Overview

TP8005 is a buck LED constant current driver that works in inductor current continuous mode. It is used to efficiently drive one or more series LEDs. The chip's input voltage range is 5V~36V, and the output current is externally adjustable, up to 1.2A.

TP8005 integrates power tubes and uses high-end current detection. The average current of LED output can be set through external resistors, and analog dimming and a wide range of PWM dimming signals can be received through the DIM pin. When the DIM voltage is lower than 0.3V, the power tube inside the chip is turned off, and TP8005 enters low-power standby mode.

TP8005 integrates an automatic temperature compensation control circuit. When the temperature inside the chip exceeds 130°C, the LED output current will gradually decrease as the temperature rises, and finally stabilize at a certain current value. This avoids the problem of low-frequency LED flickering caused by traditional over-temperature protection. When the temperature inside the chip rises to 150°C, the LED output current decreases to zero.

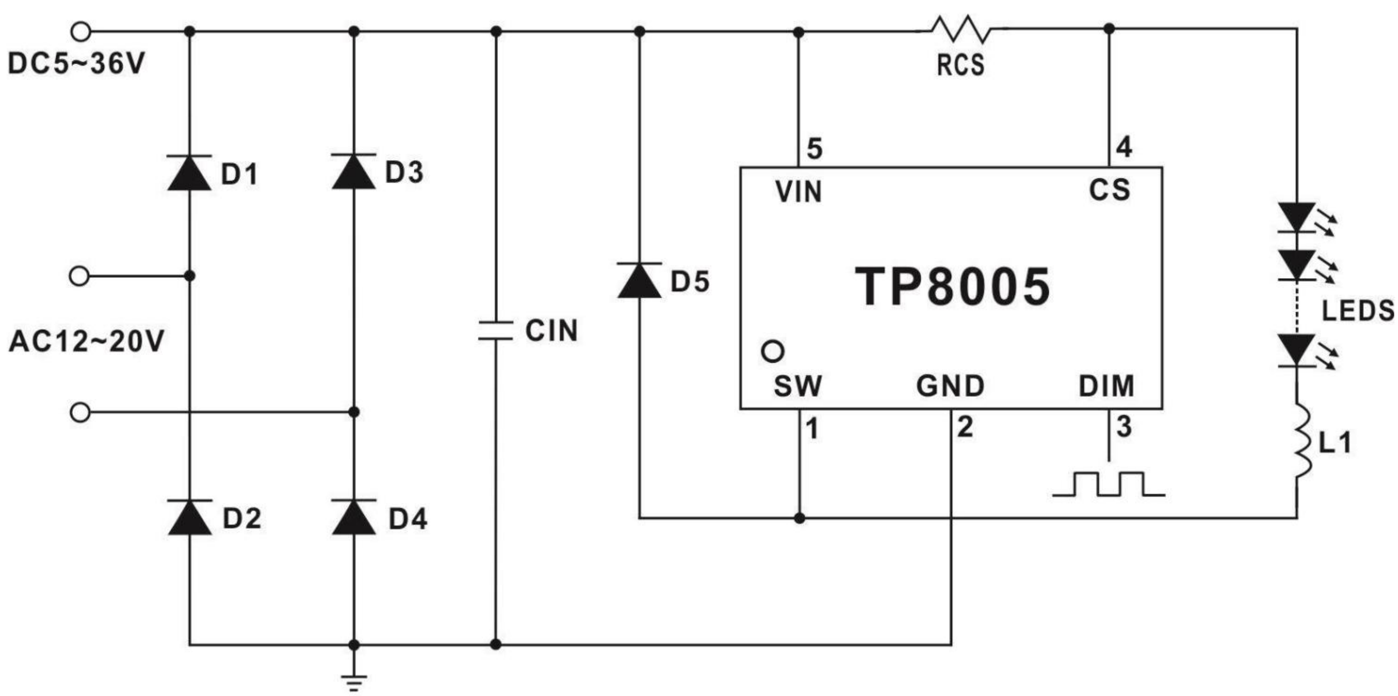
Features

• Up to 95% efficiency • Automatic temperature compensation control
• Wide input voltage range: 5V~36V • Maximum 1.2A output current • DIM pin for PWM and analog dimming • ±3% output current accuracy • Built-in LED open circuit protection • Adjustable soft start time • Available in SOT89-5L package

