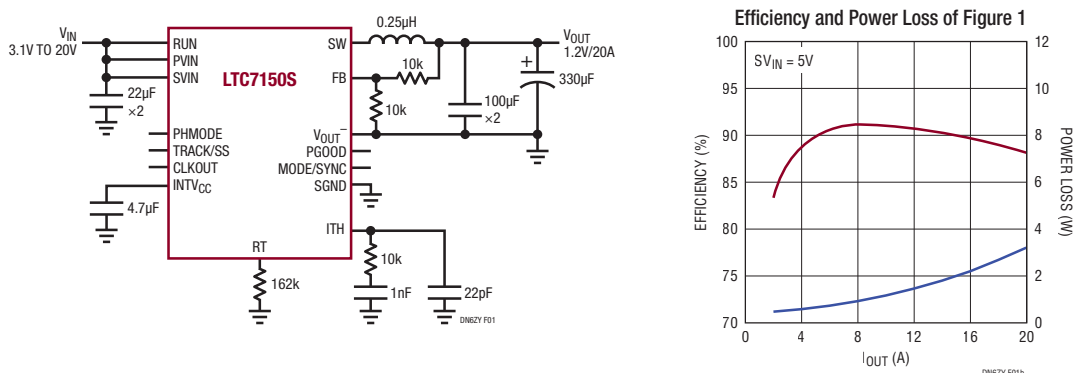


Figure 1. Schematic and Efficiency of the Buck Converter: 12V_{IN} to 1.2V_{OUT} at 20A

Analog Devices' proprietary Silent Switcher 2 architecture self-cancels EMI via integrated hot loop capacitors, minimizing noisy antenna size. This, combined with integrated MOSFETs, significantly reduces switching node ringing and associated energy stored in the hot loop, even with very fast switching edges. The result is exceptional EMI performance while minimizing the AC switching losses. Silent Switcher 2 is incorporated in the **LTC7150S** to minimize EMI and deliver high efficiency, greatly simplifying EMI filter design and layout, ideal for noise-sensitive environments. LTC7150S passes the CISPR22/32 conducted and radiated EMI peak limits with only a simple EMI filter in front. Figure 2b shows the radiated EMI CISPR22 test result.

High Frequency, High Efficiency Fits Tight Space

Integrated MOSFETs, integrated hot-loop decoupling capacitors, built-in compensation circuit—all take the design complexity out of the system and minimize total solution size with circuitry simplicity and Silent Switcher 2 architecture. Thanks to high-performance power conversion, LTC7150S delivers high current without the

need for additional heat sinks or airflow. Unlike most solutions, both low EMI and high efficiency can be achieved at high frequency operation, ensuring small passive component size. Figure 3 shows a 2MHz solution, which uses a small 72nH inductor and all ceramic capacitors in a very low profile solution for FPGA and μ P applications.

Conclusion

The demand for more intelligence, automation, and sensing in industrial and automotive environments is resulting in a proliferation of electronic systems that require increasingly high performance power supplies. Low EMI has risen from an afterthought to a key power supply requirement—in addition to solution size, high efficiency, thermal efficiency, robustness, and ease-of-use. The LTC7150S meets stringent EMI demands in a compact footprint by incorporating Silent Switcher 2 technology. Integrated MOSFETs and thermal management features enable robust and reliable delivery of currents up to 20A continuously from input ranges up to 20V, with switching frequency as high as 3MHz.

