02.2008

Power Management for LEDs

High Performance Analog ICs

LINEAR TECHNOLOGY

LEDs and LED Driver Technology

A light-emitting diode (LED) is a semiconductor device that emits incoherent narrow-spectrum light when electrically forward biased, resulting in a form of electroluminescence. The color of the emitted light depends on the chemical composition of the semiconductor material used, and can be near-ultraviolet, visible or infrared. LEDs are more prevalent today than ever before, replacing traditional incandescent bulbs and fluorescent lights in many applications. Unlike ordinary incandescent bulbs, LEDs do not have a filament that will burn out, and they tend to run cooler. Incandescent bulbs waste 95 percent of the energy they consume as heat. Fluorescent bulbs are more efficient, but their harsh color has prevented them from fully penetrating the lighting market.

Key Advantages of LEDs vs. Alternative Lighting Sources

- High energy efficiency – LEDs use only 10% of the electricity required to power traditional incandescent bulbs and give off less heat with similar light output; efficiencies approach that of fluorescent bulbs
- Extremely long life – typically ten years, twice as long as the best fluorescent bulbs and twenty times longer than the best incandescent bulbs
- Solid state reliability
- Nearly indestructible, solid epoxy lens cases – insensitive to vibration and shock
- Added safety – lamps typically remain cool to the touch and operate at a relatively low voltage
- Fast turn-on time – light up very quickly
- Compact size
- Capable of emitting light of an intended color without the use of color filters
- The shape of the LED package allows light to be focused. Incandescent and fluorescent sources often require an external reflector to collect light and direct it in a usable manner
- Fail by dimming over time, rather than the sudden burn-out of incandescent bulbs

The main advantage of LEDs is high efficiency. In conventional incandescent bulbs, the light production process involves the generation of a lot of heat (to warm the filament). This is completely wasted energy since the majority of the available energy is not converted into visible light. On the other hand, LEDs generate relatively little heat. A much higher percentage of the electrical power into the LED goes directly toward generating light, significantly reducing power demands.

Key advances in LED reliability have enabled lifetimes in excess of 100,000 hours. These advances include alternative semiconductor doping techniques, new optical lens technologies and advanced heat sink and packaging techniques. Many developments are underway that may increase efficiency and lifetimes even further, including new case/housing designs, further improvements in light conversion efficiency, production of larger semiconductors and more thermally efficient packages for higher current operation.

LED Driver Technology

LED driver circuits are available in a variety of topologies, including series (switchmode) drivers and parallel (non-inductor based) drivers. Selecting the appropriate IC and topology depends on the following:

- The relation of LED voltage to battery voltage range
- Efficiency – crucial for driving high brightness (HB) LEDs such as in automotive electronics
- Current consumption required during off-time
- Ability to accurately regulate LED current – eliminates the need for ballast resistors
- Dimming characteristics required
- Total solution size and cost

LED driver circuits tend to be smaller in size compared to alternative solutions, increasing their appeal in space-constrained portable power applications. Popular switchmode LED driver configurations include buck, boost, buck-boost, and SEPIC, with the ability to drive currents from 25mA/LED to 1.5A/LED or more.

Boost-converter-based series LED drivers offer the best possible brightness matching and high efficiency due to inductor-based boosting. PCB traces are also minimized by the series-driver topology, enabling flexibility in space-constrained portable electronic devices.

Higher LED currents result in higher LED forward voltages, and vice-versa. Forward voltage also varies inversely with temperature. Buck-boost topology circuits are advantageous, as the forward voltage of the LED may be above or below the battery (e.g., Lithium-Ion/Polymer) depending on the operating conditions.

Charge pump (inductorless)-based LED drivers are an excellent choice where low to moderate current levels are required and board space is limited. These types of drivers generate a boosted supply to power multiple LEDs connected in parallel. Charge pumps offer a small, low profile solution and are capable of high-efficiency conversion via operation in multiple conversion modes, and are cost-effective to implement. Because charge pumps power LEDs in parallel, they are well-suited for multiple display applications. Charge pumps also have the benefit of low conducted and radiated noise performance.

LEDs are driven with constant current, and DC current level is proportional to LED brightness. To vary the LED brightness, there are two methods of dimming the light by controlling the LED current. The first method is analog dimming, in which the LED DC current level is reduced proportionally to a maximum 10:1 ratio by reducing the constant LED current level. Reducing the LED current further can result in a change in LED color or inaccurate control of the LED current. The second method is digital or PWM dimming. PWM dimming switches the LED on and off at a frequency at or above 100Hz (not perceivable by the human eye). The PWM dimming duty cycle is proportional to LED brightness, while the on-time LED current remains at the same level set by the LED driver IC, maintaining constant LED color during high dimming ratios, i.e., True Color PWM™ Dimming. This method of PWM dimming may be used with ratios as high as 3000:1 in some applications.

Choosing the best LED driver or display bias power IC depends on many factors. As a result, Linear Technology provides a broad range of LED solutions.

Key LED Applications for Semiconductor ICs:

- Automotive Lighting – Interior and Exterior
- Commercial Lighting
- LCD and CCD Panel Backlights
- Photo Sensors
- Portable Electronic Devices
- Residential Lighting
- Signaling
- Signs and Illumination

LED Driver Solutions

Linear Technology has a broad line of LED drivers including inductor based (for LEDs in series) and inductorless (for LEDs in parallel) converters. These are offered in various topologies, providing the highest efficiency, lowest noise and smallest footprints. Other key features include integrated Schottky diodes, accurate LED current matching, a variety of dimming options and multiple output capability.

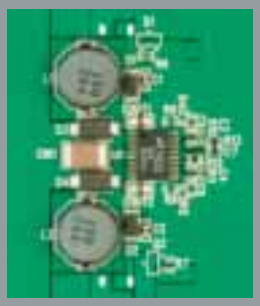
This selection guide features recommended Linear Technology solutions for a wide variety of LED driver applications. For information on our latest products, visit our website at www.linear.com.

High Power (350mA to 10A) LED Drivers - Buck

High-current inductor-based step-down switching LED drivers provide tiny, efficient high power LED lighting solutions for automotive, architechtural and display backlighting. Key features include wide-ranging True Color PWM dimming, wide input voltage range, high side sensing and high switching frequency.

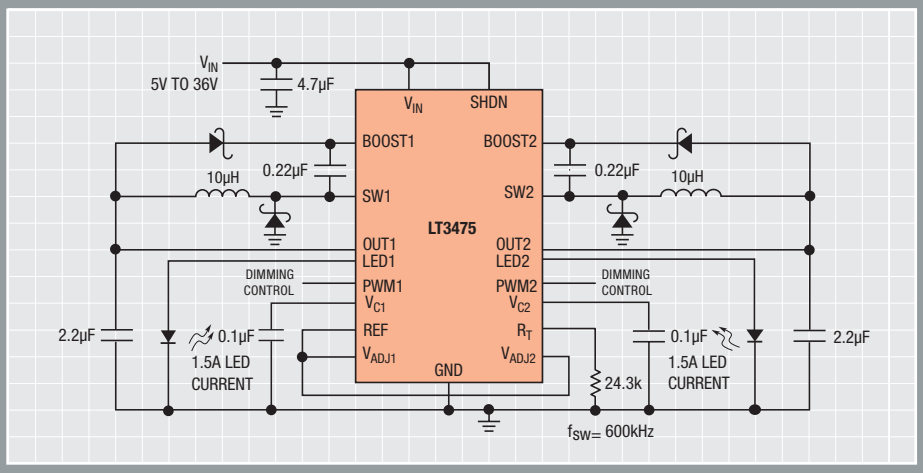
Applications:

- Automotive and Avionic Lighting
- Architectural Detail Lighting
- Display Backlighting
- Constant Current Sources