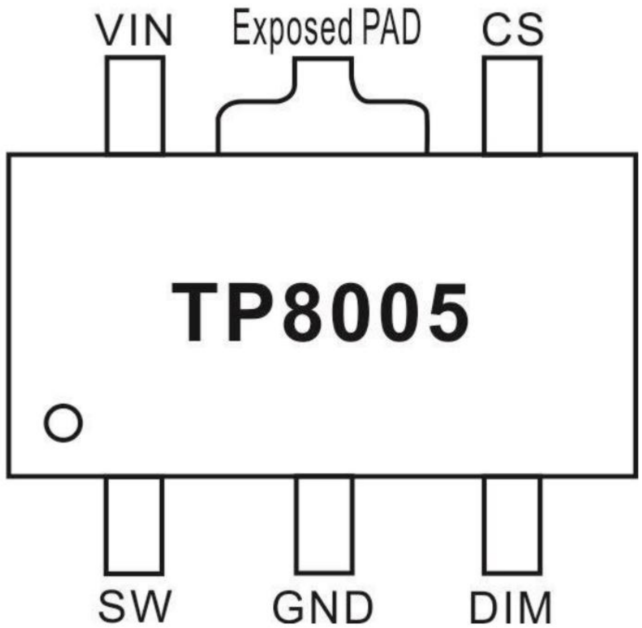
application

• Low voltage LED spotlights to replace halogen lamps • Low voltage industrial LED lighting • LED decorative lighting • Other LED lighting

Typical application circuit



Pins



SOT89-5L

Pin Description

Pin Number	Pin Name	describe
1	SW	Internal power tube drain
2	GND	Chip ground
3	DIM	chip enable pin, analog dimming and PWM dimming input
4	CS	output current sampling pin, the sampling resistor is connected between VIN and CS
5	VIN	power input pin, capacitor must be connected to ground close to the pin
-	Exposed PAD	heat sink, connected to chip ground

Limit parameters (Note 1)

parameter	Rated	unit
VIN to GND Voltage	value -0.3~+40	In
SW to GND Voltage	-0.3~+40	In
CS to VIN Voltage	-1.0~+1.0	In
DIM to GND voltage Power	-0.3~+6	In
tube output current Power	1.2	A
loss (Note 2) Operating	1.5	IN
junction temperature	-40~150	ÿ
range Storage temperature range	-50~150	ÿ
ESD Level (HBM)	2000	In
ESD Level(MM)	200	In

Recommended working range

Parameters	symbol	Working	Recommended	value unit
Supply Voltage	COME	conditions	0~36	In
Operating Temperature	TOP	Normal working conditions	-40~85	ÿ

Note 1: The maximum limit value means that the chip may be damaged if it exceeds the working range. The recommended working range means that the chip works normally within the range, but it is not guaranteed to meet the individual performance specifications.

The electrical parameters define the DC and AC electrical parameter specifications of the device within the operating range and under test conditions that guarantee specific performance indicators.

These are limited parameters and their accuracy is not guaranteed by this specification, but their typical values reasonably reflect the performance of the device.

Note 2: The maximum power consumption will decrease as the ambient temperature rises. This is determined by TJMAX, ÿJA and the ambient temperature TA. The maximum allowable power consumption is PDMAX = (TJMAX-TA) / ÿJA or the limit parameter

The lower value in the given range.

