LD1611

High Power LED Driver

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1. GENERAL DESCRIPTION

The LD1611 is a continuous mode inductive step-down converter, designed for driving single or multiple series connected High Power LEDs with external switching transistor. It operates from an input voltage range of 7V to 40V and provides an externally adjustable output current up to 1.5A depending upon input voltage and external components. The LD1611 has regulator and output current sensing circuit, which uses an external resistor to set the nominal average output current. The LED dimming can be controlled via pulse width modulation (PWM) through DIM pin. Additionally, to ensure the system reliability, the LD1611 has internal thermal shutdown circuit.

2. FEATURES

- 7V ~ 40V input range generates maximum 1.5A output constant current.
- Regulation voltage is 4.5V.
- Over temperature thermal protection
- Over voltage circuit protection
- External dimming control PIN
- Package : 8-pin SOP

3. ORDERING INFORMATION

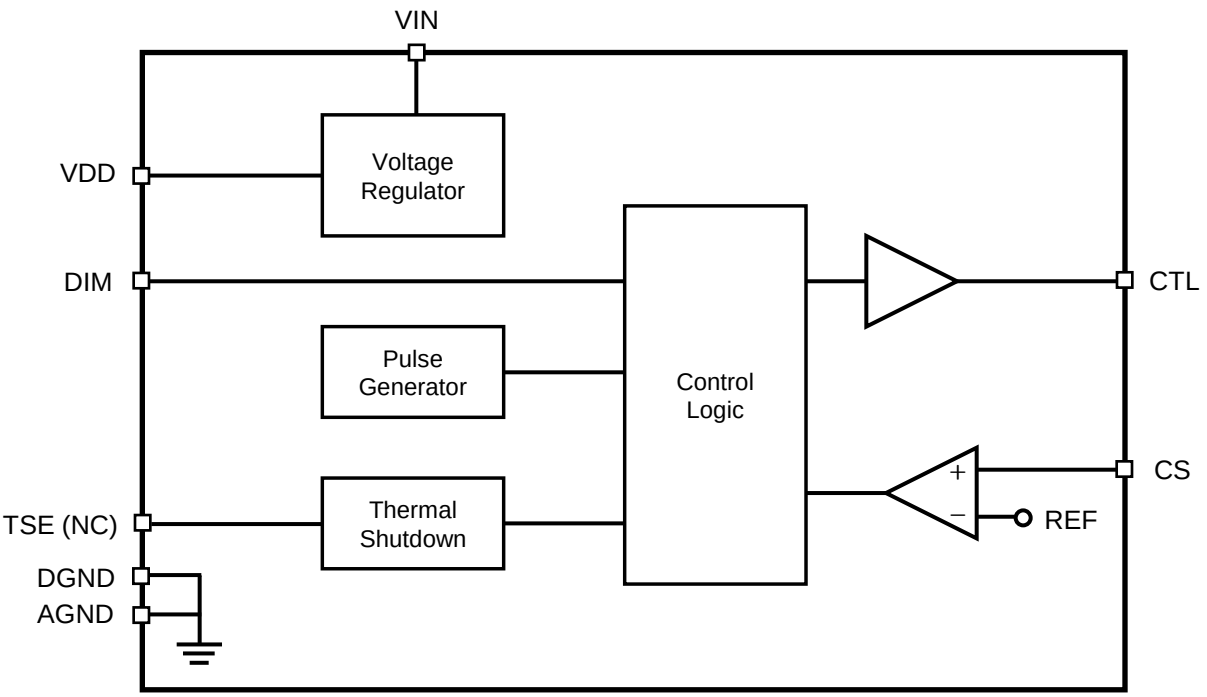
PART NUMBER	PACKAGE	Ta
LD1611-SP	8 SOP	-40°C to 85 °C