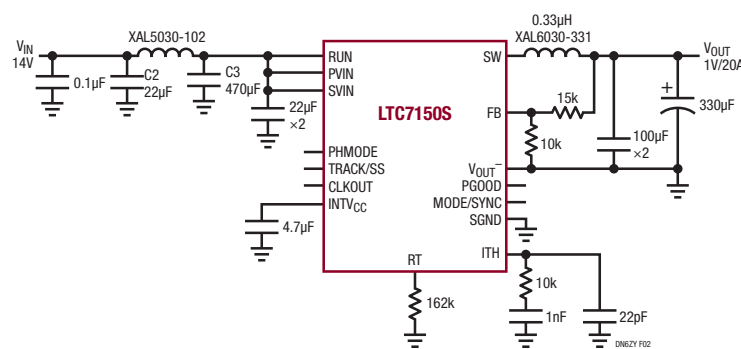


Figure 2(a) $V_{IN} = 14V$, $V_{OUT} = 1V$, 20A. $f_{SW} = 400kHz$

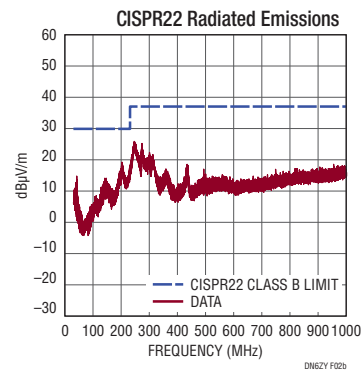


Figure 2(b) Radiated EMI Performance of Figure 2a

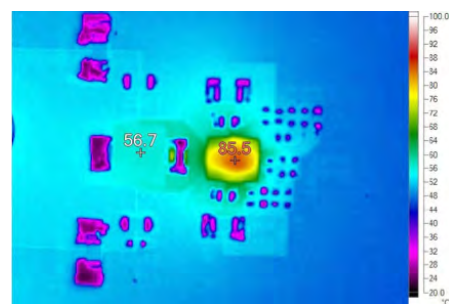
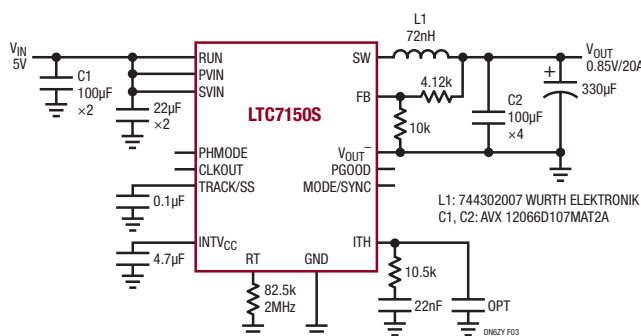


Figure 3. LTC7150S Schematic and Thermal Image for 5V Input to 0.85V/20A Output with $f_{SW} = 2MHz$

Data Sheet Download
www.analog.com/LTC7150S

Design Note

42V Monolithic Synchronous Step-Down Regulators with 2.5μA Quiescent Current and Ultralow EMI

Dong Wang

Introduction

High efficiency, low EMI step-down regulators are found throughout automotive, industrial, medical and telecom environments, where they power a wide variety of applications from a broad array of input sources. Particularly in battery powered applications, a significant amount of time is spent in standby mode, requiring all electrical circuits to operate with a low quiescent current in order to preserve battery run times.

The LT8606/LT8607/LT8608 are a series of monolithic step-down regulators optimized for applications with a wide input voltage range, low EMI levels and small solution sizes. All share the same thermally enhanced 10-lead MSE package and 8-pin 2mm × 2mm DFN package, enabling them to fit into tight spaces. They differ in their output current capabilities, as shown in Table 1.

The low I_Q of the LT8606/LT8607/LT8608 is indispensable in battery-powered applications where idle current must be kept low. They feature a Burst Mode® option, which consumes only 2.5μA quiescent current from the input source even while regulating the output voltage, maintaining battery standby time for as long as possible. The 3V~42V wide input voltage range satisfies the demanding

requirements of industrial and automotive applications, which are distinguished by their lack of stable, high quality voltage sources. The devices come in the 10-lead MSE package and also include spread spectrum operation to meet ultralow EMI emission requirements.

Table 1.