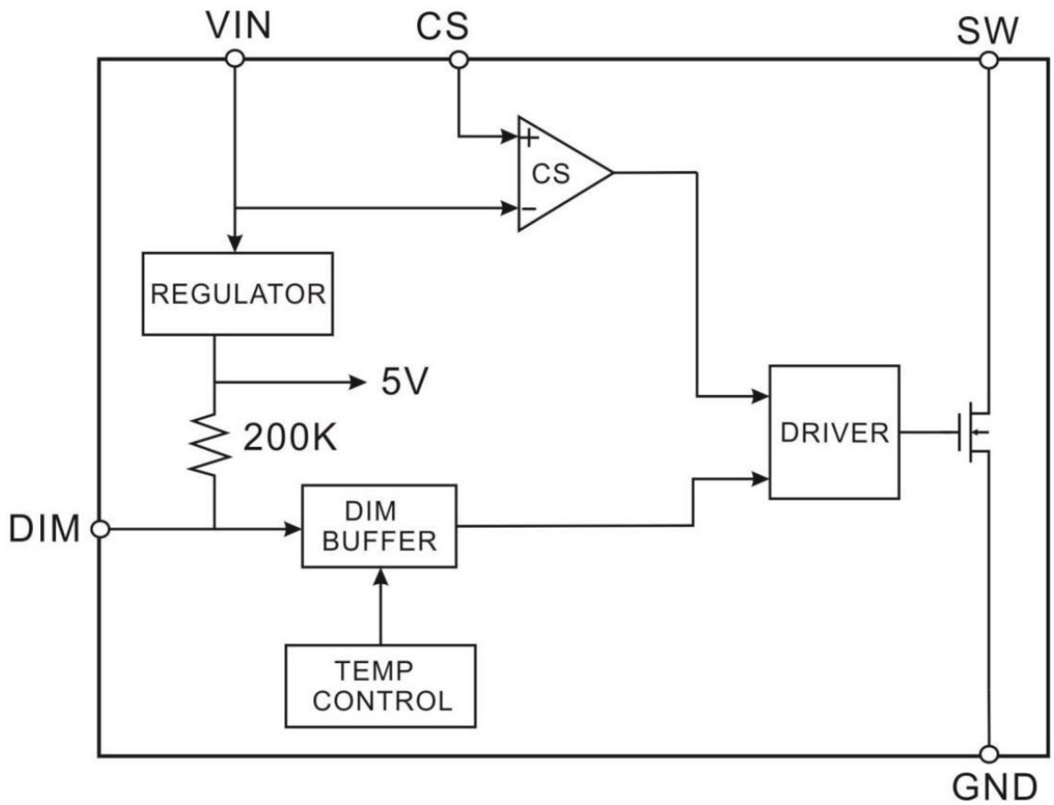
Electrical parameters (Note 3)

(Unless otherwise specified, Ta=25ÿ, VIN=12V)

Symbol parameter	Input voltage	Test conditions	Min Typ Max	Unit		
COME	Input voltage		5		36	In
IOP working current undervoltage protection		VIN=VCS=12V	100	150	250	a
VUVLO		VIN rises		4.2		In
VUVLO,HYS undervoltage protection hysteresis		VIN drops		4.0		In
current sampling						
VCS average sampling voltage		VIN–VCS	97	100	103	mV
VCS,HYS sampling voltage hysteresis				±15		%
ICS	CS pin input current	VIN–VCS=50mV		8		ÿA
operating frequency						
FSW	Maximum operating frequency				1	MHz
DIM Input						
VDI	DIM floating voltage	DIM Float		5		In
RDIM	DIM pull-up resistor			200		Kÿ
IDIM_L	DIM Ground leakage current	VDIM=0		25		ÿA
VDIM_H	DIM input high level		2.5			In
VDIM_L	DIM input low level				0.3	In
DIM						
VDIM_DC analog dimming voltage range fDIM			0.5		2.5	In
maximum PWM dimming frequency fosc=500KHz					50	KHz
DPWM_LF low frequency PWM dimming duty cycle fDIM=100Hz			0.05%		100%	
DPWM_HF high frequency PWM dimming duty cycle fDIM=20kHz power tube			10%		100%	
RSW	SW on-resistance			0.35		Oh
ISW_MEAN	SW continuous current				1.2	A
ILEAK	SW leakage current			0.5	5	ÿA
Temperature Control						
TST	Temperature compensation start temperature			130		ÿ

Note 3: The minimum and maximum specification ranges in the data sheet are guaranteed by testing, and the typical values are guaranteed by design, testing or statistical analysis.

Internal Block Diagram



Application Notes

TP8005, inductor L1 and current sampling resistor RCS together form a self-oscillating inductor current continuous mode buck LED constant current driver.

