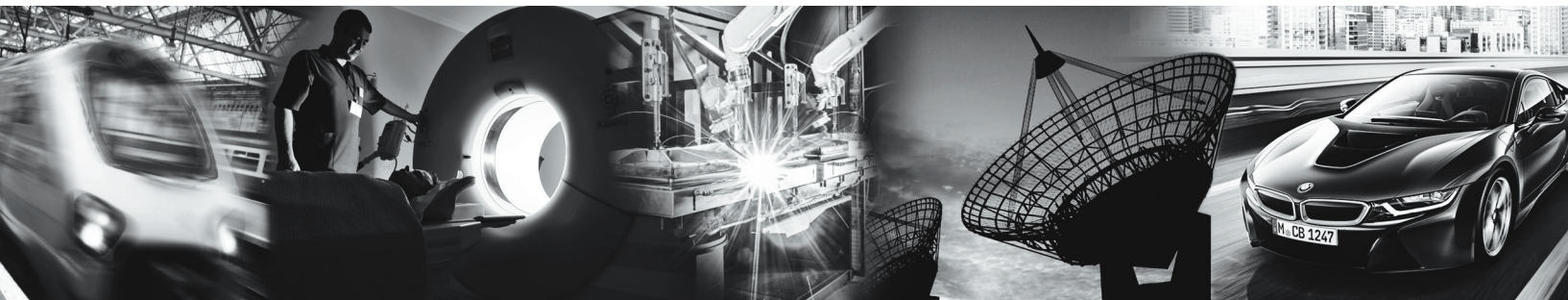


September 2017

New Products Catalog

High Performance Analog ICs



LTC2333-16 Buffered 8-Channel, 16-Bit, 800ksps Differential $\pm 10.24\text{V}$ ADC with $30\text{V}_{\text{p-p}}$ Common Mode Range

LTC7001 Fast 150V High Side NMOS Static Switch Driver

LTC5552 3GHz to 20GHz Microwave Mixer with Wideband DC to 6GHz IF

LT3932 36V, 2A Synchronous Step-Down LED Driver

LTC7103 105V, 2.3A Low EMI Synchronous Step-Down Regulator

LTC7801 150V Low I_{Q} , Synchronous Step-Down DC/DC Controller



NOW PART OF



Amplifiers

LT®1210X High Temperature 1.0A, 35MHz Current Feedback Amplifier	1
LT6203X High Temperature 175°C Dual 100MHz, Rail-to-Rail Input and Output, Ultralow 1.9nV/√Hz Noise, Low Power Op Amp	2

Battery Charger

LT®4091 36V Battery Charger and Power Backup Manager	3
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Data Converters

LTC2324-12 Quad, 12-Bit + Sign, 2Msps/Ch Simultaneous Sampling ADC	4
LTC2324-14 Quad, 14-Bit + Sign, 2Msps/Ch Simultaneous Sampling ADC	5
LTC2324-16 Quad, 16-Bit, 2Msps/Ch Simultaneous Sampling ADC	6
LTC2333-16 Buffered 8-Channel, 16-Bit, 800ksps Differential ±10.24V ADC with 30V _{P-P} Common Mode Range	7

FET Drivers

LTC7001 Fast 150V High Side NMOS Static Switch Driver	9
LTC7003 Fast 60V Protected High Side NMOS Static Switch Driver	10
LTC7004 Fast 60V High Side NMOS Static Switch Driver	11

High Frequency

LTC5552 3GHz to 20GHz Microwave Mixer with Wideband DC to 6GHz IF	12
---	----

Interface

LTC2862A ±60V Fault Protected 3V to 5.5V RS485/RS422 Transceiver with Level 4 IEC ESD	14
---	----

LED Driver

LT3932 36V, 2A Synchronous Step-Down LED Driver	15
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µModule® Regulators

LTM®4622A Dual Ultrathin 2A or Single 4A Step-Down DC/DC µModule Regulator	18
--	----

Switching Regulators—Monolithic

LTC3636/LTC3636-1 Dual Channel 6A, 20V Monolithic Synchronous Step-Down Regulator	20
LTC7103 105V, 2.3A Low EMI Synchronous Step-Down Regulator	21
LTC7124 17V, Dual 3.5A Synchronous Step-Down Regulator with Ultralow Quiescent Current	22
LTC7150S 20V, 20A Synchronous Step-Down Regulator	23

Switching Regulators—Controllers

LTC7800 Low I_Q , 60V, High Frequency Synchronous Step-Down Controller	24
LTC7801 150V Low I_Q , Synchronous Step-Down DC/DC Controller	25
LT8390A 60V 2MHz Synchronous 4-Switch Buck-Boost Controller with Spread Spectrum	26

Design Notes

DN564 Lower Power Op Amp: Utility Sine Wave

DN565 Simple Power Backup Supply for a 3.3V Rail

LT1210X

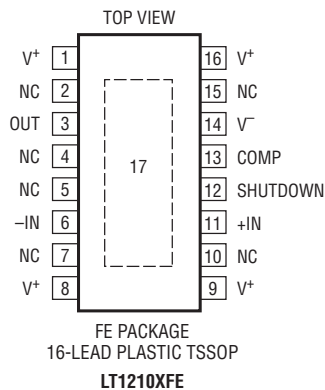
High Temperature 1.0A, 35MHz Current Feedback Amplifier

FEATURES

- **Extreme High Temperature Operation: -40°C to 175°C**
- **1.0A Minimum Output Drive Current**
- **35MHz Bandwidth, $A_V = 2$, $R_L = 10\Omega$**
- **900V/ μs Slew Rate, $A_V = 2$, $R_L = 10\Omega$**
- High Input Impedance: $10\text{M}\Omega$
- Wide Supply Range: $\pm 5\text{V}$ to $\pm 15\text{V}$
- Shutdown Mode: $I_S < 200\mu\text{A}$
- Adjustable Supply Current
- Stable with $C_L = 10,000\text{pF}$
- Available as Dice
- Available in 16-Lead Thermally Enhanced TSSOP Package

APPLICATIONS

- Down-Hole Drilling and Instrumentation
- Heavy Industrial
- Avionics
- High Temperature Environments
- Cable Drivers
- Buffers
- Test Equipment Amplifiers
- Video Amplifiers
- ADSL Drivers



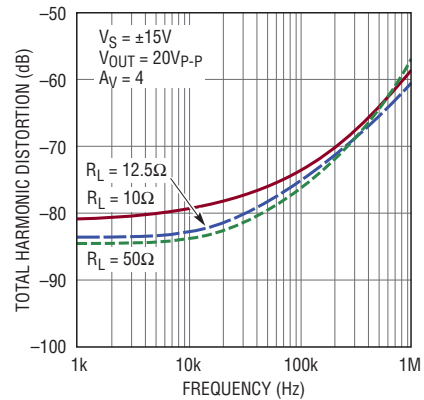
DESCRIPTION

The LT1210X is a current feedback amplifier with high output current and excellent large-signal characteristics. The combination of high slew rate, 1.0A output drive and $\pm 15\text{V}$ operation, enables the device to deliver significant power at frequencies in the 1MHz to 2MHz range. Short-circuit protection ensures the device's ruggedness. The LT1210X is stable with large capacitive loads and can easily supply the large currents required by the capacitive loading. A shutdown feature switches the device into a high impedance and low supply current mode, reducing dissipation when the device is not in use. For lower bandwidth applications, the supply current can be reduced with a single external resistor.

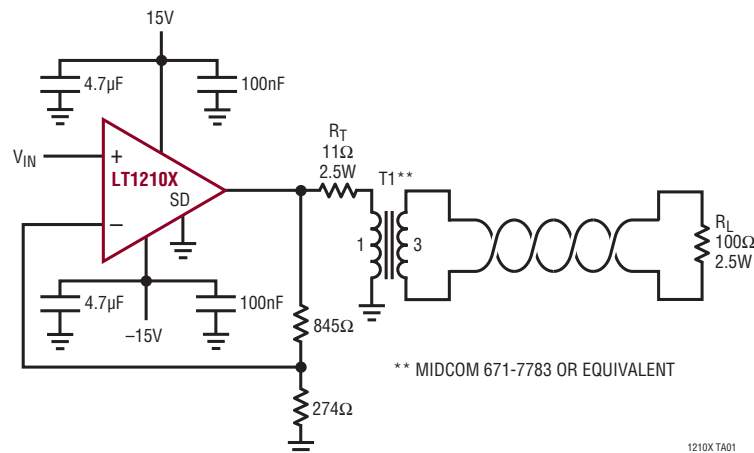
The LT1210X is a member of our growing series of high temperature qualified products. For a complete selection of high temperature products, please consult our website www.linear.com.

The LT1210X is available in the thermally enhanced TSSOP16-E package for operation with supplies from $\pm 5\text{V}$ up to $\pm 15\text{V}$. The LT1210X is also available as dice.

Total Harmonic Distortion vs Frequency



Twisted Pair Driver



LT6203X

High Temperature 175°C Dual 100MHz, Rail-to-Rail Input and Output, Ultralow 1.9nV/ $\sqrt{\text{Hz}}$ Noise, Low Power Op Amp

FEATURES

- **Extreme High Temperature Operation: -40°C to 175°C**
- **Low Noise Voltage: 1.9nV/ $\sqrt{\text{Hz}}$ (100kHz)**
- **Low Supply Current: 3mA/Amp Max**
- **Gain-Bandwidth Product: 100MHz**
- Low Distortion: -80dB at 1MHz
- Low Offset Voltage: 500 μV Max
- Wide Supply Range: 2.5V to 12.6V
- Inputs and Outputs Swing Rail-to-Rail
- Common Mode Rejection Ratio 90dB Typ
- Low Noise Current: 1.1pA/ $\sqrt{\text{Hz}}$
- Output Current: 30mA Min
- 8-Lead SO Package
- Available as Dice

APPLICATIONS

- Down-Hole Drilling and Instrumentation
- Heavy Industrial
- Avionics
- High Temperature Environments
- Low Noise, Low Power Signal Processing
- Active Filters
- Rail-to-Rail Buffer Amplifiers
- Driving A/D Converters
- DSL Receivers
- Battery-Powered/Battery-Backed Equipment

DESCRIPTION

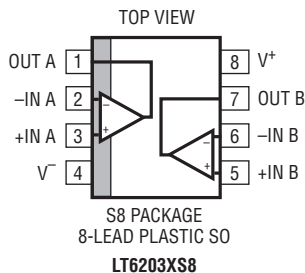
The LT6203X is a dual low noise, rail-to-rail input and output unity gain stable op amp that features 1.9nV/ $\sqrt{\text{Hz}}$ noise voltage and draws only 2.5mA of supply current per amplifier. These amplifiers combine very low noise and supply current with a 100MHz gain-bandwidth product, a 25V/ μs slew rate, and are optimized for low supply signal conditioning systems.

These amplifiers maintain their performance for supplies from 2.5V to 12.6V and are specified at 3V, 5V and $\pm 5\text{V}$ supplies. Harmonic distortion is less than -80dBc at 1MHz making these amplifiers suitable in low power data acquisition systems.

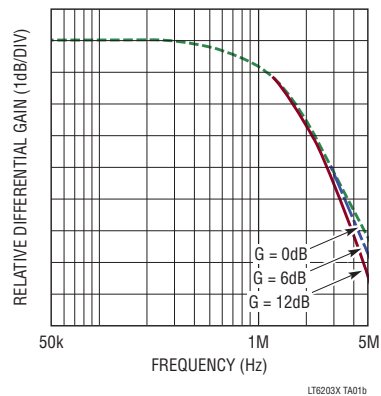
These devices can be used as plug-in replacements for many op amps to improve input/output range and noise performance.

The LT6203X is a member of our growing series of high temperature qualified products. For a complete selection of high temperature products, please consult our website www.linear.com.

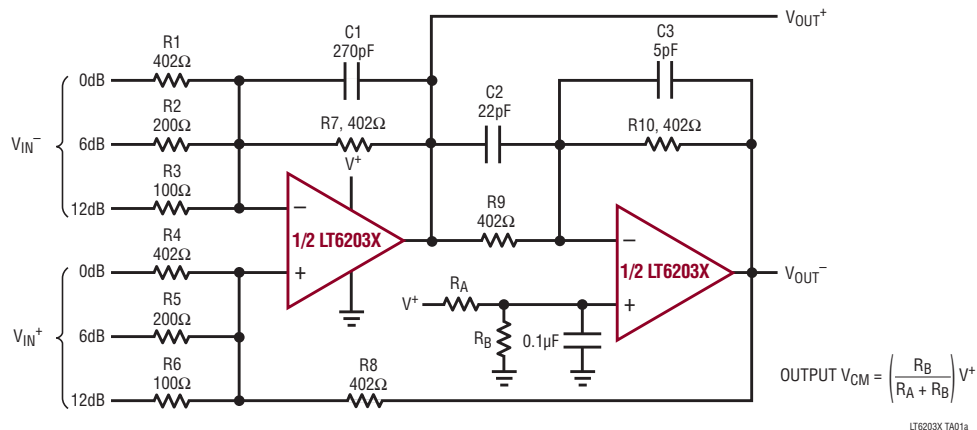
The LT6203X comes in an 8-lead SO package with standard dual op amp pinout. The LT6203X is also available as dice.



Low Noise Differential Amplifier Frequency Response



Low Noise Differential Amplifier with Gain Adjust and Common Mode Control



LTC4091

36V Battery Charger and Power Backup Manager

FEATURES

- Seamless Transition Between Primary Power Source and Li-Ion Battery
- 2A High Voltage Step-Down Regulator with Adaptive Output Control
- Internal 75mΩ Ideal Diode Plus Optional External Ideal Diode Controller Provides Low Loss PowerPath™ When Primary Supply Not Present
- Wide Input Voltage Range: 6V to 36V (60V Abs Max)
- 4.45V Max Output Voltage
- Full Featured Li-Ion Battery Charger
- Pin-Selectable 4.1V and 4.2V Charge Voltage Options
- Thermally Enhanced Low Profile (0.75mm) 6mm × 3mm 22-Lead DFN Package

APPLICATIONS

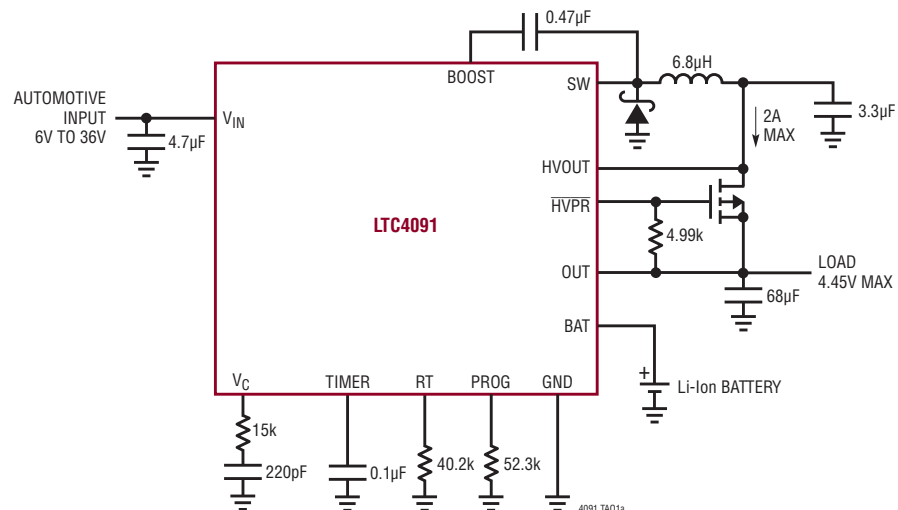
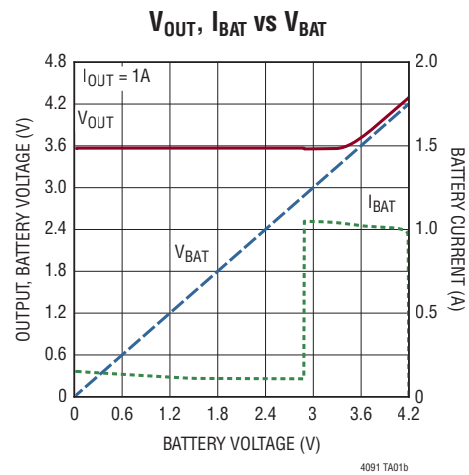
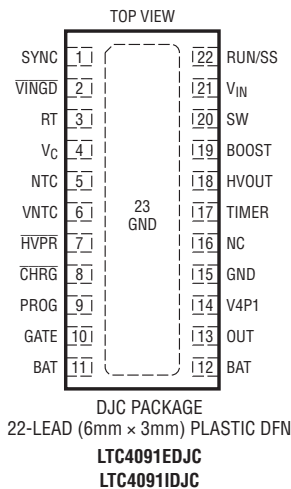
- Fleet and Asset Tracking
- Automotive GPS Data Loggers
- Automotive Telematics Systems
- Battery Backup Systems

DESCRIPTION

The LTC4091 is a 36V Li-Ion battery charger and power backup manager. The integrated step-down switching regulator charges a battery from a primary power source while providing power to the load. If primary power is lost, the load is seamlessly transitioned to the backup Li-Ion/polymer battery. To protect sensitive downstream loads, the maximum output voltage is 4.45V.