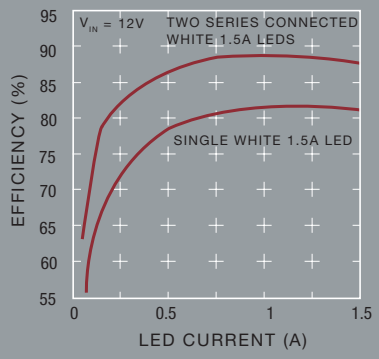


LT3475: Actual Size, Complete Solution

LT3475 : Dual Step Down 1.5A LED Driver



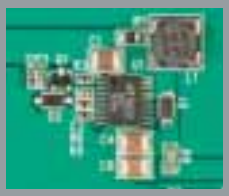
Efficiency



Part Number	Topology	Dimming Type	Max # of LEDs x I_{LED} from $24V_{IN}$	LED Configuration	Input Voltage Range (V)	Max. Output Voltage (V)	I_{SW}(A)	Operating Efficiency (%)	Package
High Power (350mA to 10A) LED Drivers - Buck									
LT3474	Buck LED Driver	400:1 PWM	3 x 500mA	Series (3 max)	4 to 36	15	1	87	TSSOP-16E
LT1618	Buck LED Driver	DC/PWM	2 x 350mA	Series (2 max)	1.6 to 18	30	1.5	87	3x3 DFN, MSOP-10
LT3477	SEPIC, Buck, Boost, Buck/Boost, Flyback, Inverter	DC/PWM	5 x 1A	Parallel or Series	2.5 to 25	Depends upon Configuration	3	91	4x4 QFN-20, TSSOP-20E
LT3478 /-1	Buck, Boost, Buck/Boost	3000:1 PWM	8 x 1.5A	1 Series String (8 max)	2.7 to 36	40	4.5	92	TSSOP-16E
LT3475	Dual Buck LED Driver	3000:1 PWM	6 x 1.5A	2 x Multiple Series String (3 max)	4 to 36	15	2 x 1.5	88	TSSOP-20E
LT3476	Quad Buck, Boost, Buck/ Boost LED Driver	1000:1 PWM	4 x 5 x 1A	4 x Multiple Series String (8 max)	2.8 to 16	Depends upon Configuration	4 x 1.5	96	5x7 QFN-38
LTC3783	SEPIC, Buck, Boost, Buck/ Boost, Flyback, Inverter	3000:1 PWM, 10:1 Analog	4 x 12 x 1A	Series/Parallel	3 to 36+	Limited by ext. FET	<10	97	4x5 DFN-16, TSSOP-16E

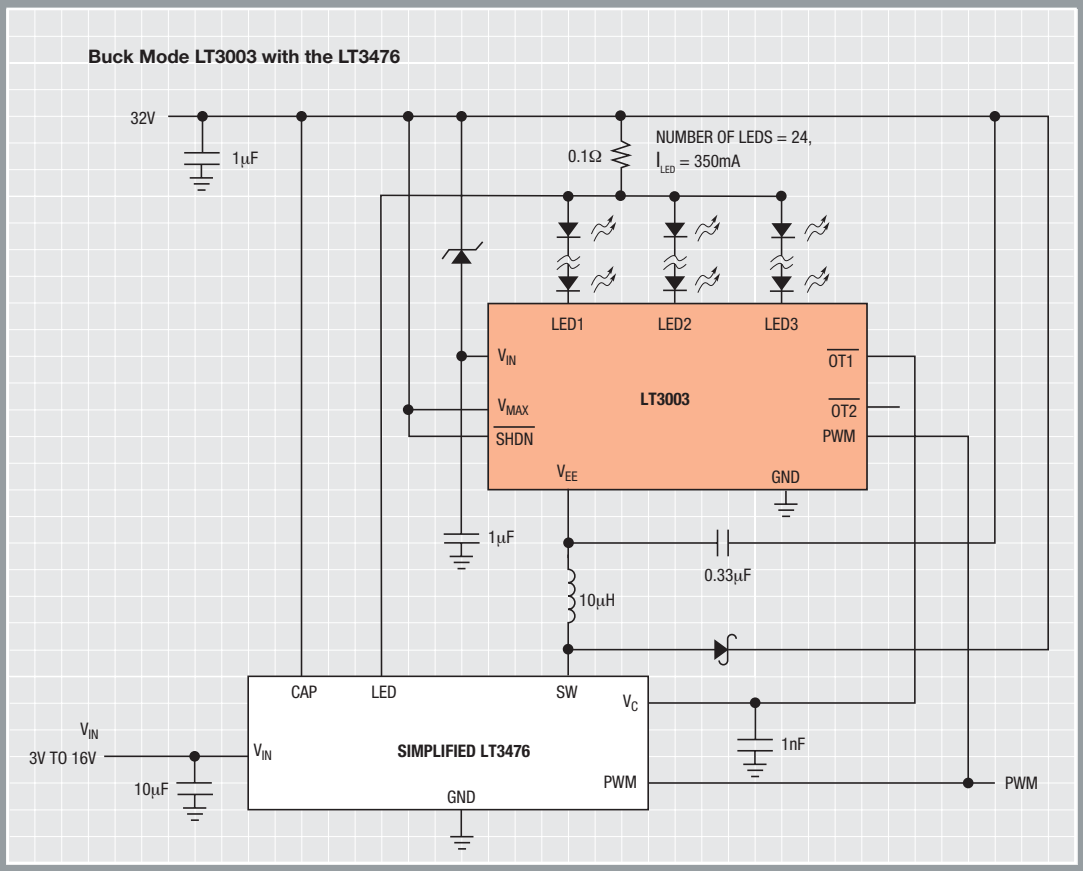
LT3003: 3-Channel LED Ballaster with PWM for up to 24 LEDs

- Can Drive up to 3 Strings with 8 LEDs per String
- 3% LED Current Matching
- Up to 350mA Continuous Current per LED String
- Up to 3000:1 PWM Dimming Range
- PWM Input Disconnects LED Strings
- Can Operate in Buck, Boost and Buck-Boost Modes
- Wide Input Range: 3V to 40V
- Overtemperature Outputs
- Works with LT1618, LT3477, LT3474, LT3475, LT3476, LTC3783
- Thermally Enhanced 10-Pin MSOP Package



LT3477: Actual Size, Complete Solution, see opposite page

Buck Mode LT3003 with the LT3476



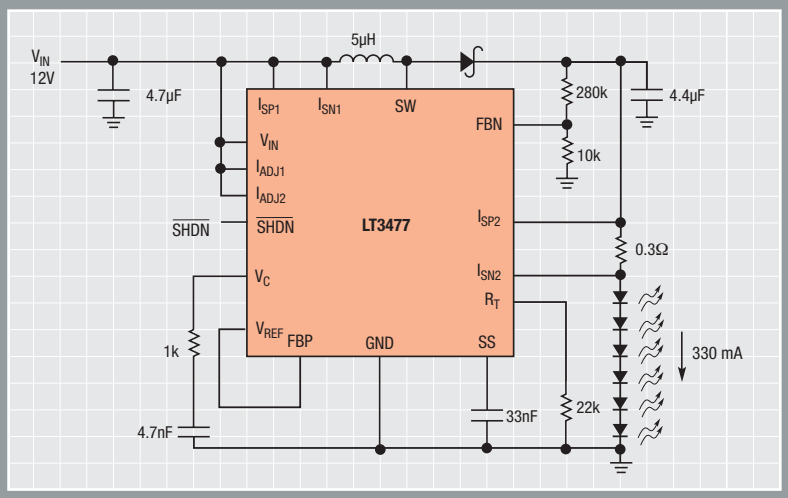
High Power (350mA to 10A) LED Drivers - Boost

High-current inductor-based step-up switching LED drivers provide compact, efficient, LED lighting solutions for notebook computer displays, cell phone camera lighting, automotive dashboard lighting, and avionics displays. Key features include high-current, high voltage switches, wide-ranging True Color PWM dimming, wide input voltage range, and high switching frequency.

