

VOL 2

Power Management for LEDs

High Performance Analog ICs



LEDs and LED Driver Technology

LEDs

A light-emitting diode (LED) is a semiconductor device that emits narrow-spectrum incoherent light when forward-biased. 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 and fluorescent bulbs in many lighting applications. Incandescents use a heated filament, are subject to breakage and burn-out and operate at a luminous efficiency of 2% to 4%. Fluorescents are more efficient, at 7% to 12%, but require high drive voltage and contain mercury, a toxic substance that may be eventually banned in certain countries. LEDs, however, produce light directly through electroluminescence, operate at low voltage and can deliver over 20% luminous efficiency.

Key Advantages of LEDs and Their Operation Versus Alternative Lighting Sources

- High energy efficiency: LEDs are 7x to 10x more efficient at producing light (lumens) than incandescent bulbs
- Extremely long life span: Typically 100,000 hours for LEDs versus 1,000 hours for incandescent bulbs and 10,000 hours for fluorescent bulbs
- Solid state reliability
- Nearly indestructible, solid epoxy lens cases – insensitive to vibration and shocks
- Fast “turn-on” time – light up very quickly
- Compact size
- Capable of emitting light of an intended color without the use of color filters
- Focused light output – incandescent and fluorescent sources often require an external reflector to collect light and direct it in a useable manner
- Gradual reduction of light output over time, rather than sudden burn-out of incandescent bulbs

LEDs deliver high efficiency, a key advantage in lighting systems. Incandescent bulbs generate significant heat as part of the light-production process. This is inefficient energy use since over 95% of the energy is not converted into visible light. On the other hand, LEDs convert a much higher percentage of electrical power into light output, substantially reducing power consumption.

Key advancements in LED reliability have enabled lifetimes in excess of 100,000 hours. Recently, these have included alternative semiconductor doping techniques, new optical lens technologies and advanced heat sink and packaging techniques. Many developments are underway that will increase efficiency and lifetime even further, including improved case/housing designs, further improvements in light conversion efficiency and more thermally efficient packages for higher current operation.

LED Driver Technology

LED driver circuits are available in several topologies:

- Inductor-based Buck, Boost, Buck-Boost and SEPIC designs (these generally drive LEDs in series or multiple strings of LEDs in series):
 - LED currents range from a few milliamps to multiple amps
 - Efficiencies in excess of 90%
 - Drivers act as constant current sources
 - Many devices use high side current sense: LED string can be returned to ground

- Inductorless charge pump-based Buck, Boost, Buck-Boost designs (these generally drive a single LED or LED strings in parallel):
 - LED currents range from a few milliamps to 1A
 - Average efficiencies over the Li-Ion battery range in excess of 80%
 - Drivers act as constant current sources
 - Very small solution footprints – ideal for handheld devices

Deciding which IC and topology to use depends on the following factors:

- The required LED current
- The relation of LED(s) forward voltage to the input voltage range: Buck, Boost, Buck-Boost, SEPIC or Flyback
- Efficiency – crucial for driving high brightness (HB) LEDs while minimizing thermal and battery life constraints
- Current consumption required during off-time
- Dimming characteristics – PWM dimming preserves chromatic characteristics across brightness levels and avoids color shifting
- Number of LEDs / serial or parallel
- Total solution size and cost constraints

ICs specifically designed as LED drivers tend to be smaller in size compared to general-purpose alternative solutions, increasing their appeal in space-constrained portable power applications. Popular switchmode LED driver configurations include Buck, Boost, Buck-Boost and SEPIC, and can deliver current from 3mA/LED to 3A/LED or more.

Choosing the best LED driver or display bias power IC depends on many factors and tradeoffs. Linear Technology provides targeted solutions for most applications.

Key LED Applications for Semiconductor ICs

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

LED Driver Solutions Overview

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

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

page

High Current LED Driver ICs (>350mA)

Switching Regulator-Based (Inductor), LEDs in Series

- 03 Buck
- 04 Boost
- 05 Buck-Boost
- 06 SEPIC-Flyback
- 07 Photoflash/Camera Torch

Charge Pump-Based (Inductorless), LEDs in Parallel

- 08 Single Output – Camera Flash/Torch

Medium Current LED Driver ICs (100-350mA)

Switching Regulator-Based (Inductor), LEDs in Series

- 09 Buck
- 10 Boost
- 11 Buck-Boost
- 12 Multidisplay

Low Current LED Driver ICs (20mA to 90mA)

Switching Regulator-Based (Inductor), LEDs in Series

- 12 Multidisplay
- 13 Buck for Large Panel TFT LCDs
- 14 Boost

Charge Pump-Based (Inductorless), LEDs in Parallel

- 17 Multidisplay
- 18 General Purpose

15–16 Multichannel LED Drivers for Large LCD Panels (30mA to 50mA)

OLED

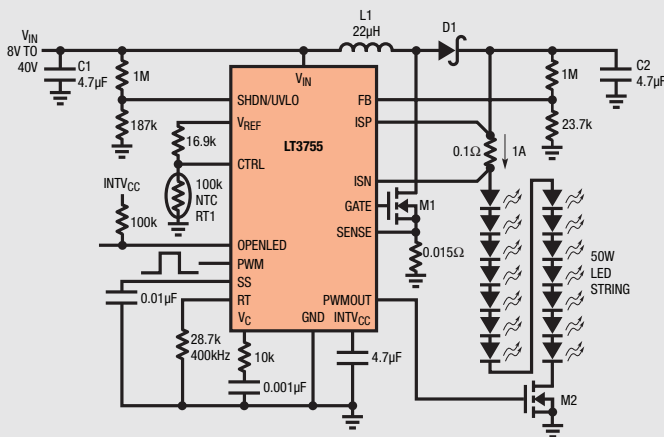
Switching Regulator Based (Inductor)

LCD & CCD Bias

Switching Regulator Based (Inductor)

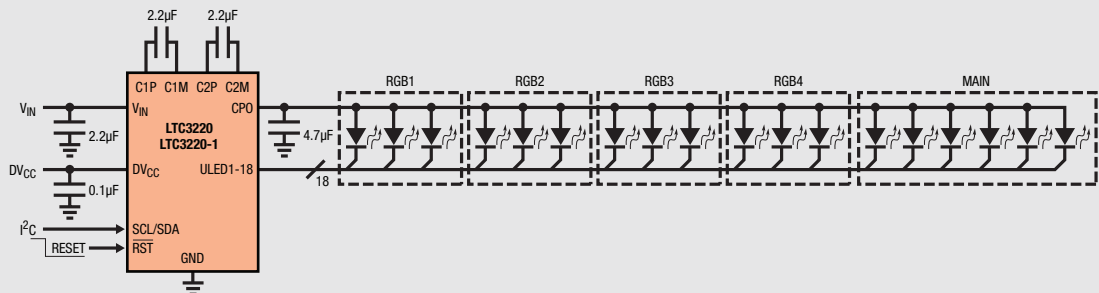
Series LED Driver ICs

03–07
09–16
19–20



Parallel LED Driver ICs

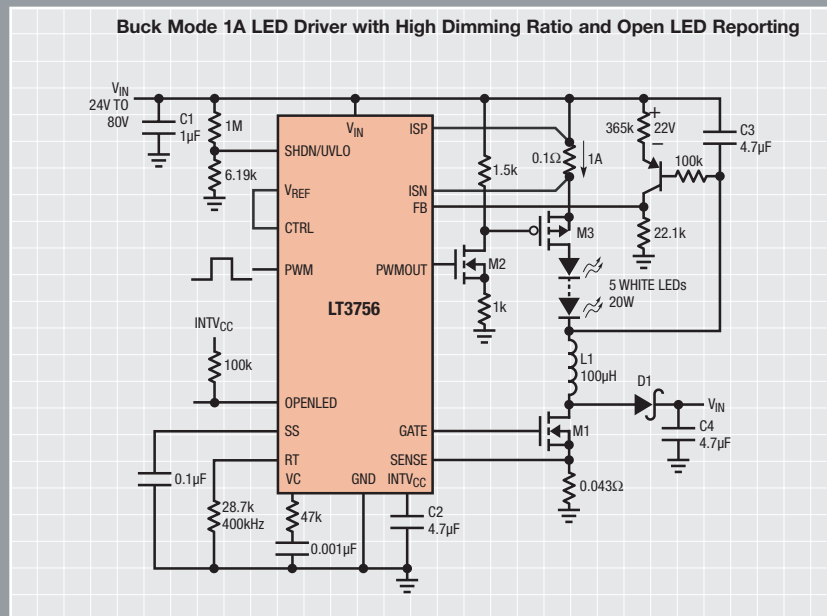
08
17–18



High Current (350mA to 10A) LED Drivers – Buck

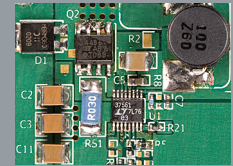
High-current inductor-based step-down switching LED drivers provide tiny, efficient high power LED lighting solutions for automotive, architectural and display backlighting. Key features include wide-ranging True Color PWM™ dimming, wide input voltage range, high side sensing and high switching frequency.