The LTC4091 provides an adaptive output that tracks the battery voltage for high efficiency charging. The charge current is programmable and an end-of-charge status output (CHRG) indicates full charge. Also featured is a termination timer and an NTC thermistor input used to monitor battery temperature while charging.

During backup, an internal 75mΩ ideal diode connects the battery to the load. An optional external ideal diode FET driver is available to reduce the voltage drop even further. 4.1V or 4.2V battery charge voltages can be selected.



LTC2324-12

Quad, 12-Bit + Sign, 2Msps/Ch Simultaneous Sampling ADC

FEATURES

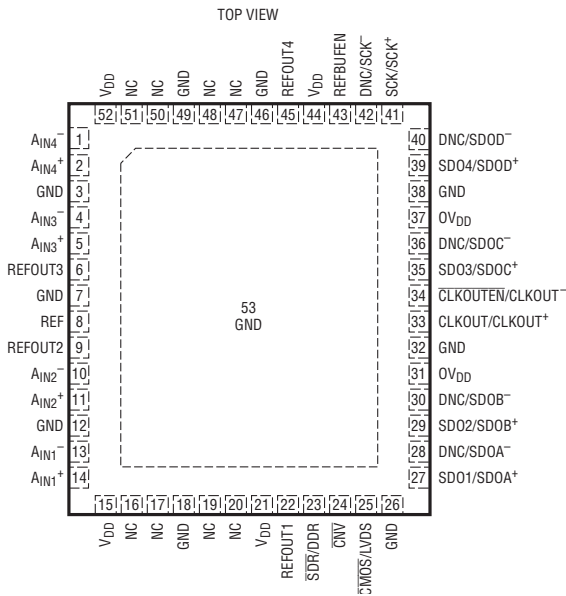
- 2Msps/Ch Throughput Rate
- Four Simultaneously Sampling Channels
- Guaranteed 12-Bit, No Missing Codes
- 8V_{P-P} Differential Inputs with Wide Input Common Mode Range
- 78dB SNR (Typ) at $f_{IN} = 500\text{kHz}$
- -88dB THD (Typ) at $f_{IN} = 500\text{kHz}$
- Guaranteed Operation to 125°C
- Single 3.3V or 5V Supply
- Low Drift (20ppm/°C Max) 2.048V or 4.096V Internal Reference
- 1.8V to 2.5V I/O Voltages
- CMOS or LVDS SPI-Compatible Serial I/O
- Power Dissipation 40mW/Ch (Typ)
- Small 52-Lead (7mm × 8mm) QFN Package

APPLICATIONS

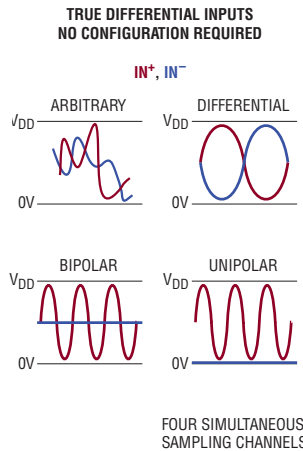
- High Speed Data Acquisition Systems
- Communications
- Optical Networking
- Multiphase Motor Control

DESCRIPTION

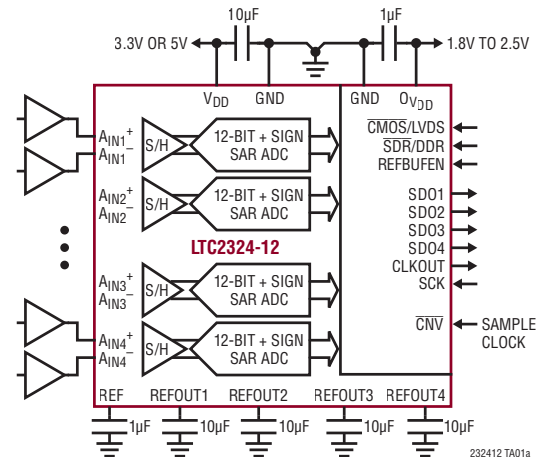
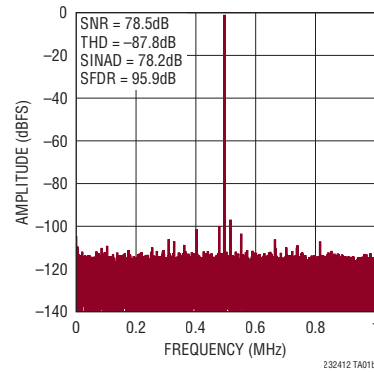
The LTC2324-12 is a low noise, high speed quad 12-bit + sign successive approximation register (SAR) ADC with differential inputs and wide input common mode range. Operating from a single 3.3V or 5V supply, the LTC2324-12 has an 8V_{P-P} differential input range, making it ideal for applications which require a wide dynamic range with high common mode rejection. The LTC2324-12 achieves ±0.5LSB INL typical, no missing codes at 12 bits and 78dB SNR. The LTC2324-12 has an onboard low drift (20ppm/°C max) 2.048V or 4.096V temperature-compensated reference. The LTC2324-12 also has a high speed SPI-compatible serial interface that supports CMOS or LVDS. The fast 2Msps per channel throughput with no latency makes the LTC2324-12 ideally suited for a wide variety of high speed applications. The LTC2324-12 dissipates only 40mW per channel and offers nap and sleep modes to reduce the power consumption to 26μW for further power savings during inactive periods.



UKG PACKAGE
52-LEAD (7mm × 8mm) PLASTIC QFN
LTC2324CUKG-12
LTC2324IUKG-12
LTC2324HUKG-12



32k Point FFT $f_{SAMPL} = 2\text{Msps}$, $f_{IN} = 500\text{kHz}$



LTC2324-14

Quad, 14-Bit + Sign, 2Msps/Ch Simultaneous Sampling ADC

FEATURES

- 2Msps/Ch Throughput Rate
- Four Simultaneously Sampling Channels
- Guaranteed 14-Bit, No Missing Codes
- 8V_{P-P} Differential Inputs with Wide Input Common Mode Range
- 81dB SNR (Typ) at $f_{IN} = 500\text{kHz}$
- -90dB THD (Typ) at $f_{IN} = 500\text{kHz}$
- Guaranteed Operation to 125°C
- Single 3.3V or 5V Supply
- Low Drift (20ppm/°C Max) 2.048V or 4.096V Internal Reference
- 1.8V to 2.5V I/O Voltages
- CMOS or LVDS SPI-Compatible Serial I/O
- Power Dissipation 40mW/Ch (Typ)
- Small 52-Lead (7mm x 8mm) QFN Package

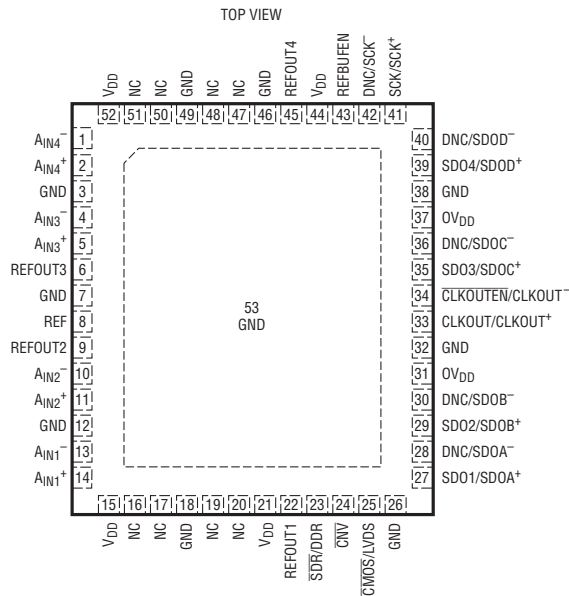
APPLICATIONS

- High Speed Data Acquisition Systems
- Communications
- Optical Networking
- Multiphase Motor Control

DESCRIPTION

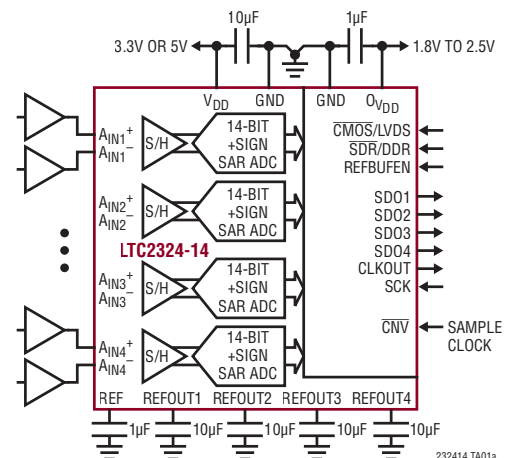
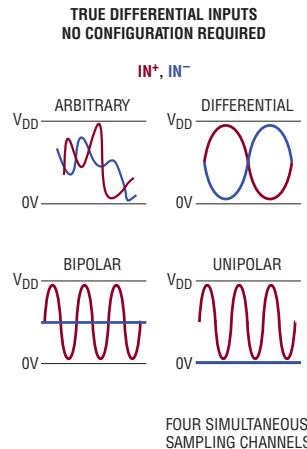
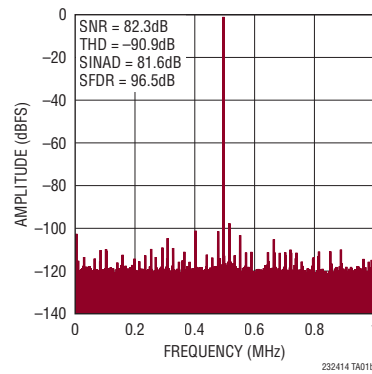
The LTC2324-14 is a low noise, high speed quad 14-bit + sign successive approximation register (SAR) ADC with differential inputs and wide input common mode range. Operating from a single 3.3V or 5V supply, the LTC2324-14 has an 8V_{P-P} differential input range, making it ideal for applications which require a wide dynamic range with high common mode rejection. The LTC2324-14 achieves $\pm 1\text{LSB}$ INL typical, no missing codes at 14 bits and 81dB SNR.

The LTC2324-14 has an onboard low drift (20ppm/°C max) 2.048V or 4.096V temperature-compensated reference. The LTC2324-14 also has a high speed SPI-compatible serial interface that supports CMOS or LVDS. The fast 2Msps per channel throughput with no latency makes the LTC2324-14 ideally suited for a wide variety of high speed applications. The LTC2324-14 dissipates only 40mW per channel and offers nap and sleep modes to reduce the power consumption to 26 μW for further power savings during inactive periods.



UKG PACKAGE
52-LEAD (7mm x 8mm) PLASTIC QFN
LTC2324CUKG-14
LTC2324IUKG-14
LTC2324HUKG-14

32k Point FFT $f_{\text{SMPL}} = 2\text{Msps}$, $f_{\text{IN}} = 500\text{kHz}$



LTC2324-16

Quad, 16-Bit, 2Msps/Ch Simultaneous Sampling ADC

FEATURES

- 2Msps/Ch Throughput Rate
- Four Simultaneously Sampling Channels
- Guaranteed 16-Bit, No Missing Codes
- 8V_{P-P} Differential Inputs with Wide Input Common Mode Range
- 82dB SNR (Typ) at $f_{IN} = 500\text{kHz}$
- -90dB THD (Typ) at $f_{IN} = 500\text{kHz}$
- Guaranteed Operation to 125°C
- Single 3.3V or 5V Supply
- Low Drift (20ppm/°C Max) 2.048V or 4.096V Internal Reference
- 1.8V to 2.5V I/O Voltages
- CMOS or LVDS SPI-Compatible Serial I/O
- Power Dissipation 40mW/Ch (Typ)
- Small 52-Lead (7mm × 8mm) QFN Package

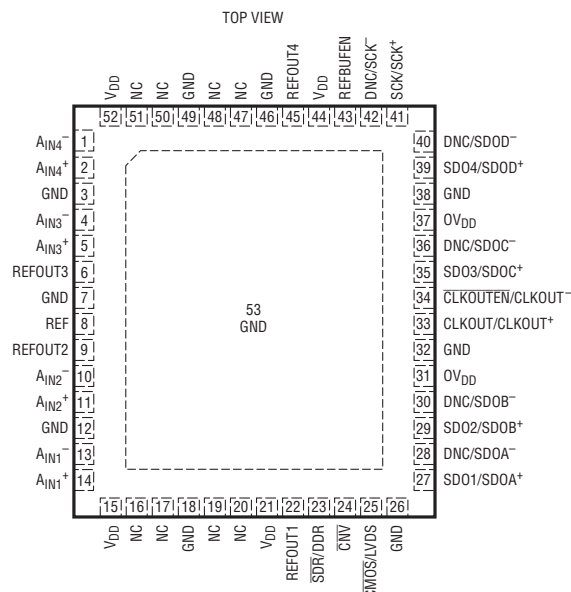
APPLICATIONS

- High Speed Data Acquisition Systems
- Communications
- Optical Networking
- Multiphase Motor Control

DESCRIPTION

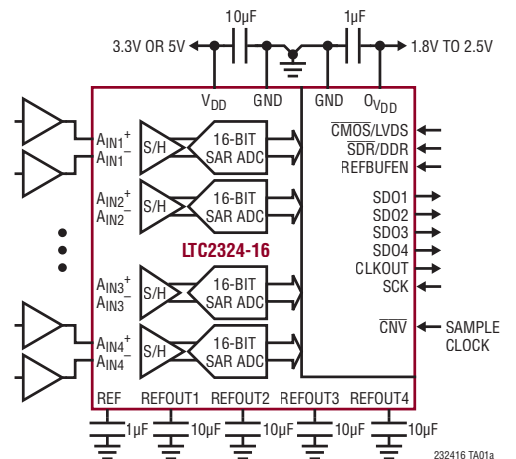
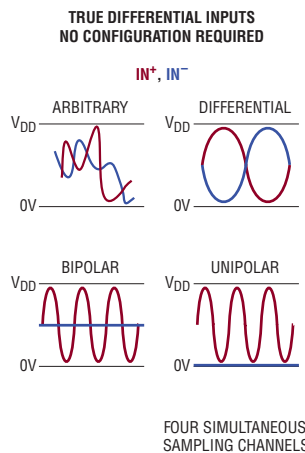
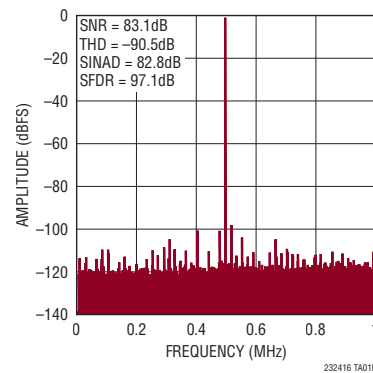
The LTC2324-16 is a low noise, high speed quad 16-bit successive approximation register (SAR) ADC with differential inputs and wide input common mode range. Operating from a single 3.3V or 5V supply, the LTC2324-16 has an 8V_{P-P} differential input range, making it ideal for applications which require a wide dynamic range with high common mode rejection. The LTC2324-16 achieves ±2LSB INL typical, no missing codes at 16 bits and 82dB SNR.