4. APPLICATIONS

- MR16 lighting
- DC/DC LED driver
- Automotive lighting
- Offline LED lamps

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5. BLOCK DIAGRAM

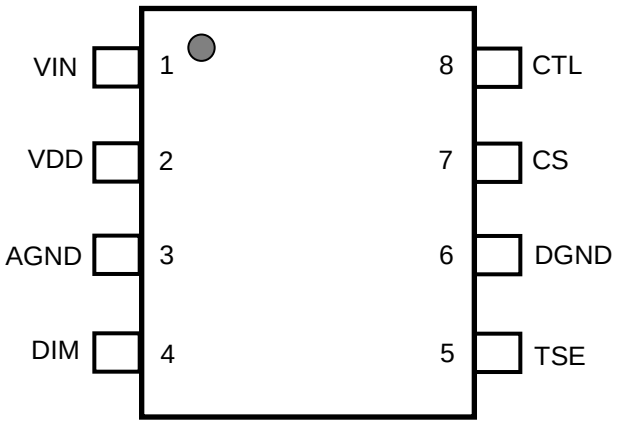


6. PIN DISCRIPTION

PIN NAME	DESCRIPTION	PIN No.
VIN	Input voltage (7V ~ 40V)	1
VDD	Internal regulator output. Connects decoupling capacitor to this pin with 1.0uF capacitor.	2
AGND	Analog ground	3
DIM	Dimming control terminal. Connect to VDD if not used.	4
TSE (NC)	Normally floating	5
DGND	Digital ground	6
CS	Current sense connection	7
CTL	Switch output terminal	8

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7. PIN CONFIGURATION



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8. ABSOLUTE MAXIMUM RATINGS

(Unless otherwise stated, GND=0V, T_A=25℃)

PARAMETERS	SYMBOL	RATING	UNIT
VIN Supply Voltage	V_{IN}	46VDC	V
Operating Ambient Temperature	T_A	-40 to 85	℃
Operating Junction Temperature	T_J	-40 to 150	℃

9. ELECTRICAL CHARACTERISTICS

(Unless otherwise stated, V_{IN}=12V, GND=0V, T_A=25℃)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
DC Input Voltage	V_{IN}	DC to V_{IN}	7		40	V
SW Frequency	F_{SW}				500[1]	kHz
VDD Output Voltage	V_{DD}			4.5		V
LED Output Current	I_{LED}			350	1500	mA
Quiescent Current					1.5	mA
Thermal Shutdown				140		℃

Note

[1] :Frequency depends on input voltage, inductance and output current.

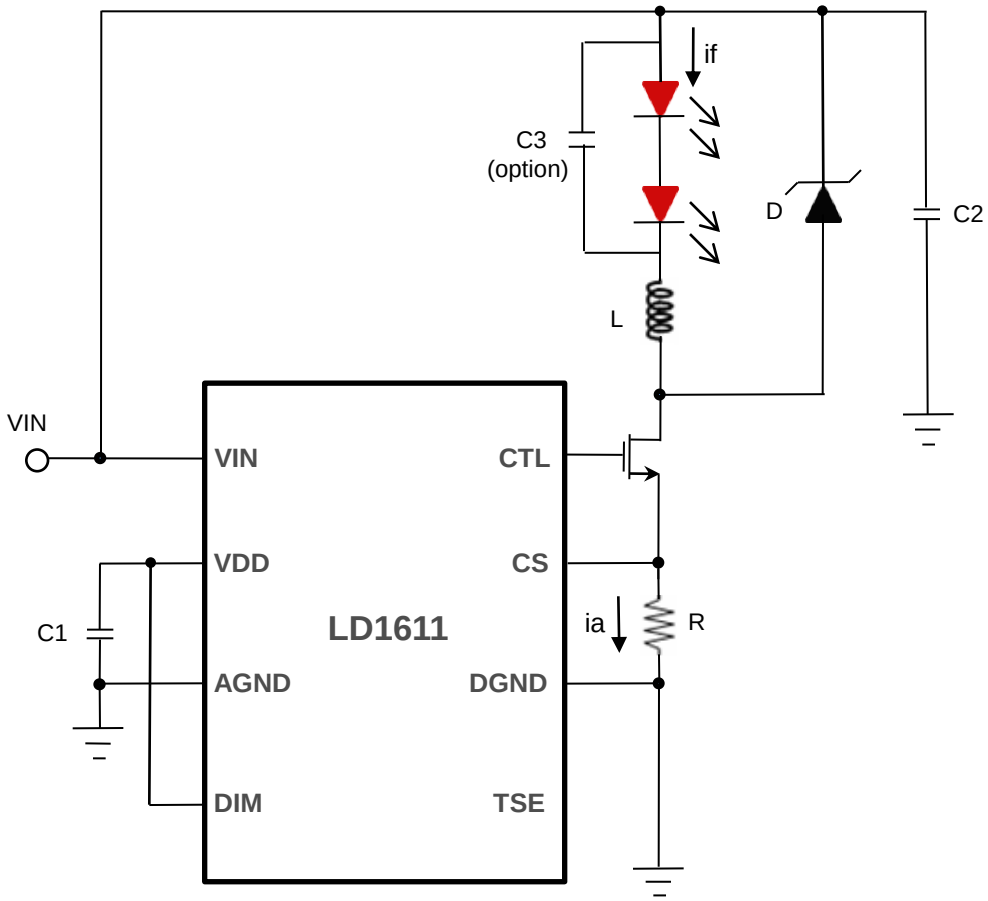
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10. CIRCUIT DESCRIPTION

During the charging operation, the turning on of the internal power NDMOS stores the input energy in an inductor. When the NDMOS is turned off during the OFF time, the stored energy will deliver to the output through the fly-back diode D, producing the ILED current through the LEDs.
Since LD1611 is designed with a high efficient constant off time controlling technique, the OFF time is fixed at 1.5μs (typical), it is important to make sure the supply voltage is less than 2 times the forward voltage drop across the LEDs.