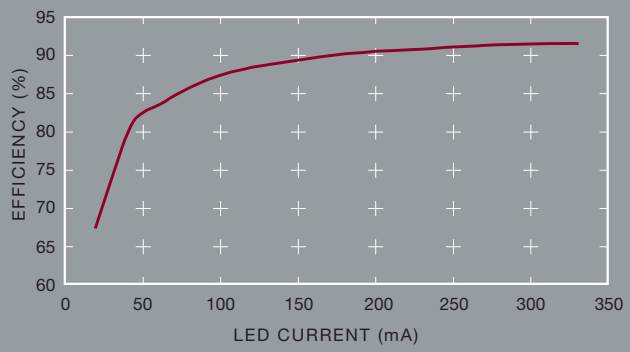
Applications:

- High Power LED Driver
- DSL Modems
- Distributed Power
- CVCC Source
- Input/ Output Current Limited Boost, SEPIC, Inverting, Flyback Converters

LT3477: 6 x 330mA LED Driver with Open LED Protection



Efficiency



Part Number	Topology	Dimming Type	Max # of LEDs x I_{LED} from $12V_{IN}$	LED Configuration	Input Voltage Range (V)	Max. Output Voltage (V)	I_{SW}(A)*	Operating Efficiency (%)	Package
High Power (350mA to 10A) LED Drivers - Boost									
LTC3490 **	Sync Boost LED Driver	DC/PWM	1 x 350mA	Single LED	1 to 3.2	4	I_{LED} = 350mA	90	3x3 DFN-8, MSOP-8
LT3486	Dual LED Driver	1000:1 PWM	2 x 7 x 350mA	Dual Parallel Strings	2.7 to 24	35	2 x 1.3	85	3x5 DFN-16
LT1618	Boost LED Driver	DC/PWM	7 x 350mA	Parallel or Series Strings	1.6 to 18	36	1.5	80	3x3 DFN-10 MSOP-10
LT3479	Boost LED Driver	DC/PWM	6 x 1A	Series Strings	2.5 to 24	40	3	89	3x4 DFN-14, TSSOP-16E
LT3477	SEPIC, Buck, Boost, Buck/ Boost, Flyback, Inverter	DC/PWM	6 x 1A	Series	2.5 to 25	40	3	92	4x4 QFN-20, TSSOP-20E
LT3478/-1	Boost LED Driver	3000:1 PWM	6 x 700mA	Series Strings	2.7 to 36	40	4.5	91	TSSOP-16E
LT3476	Quad Buck, Boost, Buck/ Boost LED Driver	1000:1 PWM	4 x 8 x 350mA	4 x Multiple Series String	2.8 to 16	36	4 x 1.5	83	5x7 QFN-38
LTC3783	SEPIC, Buck, Boost, Buck/ Boost, Flyback, Inverter	3000:1 PWM 10:1 Analog	12 x 3 x 1A	Series/Parallel	3 to 36+	Limited by ext. FET	Ext FET	95	4x5 DFN-16, TSSOP-16E

* I_{OUT} ~ 0.65 I_{SW} x (V_{IN} / V_{OUT}). Estimate: may vary depending on external component selection.
** Max V_{IN} = 3.2V

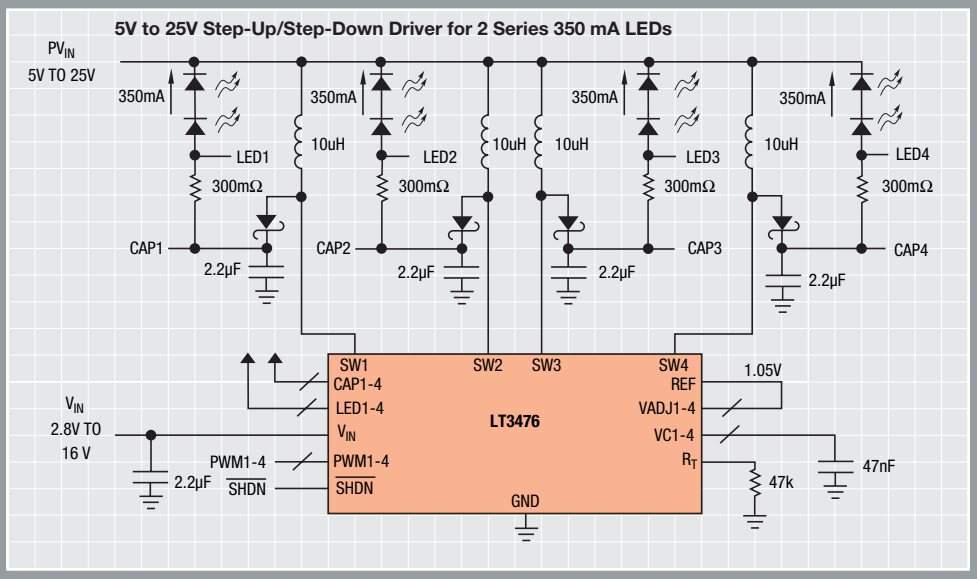
High Power (350mA to 10A) LED Drivers - Buck-Boost

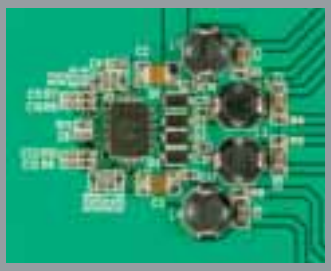
High-current inductor-based buck-boost switching LED drivers provide flexible, tiny, efficient solutions for DSL modem, CVCC and distributed power applications. Key features include high-current, high-voltage switches, adjustable LED currents, wide input voltage range, and high-switching frequency.

Applications:

- RGGB Lighting
- Automotive and Avionic Lighting
- TFT LCD Backlighting
- Constant-Current Sources

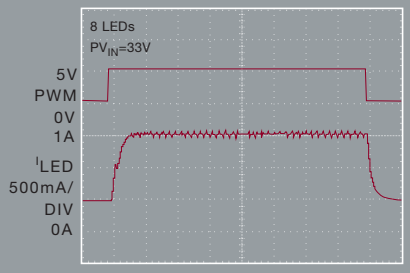
LT3476: High-Current Quad Output LED Driver





LT3476: Actual Size, Complete Solution

100:1 PWM Dimming at 120Hz



Part Number	Topology	Dimming Type	Max # of LEDs x I_{LED} from 12 V_{IN}	LED Configuration	Input Voltage Range (V)	Max. Output Voltage (V)	I_{SW} (A)	Operating Efficiency (%)	Package
High Power (350mA to 10A) LED Drivers - Buck-Boost									
LT1618	Buck/Boost	DC/PWM	1 x 350mA	Series	1.6 to 18	35	1.5	78	3x3 DFN-10, MSOP-10
LTC3453	Synchronous Buck-Boost LED Driver	DC/PWM	1 x 500mA	1 LED	2.7 to 5.5	4.5	1.1	90	4x4 QFN-16
LTC3454	Synchronous Buck-Boost LED Driver	DC/PWM	1 x 1A	1 LED	2.7 to 5.5	5.15	2.5	93	3x3 DFN-10
LT3477	SEPIC, Buck, Boost, Buck/ Boost, Flyback, Inverter	DC/PWM	5 x 350mA	Series	2.5 to 25	40	3	78	4x4 QFN-20, TSSOP-20
LT3478/-1	Buck, Boost, Buck/Boost	3000:1 PWM	4 x 1A	Series	2.7 to 36	40	4.5	92	TSSOP-16E
LT3476	Quad Buck, Boost, Buck/ Boost LED Driver	1000:1 PWM	4 x 4 x 350mA	4 x Multiple Series String	2.8 to 16	36	4 x 1.5	78	5x7 QFN-38
LTC3783	SEPIC, Buck, Boost, Buck/ Boost, Flyback, Inverter	3000:1 PWM, 10:1 Analog	12 X 3 x 1A	Series/Parallel	3 to 36	Limited by ext. FET	Ext FET	93	4x5 DFN-16, TSSOP-16