The LTC2324-16 has an onboard low drift (20ppm/°C max) 2.048V or 4.096V temperature-compensated reference. The LTC2324-16 also has a high speed SPI-compatible serial interface that supports CMOS or LVDS. The fast 2Msps per channel throughput with no latency makes the LTC2324-16 ideally suited for a wide variety of high speed applications. The LTC2324-16 dissipates only 40mW per channel and offers nap and sleep modes to reduce the power consumption to 26µW for further power savings during inactive periods.



UKG PACKAGE
52-LEAD (7mm × 8mm) PLASTIC QFN
LTC2324CUKG-16
LTC2324IUKG-16
LTC2324HUKG-16

32k Point FFT $f_{SAMPL} = 2\text{Msps}$, $f_{IN} = 500\text{kHz}$



LTC2333-16

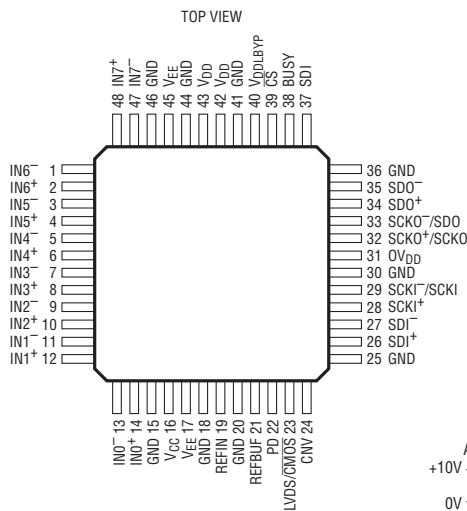
Buffered 8-Channel, 16-Bit, 800ksps Differential $\pm 10.24V$ ADC with $30V_{P-P}$ Common Mode Range

FEATURES

- Eight Buffered Multiplexed Channels
- 800ksps Throughput
- 500pA/12nA Maximum Input Leakage at 85°C/125°C
- ± 1 LSB INL (Maximum $\pm 10.24V$ Range)
- Guaranteed 16-Bit, No Missing Codes
- Differential, Wide Common Mode Range Inputs
- 8-Channel Multiplexer with SoftSpan™ Input Ranges:
 - $\pm 10.24V$, 0V to 10.24V, $\pm 5.12V$, 0V to 5.12V
 - $\pm 12.5V$, 0V to 12.5V, $\pm 6.25V$, 0V to 6.25V
- 94.2dB Single-Conversion SNR (Typical)
- -110 dB THD (Typical) at $f_{IN} = 2$ kHz
- 128dB CMRR, -125 dB Active Crosstalk (Typical)
- 420ns Step Response (Full-Scale, 0.005% Settling)
- Rail-to-Rail Input Overdrive Tolerance
- Programmable Sequencer with No Latency Control
- Integrated Reference and Buffer (4.096V)
- SPI CMOS (1.8V to 5V) and LVDS Serial I/O
- 268mW Power Dissipation (Typical)
- 48-Lead (7mm \times 7mm) LQFP Package

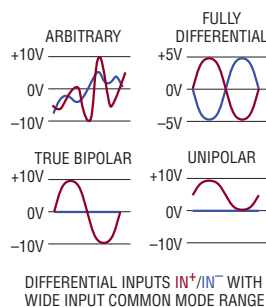
APPLICATIONS

- Direct Sensor Measurement
- Programmable Logic Controllers
- Industrial Process Control
- Test and Measurement



LX PACKAGE
48-LEAD (7mm \times 7mm) PLASTIC LQFP

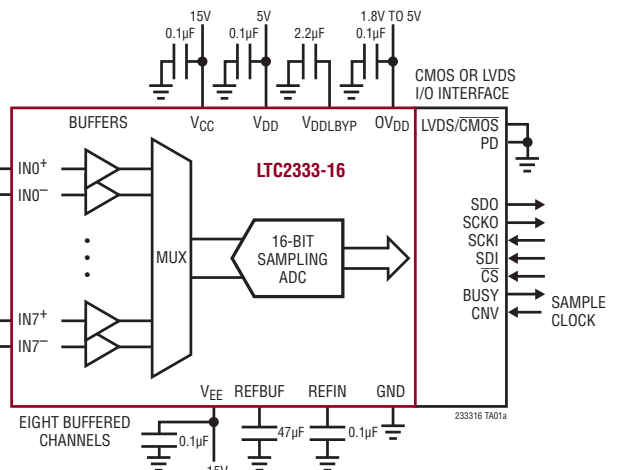
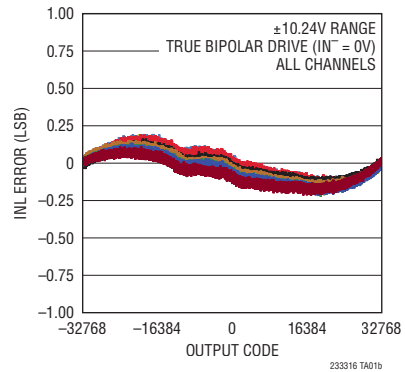
LTC2333CLX-16
LTC2333ILX-16
LTC2333HLX-16



DESCRIPTION

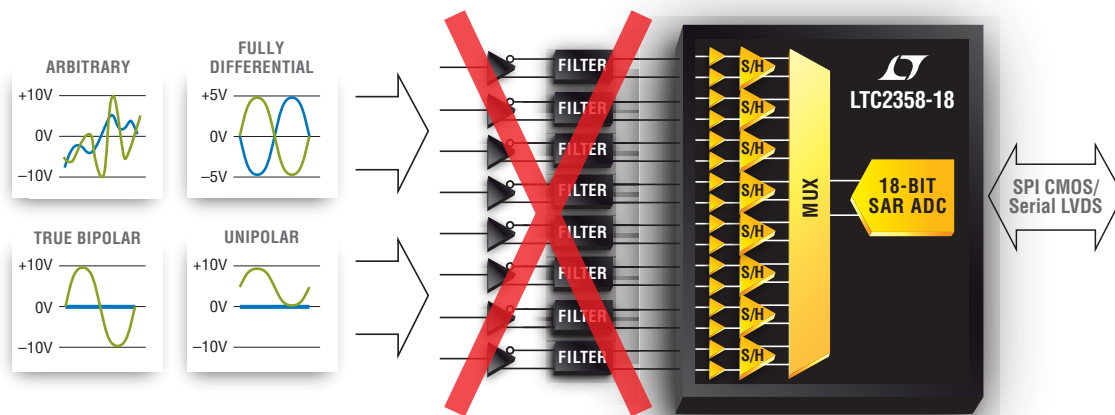
The LTC2333-16 is a 16-bit, low noise 8-channel multiplexed successive approximation register (SAR) ADC with buffered differential, wide common mode range picoamp inputs. Operating from a 5V low voltage supply, flexible high voltage supplies, and using the internal reference and buffer, this SoftSpan ADC can be configured on a conversion-by-conversion basis to accept $\pm 10.24V$, 0V to 10.24V, $\pm 5.12V$ or 0V to 5.12V signals on any channel. Alternately, the ADC may be programmed to cycle through a sequence of channels and ranges without further user intervention. The integrated picoamp-input analog buffers, wide input common mode range and 128dB CMRR of the LTC2333-16 allow the ADC to directly digitize a variety of signals using minimal board space and power. This input signal flexibility, combined with ± 1 LSB INL, no missing codes at 16 bits, and 94.2dB SNR, makes the LTC2333-16 an ideal choice for many high voltage applications requiring wide dynamic range. The LTC2333-16 supports pin-selectable SPI CMOS (1.8V to 5V) and LVDS serial interfaces.

Integral Nonlinearity vs Output Code and Channel



18-Bit Octal SAR ADC with Integrated Buffers

Eliminate up to 88 Analog Components with a Single Part

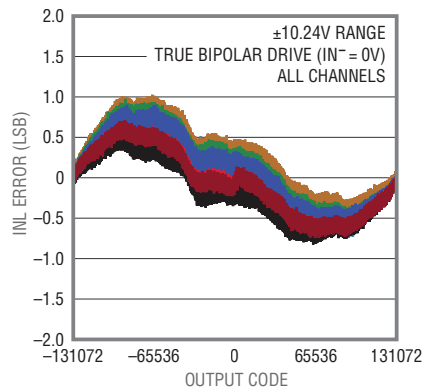


One of the biggest challenges designers face after selecting an ADC is finding space for all of the signal conditioning circuitry required to drive the inputs. The LTC[®]2358 alleviates this problem, integrating front end buffers that accept a wide 30V_{p-p} common mode range, providing a compact solution in a 7mm x 7mm footprint. Picoamp inputs and 128dB CMRR enable the ADC to connect directly to a wide range of sensors without compromising measurement accuracy, thus saving significant board space, power consumption and component cost.

▼ Features

- 200ksps per Channel Throughput
- Eight Buffered Simultaneous Sampling Channels
- Differential, 30V_{p-p} Common Mode Range Inputs
- Per-Channel SoftSpan™ Input Ranges:
 - ±10.24V, 0V to 10.24V, ±5.12V, 0V to 5.12V
 - ±12.5V, 0V to 12.5V, ±6.25V, 0V to 6.25V
- 96.4dB Single-Conversion SNR (Typical)
- 48-Lead (7mm x 7mm) LQFP Package

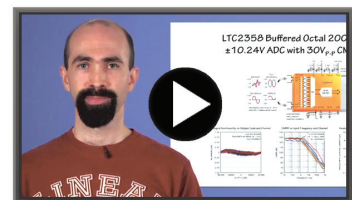
Integral Nonlinearity vs Output Code and Channel



▼ Info & Free Samples

www.linear.com/product/2358

1-800-4-LINEAR



video.linear.com/7641

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

LTC7001

Fast 150V High Side NMOS Static Switch Driver

FEATURES

- Wide Operating V_{IN} : Up to 135V (150V Abs Max)
- 1 Ω Pull-Down, 2.2 Ω Pull-Up for Fast Turn-On and Turn-Off Times with 35ns Propagation Delays
- Internal Charge Pump for 100% Duty Cycle
- Adjustable Turn-On Slew Rate
- Gate Driver Supply from 3.5V to 15V
- Adjustable V_{IN} Overvoltage Lockout
- Adjustable Driver Supply V_{CC} Undervoltage Lockout
- CMOS Compatible Input
- Thermally Enhanced, High Voltage Capable 10-Lead MSOP Package

APPLICATIONS

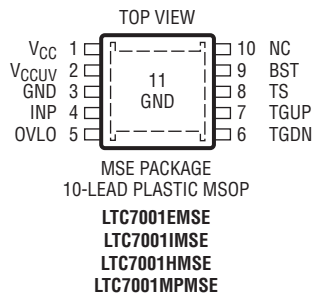
- Static Switch Driver
- Load and Supply Switch Driver
- Electronic Valve Driver
- High Frequency High Side Gate Driver

DESCRIPTION

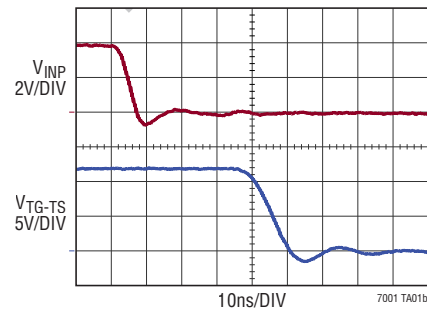
The LTC7001 is a fast high side N-channel MOSFET gate driver that operates from input voltages up to 135V. It contains an internal charge pump that fully enhances an external N-channel MOSFET switch, allowing it to remain on indefinitely.

Its powerful driver can easily drive large gate capacitances with very short transition times, making it well suited for both high frequency switching applications or static switch applications that require a fast turn-on and/or turn-off time.

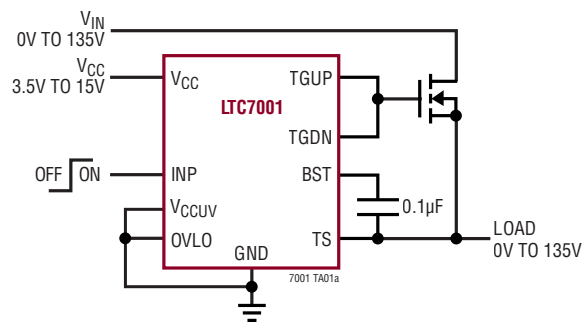
The LTC7001 is available in the thermally enhanced 10-lead MSOP package.



LTC7001 Driving a 1nF Capacitive Load



High Voltage, High Side Switch with 100% Duty Cycle



LTC7003

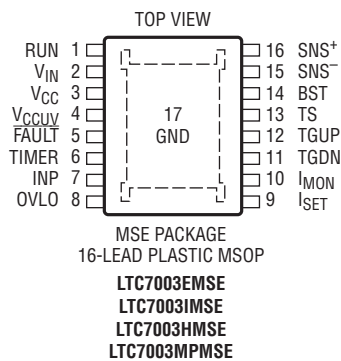
Fast 60V Protected High Side NMOS Static Switch Driver

FEATURES

- Wide Operating V_{IN} : 3.5V to 60V
- 1 Ω Pull-Down, 2.2 Ω Pull-Up for Fast Turn-On and Turn-Off Times with 35ns Propagation Delays
- Internal Charge Pump for 100% Duty Cycle
- Short-Circuit Protected
- Adjustable Current Trip Threshold
- Current Monitor Output
- Automatic Restart Timer
- Open-Drain Fault Flag
- Adjustable Turn-On Slew Rate
- Gate Driver Supply from 3.5V to 15V
- Adjustable V_{IN} Undervoltage and Overvoltage Lockouts
- Adjustable Driver Supply V_{CC} Undervoltage Lockout
- Low Shutdown Current: 1 μ A
- CMOS Compatible Input
- Thermally Enhanced, High Voltage Capable 16-Lead MSOP Package

APPLICATIONS

- Static Switch Driver
- Load and Supply Switch Driver
- Electronic Valve Driver
- High Frequency High Side Gate Driver



DESCRIPTION

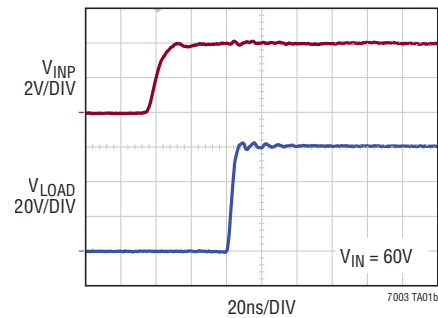
The LTC7003 is a fast high side N-channel MOSFET gate driver that operates from input voltages up to 60V. It contains an internal charge pump that fully enhances an external N-channel MOSFET switch, allowing it to remain on indefinitely.