Part#	Current Level	Package	Operation Mode
LT8606	350mA	MSE-10	Burst Mode Operation Pulse-Skipping Mode Spread Spectrum Mode Sync Mode
		DFN-8	Burst Mode Operation Only
LT8607	750mA	MSE-10	Burst Mode Operation Pulse-Skipping Mode Spread Spectrum Mode Sync Mode
		DFN-8	Burst Mode Operation Only
LT8608	1.5A	MSE-10	Burst Mode Operation Pulse-Skipping Mode Spread Spectrum Mode Sync Mode
		DFN-8	Burst Mode Operation Only

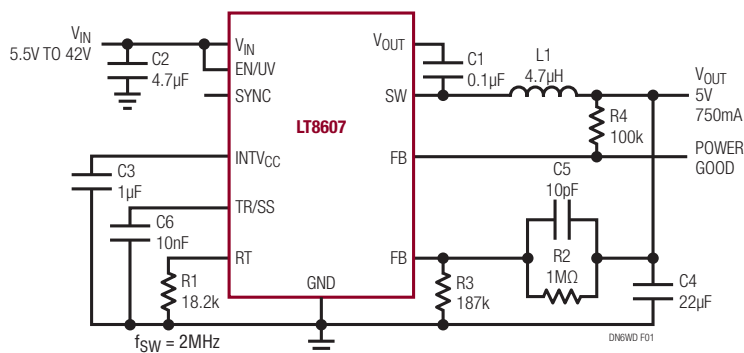


Figure 1. High Efficiency LT8607 12V to 5V Synchronous Step-Down Converter

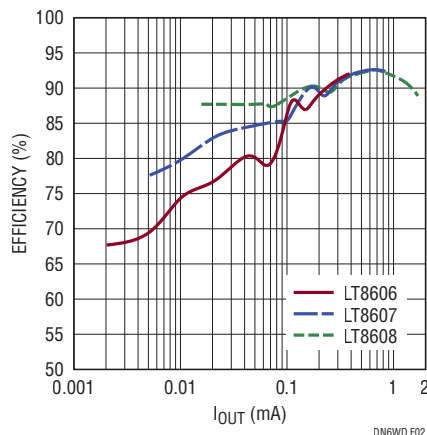


Figure 2. Efficiency vs. Load Current for LT8606/LT8607/LT8608 Based 12V_{IN} to 5V_{OUT} Step-Down Converter

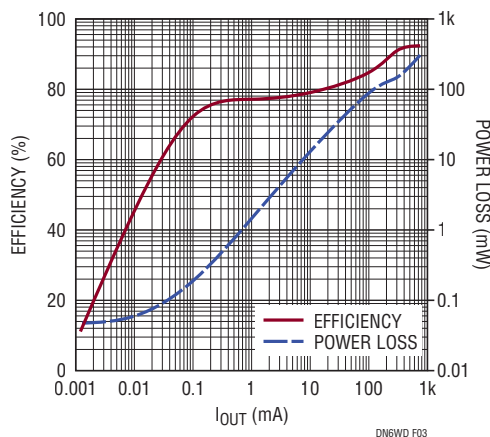


Figure 3. Efficiency and Power Loss vs Load Current for the Circuit in Figure 1

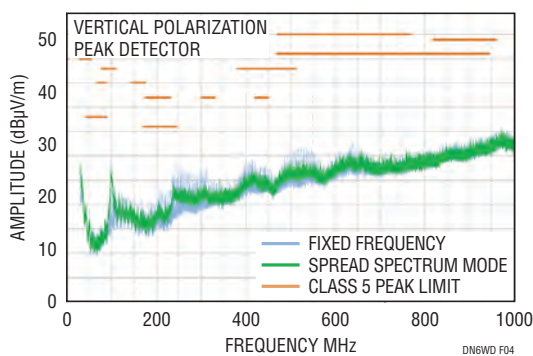


Figure 4. CISPR25 Radiated EMI Performance for the Circuit in Figure 1

Data Sheet Download
www.analog.com/LT8607

Circuit Description and Functionality

Figure 1 shows a 5V output power supply based on the 10-lead LT8607 regulator. The input voltage extends up to 42V and the output is set to 5V at 750mA with 2MHz switching frequency. Only a few additional components are required for the complete solution, including inductor L1 and a few passive components. Figure 2 shows that this circuit can achieve 92.5% peak efficiency.