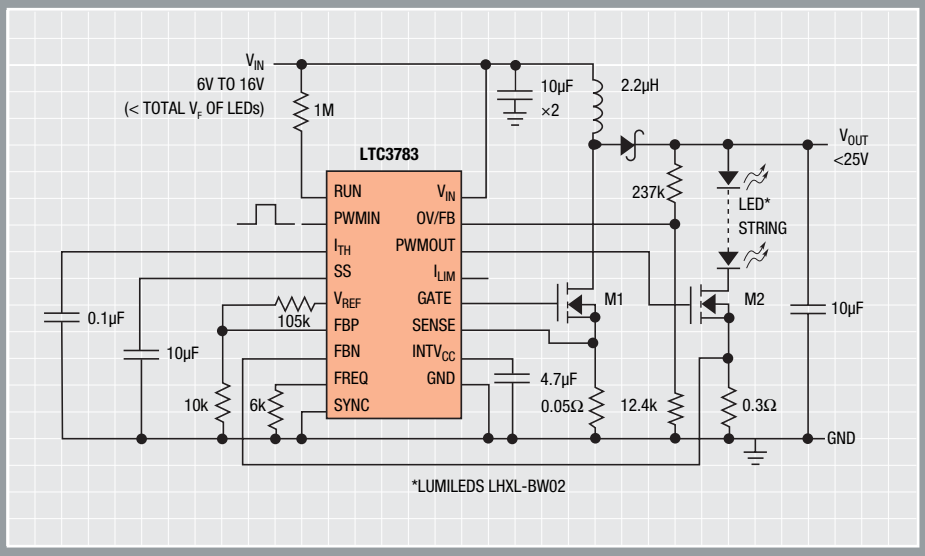
High Power (350mA to 10A) LED Drivers - Multi-Topology

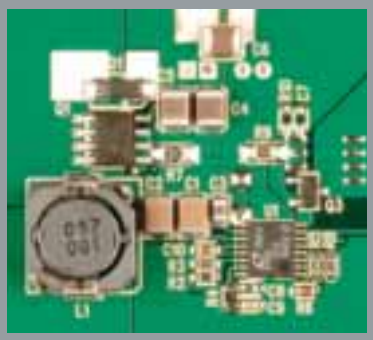
High-current inductor-based multi-topology switching LED drivers provide flexible solutions for high-voltage LED arrays. Key features include high current, wide input voltage range, scalable output voltage, and wide-ranging True Color dimming.

Applications:

- RGGB Lighting
- Automotive and Avionic Lighting
- TFT LCD Backlighting
- Constant-Current Sources

LTC3783: PWM LED Driver in Boost Mode





LTC3783: Actual Size, Complete Solution

Part Number	Topology	Dimming Type	Max # of LEDs x I_{LED}	LED Configuration	Input Voltage Range (V)	Max. Output Voltage (V)	I_{SW} (A)	Operating Efficiency (%)	Package
High Power (350mA to 10A) LED Drivers - Multi-Topology									
LT1618	SEPIC, Buck, Boost, Buck/ Boost, Flyback, Inverter	DC/PWM	2 x 350mA (In Buck-Mode)	Series	1.5 to 18	Depends on Configuration	1.5	85	3x3 DFN-10, MSOP-10
LT3477	SEPIC, Buck, Boost, Buck/ Boost, Flyback, Inverter	DC/PWM	4 x 1A (In Buck-Mode)	Series	2.5 to 25	Depends on Configuration	3	91	4x4 QFN-20, TSSOP-20E
LT3478/ -1	Buck, Boost, Buck/Boost	3000:1 PWM	8 x 1.5A (In Buck-Mode)	Series	2.7 to 36	Depends on Configuration	4.5	92	TSSOP-16E
LT3476	Quad Buck, Boost, Buck/ Boost LED Driver	1000:1 PWM	4 x 8 x 1A (In Buck-Mode)	4 x Multiple Series String	2.8 to 16	Depends on Configuration	4 x 1.5	96	5x7 QFN-38
LTC3783	SEPIC, Buck, Boost, Buck/ Boost, Flyback, Inverter	3000:1 PWM, 10:1 Analog	4 x 12 x 1A (In Buck-Mode)	Series/Parallel	3 to 36	Limited by ext. FET	Ext FET	90+	4x5 DFN-16, TSSOP-16

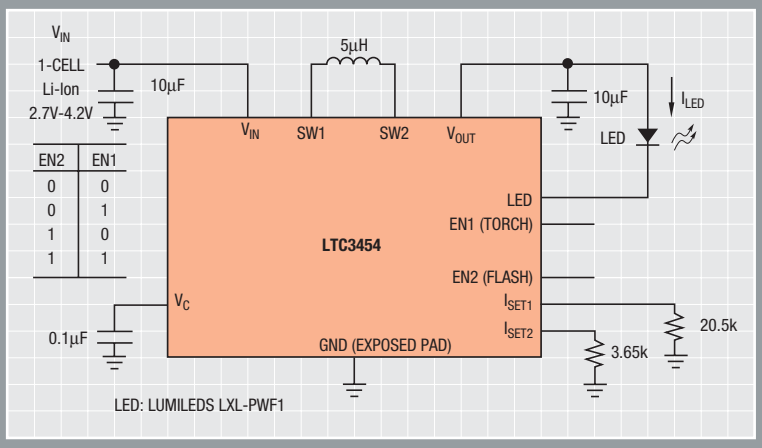
Medium to High Power (100mA to 2A) LED Drivers for PhotoFlash/Torch Lighting

High-current inductor-based switching LED drivers for camera photoflash, torch and video lighting feature various topologies including buck-boost and boost and provide tiny, efficient high power solutions for camera phone applications.

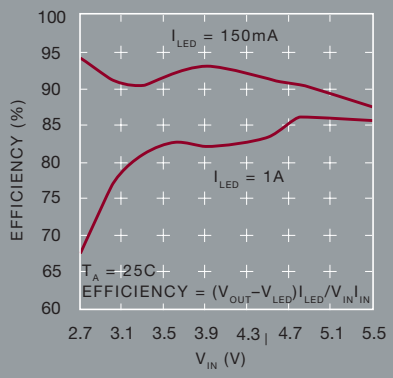
Applications:

- Cell Phone Camera Flash
- Cell Phone Torch Lighting
- Digital Cameras
- PDAs
- Misc. Li-Ion/Polymer-Based Systems

LTC3454: 1A Synchronous Buck-Boost High Current LED Driver



LED Power Efficiency vs V_{IN}



LTC3454: Actual Size, Complete Solution

Part Number	Topology	V_{IN} (V)	V_{OUT} (V)*	Max. Total LED Current (mA)*	Max. No. of White LEDs	Dimming Control	Frequency (MHz)	I_Q (mA)	I_{SD} (µA)	Package
Medium to High Power (100mA to 2A) LED Drivers for PhotoFlash/Torch Lighting										
LTC3452	Buck-Boost	2.7 to 5.5	4.5	200	4	DC/PWM	1	0.6	<1	4x4 QFN-20
LTC3490	Boost	1.0 to 3.2	4	350	1	DC/PWM	1.3	1	<50	3x3 DFN-8, SO-8
LTC3453	Buck-Boost	2.7 to 5.5	4.5	500	1	DC/PWM	1	2.5	<6	4x4 QFN-16
LT1618	Buck-Boost	1.6 to 18	34	500	1	DC/PWM	1.4	1.8	<1	MSOP-10
LTC3454	Buck-Boost	2.7 to 5.5	5.15	1A	1	DC/PWM	1	0.8	<1	3x3 DFN-10
LT3477	Buck-Boost, Boost	2.5 to 25	42	2A	1	DC/PWM	200kHz to 3.5MHz	5	<1	TSSOP-20E, 4x4 QFN-20
LT3479	Boost	2.5 to 24	40	2A	1	DC/PWM	1	6.5	<1	TSSOP-16, 3x4 DFN-14