LT3756: 100V High Voltage Full Featured LED Driver

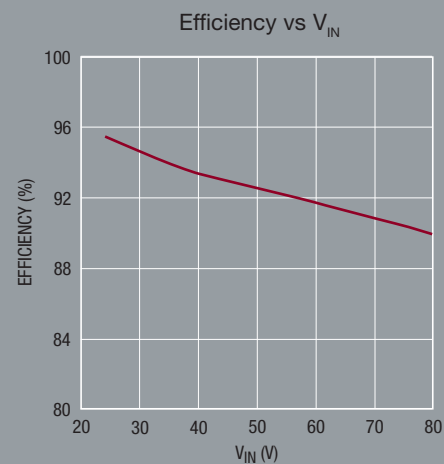


Applications:

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



LT3756: Actual Size,
Complete Solution



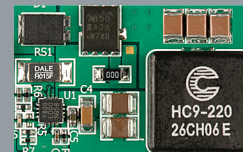
Part Number	Topology	Dimming Type	Max # of LEDs x I _{LED} from 24V _{IN}	LED Configuration	Input Voltage Range (V)	Max. Output Voltage (V)	I _{sw} (A)	Operating Efficiency (%)	Package
High Current (350mA to 10A) LED Drivers - Buck									
LT3474/-1	Buck	400:1 PWM	4 x 1A	Series	3 to 30 (40V _{MAX})	15/25	1.5	88	TSSOP-16E
LT3592	Buck	10:1 Analog	4 x 500mA	Series	4 to 36	30	0.8	88	2x2 DFN-10 MSOP-10E
LT3517	Buck	5000:1 PWM	5 x 1A	Series	3 to 30 (40V _{MAX})	40	1.5	92	4x4 QFN-16 TSSOP-16E
LT3518	Buck	5000:1 PWM	5 x 1.5A	Series	3 to 30 (40V _{MAX})	40	2.3	92	4x4 QFN-16 TSSOP-16E
LT3496	Triple Buck	3000:1 PWM	3 x 5 x 0.5A	3 x Series Strings	3 to 30 (40V _{MAX})	40	3 x 0.75	92	4x5 QFN-28
LT3475/-1	Dual Buck	3000:1 PWM	2 x 4 x 1.5A	2 x Series Strings	4 to 36	15/25	2 x 1.5	88	TSSOP-20/E
LT3478/-1	Buck	3000:1 PWM	5 x 1.5A	Series	2.7 to 36	30	4.5	92	TSSOP-16E
LT3476	Quad Buck	1000:1 PWM	4 x 5 x 1A	4 x Series Strings	2.8 to 36	30	4 x 1.5	96	5x7 QFN-38
LTC3783	Buck	3000:1 PWM	5 x 1A +	Series	3 to 36	36	Ext FET	95	4x5 DFN-16 TSSOP-16
LT3755/-1	Buck	3000:1 PWM	5 x 1A +	Series	4.5 to 40	75	Ext FET	96	3x3 QFN-16 MSOP-16E
LT3756	Buck	3000:1 PWM	5 x 1A +	Series	6 to 100	100	Ext FET	96	3x3 QFN-16 MSOP-16E

High Current (350mA to 10A) LED Drivers – Boost

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

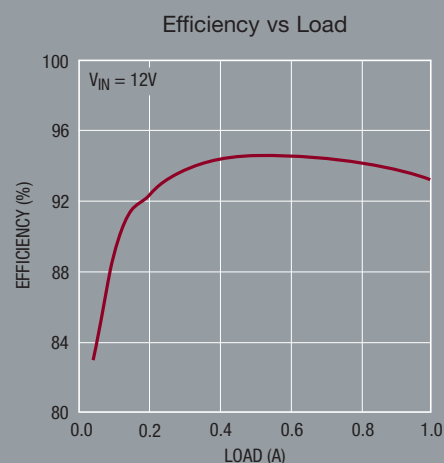
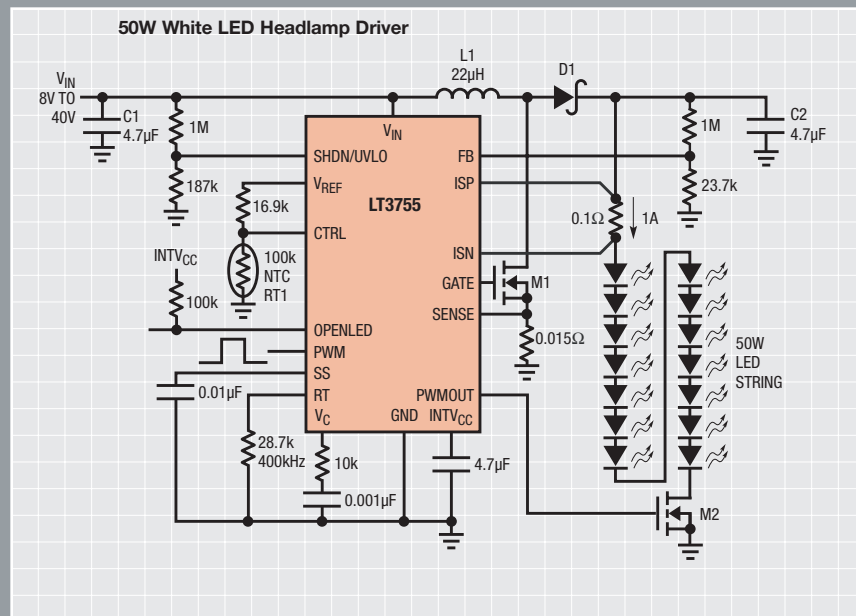
Applications:

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



LT3755: Boost Demo Circuit. Actual Size, Complete Solution

LT3755: 75V High Voltage Full Featured LED Driver



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 Current (350mA to 10A) LED Drivers – Boost									
LT3486	Dual Boost	1000:1 PWM	2 x 5 x 350mA	2x Series Strings	2.7 to 24	35	2 x 1.3	85	3x5 DFN-16
LT3517	Boost	5000:1 PWM	8 x 350mA	Series	3 to 30 ($40V_{MAX}$)	45	1.5	87	4x4 QFN-16 TSSOP-16E
LT1618	Boost	Analog/PWM	6 x 350mA	Series	1.6 to 18	36	1.5	85	3x3 DFN-10 MSOP-10
LT3518	Boost	5000:1 PWM	11 x 350mA	Series	3 to 30 ($40V_{MAX}$)	45	2.3	87	4x4 QFN-16 TSSOP-16E
LT3496	Triple Boost	3000:1 PWM	3 x 4 x 350mA	3 x Series Strings	3 to 30 ($40V_{MAX}$)	45	3 x 0.75	87	4x5 QFN-28
LT3478/-1	Boost	3000:1 PWM	10 x 700mA	Series	2.7 to 36	40	4.5	87	TSSOP-16E
LT3476	Quad Boost	1000:1 PWM	4 x 8 x 350mA	4 x Series Strings	2.8 to 16	36	4 x 1.5	87	5x7 QFN-38
LTC3783	Boost	3000:1 PWM 10:1 Analog	10 x 1A	Series	3 to 36+	36	Ext FET	93	4x5 DFN-16 TSSOP-16
LT3755/-1	Boost	3000:1 PWM	15 x 1A	Series	4.5 to 40	75	Ext FET	93	3x3 QFN-16 MSOP-16E
LT3756	Boost	3000:1 PWM	25 x 0.5A	Series	6 to 100	100	Ext FET	93	3x3 QFN-16 MSOP-16E

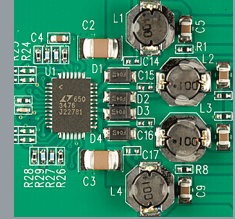
* $I_{OUT} \sim 0.65 I_{SW} \times (V_{IN} / V_{OUT})$. Estimate: may vary depending on external component selection.

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

High current inductor-based buck-boost switching LED drivers provide flexible, tiny, efficient solutions for TFT backlighting, automotive and avionic lighting applications. Key features include high current, high voltage switches, adjustable LED currents, wide input voltage range, and high switching frequency.

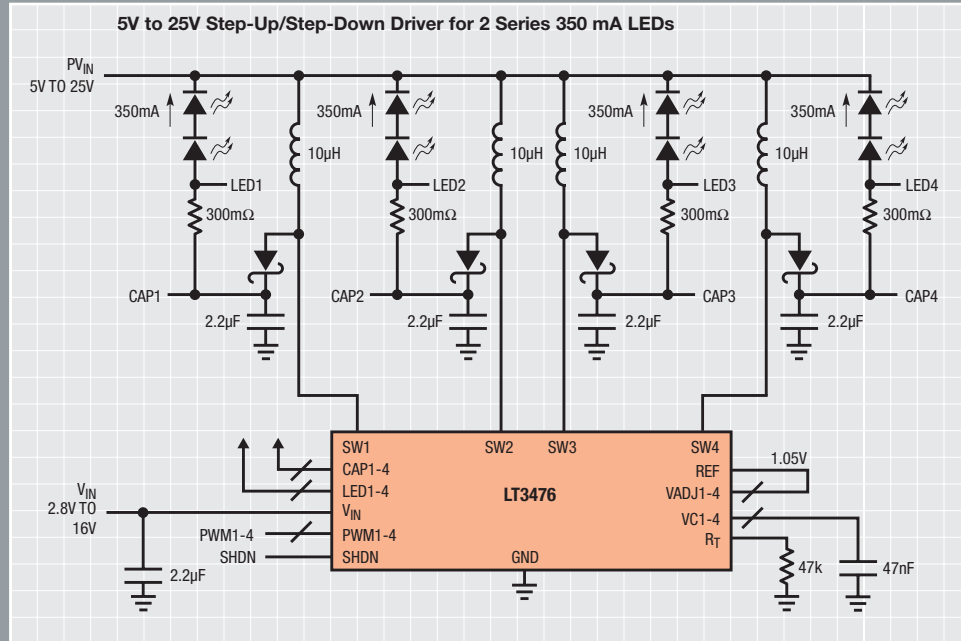
Applications:

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



LT3476: Actual Size, Complete Solution

LT3476: High Current Quad Output LED Driver



1000:1 PWM Dimming at 100Hz



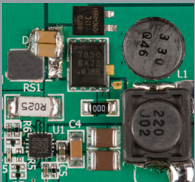
Part Number	Topology	Dimming Type	Max # of LEDs x I_{LED} from $12V_{IN}$	LED Configuration	Input Voltage Range (V)	Max. Output Voltage (V)	I_{SW} (A)	Operating Efficiency (%)	Package
High Current (350mA to 10A) LED Drivers – Buck-Boost									
LT3517	Buck-Boost	5000:1 PWM	6 x 350mA	Series	3 to 30 ($40V_{MAX}$)	45	1.5	80	4x4 QFN-16 TSSOP-16E
LT3518	Buck-Boost	5000:1 PWM	6 x 500mA	Series	3 to 30 ($40V_{MAX}$)	45	2.3	80	4x4 QFN-16 TSSOP-16E
LT3496	Triple Buck-Boost	3000:1 PWM	3 x 350mA	Series	3 to 30 ($40V_{MAX}$)	45	3 x 0.75	80	4x5 QFN-28
LT3478/-1	Buck-Boost	3000:1 PWM	5 x 700mA	Series	2.7 to 36	40	4.5	80	TSSOP-16E
LT3476	Quad Buck-Boost	1000:1 PWM	4 x 5 x 350mA	4 x Series Strings	2.8 to 16	36	4 x 1.5	80	5x7 QFN-38
LTC3783	Buck-Boost	3000:1 PWM 10:1 Analog	6 x 1A	Series	3 to 36+	36	Ext FET	85	4x5 DFN-16 TSSOP-16
LT3755/-1	Buck-Boost	3000:1 PWM	10 x 1A	Series	4.5 to 40	75	Ext FET	85	3x3 QFN-16 MSOP-16E
LT3756	Buck-Boost	3000:1 PWM	15 x 1A	Series	6 to 100	100	Ext FET	85	3x3 QFN-16 MSOP-16E

High Current (350mA to 10A) LED Drivers – SEPIC and Flyback

High current inductor-based multitopology 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.

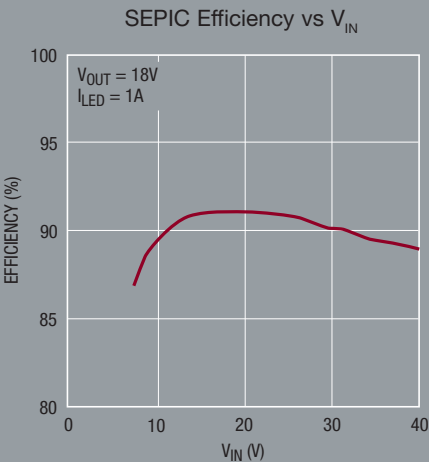
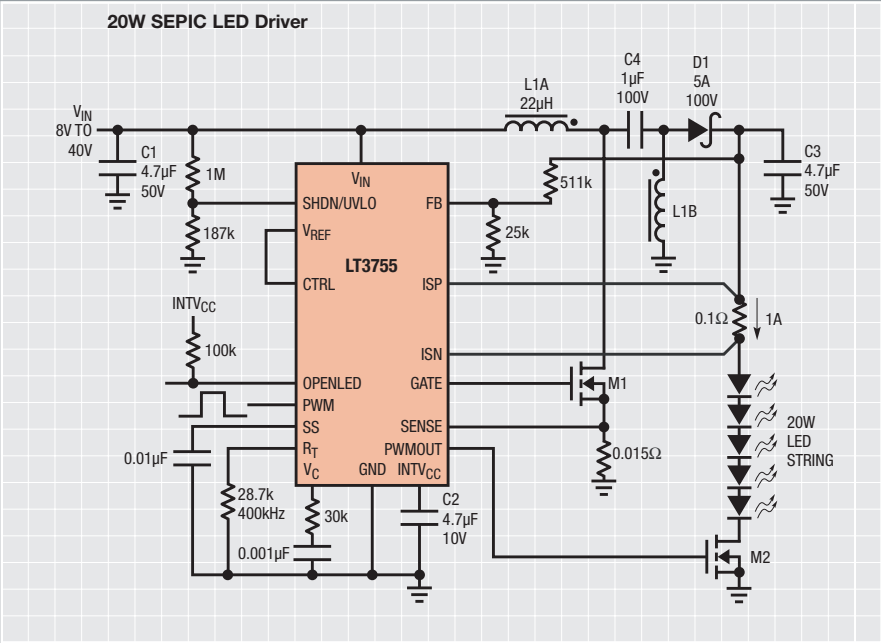
Applications:

- High Power LED Applications
- Industrial
- Automotive



LT3755: 75V High Voltage Full Featured LED Driver

LT3755: SEPIC Demo Circuit. Actual Size, Complete Solution



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 Current (350mA to 10A) LED Drivers – SEPIC and Flyback									
LT3517	SEPIC/FlyBack	5000:1 PWM	4 x 350mA	Series	3 to 30 (40V _{MAX})	45*	1.5	80	4x4 QFN-16 TSSOP-16E
LT3518	SEPIC/FlyBack	5000:1 PWM	6 x 350mA	Series	3 to 30 (40V _{MAX})	45*	2.3	80	4x4 QFN-16 TSSOP-16E
LT3478/-1	SEPIC/FlyBack	3000:1 PWM	6 x 500mA	Series	2.7 to 36	40*	4.5	80	TSSOP-16E
LT3476	Quad SEPIC/FlyBack	1000:1 PWM	4 x 3 x 350mA	4 x Series Strings	2.8 to 16	36*	4 x 1.5	80	5x7 QFN-38
LTC3783	SEPIC/FlyBack	3000:1 PWM 10:1 Analog	6 x 1A	Series	3 to 36+	Limited by ext. FET	Ext FET	85	4x5 DFN-16 TSSOP-16
LT3755/-1	SEPIC/FlyBack	3000:1 PWM	6 x 1A	Series	4.5 to 40	75	Ext FET	85	3x3 QFN-16 MSOP-16E
LT3756	SEPIC/FlyBack	3000:1 PWM	8 x 1A	Series	6 to 100	100	Ext FET	90	3x3 QFN-16 MSOP-16E

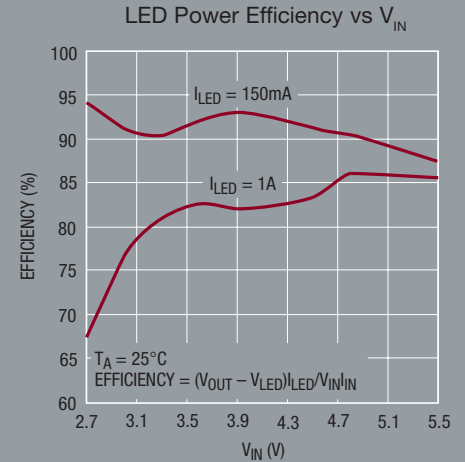
* V_{IN} + V_{OUT}

Medium to High Current (100mA to 1A) LED Drivers for Photoflash/Torch Lighting

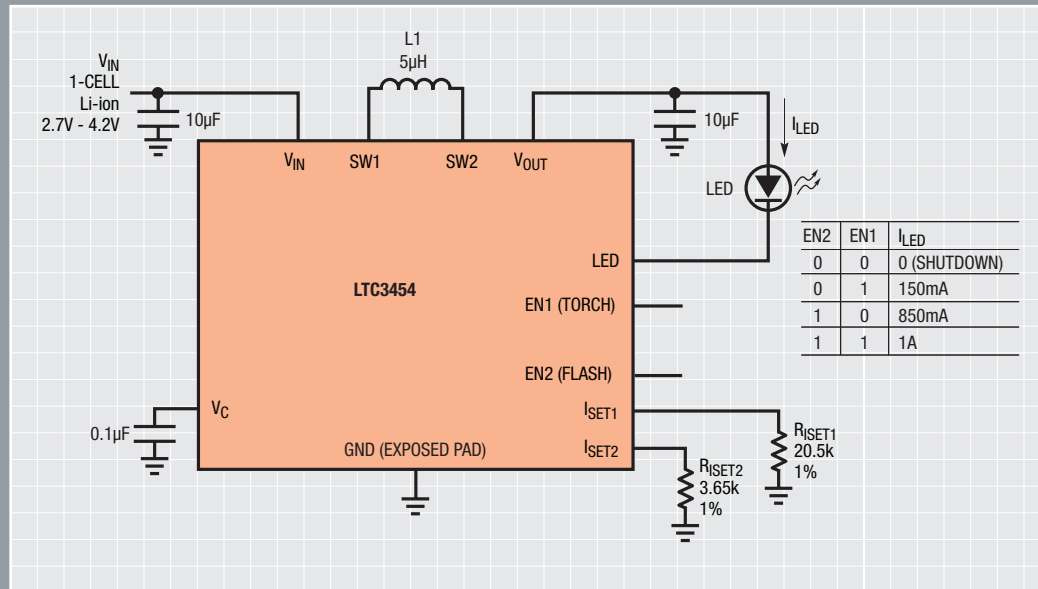
High current inductor-based switching LED drivers for camera photoflash, torch and video lighting feature various topologies including buck-boost and boost and provide tiny, efficient high power solutions for camera phone applications.