Its powerful driver can easily drive large gate capacitances with very short transition times, making it well suited for both high frequency switching applications or static switch applications that require a fast turn-on and/or turn-off time.

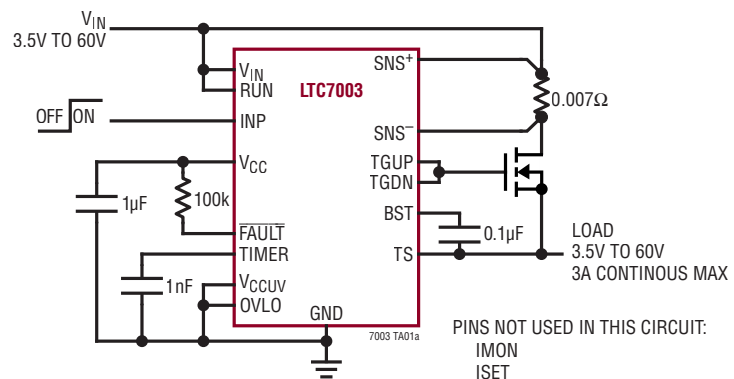
When an internal comparator senses that the switch current has exceeded a preset level, a fault flag is asserted and the switch is turned off after a period of time set by an external timing capacitor. After a cooldown period, the LTC7003 automatically retries.

The LTC7003 is available in the thermally enhanced 16-lead MSOP package.

Turn-On Transient Waveform



High Side Switch with 100% Duty Cycle and Overcurrent Protection



LTC7004

Fast 60V High Side NMOS Static Switch Driver

FEATURES

- **Wide Operating V_{IN} : Up to 60V**
- **1 Ω Pull-Down, 2.2 Ω Pull-Up for Fast Turn-On and Turn-Off Times with 35ns Propagation Delays**
- **Internal Charge Pump for 100% Duty Cycle**
- Adjustable Turn-On Slew Rate
- Gate Driver Supply from 3.5V to 15V
- Adjustable V_{IN} Overvoltage Lockout
- Adjustable Driver Supply V_{CC} Undervoltage Lockout
- CMOS Compatible Input
- Thermally Enhanced, High Voltage Capable 10-Lead MSOP Package

APPLICATIONS

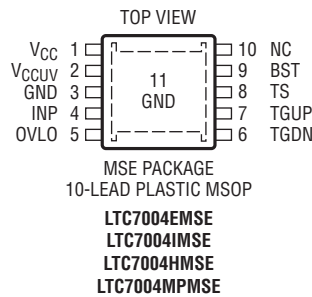
- Static Switch Driver
- Load and Supply Switch Driver
- Electronic Valve Driver
- High Frequency High Side Gate Driver

DESCRIPTION

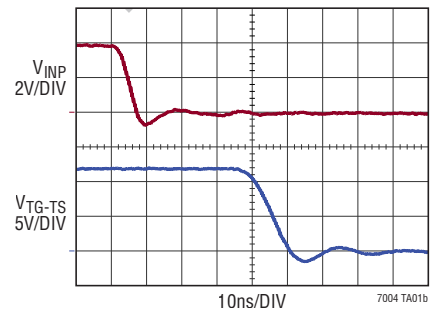
The LTC7004 is a fast high side N-channel MOSFET gate driver that operates from input voltages up to 60V. It contains an internal charge pump that fully enhances an external N-channel MOSFET switch, allowing it to remain on indefinitely.

Its powerful driver can easily drive large gate capacitances with very short transition times, making it well suited for both high frequency switching applications or static switch applications that require a fast turn-on and/or turn-off time.

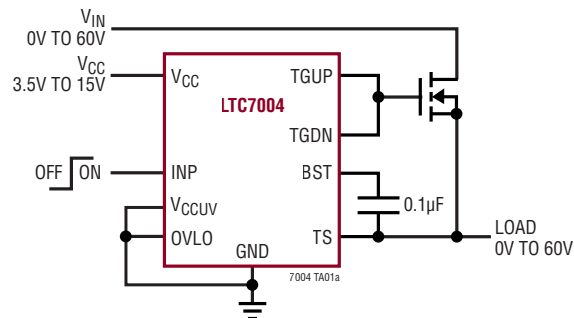
The LTC7004 is available in the thermally enhanced 10-lead MSOP package.



LTC7004 Driving a 1nF Capacitive Load



High Voltage, High Side Switch with 100% Duty Cycle



LTC5552
3GHz to 20GHz Microwave Mixer
with Wideband DC to 6GHz IF

FEATURES

- **Integrated LO Buffer: 0dBm LO Drive**
- **50Ω Wideband Matched RF and LO Ports**
- **Wide IF Bandwidth: DC to 6GHz**
- **Upconversion or Downconversion**
- **High IIP3:**
 - **+22.5dBm at 10GHz**
 - **+18.3dBm at 17GHz**
- **+14.6dBm Input P1dB at 10GHz**
- **8dB Conversion Loss at 10GHz**
- 3.3V/132mA Supply
- Fast Turn ON/OFF for TDD Operation
- 3mm × 2mm, 12-Lead QFN Package

APPLICATIONS

- 5G Broadband Wireless Access
- Microwave Transceivers
- Wireless Backhaul
- Point-to-Point Microwave
- Phased-Array Antennas
- C, X and Ku Band RADAR
- Test Equipment
- Satellite Modems

DESCRIPTION

The LTC5552 is a high performance, microwave double balanced passive mixer that can be used for frequency upconversion or downconversion. The device is similar to the LTC5553, but with a broadband, differential DC to 6GHz IF port. The LTC5552 is recommended for applications where the IF frequency range extends below 500MHz. For applications where the IF frequency is always above 500MHz, the LTC5553 is recommended, since it includes an integrated IF balun.

The mixer and integrated RF balun are optimized to cover the 3GHz to 20GHz RF frequency range. The integrated LO amplifier is optimized for the 1GHz to 20GHz frequency range, requiring only 0dBm drive.

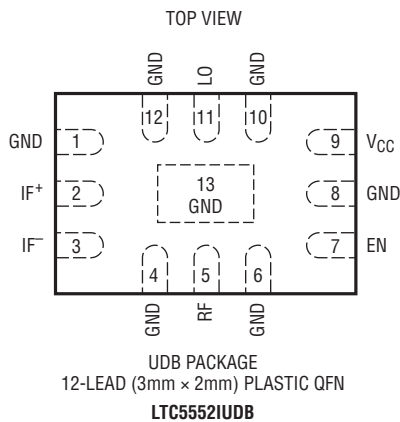
The part delivers high IIP3 and P1dB, low LO leakage and high integration in a small package.

Electrostatic Sensitive Device

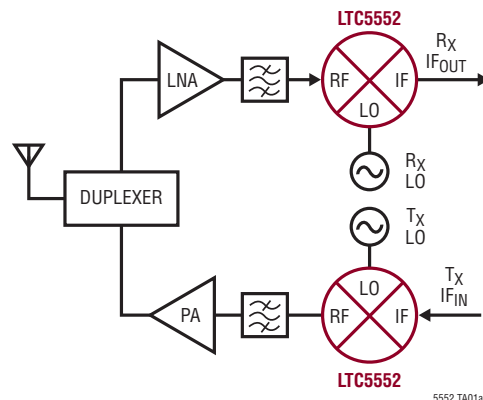
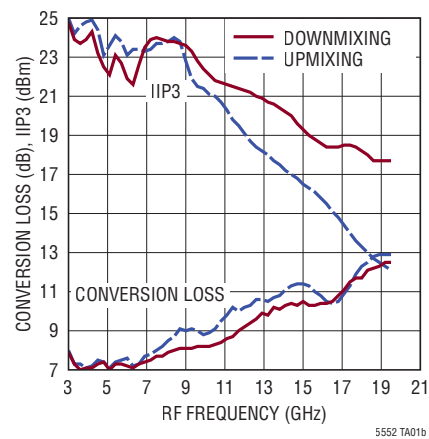
Observe Handling Precautions

ESD Sensitivity:

- HBM = Class 0 on Pin 11
Class 1C All Other Pins
- CDM = 500V All Pins

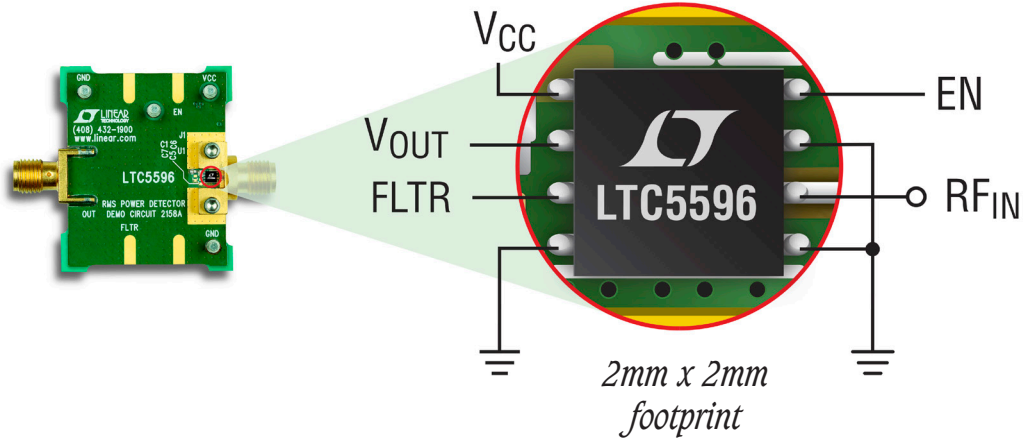


**Conversion Loss and IIP3 vs RF Frequency
(Low Side LO, IF = 240MHz)**



Measure RMS Power to 40GHz

Improve Measurement Accuracy and Detection Sensitivity

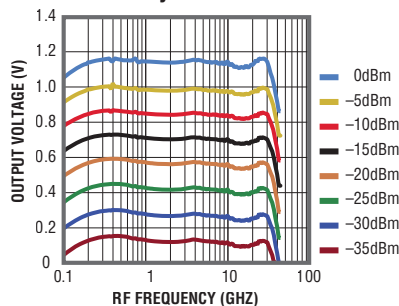


The LTC5596 provides accurate RF power measurement covering a wide frequency range from 100MHz to 40GHz, over temperature variations and wide signal levels—regardless of signal type or modulation waveforms, including OFDM, high order QAM, multi-carrier and radar signals.

Features

- RF Input 50Ω-Matched from 100MHz to 40GHz
- 35dB Log-Linear Dynamic Range to ±1dB Accuracy
- -32.6dBm Minimum Detectable Signal Sensitivity

Efficiency vs Load Current



Info & Online Store

www.linear.com/product/LTC5596

1-800-4-LINEAR

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

LTC2862A

±60V Fault Protected 3V to 5.5V RS485/
RS422 Transceiver with Level 4 IEC ESD

FEATURES

- Protected from Overvoltage Line Faults to ±60V
- 3V to 5.5V Supply Voltage
- 20Mbps or Low EMI 250kbps Data Rate
- ±40kV HBM ESD Interface Pins, ±15kV Other Pins
- Enhanced Receiver and Failsafe Noise Immunity
- IEC Level 4 ESD and EFT on Interface Pins
- Extended Common Mode Range: ±25V
- Guaranteed Failsafe Receiver Operation
- High Input Impedance Supports 224 Nodes
- MP-Grade Option Available (–55°C to 125°C)
- Fully Balanced Differential Receiver Thresholds for Low Duty Cycle Distortion
- Current Limited Drivers and Thermal Shutdown
- Compliant with TIA/EIA-485-A
- Pin Compatible with LTC2862 and LT1785
- Available in DFN and Leaded Packages

APPLICATIONS

- Supervisory Control and Data Acquisition (SCADA)
- Industrial Control and Instrumentation Networks
- Automotive and Transportation Electronics
- Building Automation, Security Systems and HVAC
- Medical Equipment
- Lighting and Sound System Control

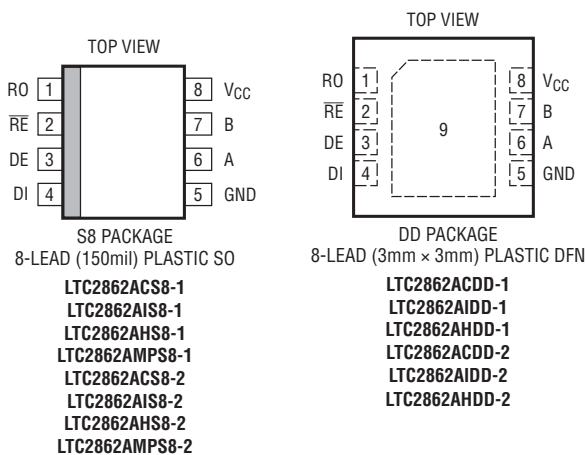
DESCRIPTION

The LTC2862A is a low power, 20Mbps or 250kbps RS485/RS422 transceiver operating on 3V to 5.5V supplies with ±60V overvoltage fault protection on the interface pins during all modes of operation, including power-down. Improvements were made to the LTC2862 for greater robustness and signal integrity: ±40kV HBM and Level 4 IEC ESD protection on the interface pins; increased resistance to electrical overstress; increased receiver noise immunity; additional receiver noise filtering on the LTC2862A-2; and an improved failsafe function optimized for high speed in the LTC2862A-1 and noise rejection in the LTC2862A-2. Low EMI slew rate limited data transmission is available in the 250kbps LTC2862A-2 option, while the LTC2862A-1 operates to 20Mbps.

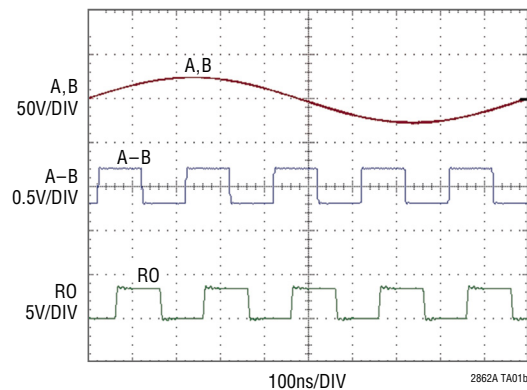
Extended ±25V input common mode range and full failsafe operation improve data communication reliability in electrically noisy environments and in the presence of large ground loop voltages.