* Output voltage and current depend on the choice of external components

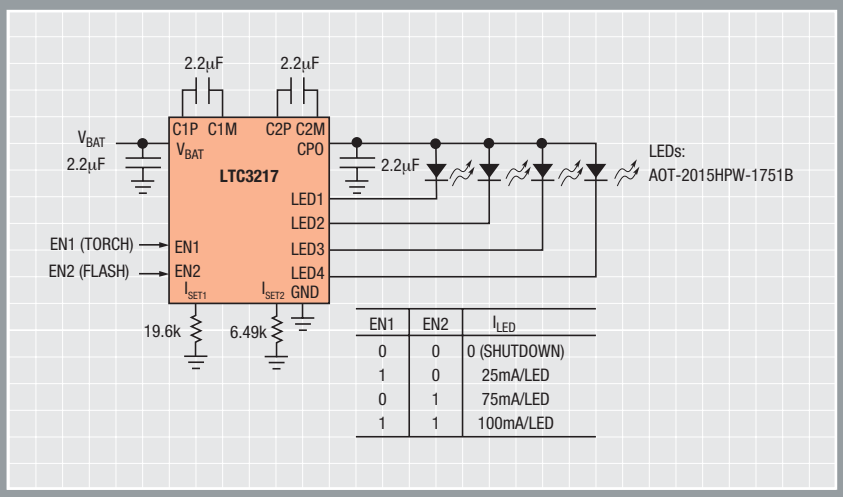
High Power (350mA to 1A) LED Drivers for Camera Flash - Inductorless

Our family of inductorless charge pump-based LED driver products features a range of performance options, the smallest footprint and highest efficiency. The ICs efficiently drive low, medium and high current white LEDs for a wide range of camera flash applications.

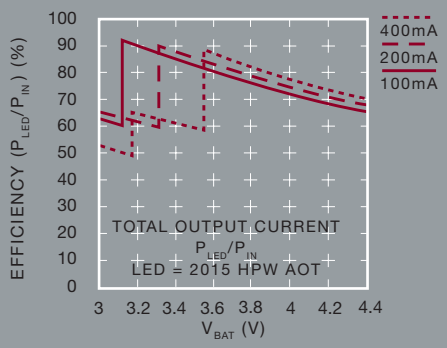
Applications:

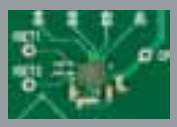
- Multi-LED Camera Light Supply for Cellphones/DSCs/PDAs

LTC3217: 600mA Low Noise Multi-LED Camera Charge Pump



Efficiency vs V_{BAT}





LTC3217: Actual Size, Complete Solution

Part Number	V_{IN} (V)	Conversion Ratio	Max. Total LED Current (mA)	Max. # of White LEDs	Dimming Control	Operating Efficiency (%)	Frequency (MHz)	I_Q (mA)	I_{SD} (µA)	Package
High Power (350mA to 1A) LED Drivers for Camera Flash - Inductorless										
LTC3218	2.9 to 4.5	1x/2x	400	1*	Resistor/PWM	92	1	0.98	<1	2x3 DFN-10
LTC3214	2.9 to 4.4	1x/1.5x/2x	500	1*	Resistor/PWM	85	0.9	0.98	<2.5	3x3 DFN-10
LTC3217	2.9 to 4.5	1x/1.5x/2x	600	4	Resistor/PWM	86	0.9	0.4	<4	3x3 QFN-16
LTC3215	2.9 to 4.4	1x/1.5x/2x	700	1*	Resistor/PWM	90	0.9	0.3	<2.5	3x3 DFN-10
LTC3216	2.9 to 4.4	1x/1.5x/2x	1000	1*	Resistor/PWM	90	0.9	0.3	<2.5	3x4 DFN-12

* High Current LED

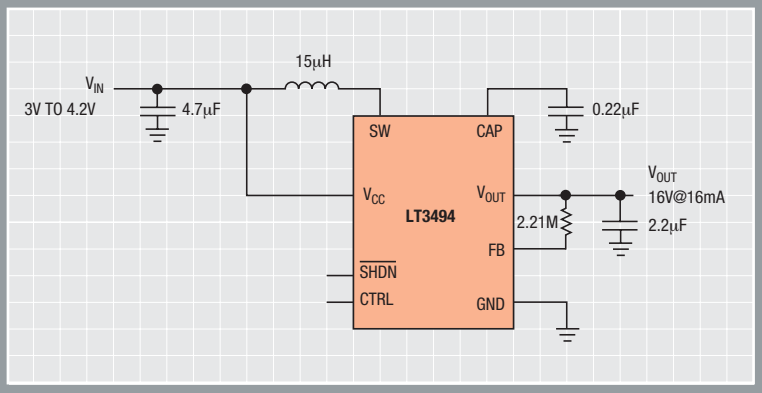
Drivers for Organic LED (OLED) Bias

Linear Technology delivers highly integrated solutions for OLED bias applications. Key features include output disconnect, soft start and integrated Schottky diodes. Their small circuit size and high efficiency make them ideal solutions for space-conscious portable device applications such as cellular phones and media players.

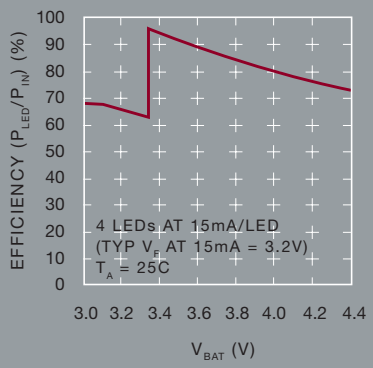
Applications:

- Organic LED Power Supply
- Low Noise Power
- MP3 Players

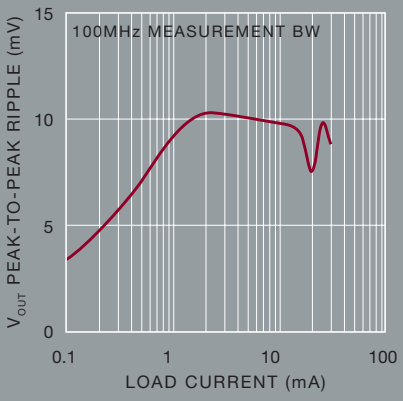
LT3494: Micropower Low Noise Boost Converter with Output Disconnect



4-LED MAIN Display
Efficiency vs Input Voltage



Output Voltage Ripple vs
Load Current



LT3494: Actual Size, Complete Solution

LTC3208: Actual Size, Complete Solution, see opposite page

Part Number	Configuration	Topology	Input Voltage Range (V)	Max. Output Voltage (V)	I_{SW} (mA)	Operating Efficiency (%)	Package
Drivers for Organic LED (OLED)							
LTC3459	Single	Synchronous Boost	1.5 to 5.5	10	60	89	ThinSOT
LT3464	Single	Boost	2.3 to 10	34	85	84	ThinSOT
LT3494/A	Single	Boost	2.3 to 16	40	150/350	85	2x3 DFN-8
LT3463	Dual	Boost and Inverter	2.4 to 15	±40	180/320	77	3x3 DFN-10
LT3472	Dual	Boost and Inverter	2.2 to 16	±40	250/300	83	3x3 DFN-10
LT1613	Single	Boost	0.9 to 10	34	550	89	ThinSOT
LT3487	Dual	Boost and Inverter	2.3 to 16	±28	750/900	77	3x3 DFN-10
LT3473/A	Single	Boost	2.2 to 16	36	1.2A	77	3x3 DFN-8
LT3467/A	Single	Boost	2.4 to 16	40	1.4A	90	ThinSOT
LT3471	Dual	Boost or Inverter	2.4 to 16	±40	2 x 1.5A	86	3x3 DFN-10
LTC3458/L	Single	Synchronous Boost	1.5 to 6	7.5/6	1.4A/1.7A	96	3x4 DFN-12