11. APPLICATION INFORMATION

11.1 Typical Application Circuit



The LD1611 is a buck mode inductive DC-DC converter, with an external switch, designed for driving single or multiple LEDs in series up to maximum 1.5A output current. VIN input voltage is 7~40V DC voltage. The constant current operation is Pulse Frequency Modulation (PFM) method.
The off time of switching is fixed at 1.5us. So, the on time of switching depends on DIM pin signal, CS pin voltage and thermal voltage.

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11.2 Setting the Output Current with Resistor (R)

If R pin voltage is below 0.2V then the switch is on. R pin voltage is over 0.2V then the switch is off. So, typical peak to peak ripple current in the inductor is 15% of LED current (if).

if = 350mA setting

ia = if + Δif/2 = 350mA + 350mA x 0.15/2
= 376.25mA
→ Δif ≈ 15%x if
Va = R x ia
→ R = Va / ia = 0.2V / 376.25mA **≈ 533mΩ**

if = 800mA setting

ia = if + Δif/2 = 800mA + 800mA x 0.15/2
= 860mA
→ Δif ≈ 15%x if
Va = R x ia
→ R = Va / ia = 0.2V / 860mA **≈ 244mΩ**

if = 1500mA setting

ia = if + Δif/2 = 1500mA + 1500mA x 0.15/2
= 1612.5mA
→ Δif ≈ 15%x if
Va = R x ia
→ R = Va / ia = 0.2V / 1612.5mA **≈ 124mΩ**

11.3 Inductor Selection

Higher values of inductance are recommended at higher supply voltage in order to minimize errors due to switching delays, which results in increased ripple and low efficiency.
High value of inductance also results in a smaller change in output current (if) over the supply voltage range.

L = VLED x toff / Δif

VLED = Vf x N
N = # of LEDs in series
Toff = 1.5us
Δif = 15% x if

If N = 3, if = 350mA, Vf = 3V

L = 3V x 3 x 1.5us / (0.15 x 350mA) **≈ 257uH**

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11.4 Layout Considerations

For high frequency and high current switching power supplies, layout is an important design step.
To reduce switching losses, the switch rise and fall times are made as short as possible.
Minimize the length and area of all traces connected to the switch and always use a ground plane under the switching regulator to inter-plane coupling.
The loop including LEDs, the PFM switch and schottky diode contains high current rising and falling and should be kept as short as possible.
The input capacitor needs not only to be close to the VIN pin, but also to the GND pin in order to reduce the supply ripple.

11.5 Thermal Considerations

The maximum IC junction temperature should be restricted to 125℃ under normal operating conditions. Calculate the maximum allowable dissipation, $P_{D,MAX}$, and keep the actual dissipation less than or equal to $P_{D,MAX}$.

$P_{D,MAX} = (125℃ - T_A) / R_{\theta JA}$

where, T_A : maximum ambient temperature, $R_{\theta JA}$: thermal resistance junction to ambient

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11.6 Components Selection

Capacitor Selection

The small size of ceramic capacitors makes them ideal for LD1610 applications. X5R and X7R types retain their capacitance over wider voltage and temperature ranges and are recommended over Y5V or Z5U types. A 4.7uF input capacitor(C2) and two 1uF capacitors(C1, C3) are sufficient for the most DC operations. The rated voltage of C2 and C3 is recommended about 1.5 times than VIN, and C1 is 1.5 times than VDD.

Table 1. Recommended Capacitor Manufacturers

Manufacturer	Site
AVX	www.avxcorp.com
Kemet	www.kemet.com
Murata	www.murata.com
Taiyo Yuden	www.t-yuden.com

Inductor Selection

Table 2. Recommended Inductor Manufacturers

Part Number	DCR [Ω]	Current Rating [A]	Inductance [uH]	Manufacturer
B1280 Series	0.01 ~ 0.47	0.75 ~ 8.1	2.2~330	sanha
SDR0805 Series	0.11 ~ 1.96	0.5 ~ 2.3	22 ~ 470	bourns
SDR1006 Series	0.10 ~ 1.48	0.8 ~ 3.5	22 ~ 470	bourns
SRU1048 Series	0.04 ~ 0.49	0.52 ~ 2	22 ~ 330	bourns
SK75-19074801C	0.96	0.8	220	Sankyo shoji
CD104-MC	0.55	0.53	220	Sumida
MSS1048-KL	0.5~1	0.43~0.95	220~470	CoilCraft
NR10050T211M	0.45	0.8	220	Taiyo yuden
74456222	0.78	0.9	220	SMD

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Diode Selection

The diode D is used in the buck converter to help the inductor release the energy during the NDMOS off-time to supply the ILED to the LED string. The reverse breakdown voltage of the diode should be greater than two times of VIN and the average current through the diode should be 2 x ILED or greater.