Product Selection Guide

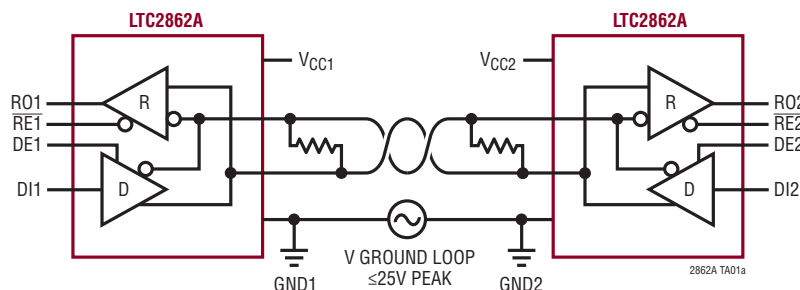
PART NUMBER	DUPLEX	ENABLES	MAX DATA RATE (bps)
LTC2862A-1	HALF	YES	20M
LTC2862A-2	HALF	YES	250k



LTC2862A-1 Receiving 10Mbps ±200mV Differential Signal with 1MHz ±25V Common Mode Sweep



RS485 Link with Large Ground Loop Voltage



LT3932 36V, 2A Synchronous Step-Down LED Driver

FEATURES

- ±1.5% LED Current Regulation
- ±1.2% Output Voltage Regulation
- 5000:1 PWM Dimming at 100Hz
- 128:1 Internal PWM Dimming
- Spread Spectrum Frequency Modulation
- Silent Switcher® Architecture for Low EMI
- 3.6V to 36V Input Voltage Range
- 0V to 36V LED String Voltage
- 2A, 36V Internal Switches
- 200kHz to 2MHz with SYNC Function
- 99.9% Maximum Duty Cycle
- Analog or Duty Cycle LED Current Control
- Open/Short LED Protection and Fault Indication
- Accurate LED Current Sense with Monitor Output
- Programmable UVLO
- Thermally Enhanced 28-Lead (4mm × 5mm) QFN

APPLICATIONS

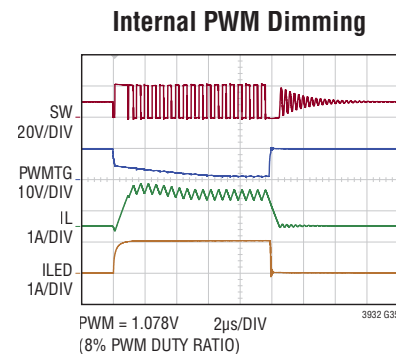
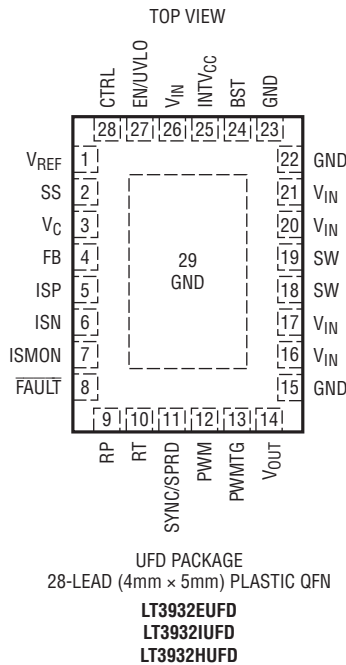
- Automotive Lighting
- Industrial and General Purpose Lighting

DESCRIPTION

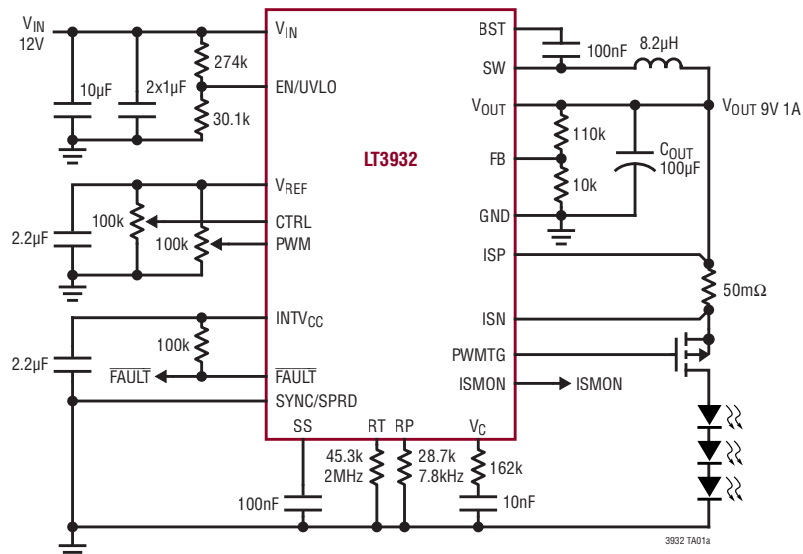
The LT3932 is a monolithic, synchronous, step-down DC/DC converter that utilizes fixed frequency, peak current control and provides PWM dimming for a string of LEDs. The LED current is programmed by an analog voltage or the duty cycle of pulses at the CTRL pin. An output voltage limit can be set with a resistor divider to the FB pin.

The switching frequency is programmable from 200kHz to 2MHz by an external resistor at the RT pin or by an external clock at the SYNC/SPRD pin. With the optional spread spectrum frequency modulation enabled, the frequency varies from 100% to 125% to reduce EMI. The LT3932 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 not available.

Additional features include 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.



2A LED Driver with Internal PWM Dimming



Low EMI μ Module Regulators

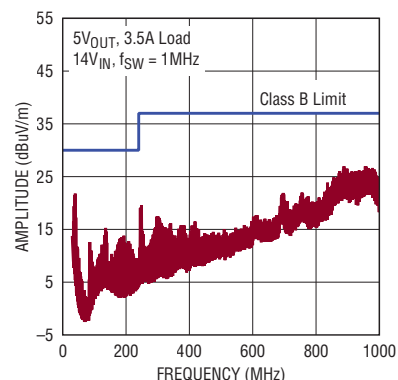
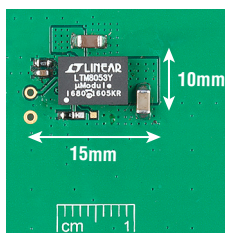
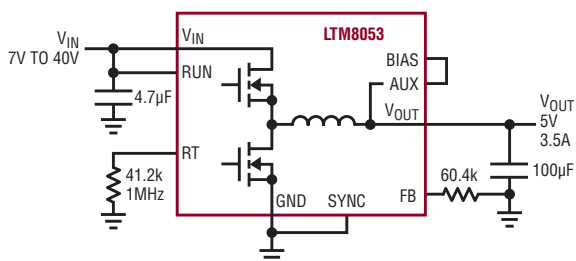
EN55022 Class B Certified CISPR 22 Class B Compliant, or CISPR 25 Class 5 Compliant*



Photo: Medical Imaging Systems

CISPR 22 Class B Compliant, Silent Switcher[®] Step-Down μ Module[®] Regulators

- LTM[®]8073: 60V_{IN}, 3A Continuous, 5A Peak
- LTM8053: 40V_{IN}, 3.5A Continuous, 6A Peak



LTM8053 Typical Application

- Requires Only Four External Components

DC1934A: LTM8053 Demo Board

- Solution Size Is Approximately 150mm²

CISPR 22 Class B Emissions

- DC1934A (LTM8053 Demo Board)
- No EMI Filter

Standard	Content	Notes
EN55022	European Standard for EMC for Information Technology Equipment	Certified by TUV Rheinland (see EMC Test Reports**)
CISPR 22	International Standard for EMC for Information Technology Equipment	Verified by Linear Technology
CISPR 25	International Standard for EMC for Automotive Products	Verified by Linear Technology

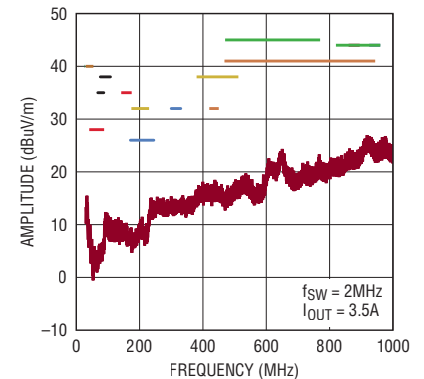
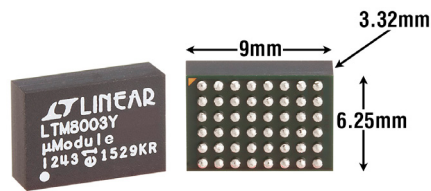
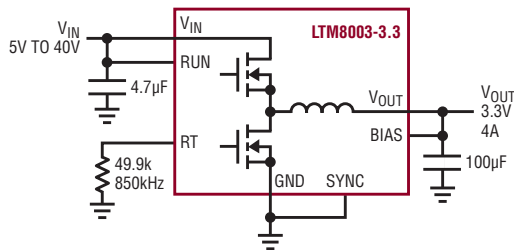
** EMC Test Reports (EN55022 Class B): <http://www.linear.com/designtools/packaging/umodule.php>

Low EMI μ Module Regulators

CISPR 25 Class 5 Compliant, Silent Switcher Step-Down Regulator

LTM8003: 40V_{IN}, 3.5A Continuous/6A Peak with:

- FMEA Compliant Pinout (LTM8003-3.3) Output Stays at or Below Regulation Voltage During Adjacent Pin Short or if a Pin Is Left Floating
- 150°C Operation (H-Grade)
- Low Quiescent Current: 25 μ A (Typ)



LTM8003 Typical Application

- 3.3V_{OUT} from 5V_{IN} to 40V_{IN} Step-Down Converter

FMEA Compliant Pinout

- 6.25mm × 9mm × 3.32mm BGA Package

CISPR 25 Class 5 Peak Radiated

- DC2416A (LTM8003 Demo Board)
- V_{OUT} = 5V, Spread Spectrum Enabled

Part Number	Input Voltage (V)		Output Voltage (V)		I _{OUT} (A)	Clock Sync Range (MHz)	Parallellable Output (Total I _{OUT})*	Package Dimensions (mm)	Package
	Min	Max	Min	Max					
CISPR 22 Class B Compliant, Step-Down μModule Regulators									
LTM8053	3.4	40	0.97	15	3.5 (Continuous) 6 (Peak)	0.2 to 3	×2 (7A)	6.25 × 9 × 3.32	BGA
LTM8073	3.6	60	0.8	15	3 (Continuous) 5 (Peak)	0.2 to 3	×2 (6A)	6.25 × 9 × 3.32	BGA
EN55022 Class B Certified, Step-Down μModule Regulators									
LTM8020	4	36	1.2	5	0.2	-	-	6.25 × 6.25 × 2.32	LGA
LTM8021	3	36	0.8	5	0.5	-	-	6.25 × 11.25 × 2.82	LGA
LTM8031	3.6	36	0.8	10	1	0.25 to 2.0	×2 (2A)	9 × 15 × 2.82	LGA
LTM8032	3.6	36	0.8	10	2	0.25 to 2.0	×2 (4A)	9 × 15 × 2.82 9 × 15 × 3.42	LGA BGA
LTM8033	3.6	36	0.8	24	3	0.25 to 2.0	×2 (6A)	11.25 × 15 × 4.32 11.25 × 15 × 4.92	LGA BGA
LTM4623	4*	20	0.6	5.5	3	0.56 to 4	×2 (6A)	6.25 × 6.25 × 1.82 6.25 × 6.25 × 2.42	LGA BGA
LTM4624	4*	14	0.6	5.5	4	-	-	6.25 × 6.25 × 5.01	BGA
LTM4612	5	36	3.3	15	5	0.18 to 1.3	×2 (10A)	15 × 15 × 2.82	LGA
LTM4606	4.5	28	0.6	5	6	0.7 to 1.1	×2 (12A)	15 × 15 × 2.82 15 × 15 × 3.42	LGA BGA
LTM4613	5	36	3.3	15	8	0.18 to 1.3	×2 (16A)	15 × 15 × 4.32 15 × 15 × 4.92	LGA BGA
CISPR 25 Class 5 Compliant, Step-Down μModule Regulator									
LTM8003	3.4	40	0.97	18	3.5 (Continuous) 6 (Peak)	0.2 to 3	-	6.25 × 9 × 3.32	BGA

*Number of devices in parallel tested and verified by Linear Technology.

LTM4622A

Dual Ultrathin 2A or Single 4A Step-Down DC/DC µModule Regulator

FEATURES

- Complete Solution in <math><1\text{cm}^2</math>
- Wide Input Voltage Range: 3.6V to 20V
- 1.5V to 12V Output Voltage
- Dual 2A (3A Peak) or Single 4A Output Current
- $\pm 1.5\%$ Maximum Total Output Voltage Regulation Error Over Load, Line and Temperature
- Current Mode Control, Fast Transient Response
- External Frequency Synchronization
- Multiphase Parallelable with Current Sharing
- Output Voltage Tracking and Soft-Start Capability
- Selectable Burst Mode[®] Operation
- Overvoltage Input and Overtemperature Protection
- Power Good Indicators
- 6.25mm × 6.25mm × 1.82mm LGA and 6.25mm × 6.25mm × 2.42mm BGA Packages

APPLICATIONS

- General Purpose Point-of-Load Conversion
- Telecom, Networking and Industrial Equipment
- Medical Diagnostic Equipment
- Test and Debug Systems

DESCRIPTION

The LTM4622A is a complete dual 2A step-down switching mode µModule (micromodule) regulator in a tiny ultrathin 6.25mm × 6.25mm × 1.82mm LGA and 2.42mm BGA packages. Included in the package are the switching controller, power FETs, inductor and support components. Operating over an input voltage range of 3.6V to 20V, the LTM4622A supports an output voltage range of 1.5V to 12V, set by a single external resistor. Its high efficiency design delivers dual 2A continuous, 3A peak, output current. Only a few ceramic input and output capacitors are needed.

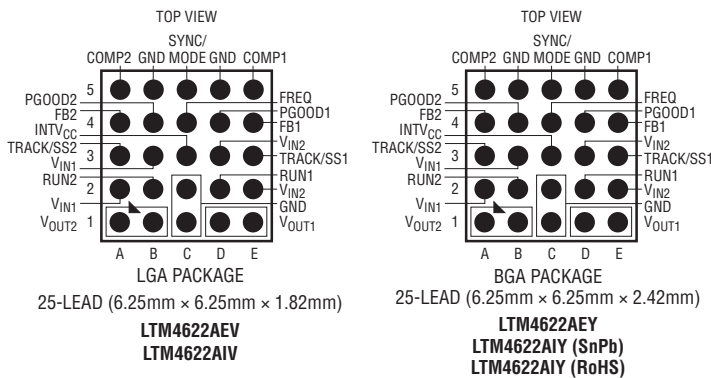
The LTM4622A supports selectable Burst Mode operation and output voltage tracking for supply rail sequencing. Its high switching frequency and current mode control enable a very fast transient response to line and load changes without sacrificing stability.

Fault protection features include input overvoltage, output overcurrent and overtemperature protection.

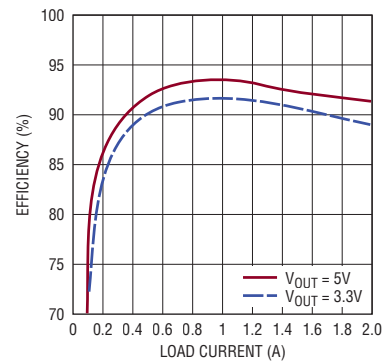
The LTM4622A is available with SnPb (BGA) or RoHS compliant terminal finish.