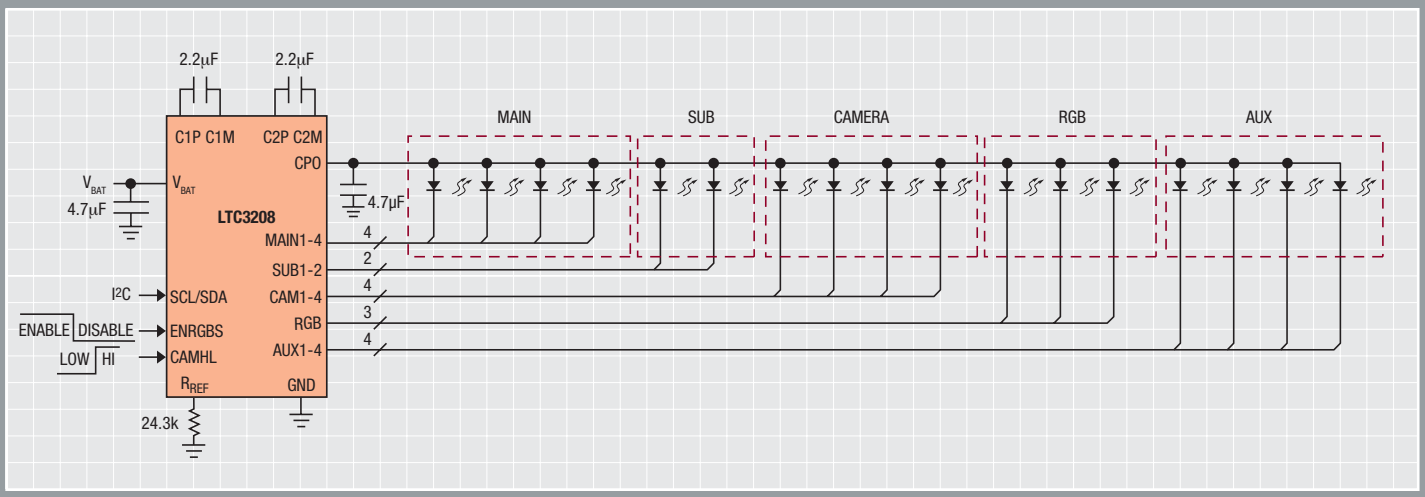
Low to Medium Power Multi-Display LED Drivers - Inductorless

Our family of inductorless, multi-display charge-pump-based LED drivers feature the highest level of integration, smallest footprint and highest efficiency. Individual display driver outputs eliminate the need for ballast resistors. These ICs optimize flexibility for designers of portable products, ranging from fully featured, multi-display cellular phones to high-current/high-resolution camera flash electronic devices.

Applications:

- Multi-Display Cellular Phones
- Video/Camera Phones with QVGA+ Displays
- General Purpose LED Lighting

LTC3208: 1A High Efficiency 5-Display LED Driver (see opposite page)



Part Number	V_{IN} (V)	Conversion Ratio	Max. Total LED Current (mA)	Number of Displays	Display Types	Max. # of White LEDs	Dimming Control	Operating Efficiency (%)	Frequency	I_Q (µA)	I_{SD} (µA)	Package
Low to Medium Power Multi-Display LED Drivers - Inductorless												
LTC3212	2.7 to 5.5	1x/2x	75	3	RGB	3****	1-wire	92	900kHz	400	<3	2x3 DFN-12
LTC3219	2.9 to 5.5	1x/1.5x/2x	250	3	Main, SUB, RGB	9***	I²C	93	850kHz	400	<2	3x3 QFN-20
LTC3206	2.8 to 4.5	1x/1.5x	400	3	Main, SUB, RGB	4 + 2 + 3	SPI*	90	1MHz	180	<1	4x4 QFN-24
LTC3210/-1	2.9 to 4.5	1x/1.5x/2x	500	2	Main, CAM	4 + 1**	1-wire	93	800kHz	400	<3	3x3 QFN-16
LTC3209-1	2.9 to 4.5	1x/1.5x/2x	600	3	Main, CAM, Aux	6 + 1** + 1	I²C	94	850kHz	400	<3	4x4 QFN-20
LTC3209-2	2.9 to 4.5	1x/1.5x/2x	600	3	Main, CAM, Aux	5 + 2** + 1	I²C	94	850kHz	400	<3	4x4 QFN-20
LTC3207	2.9 to 5.5	1x/1.5x/2x	600	4	Main, Sub, CAM, RGB	12*** + 1**	I²C	90	850kHz	400	<2	4x4 QFN-24
LTC3208	2.9 to 4.5	1x/1.5x/2x	1000	5	Main, SUB, CAM, RGB, Aux	4 + 2 + 4 + 3 + 4	I²C	90	850kHz	250	<1	5x5 QFN-32

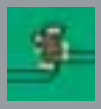
* Serial Peripheral Interface ** High Current LED *** Universally Configurable **** R, G, B LEDs

Low to Medium Power Single Output LED Drivers - Inductorless

Our family of charge pumps includes the widest selection of simple and compact inductorless DC/DC converter designs. These step-up converters offer low ripple and can be used to boost an input voltage to drive parallel LEDs. By eliminating the inductor, these switched capacitor converters provide small solution footprint and a simple design.

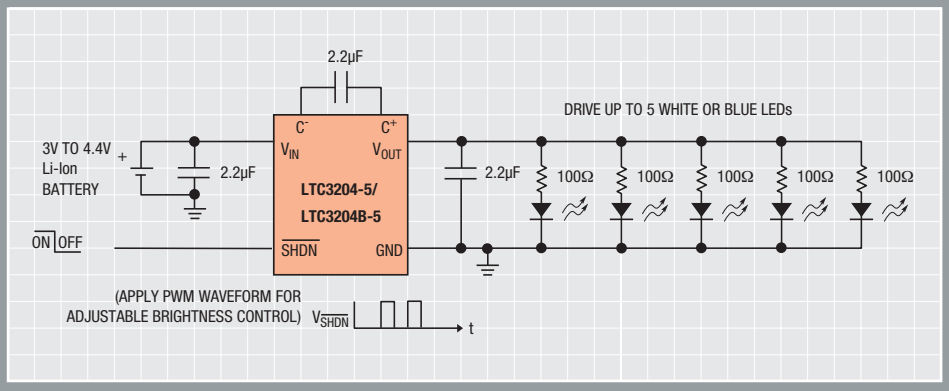
Applications:

- 2 AA Cell to 3.3V Conversion
- Li-Ion to 5V Conversion
- USB On-the-Go Devices
- LED Drivers
- Handheld Devices