Applications:

- Cell Phone Camera Flash
- Cell Phone Torch Lighting
- Digital Cameras
- PDAs
- Miscellaneous Li-Ion/Polymer-Based LED Driver Applications



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



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)	$I_o (mA)$	$I_{SD} (\mu A)$	Package
Medium to High Current (100mA to 1A) 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

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

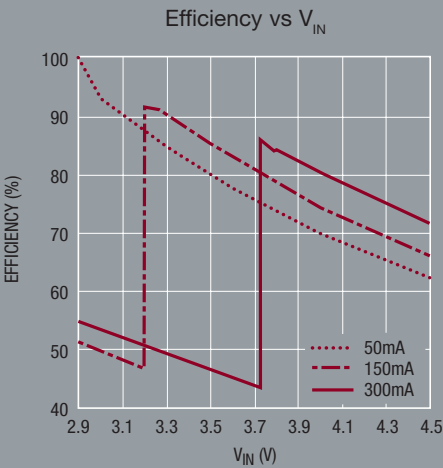
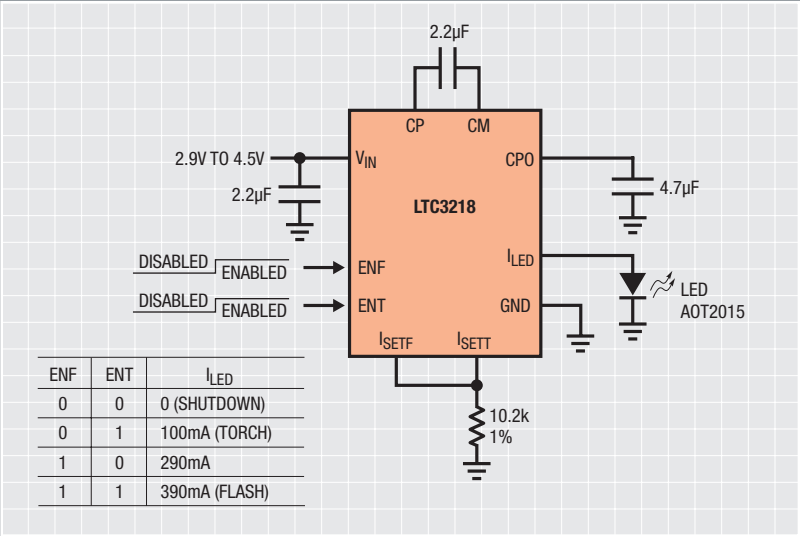
High Current LED Drivers for Camera Flash/Torch – Inductorless

Our family of inductorless charge pump-based camera LED driver products offers high efficiency and low ripple and can be used to boost an input voltage to drive high current LEDs for camera torch (continuous) and flash applications. By eliminating the inductor, these switched capacitor converters provide a small solution footprint and a simple design.

Applications:

- LED Camera Light Supply for Cellphones/DSCs/PDAs

LTC3218: 400mA Single Wire Camera LED Charge Pump



LTC3218: Actual Size, Complete Solution

Part Number	V _{IN} (V)	Conversion Ratio/Boost Factor	Total LED Current (mA)	Max. # of White LEDs x I _{LED}	Dimming Control	Maximum Operating Efficiency** (%)	Frequency (MHz)	I _O (mA)	I _{SD} (µA)	Package
High Current (350mA to 1A) LED Drivers for Camera Flash - Inductorless										
LTC3218	2.9 to 4.5	1x/2x	400	1 x 400mA*	Resistor/PWM	92	1	0.98	<1	2x3 DFN-10
LTC3214	2.9 to 4.4	1x/1.5x/2x	500	1 x 500mA*	Resistor/PWM	85	0.9	0.98	<2.5	3x3 DFN-10
LTC3217	2.9 to 4.5	1x/1.5x/2x	600	4 x 150mA*	Resistor/PWM	86	0.9	0.4	<4	3x3 QFN-16
LTC3215	2.9 to 4.4	1x/1.5x/2x	700	1 x 700mA*	Resistor/PWM	90	0.9	0.3	<2.5	3x3 DFN-10
LTC3216	2.9 to 4.4	1x/1.5x/2x	1000	1 x 1A*	Resistor/PWM	90	0.9	0.3	<2.5	3x4 DFN-12

* Flash Mode
** Dependent on V_{IN}, V_{LED}, I_{LED}

Medium Current (100mA to 350mA) LED Drivers – Buck

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

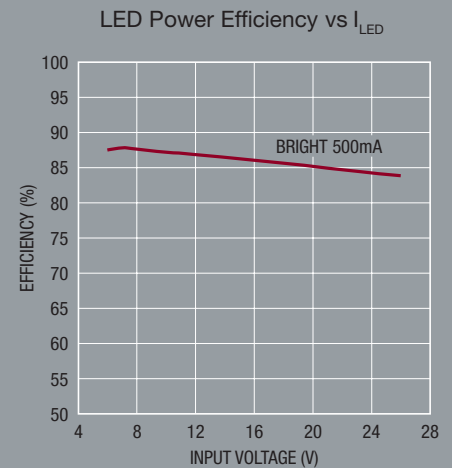
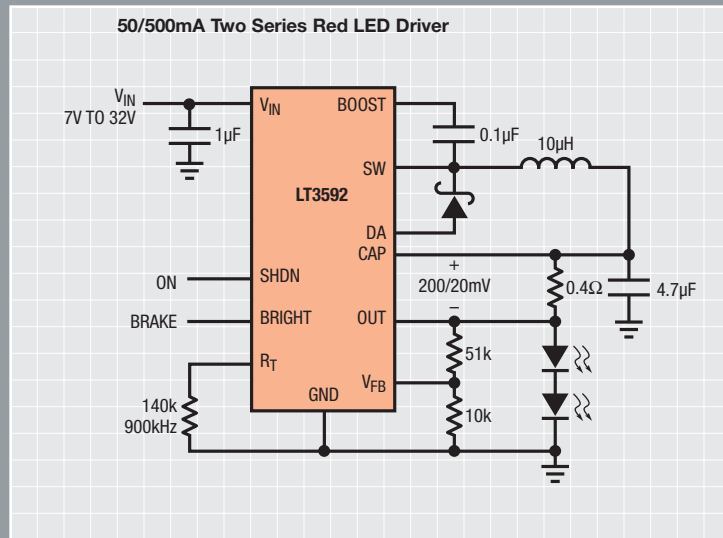
Applications:

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



LT3592: Actual Size,
Complete Solution

LT3592: 500mA Wide Input Voltage Range Step-Down LED Driver with 10:1 Dimming

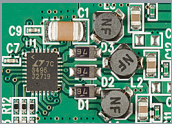
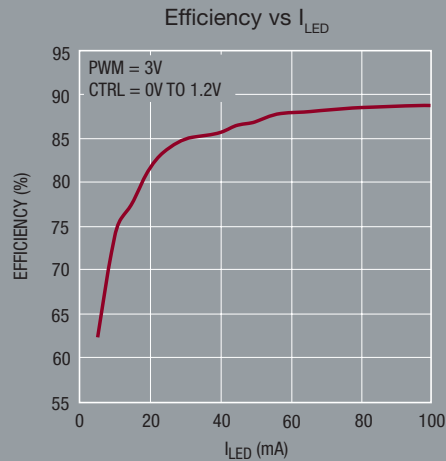


Part Number	Topology	Dimming Type	Max # of LEDs $\times I_{LED}$ from $24V_{IN}$	LED Configuration	Input Voltage Range (V)	Max. Output Voltage (V)	I_{SW} (A)	Operating Efficiency (%)	Package
Medium Current (100mA to 350mA) LED Drivers – Buck									
LT3591	Buck	80:1 PWM	5 x 200mA	Series	2.5 to 12	30	0.5	92	2x3 DFN-8
LT3517	Buck	5000:1 PWM	5 x 300mA	Series	3 to 30 ($40V_{MAX}$)	30	1.5	92	4x4 QFN-16 TSSOP-16E
LT3592	Buck	10%/100% Analog	6 x 350mA	Series	3 to 36 ($60V_{MAX}$)	32	0.8	92	2x3 DFN-10 MSOP-10E
LT3496	Buck	3000:1 PWM	3 x 5 x 300mA	3 x Multiple Series Strings	3 to 30 ($40V_{MAX}$)	30	3 x 0.75	92	4x5 QFN-28

Medium Current (100mA to 350mA) LED Drivers – Boost

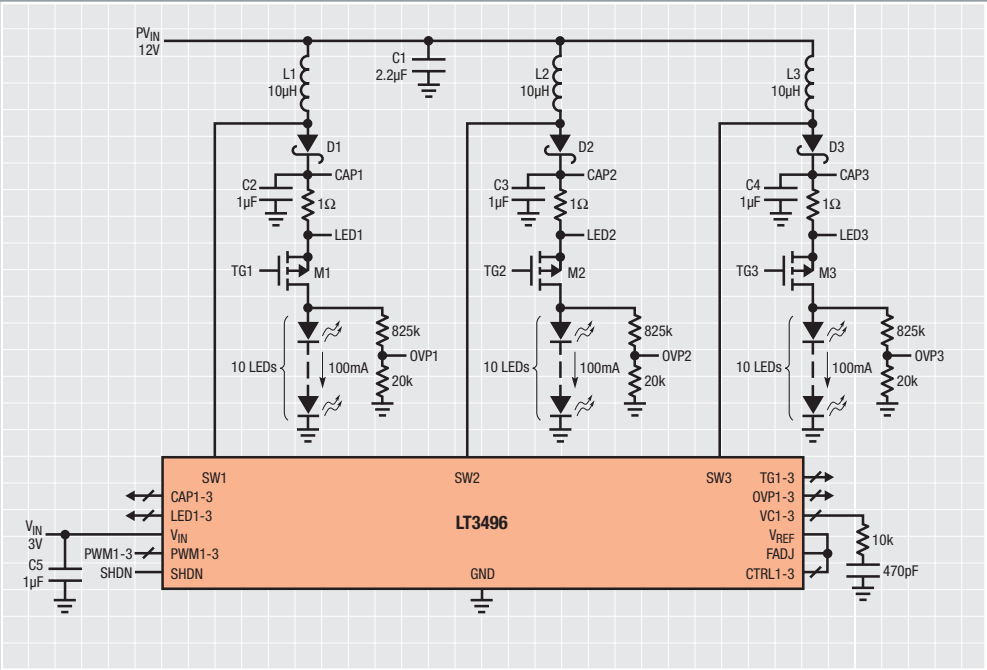
Applications:

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



LT3496: Actual Size, Complete Solution

LT3496: Triple Output LED Driver



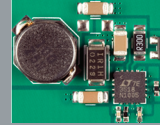
Part Number	Topology	Dimming Type	Max # of LEDs x I_{LED} from 12V _{IN}	LED Configuration	Input Voltage Range (V)	Max. Output Voltage (V)	I_{SW} (A)*	Operating Efficiency (%)	Package
Medium Current (100mA to 350mA) LED Drivers – Boost									
LT3486	Dual Boost	1000:1 PWM	2 x 8 x 100mA	2 x Series Strings	2.7 to 24	35	2 x 1.3	87	3x5 DFN-16
LT3517	Boost	5000:1 PWM	10 x 200mA	Series	3 to 30 (40V _{MAX})	45	1.5	87	4x4 QFN-16 TSSOP-16E
LT3518	Boost	5000:1 PWM	10 x 300mA	Series	3 to 36 (60V _{MAX})	45	2.3	87	4x4 QFN-16 TSSOP-16E
LT3496	Triple Boost	3000:1 PWM	3 x 10 x 100mA	3 x Series Strings	3 to 30 (40V _{MAX})	45	3 x 0.75	87	4x5 QFN-28

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

Medium Current (100mA to 350mA) LED Drivers – Buck-Boost

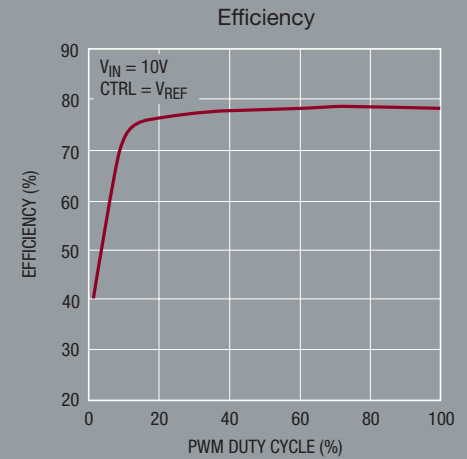
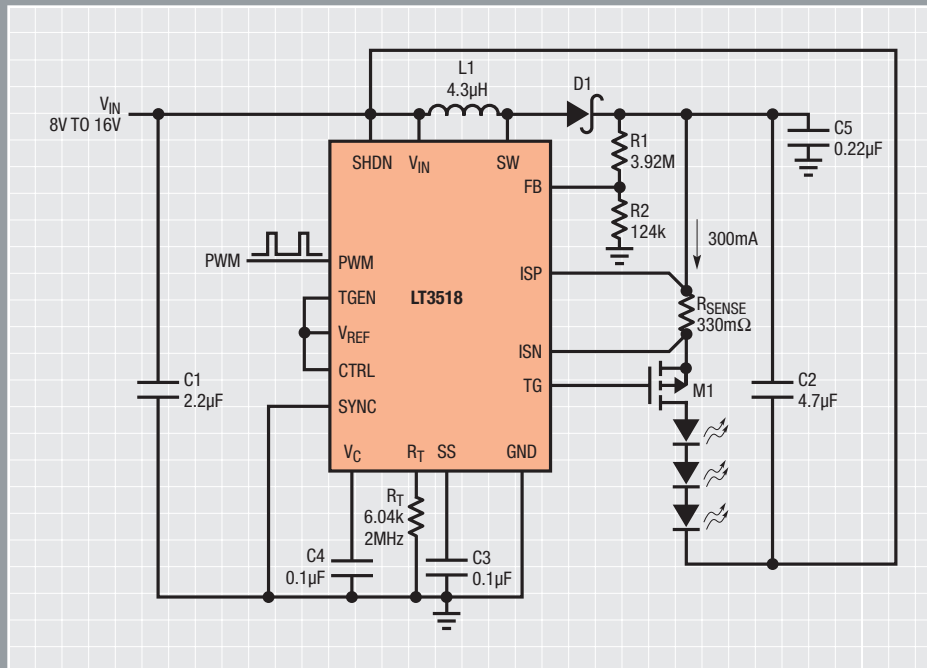
Applications:

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



LT3518: Actual Size,
Complete Solution

LT3518: Full-Featured LED Driver with 2.3A Switch Current



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
Medium Current (100mA to 350mA) LED Drivers – Buck-Boost									
LT3517	Buck-Boost	5000:1 PWM	6 x 300mA	Series	3 to 30 ($40V_{MAX}$)	45	1.5	80	4x4 QFN-16 TSSOP-16E
LT3518	Buck-Boost	5000:1 PWM	8 x 300mA	Series	3 to 36 ($60V_{MAX}$)	45	2.3	80	4x4 QFN-16 TSSOP-16E
LT3496	Triple Buck-Boost	3000:1 PWM	3 x 6 x 100mA	3 x Series Strings	3 to 30 ($40V_{MAX}$)	45	3 x 0.75	80	4x5 QFN-28

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

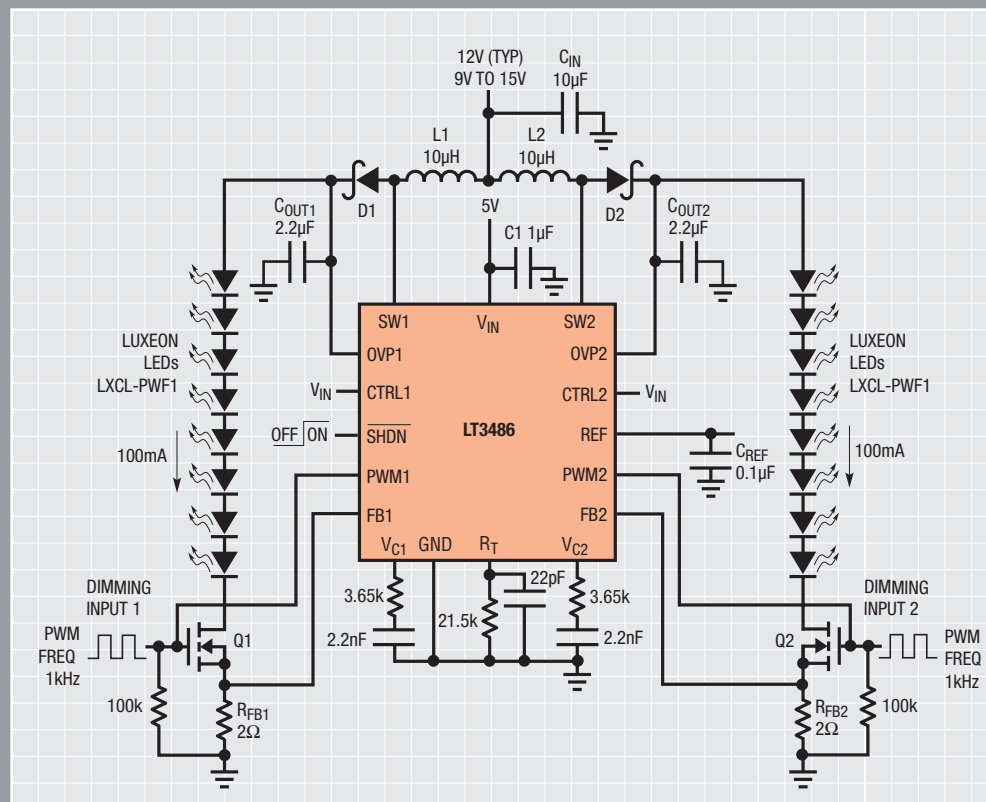
Low to Medium Current (20-200mA/LED) Multidisplay LED Drivers – Inductor Based

Multidisplay inductor-based white LED drivers are capable of driving up to 20 white LEDs from a single cell Li-Ion 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.

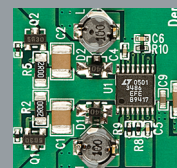
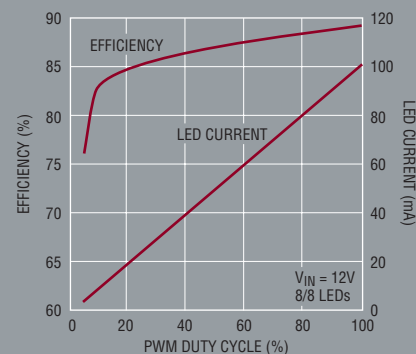
Applications:

- Main/Sub-Displays
- Digital Cameras, Sub-Notebook PCs
- PDAs, Handheld Computers
- Automotive

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



LED Efficiency and Current 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 to Medium Current Multidisplay LED Drivers – Inductor Based									
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 25 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 8 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 Current (20mA to 50mA) LED Drivers – Buck

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

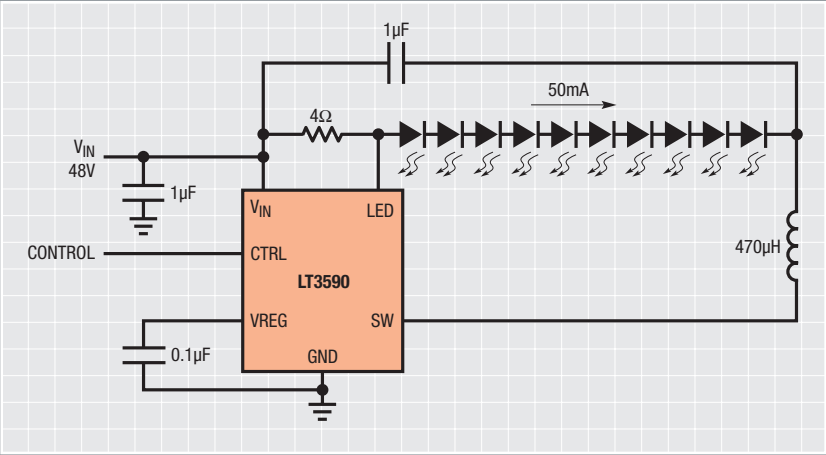
Applications:

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

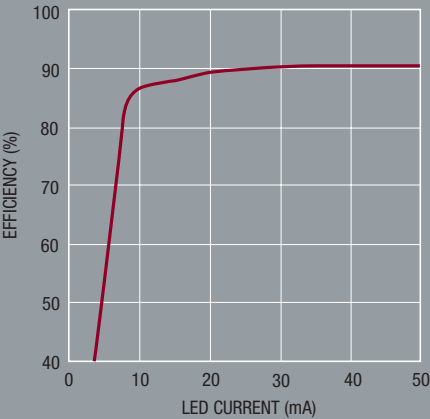


LT3590: Actual Size, Complete Solution

LT3590: 48V Buck Mode 50mA LED Driver in 2mm x 2mm DFN



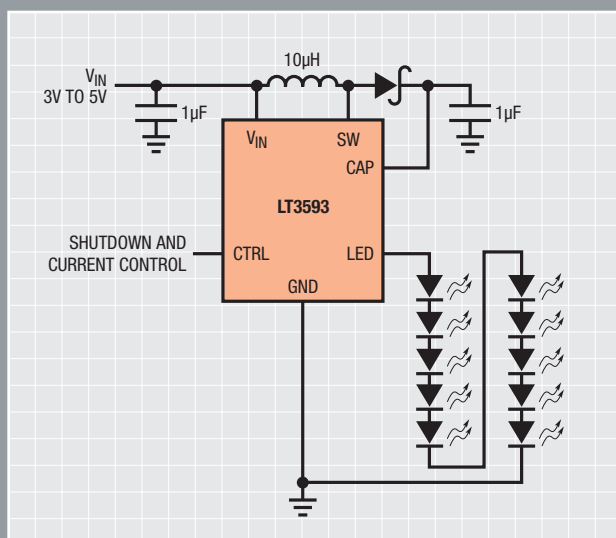
Conversion Efficiency



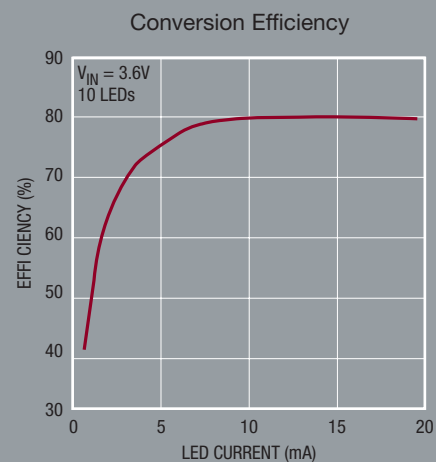
Part Number	Topology	Dimming Type	Max # of LEDs x I _{LED} from 40V _{IN}	LED Configuration	Input Voltage Range (V)	Max. Output Voltage (V)	I _{sw} (mA)	Operating Efficiency (%)	Package
Low Current (20mA to 50mA) LED Drivers – Buck									
LT3590	Buck	10:1 DC	8 x 50mA	Series	4.5 to 55	40	80	90	2x2 DFN-6 SC-70
LT3517	Buck	5000:1 PWM	8 x 50mA	Series	3 to 30 (40V _{MAX})	40	1.5A	92	4x4 QFN-16 TSSOP-16E
LT3595	16-Channel Buck	5000:1 PWM	16 x 10 x 50mA	16 x Multiple Series Strings	4.5 to 45	45	16 x 0.09	92	5x9 QFN-56
LT3496	Buck	3000:1 PWM	3 x 8 x 50mA	3 x Multiple Series Strings	3 to 30 (40V _{MAX})	40	3 x 0.75	95	4x5 QFN-28

Low Current (20mA to 50mA) LED Drivers – Boost

LT3593: 1MHz White LED Driver with Digitally Controlled Current



LT3593: Actual Size, Complete Solution



Part Number	Type	Dimming Type	Max # of LEDs x I_{OUT}^* ($V_{IN}=3.6V$)	LED Configuration	Input Voltage Range (V)	Max. Output Voltage (V)	I_{SW} (mA)*	Operating Efficiency (%)	Package
Low Current (20mA to 50mA) LED Drivers – Boost									
LT3491	Boost LED Driver	300:1 PWM	6 x 25mA	Series	2.5 to 12	27	260	76	SC70
LT3498	Boost LED and OLED Driver	DC/PWM	6 x 20mA	Series	2.5 to 12	32	300 + 180	77	2x3 DFN-12
LT3591	Boost LED Driver	90:1 PWM	10 x 25mA	Series	2.5 to 12	42	450	77	2x3 DFN-8
LT3593	Boost LED Driver	32:1 Digital	10 x 25mA	Series	2.5 to 5.5	45	550	80	2x2 DFN-6 ThinSOT
LT3497	Dual Boost LED Driver	250:1 PWM	2 x 6 x 20mA	2 Parallel Series Strings of 6	2.5 to 10	32	2 x 300	77	2x3 DFN-10
LT3466	Dual Boost 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	Boost LED Driver + Boost	DC/PWM	10 x 25mA	Series	2.7 to 24	40	2 x 320	84	3x3 DFN-10
LT3598	6-Channel Buck LED Driver	1000:1 PWM	6 x 10 x 30mA	6 x Multiple Series Strings	3 to 30 ($40V_{MAX}$)	44	1.5A	88	4x4 QFN-24
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

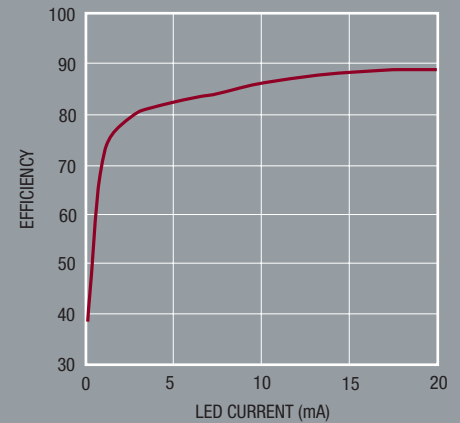
* $I_{OUT} \sim 0.65 I_{SW} \times (V_{IN} / V_{OUT})$. Estimate: may vary depending on external component selection.

Multichannel LED Drivers for Large LCD Panels (30mA to 50mA)

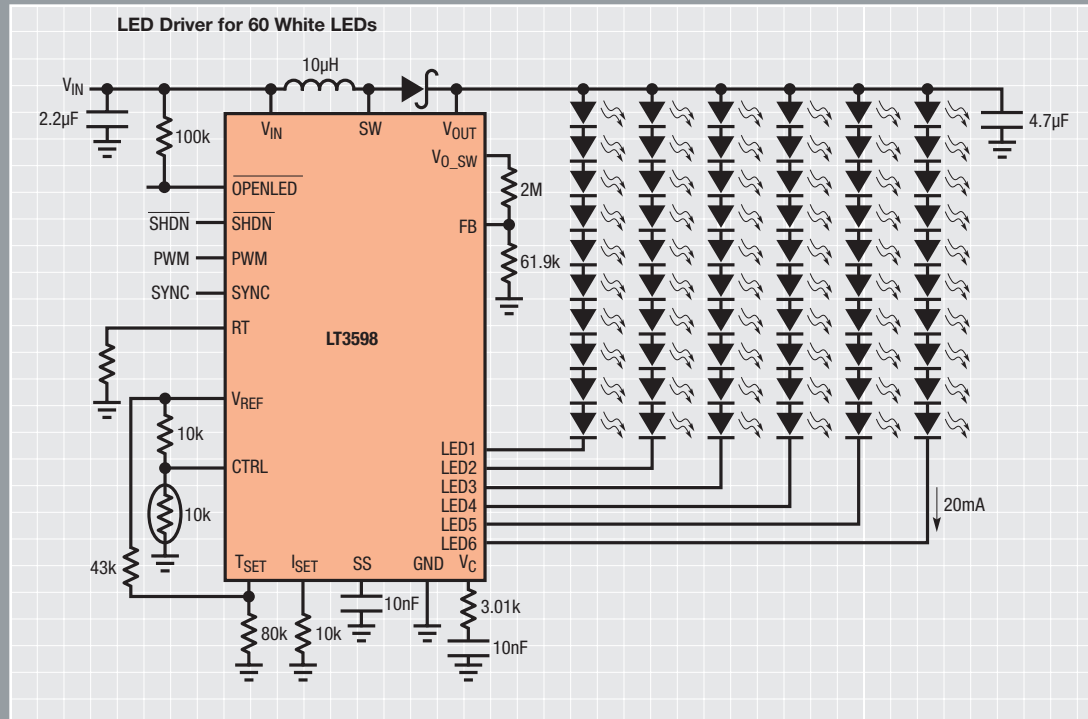
LT3598: 1.5A Boost Converter with 6-Channel 30mA LED Driver

- Drives Six Strings of LEDs at Up to 30mA
- 2% Accurate LED Current Regulation
- Wide Input Voltage Range:
 - Operation from 3V to 30V
 - Transient Protection to 40V
- Output Voltage Up to 50V
- Regulates Current Even When $V_{IN} > V_{OUT}$
- Disconnects LEDs in Shutdown
- Analog and PWM Dimming Control
- Programmable Open LED Protection (Regulated)
- OPENLED Alert Pin
- Programmable LED Temperature Derating
- Adjustable Frequency: 200kHz to 2.5MHz
- Synchronizable to an External Clock
- 4mm x 4mm QFN-24 Package

LT3598 Efficiency – Adaptive Feedback Loop Maximizes Efficiency



LT3598: Actual Size, Complete Solution

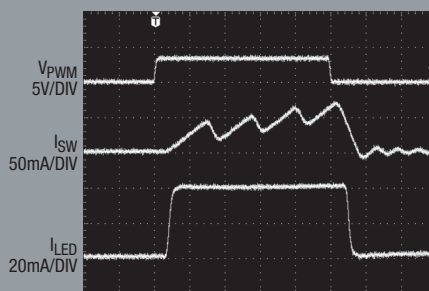


Multichannel LED Drivers for Large LCD Panels (30mA to 50mA)