Product Selection Guide

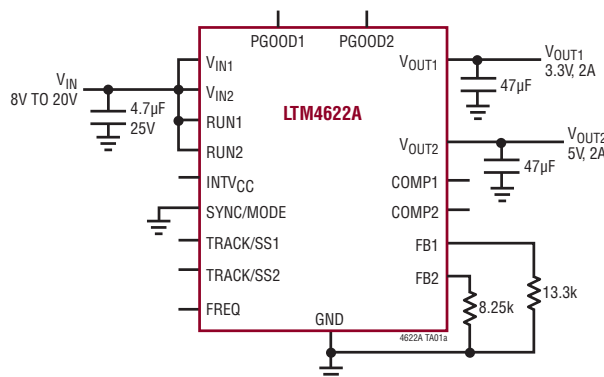
PART NUMBER	V _{IN} RANGE	V _{OUT} RANGE	I _{OUT}
LTM4622	3.6V to 20V	0.6V to 5.5V	Dual 2.5A or Single 5A
LTM4622A		1.5V to 12V	Dual 2A or Single 4A



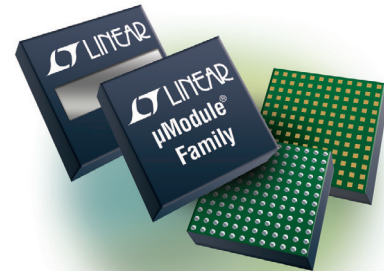
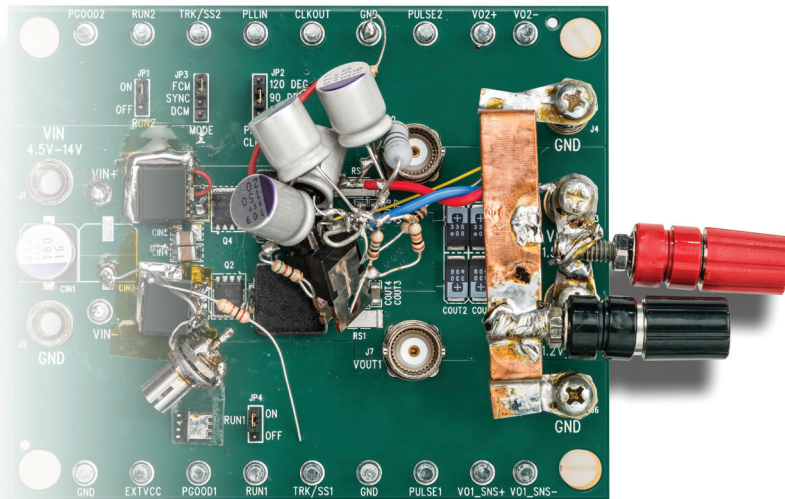
12V Input, 3.3V and 5V Output, Efficiency vs Load Current



3.3V and 5V Dual Output DC/DC Step-Down µModule Regulator



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.

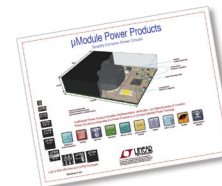
μModule Product Family Examples

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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Brochure

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

LTC3636/LTC3636-1 Dual Channel 6A, 20V Monolithic Synchronous Step-Down Regulator

FEATURES

- Wide V_{IN} Range: 3.1V to 20V
- Wide V_{OUT} Range:
 - 0.6V to 5V (LTC3636)
 - 1.8V to 12V (LTC3636-1)
- Output Current per Channel: 6A
- High Efficiency: Up to 95%
- Die Temperature Monitor
- Adjustable Switching Frequency: 500kHz to 4MHz
- External Frequency Synchronization
- Current Mode Operation for Excellent Line and Load Transient Response
- 0.6V Reference Allows Low Output Voltages
- User-Selectable Burst Mode Operation or Forced Continuous Operation
- Output Voltage Tracking and Soft-Start Capability
- Short-Circuit Protected
- Overvoltage Input and Overtemperature Protection
- Power Good Status Outputs
- Low Profile 4mm × 5mm 28-Lead QFN Package

APPLICATIONS

- Distributed Power Systems
- Battery-Powered Instruments
- Point-of-Load Power Supplies

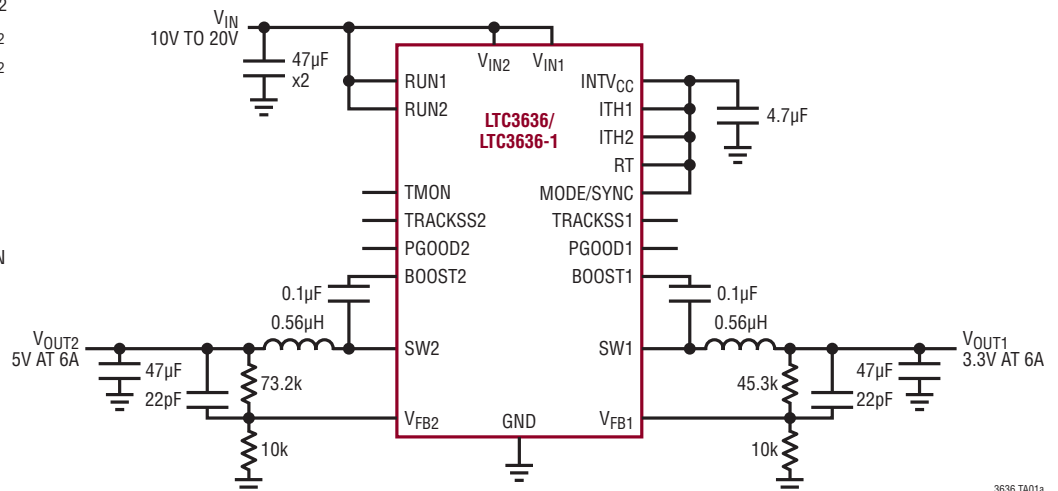
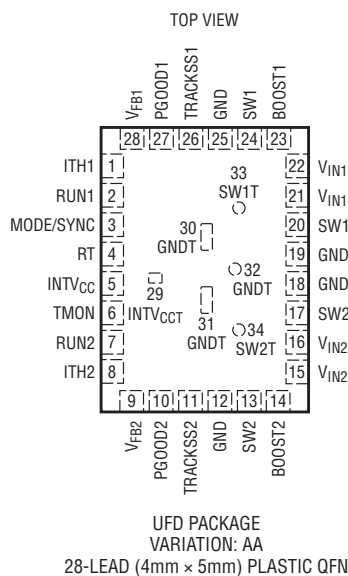
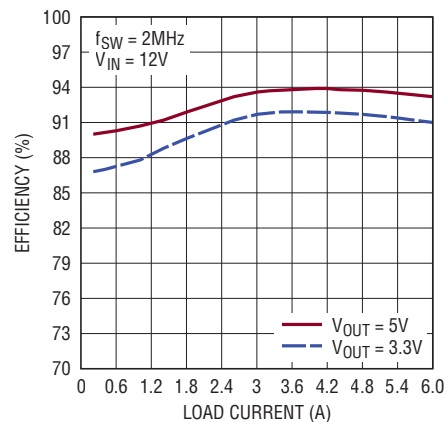
DESCRIPTION

The LTC3636/LTC3636-1 is a high efficiency, dual channel monolithic synchronous buck regulator using a controlled on-time current mode architecture, with phase-lockable switching frequency. The operating supply voltage range is from 3.1V to 20V, making it suitable for lithium-ion battery stacks as well as point-of-load power supply applications from a 12V or 5V input.

The operating frequency is programmable from 500kHz to 4MHz with an external resistor and may be synchronized to an external clock signal. The high frequency capability allows the use of small surface mount inductors and capacitors. The unique constant-frequency/controlled on-time architecture is ideal for high step-down ratio applications that operate at high frequency while demanding fast transient response.

The LTC3636/LTC3636-1 can select between forced continuous mode and high efficiency Burst Mode operation. The LTC3636 and LTC3636-1 differ in their output voltage sense range.

Efficiency vs Load Current



LTC7124

17V, Dual 3.5A Synchronous Step-Down Regulator with Ultralow Quiescent Current

FEATURES

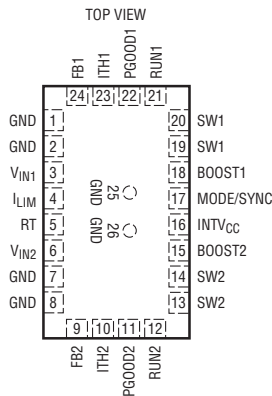
- Wide V_{IN} Range: 3.1V to 17V
- Wide V_{OUT} Range: 0.6V to 99% V_{IN}
- Dual Step-Down Outputs: 3.5A per Channel
- Integrated 80m Ω /40m Ω N-Channel MOSFETs Provide Up to 95% Efficiency
- No Load $I_Q < 8\mu A$ with Both Channels Enabled; $I_Q < 5.5\mu A$ with Only One Channel Enabled
- Programmable Frequency (500kHz to 4MHz) with $\pm 25\%$ Frequency Synchronization Range
- Configurable for a Two-Phase Single Output at Up to 7A
- $\pm 1.0\%$ Output Voltage Accuracy
- Current Mode Operation for Excellent Line and Load Transient Response
- Internal or Programmable External Loop Compensation
- Available in a 3mm \times 5mm QFN-24 Package

APPLICATIONS

- Battery-Powered Systems
- Point-of-Load Supplies
- Portable Instruments
- Handheld Scanners

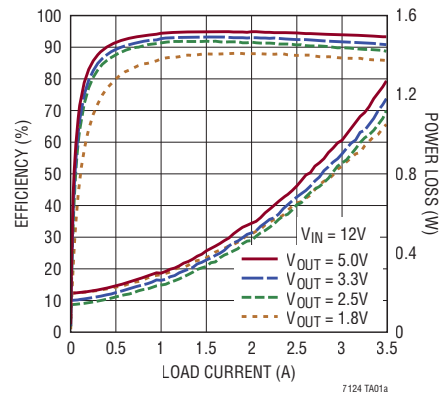
DESCRIPTION

The LTC7124 is a dual channel, 3.5A per output, high efficiency monolithic step-down regulator capable of operating from input supplies up to 17V. The programmable switching frequency ranges from 500kHz to 4MHz with a $\pm 25\%$ external clock synchronization capability around the programmed frequency. The regulator features ultralow quiescent current for high efficiency over a wide V_{OUT} range. The step-down regulator operates from an input voltage range of 3.1V to 17V and provides an adjustable output range from 0.6V to 99% of V_{IN} while delivering up to 3.5A of output current per channel. A user-selectable mode input is provided to allow the user to trade off output ripple for light load efficiency. Burst Mode operation provides the highest efficiency at light loads, while forced continuous mode provides the lowest output ripple. The LTC7124 includes spread spectrum modulation for low radiated and conductive noise. The LTC7124 is offered in a thermally enhanced, low profile 24-lead 3mm \times 5mm QFN package.

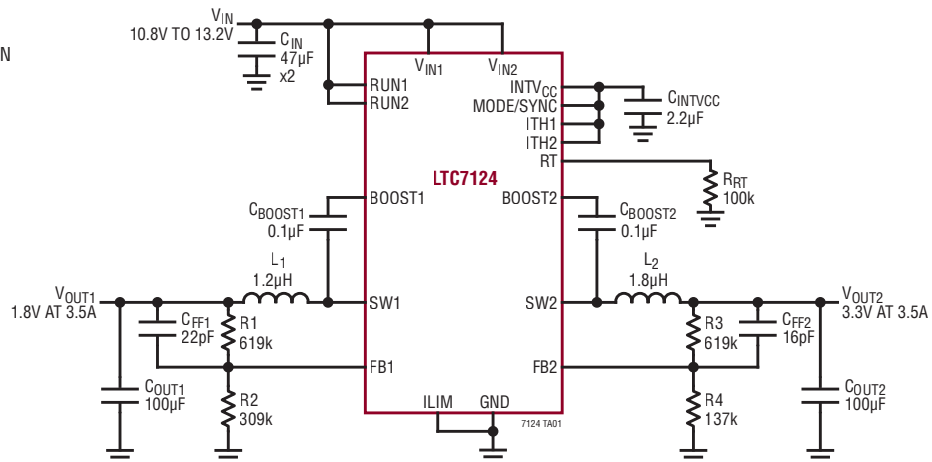


UDD PACKAGE
VARIATION: AA
24-LEAD (3mm \times 5mm) PLASTIC QFN
LTC7124EUDD
LTC7124IUDD

Efficiency and Power Loss vs Load Current at 1MHz



1.8V/3.3V 1MHz Step-Down Regulator



LTC7150S 20V, 20A Synchronous Step-Down Regulator

FEATURES

- Silent Switcher 2 Architecture for Low EMI
- V_{IN} Range: 3.1V to 20V
- V_{OUT} Range: 0.6V to 5.5V
- Differential V_{OUT} Remote Sense
- Adjustable Frequency: 400kHz to 3MHz
- PolyPhase® Operation: Up to 12 Phases
- Output Tracking and Soft-Start
- Reference Accuracy: 0.6V \pm 1% Over Temperature
- Current Mode Operation for Excellent Line and Load Transient Response
- Accurate 1.2V Run Pin Threshold
- Supports Forced Continuous/Discontinuous Modes
- 42-Lead 6mm \times 5mm \times 1.3mm BGA Package

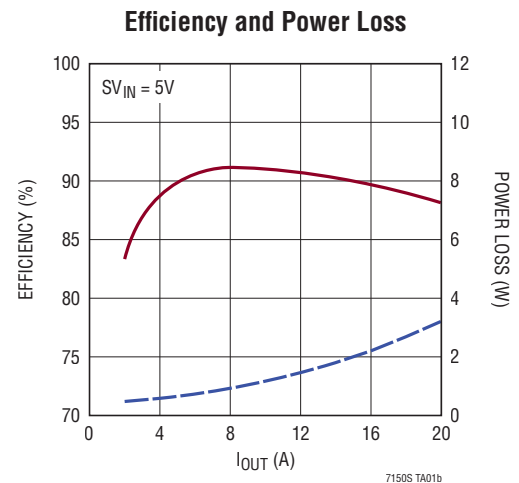
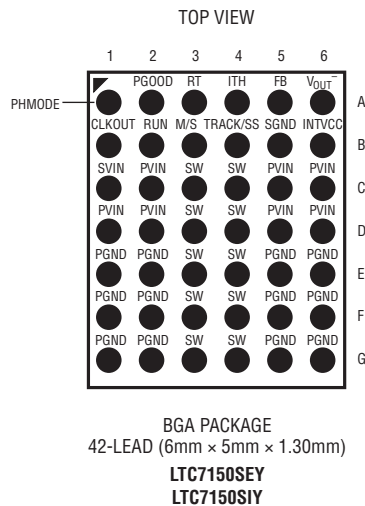
APPLICATIONS

- Server Power Applications
- Distributed Power Systems
- Point-of-Load Supply for ASIC, FPGA, DSP, μ P, etc.

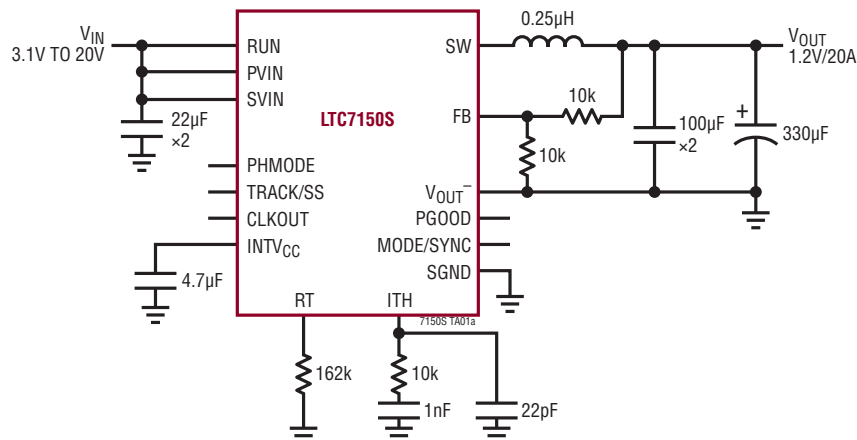
DESCRIPTION

The LTC7150S is a high efficiency monolithic synchronous buck regulator capable of delivering 20A to the load. It uses a phase-lockable controlled on-time constant-frequency, current mode architecture. PolyPhase operation allows multiple LTC7150S regulators to run out-of-phase, which reduces the amount of input and output capacitors required. The operating supply voltage range is from 3.1V to 20V.