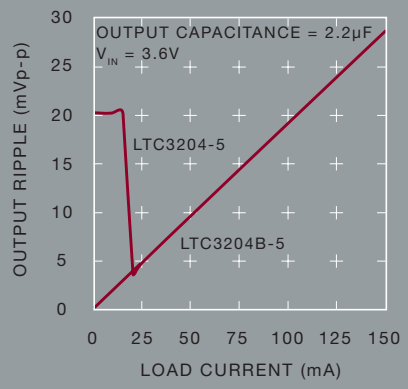


LTC3204-5: Actual Size, Complete Solution

LTC3204/B: Low Noise, Miniature 2x2 DFN Regulated Charge Pump Doubler



Output Ripple vs Load Current



Part Number	Dimming Type	# of LEDs	LED Configura-tion	Input Voltage Range (V)	Output Voltage (V)	Output Current (mA)	Operating Efficiency (%)	Package
Low to Medium Power LED Drivers - Inductorless								
LTC3200	PWM	5+	Parallel	2.7 to 4.5	Adj (1.268 to 5.4)	100	87	MSOP-8
LTC3200-5	PWM	5+	Parallel	2.7 to 4.5	5	100	87	ThinSOT
LTC3201	DAC	5+	Parallel	2.7 to 4.5	Adj (3.19 to 4.6)	100	87	MSOP-10
LTC3202	DAC	6+	Parallel	2.7 to 4.5	Adj (3.3 to 4.0)	125	87	3x3 DFN-10 MSOP-10
LTC3204-5*	PWM	6+	Parallel	2.7 to 5.5	5	150	93	2x2 DFN-6
LTC3204B-5	PWM	6+	Parallel	2.7 to 5.5	5	150	93	2x2 DFN-6
LTC3203B	PWM	6+	Parallel	2.7 to 5.5	Adj (0.9 to 5.4)	500	90	3x3 DFN-10
LTC3203-1*	PWM	6+	Parallel	2.7 to 5.5	4.5, 5	500	90	3x3 DFN-10
LTC3203B-1	PWM	6+	Parallel	2.7 to 5.5	4.5, 5	500	90	3x3 DFN-10

* Burst Mode Operation

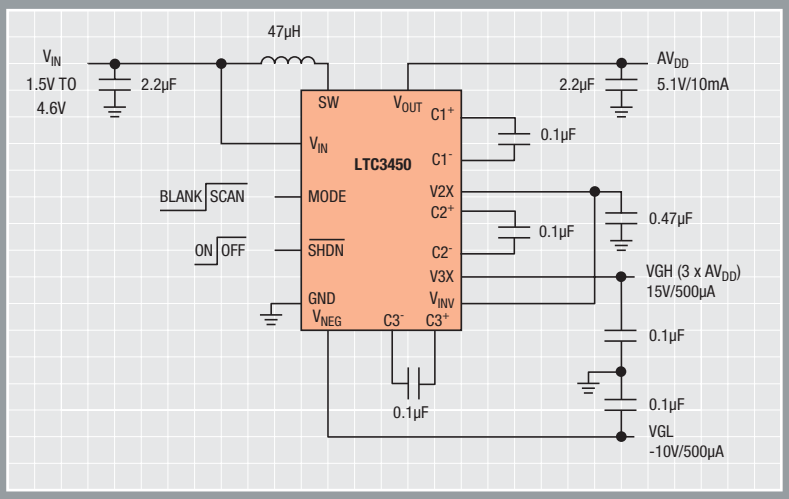
LCD and CCD Bias Power

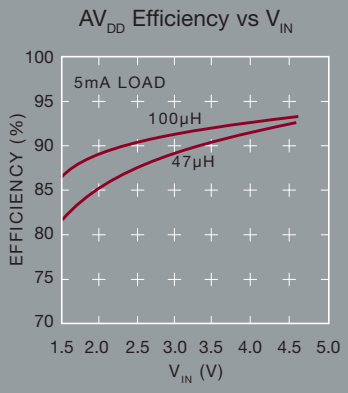
LCD and CCD Bias ICs deliver highly compact and efficient power supply solutions for small LCD displays. Key features include wide input voltage range, built-in inrush current limiting, output disconnect and power saving controls to simplify the task of implementing power friendly LCD displays.

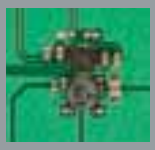
Applications:

- Cellular Handsets with Color Display
- Handheld Instruments
- PDAs

LTC3450: Triple Output Power Supply for Small TFT-LCD Displays







LTC3450: Actual Size, Complete Solution

Part Number	Number of Outputs	V_{IN} (V)	V_{OUT} (V)	I_{SW} (A)*	Frequency	I_Q (µA)	Output Disconnect	Package
LCD and CCD Bias Power								
LT1611	1	1.1 to 10	-34	0.55	1.4MHz	3mA	-	ThinSOT
LT1945	1	1.2 to 15	±34	0.25	Constant Off-Time	20	-	MSOP-10
LT1618	1	1.6 to 18	36	1.50	1.4MHz	1.8mA	-	MSOP-10
LT3472	1	2.2 to 16	±34	0.35	1.2MHz	2.8mA	Yes	3x3 DFN-10
LT3473/A	1	2.2 to 16	34	1.20	1.2MHz	150	Yes	3x3 DFN-8
LT3464	1	2.3 to 10	34	0.085	Constant Off-Time	25	-	ThinSOT
LT3467	1	2.4 to 16	40	1.10	1.3MHz	1mA	-	ThinSOT
LT3479	1	2.5 to 24	40	3.00	3.5MHz	5mA	-	DFN/TSSOP
LT3461/A	1	2.5 to 16	38	0.30	1.3MHz/ 3MHz	2.8mA	-	ThinSOT
LT1930/A	1	2.6 to 16	34	1.00	1.2MHz/ 2.2MHz	4.2mA/ 5.5mA	-	ThinSOT
LT1931/A	1	2.6 to 16	-34	1.00	1.2MHz/ 2.2MHz	5.8mA	-	ThinSOT
LTC1697	1	2.8 to 5.5	6	0.9	300kHz	0.9mA	-	MSOP-10
LT1617/-1	2	1.2 to 15	-34	0.35/0.10	Constant Off-Time	20	-	ThinSOT
LT3463/A	2	2.4 to 15	±40	0.25 x 2	Constant Off-Time	40	Yes	3x3 DFN-10
LT3471	2	2.4 to 16	±40	2 x 1.30	1.2MHz	2.5mA	-	3x3 DFN-10
LT3466-1	2	2.7 to 24	40	0.32 x 2	1.0MHz	5mA	-	3x3 DFN-10, TSSOP-16E
LTC3450	3	1.5 to 4.6	±15	0.09	550kHz	75	-	3x3 QFN-16
LT1942	4	2.6 to 16	44	0.55/0.15/ 0.5/0.5	1MHz	7mA	Yes	4x4 QFN-24

* $I_{OUT} \sim 0.65\ I_{SW} \times (V_{IN} / V_{OUT})$. Estimate: may vary depending on external component selection.

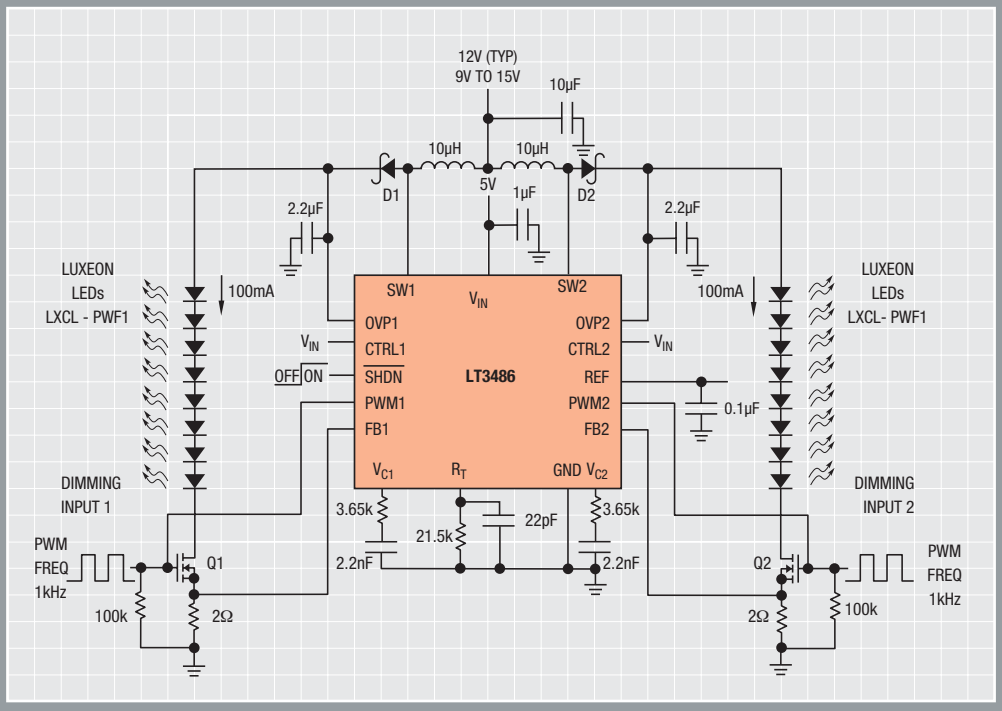
Low Power Multi-Display LED Drivers - Inductor Based