LT3595: 16-Channel Buck Mode 50mA LED Driver

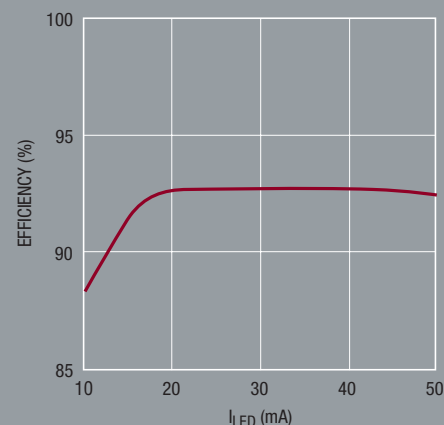
- 4.5V to 45V Input Supply Range
- Up to 50mA LED Current per Channel
- 100mA, 45V Internal Switches
- 8% Relative LED Current Match at 20mA
- 16 Independent LED Channels
- 5000:1 True Color PWM Dimming Range
- LEDs Disconnected in Shutdown
- Internal Schottky Diodes
- Low Quiescent Current
- 2MHz Switching Frequency
- R_{SET} Pin Sets Master LED Current
- Typical Efficiency: 92%
- Open LED Detection and Thermal Protection
- 5mm × 9mm × 0.75mm QFN-56 Package

5000:1 PWM Dimming at 100Hz

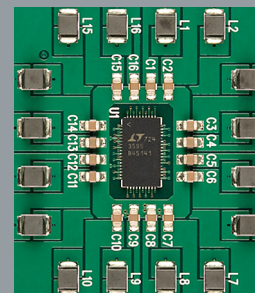
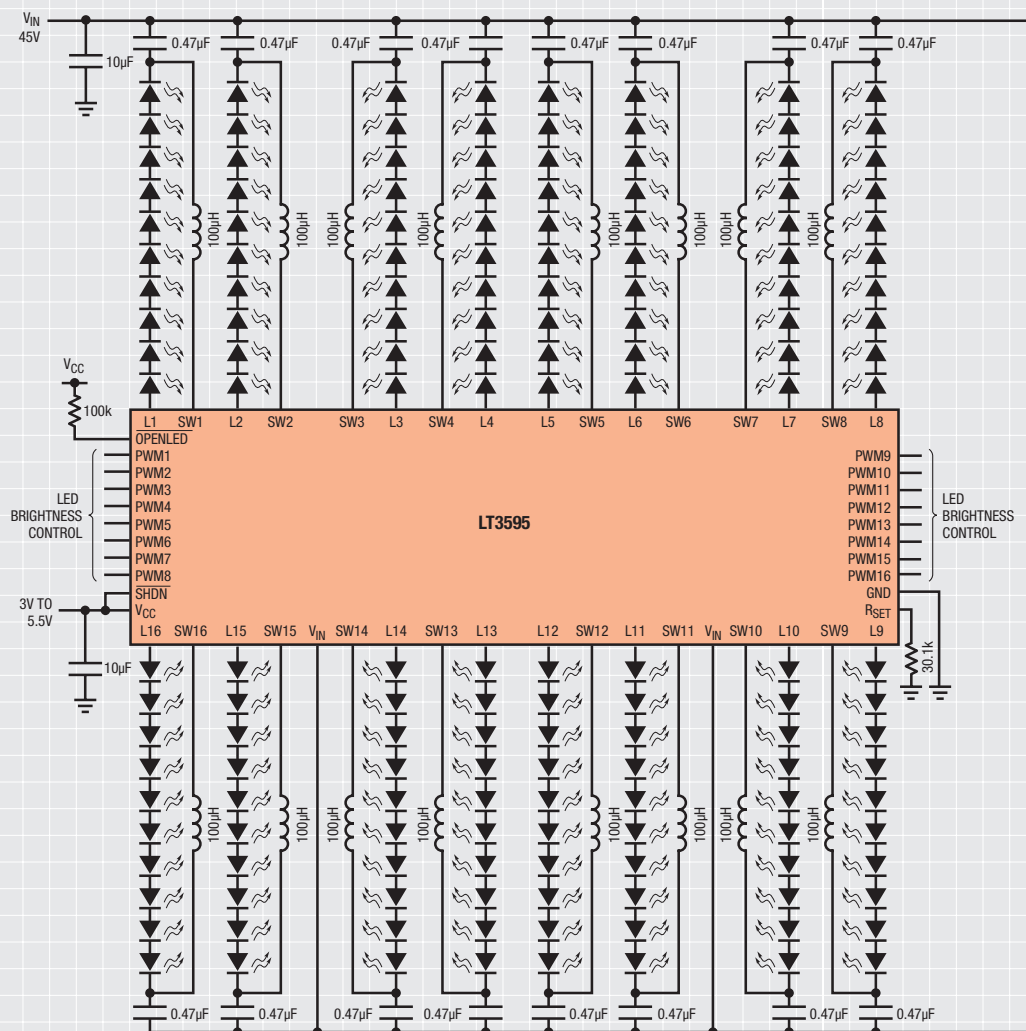


10 LEDs AT 40mA

Conversion Efficiency



30W LED Driver for 160 LEDs (16 Strings, 10 LEDs per String) at 50mA



LT3595: Actual Size, Complete Solution

Low Current Multidisplay LED Drivers – Inductorless

Our family of inductorless, charge pump-based multidisplay LED drivers feature the highest level of integration, smallest footprint and highest efficiency. Individual display driver outputs eliminate the need for ballast resistors, while the universal topology enables an even higher level of design flexibility without display type restrictions. These ICs optimize designs for a wide range of applications, from general illumination and keypads to portable products such as multidisplay cellular phones and high current/ high resolution camera flash devices.

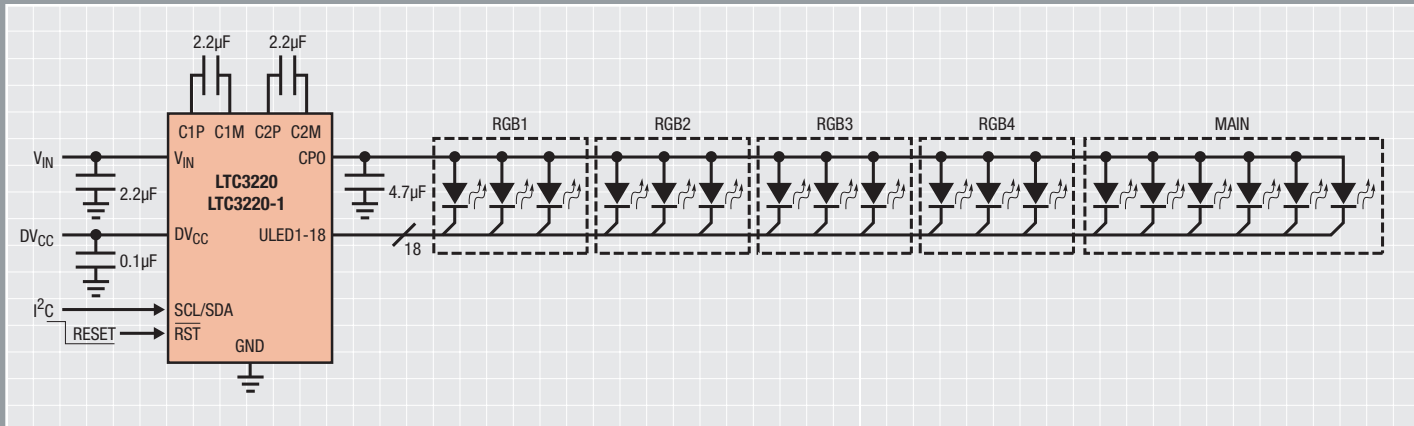
Applications:

- Video Phones with QVGA+ Displays
- Keyboard Lighting
- General Lighting



LTC3220/-1: Actual Size, Complete Solution

LTC3220/-1: 360mA Universal 18-Channel LED Driver



Part Number	V _{IN} (V)	Conversion Ratio/ Boost Factor	Total LED Current (mA)	Max. # of White LEDs x I _{LED}	Display Types	Number of Displays	Dimming Control	Maximum Operating Efficiency*** (%)	Frequency (MHz)	I _O (µA)	I _{SD} (µA)	Package
Low Current Multidisplay LED Drivers – Inductorless												
LTC3212	2.7 to 5.5	1x/2x	75	3**x25mA	RGB	3	1-wire	81	0.9	400	<3	2x3 DFN-12
LTC3230	2.7 to 5.5	1x/1.5x/2x	125	5x25mA	Main, Sub, + 2 LDOs	2	1-wire	91	0.8	400	<3	3x3 QFN-20
LTC3219	2.9 to 5.5	1x/1.5x/2x	250	9x28mA	Universal	Up to 9	I ² C	91	0.85	400	<2	3x3 QFN-20
LTC3220 LTC3220-1*	2.9 to 5.5	1x/1.5x/2x	360	18x20mA	Universal	Up to 18	I ² C	91	0.85	500	<4	4x4 UTQFN-28
LTC3206	2.8 to 4.5	1x/1.5x	400	(5+3+3)x 35mA	Main, SUB, RGB	3	SPI*	90	1	180	<1	4x4 QFN-24
LTC3210/-1	2.9 to 4.5	1x/1.5x/2x	500	4x25mA + 1**x400mA	Main, CAM	2	1-wire	93	0.8	400	<3	3x3 QFN-16
LTC3209-1	2.9 to 4.5	1x/1.5x/2x	600	6x25mA + 1x15mA + 1**x400mA	Main, Aux, CAM	3	I ² C	94	0.85	400	<3	4x4 QFN-20
LTC3209-2	2.9 to 4.5	1x/1.5x/2x	600	5x25mA + 1x15mA + 2**x200mA	Main, Aux, CAM	3	I ² C	94	0.85	400	<3	4x4 QFN-20
LTC3207	2.9 to 5.5	1x/1.5x/2x	600	12x28mA + 1**x425mA	Universal, CAM	Up to 13	I ² C	91	0.85	500	<2	4x4 QFN-24
LTC3208	2.9 to 4.5	1x/1.5x/2x	1000	(4+2+3+4)x 27.5mA + 4x100mA	Main, SUB, RGB, Aux, CAM	5	I ² C	95	0.85	250	<1	5x5 QFN-32