The operating frequency is programmable from 400kHz to 3MHz with an external resistor. The high frequency capability allows the use of physically smaller inductor and capacitor sizes. For switching noise sensitive applications, the LTC7150S can be externally synchronized from 400kHz to 3MHz. The PHMODE pin allows the user control of the phase of the outgoing clock signal. The unique constant-frequency/controlled on-time architecture is ideal for high step-down ratio applications that operate at high frequencies while demanding fast transient response. The LTC7150S uses second generation Silent Switcher technology including integrated bypass capacitors to deliver a highly efficient solution at high frequencies with excellent EMI performance.



12V_{IN} to 1.2V_{OUT} Application



LTC7800

Low I_Q , 60V, High Frequency Synchronous Step-Down Controller

FEATURES

- Wide V_{IN} Range: 4V to 60V (65V Abs Max)
- Low Operating I_Q : 50 μ A
- Wide Output Voltage Range: $0.8V \leq V_{OUT} \leq 24V$
- R_{SENSE} or DCR Current Sensing
- Phase-Lockable Frequency (320kHz to 2.25MHz)
- Programmable Fixed Frequency (320kHz to 2.25MHz)
- Selectable Continuous, Pulse-Skipping or Low Ripple Burst Mode Operation at Light Load
- Selectable Current Limit
- Very Low Dropout Operation: 98% Duty Cycle
- Adjustable Output Voltage Soft-Start or Tracking
- Power Good Output Voltage Monitor
- Output Overvoltage Protection
- Low Shutdown I_Q : < 14 μ A
- Internal LDO Powers Gate Drive from V_{IN} or $EXTV_{CC}$
- No Current Foldback During Start-Up
- Small 20-Lead 3mm \times 4mm QFN Package

APPLICATIONS

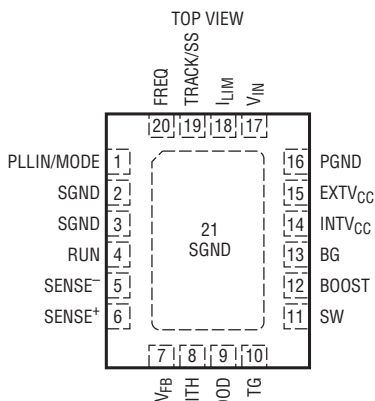
- Automotive Always-On Systems
- Battery-Powered Digital Devices
- Distributed DC Power Systems

DESCRIPTION

The LTC7800 is a high performance step-down switching regulator DC/DC controller that drives an all N-channel synchronous power MOSFET stage. A constant-frequency current mode architecture allows a phase-lockable frequency of up to 2.25MHz.

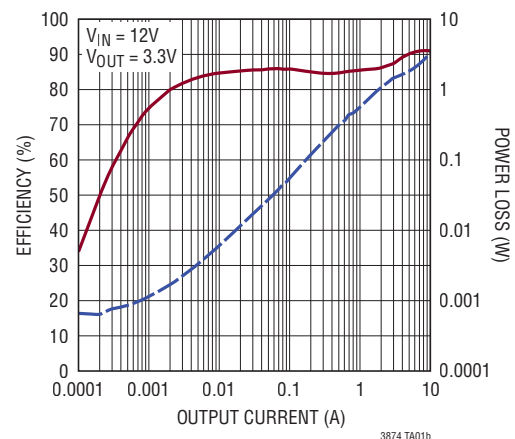
The 50 μ A no load quiescent current extends operating run time in battery-powered systems. OPTI-LOOP compensation allows the transient response to be optimized over a wide range of output capacitance and ESR values. The LTC7800 features a precision 0.8V reference and power good output indicator. A wide 4V to 60V input supply range encompasses a wide range of intermediate bus voltages and battery chemistries. The output voltage of the LTC7800 can be programmed between 0.8V to 24V.

The TRACK/SS pin ramps the output voltages during start-up. Current foldback limits MOSFET heat dissipation during short-circuit conditions. The PLLIN/MODE pin selects among Burst Mode operation, pulse-skipping mode or continuous conduction mode at light loads.

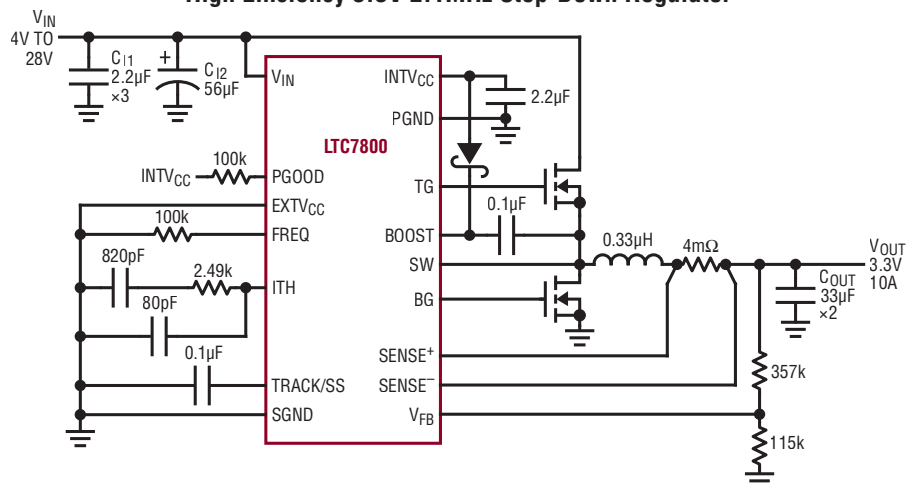


UDC PACKAGE
20-LEAD (3mm \times 4mm) PLASTIC QFN
LTC7800EUDC
LTC7800IUDC
LTC7800HUDC

Efficiency and Power Loss vs Output Current



High Efficiency 3.3V 2.1MHz Step-Down Regulator



LTC7801

150V Low I_Q , Synchronous Step-Down DC/DC Controller

FEATURES

- Wide V_{IN} Range: 4V to 140V (150V Abs Max)
- Wide Output Voltage Range: 0.8V to 60V
- Adjustable Gate Drive Level: 5V to 10V (OPTI-DRIVE)
- Low Operating I_Q : 40 μ A (Shutdown = 10 μ A)
- 100% Duty Cycle Operation
- No External Bootstrap Diode Required
- Selectable Gate Drive UVLO Thresholds
- Onboard LDO or External NMOS LDO for DRV_{CC}
- EXT V_{CC} LDO Powers Drivers from V_{OUT}
- Phase-Lockable Frequency (75kHz to 850kHz)
- Programmable Fixed Frequency (50kHz to 900kHz)
- Selectable Continuous, Pulse-Skipping or Low Ripple Burst Mode Operation at Light Loads
- Adjustable Burst Clamp
- Power Good Output Voltage Monitor
- Programmable Input Overvoltage Lockout
- Small 24-Lead 4mm x 5mm QFN or TSSOP Packages

APPLICATIONS

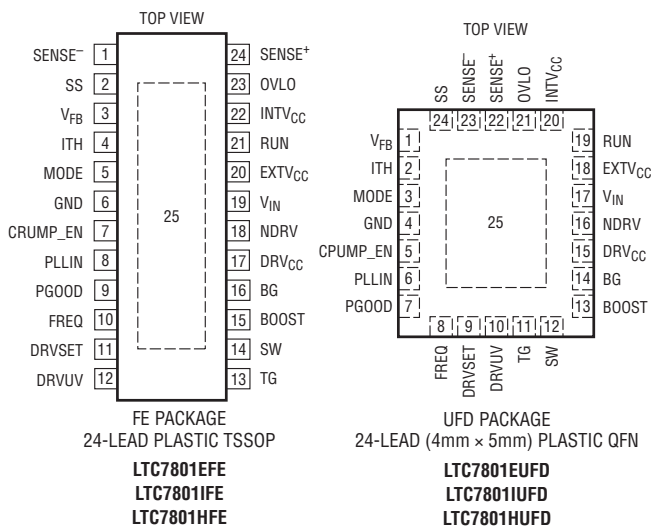
- Automotive and Industrial Power Systems
- High Voltage Battery Operated Systems
- Telecommunications Power Systems

DESCRIPTION

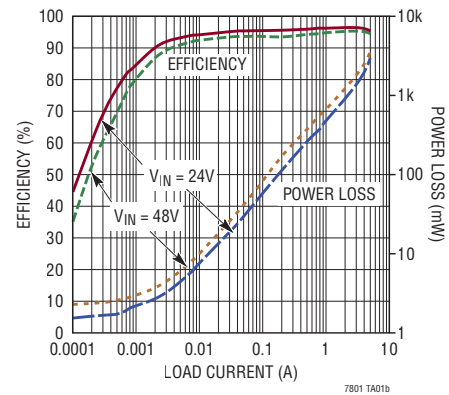
The LTC7801 is a high performance step-down switching regulator DC/DC controller that drives an all N-channel synchronous power MOSFET stage that can operate from input voltages up to 140V. A constant-frequency current mode architecture allows a phase-lockable frequency of up to 850kHz.

The gate drive voltage can be programmed from 5V to 10V to allow the use of logic or standard-level FETs to maximize efficiency. An integrated switch in the top gate driver eliminates the need for an external bootstrap diode. An internal charge pump allows for 100% duty cycle operation.

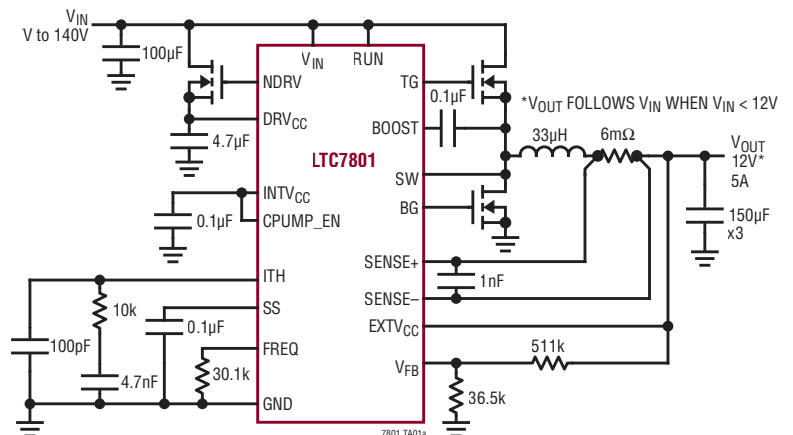
The low 40 μ A no load quiescent current extends operating run time in battery-powered systems. OPTI-LOOP compensation allows the transient response to be optimized over a wide range of output capacitance and ESR values. The LTC7801 features a precision 0.8V reference and power good output indicator. The output voltage can be programmed between 0.8V to 60V using external resistors.



Efficiency and Power Loss vs Load Current



High Efficiency High Voltage 12V Output Step-Down Regulator



LT8390A

60V 2MHz Synchronous 4-Switch Buck-Boost Controller with Spread Spectrum

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
- $\pm 1.5\%$ Output Voltage Accuracy: $1V \leq V_{OUT} \leq 60V$
- $\pm 3\%$ Input or Output Current Accuracy with Monitor
- Spread Spectrum Frequency Modulation for Low EMI
- High Side PMOS Load Switch Driver
- No Top MOSFET Refresh Noise in Buck or Boost
- Adjustable and Synchronizable: 600kHz to 2MHz
- V_{OUT} Disconnected from V_{IN} During Shutdown
- Available in 28-Lead TSSOP with Exposed Pad and 28-Lead QFN (4mm x 5mm)

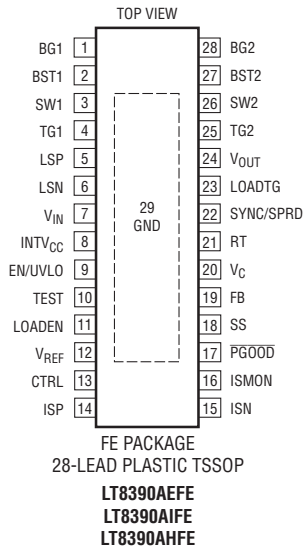
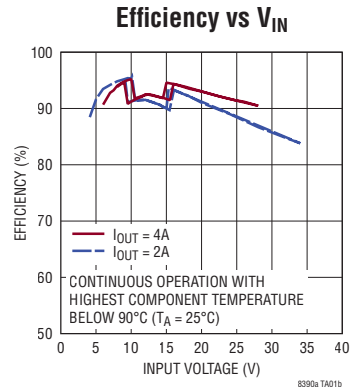
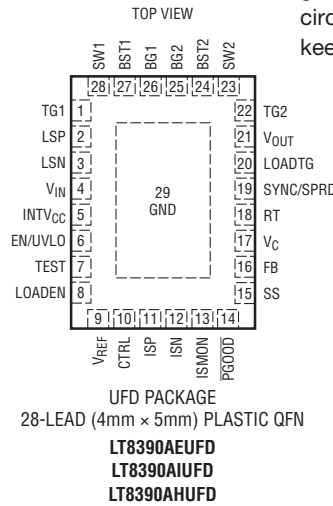
APPLICATIONS

- Automotive, Industrial, Telecom Systems
- High Frequency Battery-Powered System

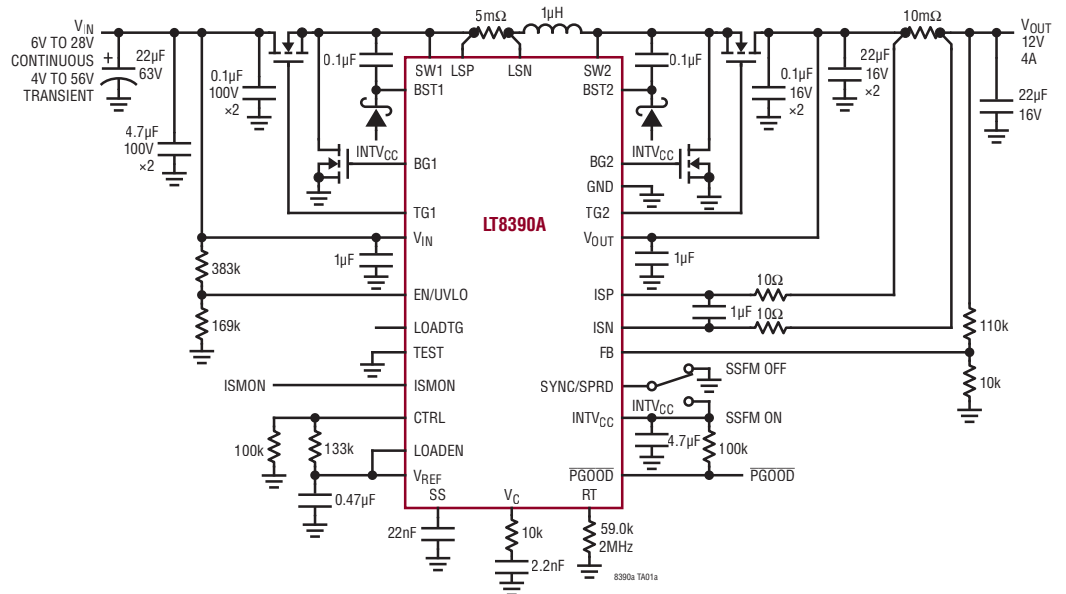
DESCRIPTION

The LT8390A is a synchronous 4-switch buck-boost DC/DC controller that regulates output voltage, input or output current from an 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 frequency modulation for low EMI. With a 4V to 60V input voltage range, 0V to 60V output voltage capability, and seamless low noise transitions between operation regions, the LT8390A is ideal for voltage regulator, battery and supercapacitor charger applications in automotive, industrial, telecom and even battery-powered systems.