Table 3. Recommended Diode Manufacturers

Part Number	Forward Current [A]	Voltage Drop [V]	Reverse Breakdown Voltage [V]	Manufacturer
STPS0540Z	2.0	0.5 at 2.0A	40	STMicroelectronics
CD214A-B360	3.0	0.5 at 3.0A	60	Bourns
CD214A-B180	1.0	0.79 at 1.0A	80	Bourns
CD214A-B1100	1.0	0.79 at 1.0A	100	STMicroelectronics
STPS2H100	2.0	0.65 at 1.0A	100	STMicroelectronics
SR series	2.0	0.5~0.85 at 2.0A	20 ~ 90	Won-Top

LED Selection

For demonstration and bench testing of LD1610 evaluation boards before shipment, the high-power W42182 LEDs are being used.

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N-Channel Power FET Selection

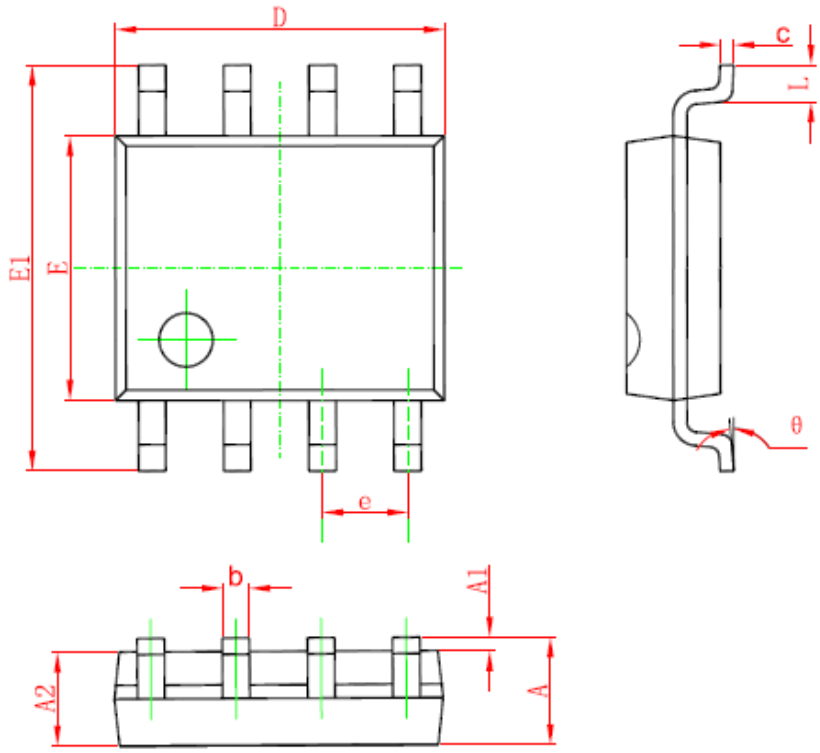
Table 4. Recommended Power FET Manufacturers

Part Number	V_{DS} [V]	$R_{DS(ON)}$ [Ω]	I_D [A]	Qg [nC]	Manufacturer
ZXMN3B14F	30	0.08 at VGS=4.5V	3.5 at VGS=4.5V	6.7 at VGS=4.5V	ZETEX
ZXMN6A11G	70	0.19 at VGS=4.5V	3.8 at VGS=4.5V	4.35 at VGS=5V	ZETEX
FDS8984	30	0.03 at VGS=4.5V	6 at VGS=4.5V	5 at VGS=5V	FAIRCHILD
Si3458	60	0.128 at VGS=4.5V	3.6 at VGS=4.5V	3.5 at VGS=4.5V	VISHAY
Si3430DV	100	0.185 at VGS=6.0V	2.3 at VGS=6V	5.5 at VGS=10V	VISHAY
DMN3024LSS	30	0.036 at VGS=4.5V	6.9 at VGS=4.5V	6.3 at VGS=4.5V	DIODES

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12. PACKAGE INFORMATION (SOP)

SOP8 PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270 (BSC)		0.050 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

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