Burst Mode Operation Improves Light Load Efficiency

During light load operation and no-load standby mode, high efficiency and low idle current are very important for battery powered applications. The LT8606/LT8607/LT8608's 2.5μA quiescent current and Burst Mode operation option are perfect solution for these requirements. During light load and no-load conditions, an LT8606/LT8607/LT8608-based converter gradually reduces the switching frequency, which reduces switching power losses while maintaining low output voltage ripple. Figure 3 shows the light load efficiency of the solution shown in Figure 1.

High Switching Frequency with Ultralow EMI Emission

In addition to efficiency, EMI/EMC compliance is demanded in automotive, industrial, computational and telecom environments. A higher switching frequency allows a smaller solution size but often at the cost of increased EMI emission. The LT8606/LT8607/LT8608's integrated MOSFETs, built-in compensation circuit and 2.2MHz operation minimize solution size, but they also achieve excellent EMI performance, due to advanced process technology. Spread spectrum mode operation of the switching frequency can further reduce EMI emissions. Figure 4 shows the CISPR25 EMI test result of the solution shown in Figure 1.

Conclusion

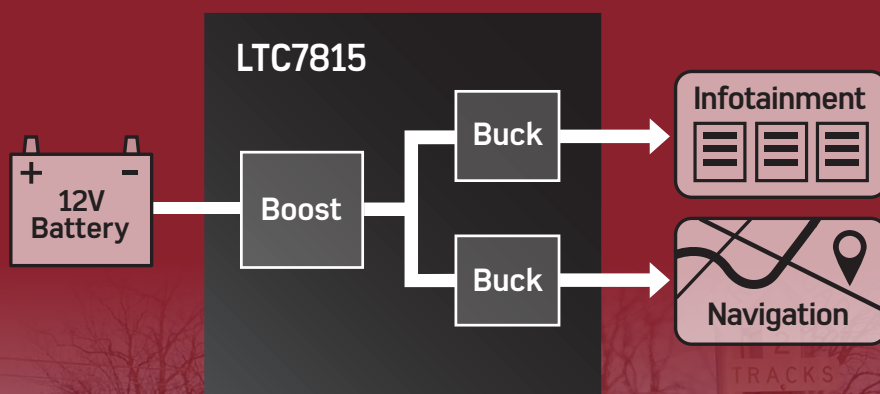
The LT8606/LT8607/LT8608 are easy-to-use monolithic step-down regulators with integrated power MOSFETs and built-in compensation. They are optimized for applications with wide input voltage ranges and low EMI noise requirements. Their 2.5μA quiescent current and Burst Mode operation option makes them ideal solutions for battery powered step-down converters, significantly extending battery standby times. The 200kHz to 2.2MHz switching frequency range makes them suitable for most low power to micropower applications. Integrated MOSFETs, together with up to 2.2MHz switching frequency ability greatly minimize the total solution size. CISPR25 scanning results show their excellent radiated EMI performance, making them compliant with most stringent EMI standards.

38V TRIPLE CONTROLLER FOR AUTO START/STOP

LTC7815

KEEPS NAV SYSTEMS
FROM RESETTING DURING
ENGINE START/STOP

- ▶ Dual Buck Plus Single Boost Synchronous Controllers
 - ▶ V_{IN} Range: 4.5V to 38V
 - ▶ Outputs Remain in Regulation Through Engine Restart Down to 2.5V
 - ▶ For 60V_{IN} Use LTC3899
 - ▶ Low Operating I_Q : 28 μ A
 - ▶ Up to 2.25MHz Operation



ANALOG



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