* Serial Peripheral Interface

* Different I²C address

** High Current Camera LED >=200-425mA

** Red, Green, Blue LEDs

*** Dependent on V_{IN}, V_{LED}, I_{LED}

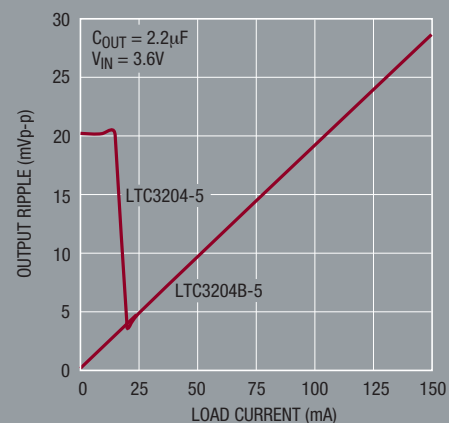
Low Current General Purpose LED Drivers – Inductorless

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 a small solution footprint and a simple design. The ICs efficiently drive low current white LEDs for a wide range of applications.

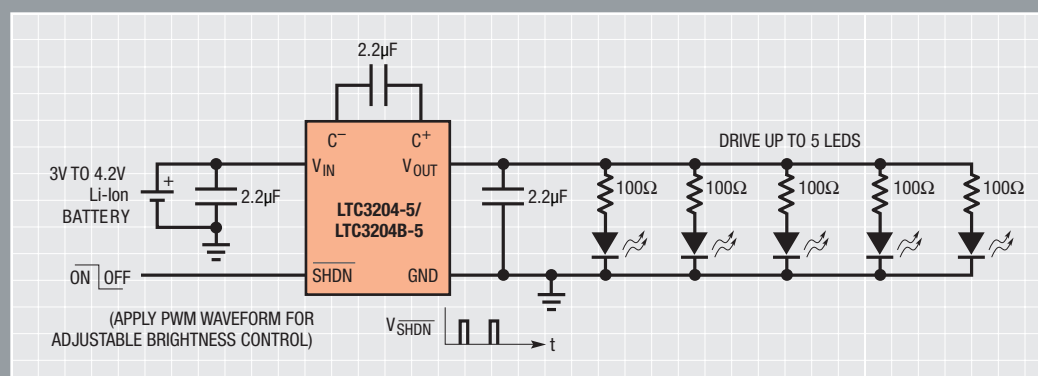
Applications:

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

Output Ripple vs Load Current



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



LTC3204-5: Actual Size, Complete Solution

Part Number	Dimming Type	# of LEDs	LED Configuration	V _{IN} (V)	Output Voltage (V)	Total Output Current (mA)	Maximum Operating Efficiency** (%)	Package
Low Current 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

** Dependent on V_N, V_{LED}, I_{LED}

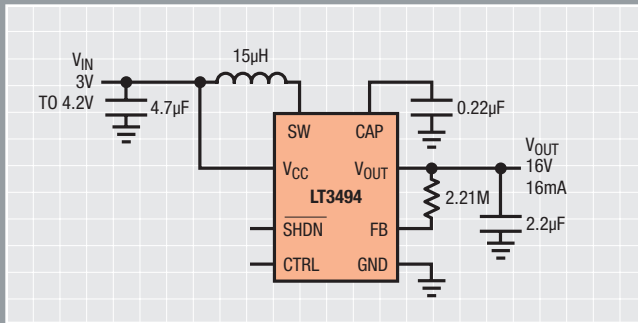
Organic LED (OLED) Bias – Low to High Current (50mA to 2A) Drivers

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.



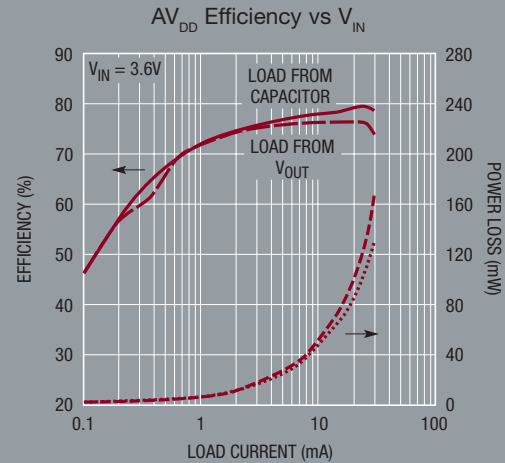
LT3494: Actual Size,
Complete Solution

LT3494: Micropower Low Noise Boost Converter with Output Disconnect



Applications:

- Organic LED Power Supply
- Digital Cameras
- White LED Power Supply
- Cellular Phones
- Medical Diagnostic Equipment
- Local $\pm 5V$ or $\pm 12V$ Supply
- TFT-LCD Bias Supply



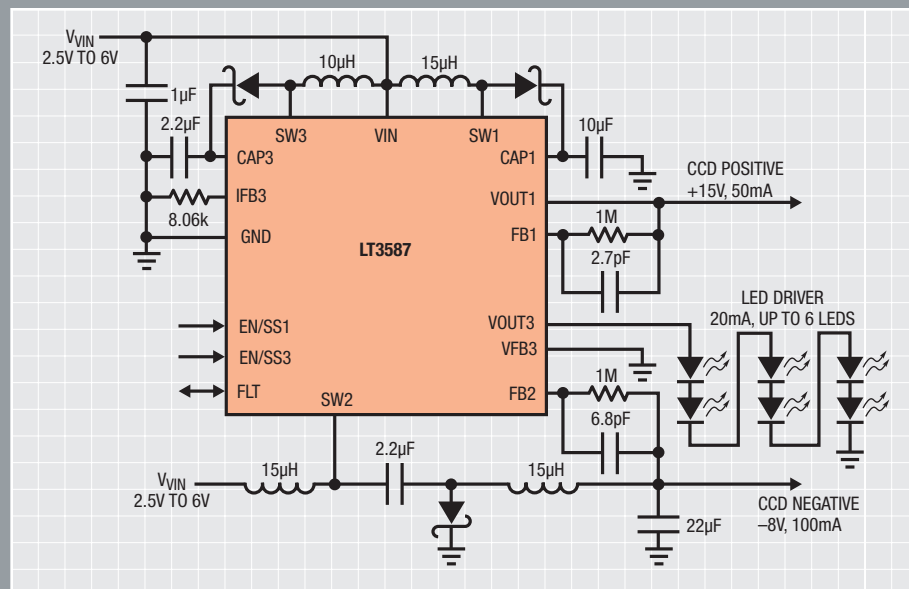
Part Number	Configuration	Topology	Input Voltage Range (V)	Max. Output Voltage (V)	I_{SW} (mA)*	Operating Efficiency (%)	Package
Low to High Current (50mA to 2A) LED Drivers for Organic LED (OLED)							
LTC3459	Single	Synchronous Boost	1.5 to 5.5	10	60	89	ThinSOT™
LT3464	Single	Boost	2.3 to 10	34	85	84	ThinSOT™
LT3494/A	Single	Boost	2.3 to 16	40	150/300	85	2x3 DFN-8
LT3498	Dual	Dual Boost	2.5 to 12	32	300/180	77	2x3 DFN-12
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
LT3582	Dual	Boost and Inverter	2.58 to 5.5	± 14	290/500	83	3x4 QFN-16
LT3495(B)/-1	Single	Boost	2.3 to 16	40	350/650	85	2x3 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

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

LCD and CCD Bias Power

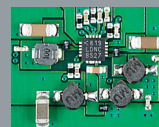
LCD and CCD Bias ICs deliver highly compact and efficient power supply solutions for small LCD displays. Key features include wide input voltage range, built-in inrush current limiting, output disconnect and power saving controls to simplify the task of implementing power-friendly LCD displays.

LT3587: High Voltage Monolithic Inverter and Dual Boost

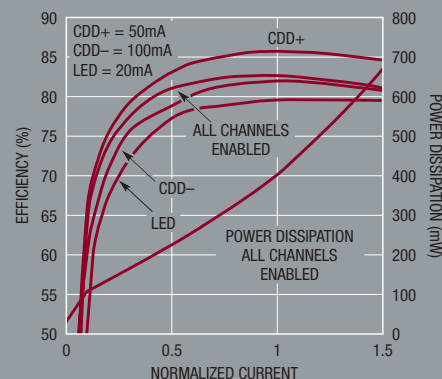


Applications:

- Digital Still and Video Cameras
- Cellular Handsets with Color Display
- Scanner and Display Systems
- Handheld Instruments
- CCD Imager Bias
- PDAs



LT3587: Actual Size, Complete Solution



Part Number	Number of Outputs	V _{IN} (V)	V _{OUT} (V)	I _{SW} (A)*	Frequency	I _O (µA)	Output Disconnect	Package
Low to Medium Current LED Drivers for LCD and CCD Biasing								
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	–	3x4 DFN-14 TSSOP-16
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
LT3587	4	2.5 to 6	±32	0.8/0.4/0.9	1.0MHz	2.4mA	Yes	3x3 QFN-20
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
LTC3524	5	2.5 to 6.0	5, ±20	0.5	1.5MHz	4.2mA	Yes	4x4 QFN-24
LT1942	4	2.6 to 16	44	0.55/0.15/0.5/0.5	1MHz	7mA	Yes	4x4 QFN-24

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

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