Multi-display inductor-based white LED drivers are capable of driving up to 20 white LEDs from a single cell Li-Ion/Polymer input. Key features include high-voltage internal power switches, internal Schottky diodes, adjustable switching frequency, DC dimming control, open LED protection and optimized internal compensation. They are ideal solutions for multipanel LCD backlight applications or space constrained portable applications such as cellular phones, PDAs and digital cameras.

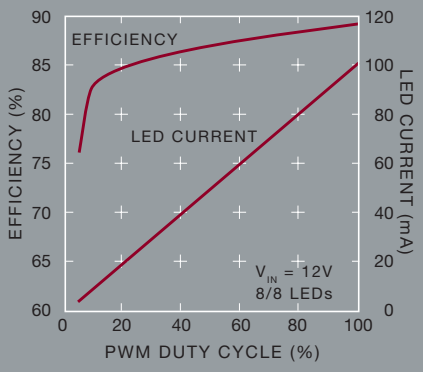
Applications:

- Notebook PC Displays
- LED Camera Light for Cell Phones
- Car Dashboard Lighting
- Avionics Displays

LT3486: Dual 1.3A White LED Step-Up Converter with 1000:1 Dimming Range



LED Current and Efficiency vs PWM Duty Cycle



LT3486: Actual Size, Complete Solution

Part Number	Type	Dimming Type	Max # of LEDs x I_{OUT}*	LED Configuration	Input Voltage Range (V)	Max. Output Voltage (V)	I_{SW} (mA)	Operating Efficiency (%)	Package
Low Power Multi-Display LED Drivers - Inductor Based									
LT3497	Dual LED Driver	250:1 PWM	2 x 6 x 20mA	Dual Series Strings	2.5 to 10	32	2 x 300	78	2x3 DFN-10
LT3466-1	LED Driver and Boost Converter	DC/PWM	10 x 25mA	Series	2.7 to 24	39.4	2 x 320	84	3x3 DFN-10, TSSOP-16E
LT3466	Dual LED Driver	DC/PWM	2 x 10 x 25mA	Dual Series Strings	2.7 to 24	39.4	2 x 320	84	3x3 DFN-10, TSSOP-16E
LTC3452	Synchronous Buck-Boost LED Driver	DC/PWM	5 x 20mA + 1 x 200mA	Parallel	2.7 to 5.5	4.5	1A	88	4x4 QFN-20
LT3486	Dual LED Driver	1000:1 PWM	2 x 10 x 100mA	Dual Series Strings	2.7 to 24	35.4	2 x 1.3A	85	3x4 DFN-16, TSSOP-16E

* Dependent on Input Voltage, number of LEDs from a 12V Input

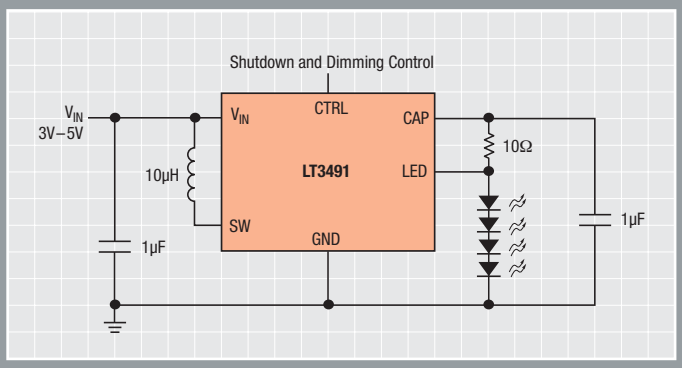
Low Power LED Drivers (up to 25mA/LED) - Inductor Based

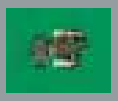
Low-current inductor-based switching LED drivers ensure light intensity matching across LEDs. Key features include the purest white LED color dimming control, low standby mode quiescent current, selectable current level, guaranteed LED brightness matching and extremely small circuit size, making them well suited for cellular phone and other portable backlight applications.

Applications:

- Cellular Phones
- PDAs, Handheld Computers
- Digital Cameras
- MP3 Players
- GPS Receivers

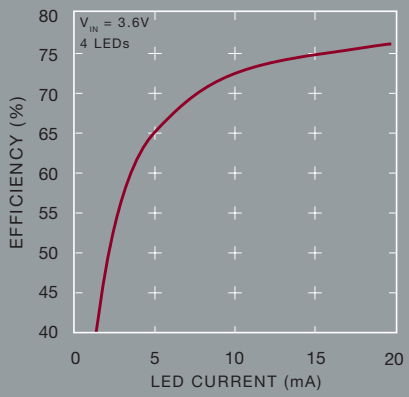
LT3491: White LED Driver in SC70 with Integrated Schottky





LT3491: Actual Size, Complete Solution

Efficiency



Part Number	Type	Dimming Type	Max # of LEDs x I_{OUT}*	LED Configuration	Input Voltage Range (V)	Max. Output Voltage (V)	I_{SW} (mA)	Operating Efficiency (%)	Package
Low Power LED Drivers - Inductor Based									
LT3465/A	LED Driver	DC/PWM	6 x 25mA	Series	2.7 to 16	30	225	81	ThinSOT
LT3591	LED Driver	90:1 PWM	10 x 20mA	Series	2.5 to 12	42	450	77	2x3 DFN-8
LT3491	LED Driver	300:1 PWM	6 x 25mA	Series	2.5 to 12	27	260	76	SC70
LTC3452	Synchronous Buck-Boost Converter	DC/PWM	5 x 20mA +200mA	Parallel	2.7 to 5.5	4.5	300	88	4x4 QFN-20
LT1937	LED Driver	DC/PWM	4 x 25mA	Series	2.5 to 10	34	320	84	ThinSOT, SC70
LT3497	Dual LED Driver	250:1 PWM	2x6x20mA	2 Parallel Series Strings of 6	2.5 to 10	32	2 x 300	77	2x3 DFN-10
LT3466	Dual LED Driver	DC/PWM	2 x 10 x 25mA	2 Parallel Series Strings of 10	2.7 to 24	40	2 x 320	84	3x3 DFN-10
LT3466-1	LED Driver/ Boost Converter	DC/PWM	10 x 25mA	Series	2.7 to 24	40	2 x 320	84	3x3 DFN-10
LT1932	LED Driver	DC/PWM	10 x 25mA	Series	1.0 to 10	34	400	80	ThinSOT
LT1942	Quad DC/DC Converter and LED Driver	DC/PWM	12 x 25mA	2 Parallel Series Strings of 6	2.6 to 16	44	550	77	4x4 QFN-24
LT1618	LED Driver	DC/PWM	8 x 25mA	Series	1.6 to 18	36	1.5A	86	MSOP-10

* from Single Cell Li-Ion / Polymer Input

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