The LT8390A provides input or output current monitor and power good flag. Fault protection is also provided to detect output short-circuit condition, during which the LT8390A retries, latches off or keeps running.



95% Efficient 48W (12V 4A) 2MHz Buck-Boost Voltage Regulator



Lower Power Op Amp: Utility Sine Wave

Design Note 564

Catherine Chang, Philip Karantzalis and Aaron Schultz

Introduction

Our op amp family has expanded with industry-leading speed versus supply current. The LTC®6258/LTC6259/LTC6260 family (single, dual, quad) provides 1.3MHz at a super low 20µA supply current, with 400µV maximum offset voltage and rail-to-rail input and output. In combination with a 1.8V to 5.25V supply, this op amp enables applications requiring uncompromised performance with low power and low voltage at reasonable cost.

Utility Sine Wave

One does not expect to generate a sine wave with -100dBc distortion using a 5V low power op amp. All the same, a bandpass filter using the LTC6258 can combine with an easy-to-use low power oscillator to create a sine wave at low cost, low voltage and extremely low dissipation.

Active Filter

The bandpass filter of Figure 1 is AC coupled to an input. As a result, the LTC6258 input does not place a burden on the previous stage to develop a particular absolute common mode voltage. A simple resistor

divider with RA1 and RA2 provides biasing for the LTC6258 bandpass filter. Pegging the op amp inputs to a fixed voltage helps to reduce distortion that might arise with moving common mode.

This filter is centered at 10kHz. The exact resistance and capacitance values can be tweaked upward or downward, depending on whether lowest resistor noise or lowest total supply current is most important. This implementation was optimized for low dissipation by reducing current in the feedback loop. The capacitors C2 and C3 were initially 4.7nF or higher, with lower resistor values. In the end, 1nF with higher resistors optimized for lower dissipation.

Besides power dissipation, a secondary but no less important aspect of feedback impedance is loading of the op amp rail-to-rail output stage. Heavier loading, such as between 1K and 10K impedance, significantly lowers open loop gain, which in turn affects the accuracy of the bandpass filter. The data sheet suggests A_{VOL} reduces by a factor of 5 from

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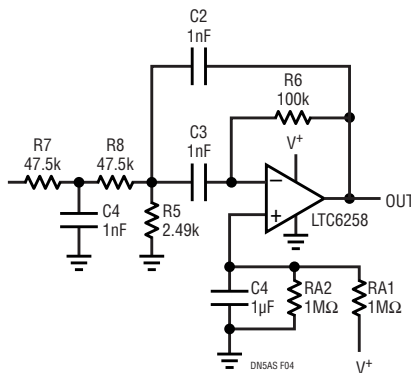


Figure 1. 10kHz Bandpass Filter

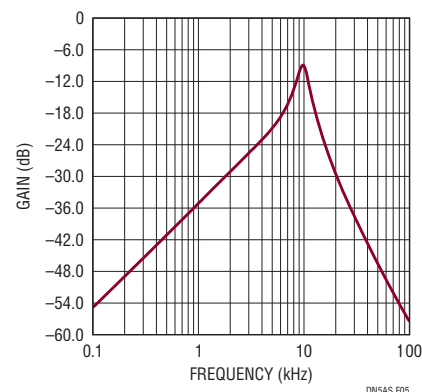


Figure 2. Bandpass Filter Gain/Phase vs Frequency

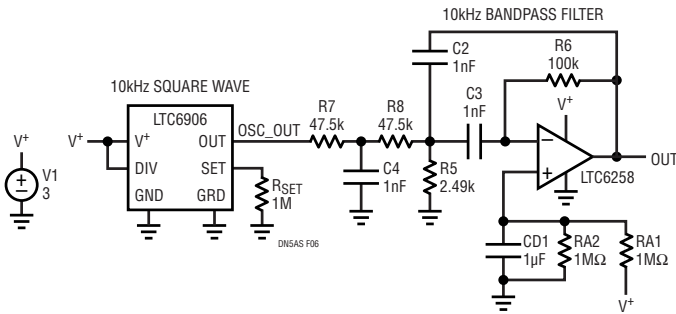


Figure 3. 10kHz Oscillator Circuit Using LTC6906 TimerBlox® Input

100kΩ to 10kΩ. Lower C2 and C3 might be feasible, but then R6 becomes even larger, introducing more noise at the output.

The target Q of this bandpass filter is moderate – approximately 3. A moderate Q, rather than a high Q, allows for use of 5% capacitors. Higher Q will demand more accurate capacitors, and very likely higher open loop gain at 10kHz than is available with the feedback impedance load. Naturally, moderate Q results in less attenuation of harmonics than a higher Q.

Adding The Oscillator

A low power sine wave generator can be derived by driving a square wave into the bandpass filter. A complete schematic is shown in Figure 3. The LTC6906 micropower resistor-set oscillator easily configures as a 10kHz square wave, and can drive the relatively benign loading seen in the bandpass filter input resistors. Supply current of the LTC6906 at 10kHz is 32.4μA.

Figure 4 shows the LTC6906 output and bandpass filter output. HD2 of the sine wave is -46.1dBc, and HD3 -32.6dBc. The output was 1.34V_{P-P} to 1.44V_{P-P} with exact level varying slightly due to finite op amp

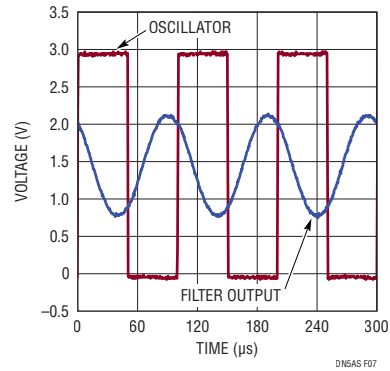


Figure 4. Voltage Waveforms Oscillator and Filter Output

open loop gain at 10kHz. Total current consumption is below 55μA on a 3V rail.

Other Enhancements

Figure 5 shows optional enhancements. A low power reference takes advantage of the ability of the LTC6906 and LTC6258 to operate on a very low supply. The reference provides 2.5V from a battery input. The fixed 2.5V supply stabilizes the output voltage swing in the presence of varying input voltage. In addition, even lower filter capacitor values with higher resistances reduce LTC6258 loading further, lowering dissipation and improving filter accuracy.

Conclusion

The LTC6258/LTC6259/LTC6260 family (single, dual, quad) provides 1.3MHz gain bandwidth at a low 20μA supply current, with 400μV maximum offset voltage and rail-to-rail input and output. In combination with 1.8V to 5.25V supply, this op amp enables applications requiring excellent performance with low power and low voltage at low cost.

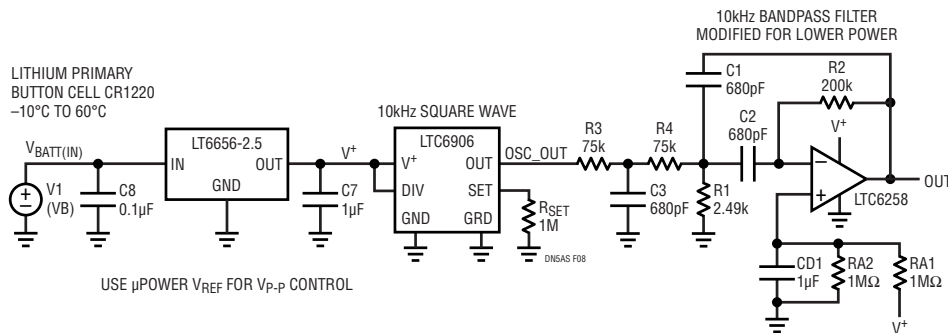
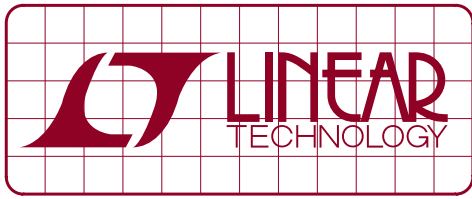


Figure 5. Oscillator and Filter with a Regulated Supply

Data Sheet Download

www.linear.com/LTC6258

For applications help,
call (408) 432-1900, Ext. 3409



DESIGN NOTES

Simple Power Backup Supply for a 3.3V Rail

Design Note 565

Victor Khasiev

Introduction

Data loss is a concern in telecom, industrial and automotive applications where embedded systems require a dependable supply of power. Sudden power interruptions can corrupt data during read and write operations performed by hard drives and flash memory. Designers often use batteries, capacitors and supercaps to store enough energy to support critical loads for a short time during a power interruption.

The LTC[®]3643 power backup supply allows designers to use a relatively inexpensive storage component: low cost electrolytic capacitors. In the backup or holdup supply presented here, the LTC3643 charges a storage capacitor to 40V when power is present, and discharges it to the critical load when power is interrupted. The load (output) voltage can be programmed to any voltage between 3V and 17V.

The LTC3643 easily fits backup solutions for 5V and 12V rails, but a 3.3V rail solution requires extra care. The minimum operating voltage of the LTC3643 is 3V, relatively close to the nominal 3.3V input voltage level. This is too tight when a blocking diode is used to decouple the backup voltage source from noncritical circuitry as shown in Figure 1a. If D1 is a Schottky diode, its forward voltage drop—as a function of load current and temperature—can reach 0.4V to 0.5V, enough to place the voltage at the LTC3643 V_{IN} pin below the 3V minimum. As a result, the backup supply circuit may not start up.

One possible solution is to move the diode to the input of the supplying DC/DC converter, D2, as shown in Figure 1b. Unfortunately, in this scenario, noncritical loads connected to the upstream DC/DC supply can draw power from the backup supply, leaving less energy for critical loads.

3.3V Backup Supply Operation

Figure 2 shows a solution to producing a 3.3V backup supply that reserves energy for critical loads using a blocking MOSFET. The blocking diode shown in Figure 1 is replaced by Q1, a low gate threshold voltage power P-channel MOSFET.

The key to operating the backup supply in a 3.3V environment is the addition of the series RA-CA circuit. At start-up, as the input voltage rises, the current through the capacitor CA is governed by the equation $I_C = C \cdot (dV/dt)$. This current generates a potential across RA, enough to enhance Q2, a low gate threshold voltage small signal N-channel MOSFET. As Q2 turns on, it pulls the gate of the Q1 to ground, providing an extremely low resistance path from the input voltage to the supply pins V_{IN} of LTC3643. Once 3.3V is applied to the converter, it starts up, pulling down both the gate of Q1 and the PFO pin, and it starts charging the storage capacitor.

As the 3.3V rail reaches steady state, the I_C current reduces to the point where the voltage across RA falls below the Q2 gate threshold level and Q2 turns off, no longer affecting the functionality of the backup converter. Also, the PFO pin grounds R3A, resetting the PFI pin power fail voltage level to the minimum 3V, to ensure that the converter remains operational when the input voltage source is disconnected.

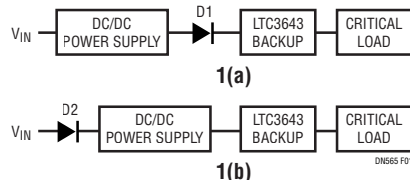
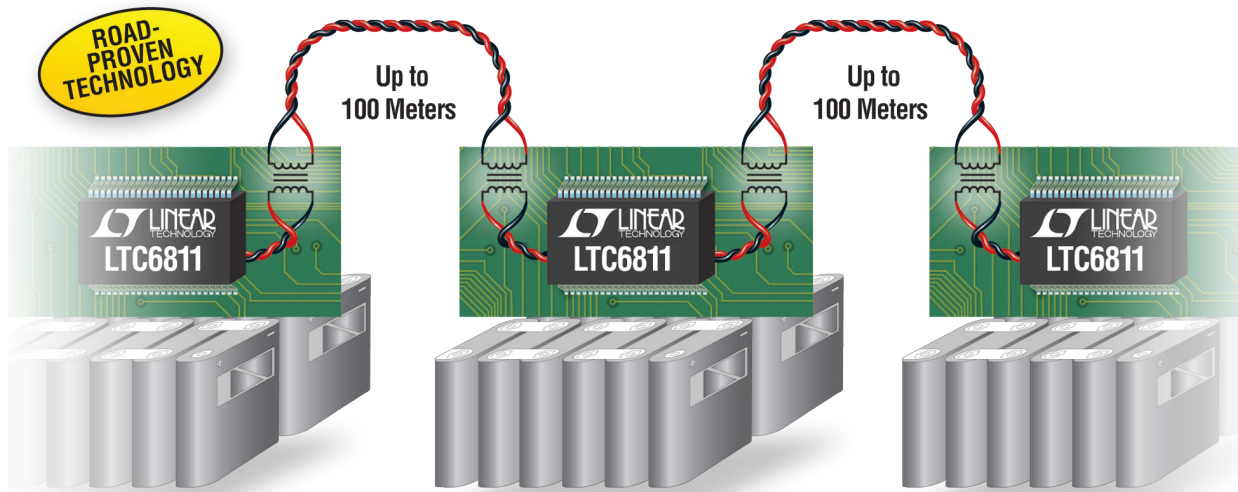


Figure 1(a) and (b). Location of the Blocking Diode in the Backup System Schematic

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1.2mV Accurate, Noise Immune Battery Stack Monitor

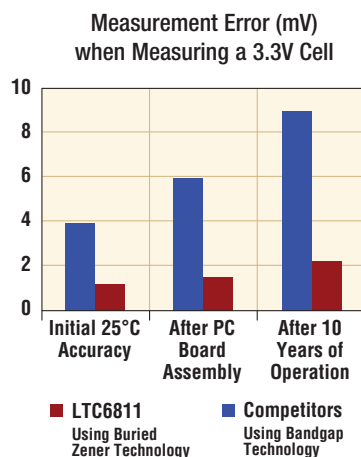


Maximize Battery Pack Safety, Life, Capacity & Driving Range

Safely extract the potential of large battery packs via precise monitoring of every cell. The LTC[®]6811 Battery Monitor measures cell voltage with less than 0.04% error, guaranteed. Measurement stability over time, temperature and operating conditions is achieved with a buried Zener voltage reference, similar to those in precision instrumentation. A programmable 3rd order noise filter keeps noise from corrupting cell measurements, and a 2-wire isoSPI[™] interface provides a cost-effective, noise immune, 100 meter interconnection for multiple LTC6811s.

▼ Features

- Total Measurement Error < 1.2mV
- Long Term Stability Assured with Laboratory-Grade Voltage Reference
- isoSPI, Isolated 2-Wire Interconnection up to 100 Meters
- 290µs to Measure All Cells
- Passive Cell Balancing
- 4µA Sleep Mode Supply Current
- AEC-Q100
- Engineered for ISO 26262 Compliance



▼ Info & Free Samples

www.linear.com/product/LTC6811
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Download White Paper
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