Working Principle

When VIN is powered on, the initial current of the inductor L1 and the resistor RCS is zero. At this time, there is no voltage difference between VIN and CS, and the CS comparator output is high. This signal is transmitted to the negative input of the PWM comparator. The output of the PWM comparator is high, the power tube inside the chip is turned on, and the SW pin is pulled down to a low level. At this time, the current is input from VIN, passes through the sampling resistor RCS, LED, inductor L1 and internal power tube flow to GND, the current rising slope is determined by VIN, L1 and LED voltage drop, a voltage drop VRCS is generated on RCS, when VRCS>115mV, the output of CS comparator turns to low level, the power tube inside the chip is turned off, the current passes through inductor L1, Schottky diode D5, RCS and LED and then returns to inductor L1, the current generates a falling voltage slope on RCS , when VRCS<85mV, the output of CS comparator turns to high level, the power tube inside the chip is turned on again. TP8005 will repeat this process periodically. So the average current on the LED is

$$IOUT = \frac{85mV + 115mV}{2 \times RCS} = \frac{100}{\quad}$$

The high-end current sampling structure reduces the number of external components and uses a 1% precision sampling resistor, so the LED output current accuracy can be controlled within ±3%.

TP8005 can input PWM signal at DIM pin for PWM modulation.

When the DIM pin voltage is lower than 0.3V, the LED current is turned off. When it is higher than 2.5V, the LED current is fully turned on. The frequency range of PWM dimming is from 100Hz to more than 20KHz. When the high level of the PWM signal is between 0.5V and 2.5V, PWM dimming can be performed. For specific application details, please refer to the following description.

The DIM pin can also be used to achieve analog dimming by applying an external DC voltage. The maximum LED current is determined by the sampling resistor RCS. The effective dimming range of the DC voltage (VDIM) is 0.5V to 2.5V. When the DC voltage (VDIM) is higher than 2.5V, the output LED current remains constant and is set by the sampling resistor RCS. The LED current can also be adjusted by connecting a resistor from DIM to ground. There is an internal pull-up resistor (typically 200K ohms) connected to the internal regulated voltage 5V. The voltage of the DIM pin is determined by the internal and external resistor divider.

The DIM pin can be left floating during normal operation. When the voltage applied to DIM is lower than 0.3V, the power tube inside the chip is turned off and the LED current drops to zero.

LED average current setting

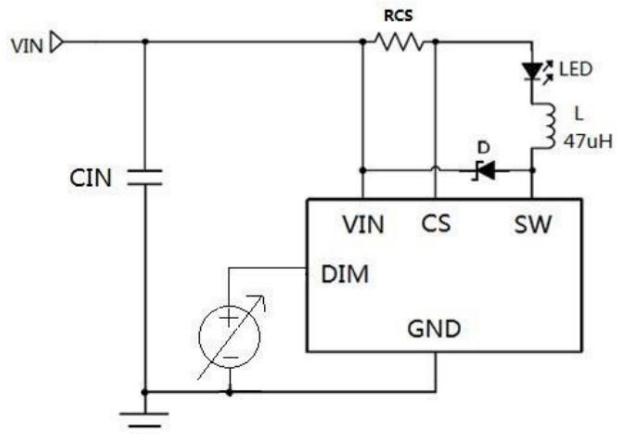
The average current of the LED is determined by the resistor RCS connected between VIN and CS :

$$IOUT = \frac{100}{\quad} \quad \text{(RCSÿ0.082ÿ)}$$

The premise for the above equation to be true is that the DIM terminal is floating or the external DIM terminal voltage is greater than 2.5V and less than 5V. In fact, RCS sets the maximum output current of the LED . By setting the DIM voltage, the actual output current of the LED can be adjusted to any value.

Analog dimming

The DIM pin can be connected to a DC voltage (VDIM) to perform analog dimming to adjust the output current of the LED, as shown in the following figure:



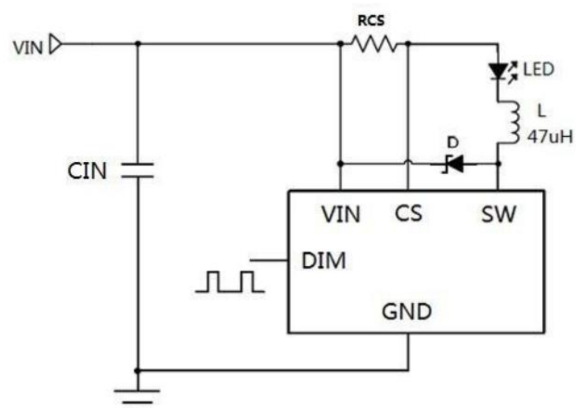
At this time, the output current can be expressed by the following two equations:

$$IOUT = \frac{100mV}{RCS} \times \frac{VDIM}{2.5V} \quad (0.5V ÿVDIMÿ2.5V)$$

$$IOUT = \frac{100mV}{RCS} \quad (2.5V ÿVDIMÿ5.0V)$$

PWM dimming

TP8005 can input PWM signal at DIM pin to perform PWM dimming to adjust the output current of LED, as shown in the following figure:



The output current is proportional to the duty cycle of the PWM signal. The average output current can be expressed by the following two equations:

$$= \frac{100}{} \times (0ÿDÿ100\%ÿ2.5VÿVPULSEÿ5V)$$

$$= \frac{100}{} \times \times \frac{}{2.5} \quad (0ÿDÿ100\%, 0.5ÿVPULSEÿ2.5V)$$

Wherein, VPULSE is the high level amplitude of the PWM signal.

Through PWM dimming, the output current of the LED can be changed from 0% to 100%. The brightness of the LED is determined by the duty cycle of the PWM signal. For example, if the duty cycle of the PWM signal is 25%, the average output current of the LED is 25% of the set current. It is recommended to set the PWM dimming frequency to above 100Hz to prevent the human eye from seeing the LED flicker. The advantage of PWM dimming over analog dimming is that it does not change the color temperature of the LED. The maximum dimming frequency of TP8005 can reach above 20kHz.

Automatic temperature compensation

control TP8005 integrates automatic temperature compensation control circuit. When the temperature inside the chip exceeds 130ÿ, the LED output current will gradually decrease as the temperature rises, and finally stabilize at a certain current value. This avoids the problem of low-frequency LED flickering caused by traditional over-temperature protection. When the temperature inside the chip rises to 150ÿ, the LED output current decreases to zero.

In shutdown mode,

the system is shut down by connecting a voltage below 0.3V to the DIM terminal. At this time, the chip is in standby mode. Normally, the typical standby current of the chip is about 80ÿA.

The soft start mode

connects a capacitor to the DIM pin, so that the voltage of the DIM pin rises slowly when the system starts, so that the output current of the LED also rises slowly, thus achieving soft start. Usually, the relationship between the soft start time and the size of the external capacitor is about 150us/nF.

LED open circuit protection

TP8005 has output open circuit protection function. Once the load is open, the chip will be set to a safe low power consumption mode, and will enter normal working state after the load is reconnected.

The LED output

current of TP8005 is in the range of 0~1.2A, and the recommended inductor parameter range is 47uHÿ100uH. The saturation current of the inductor must be 30% to 50% higher than the LED output current .

Diode Selection To ensure

maximum efficiency and performance, the diode (D5) should be a Schottky diode with fast recovery, low forward voltage drop, low parasitic capacitance, and low leakage. The current capability and withstand voltage depend on the specific application, but a 30% margin should be maintained to facilitate stable and reliable operation. Another point worth noting is that the reverse leakage current of Schottky should be considered when the temperature is above 85°C. Excessive leakage will lead to increased system power consumption. AC12V Input Rectifier Diode (D1~D4) must use low voltage drop Schottky diodes to reduce their own power loss

Reduce output ripple If you

need to reduce the LED output current ripple, you can

The output capacitor can be connected in parallel with the LED terminal to achieve this. The 1uF output capacitor can reduce the LED output current ripple by about 1/3. Properly increasing the output capacitor can suppress more ripple. It should be noted that the output capacitor will not affect the operating frequency and efficiency of the system, but it will affect the system startup delay and PWM dimming frequency.

When the system is

operating in a high ambient temperature and driving a high current load, care must be taken to avoid the system reaching the power limit. Increasing the copper area at the chip pin soldering is conducive to chip heat dissipation. In practical applications, the current density of about 1oz copper is required for every 25mm2 of PCB to facilitate heat dissipation. It should be noted that the selection of inappropriate inductance and the presence of excessive parasitic capacitance at the switch switching point will lead to reduced system efficiency.

Thermal compensation of load current High

brightness LED sometimes needs to provide output current temperature compensation to ensure reliable and stable operation. TP8005 can connect an external thermistor through the DIM pin

Place an NTC or negative temperature coefficient diode near the LED to detect the LED

The temperature of the lamp thereby adjusts the output current of the LED load.

PCB Layout

Reasonable PCB layout is important to ensure maximum system stability and low noise. Using multi-layer PCB is an effective way to avoid noise interference. In order to effectively reduce the noise of the current loop, the input bypass capacitor should be grounded separately.

SW The foot

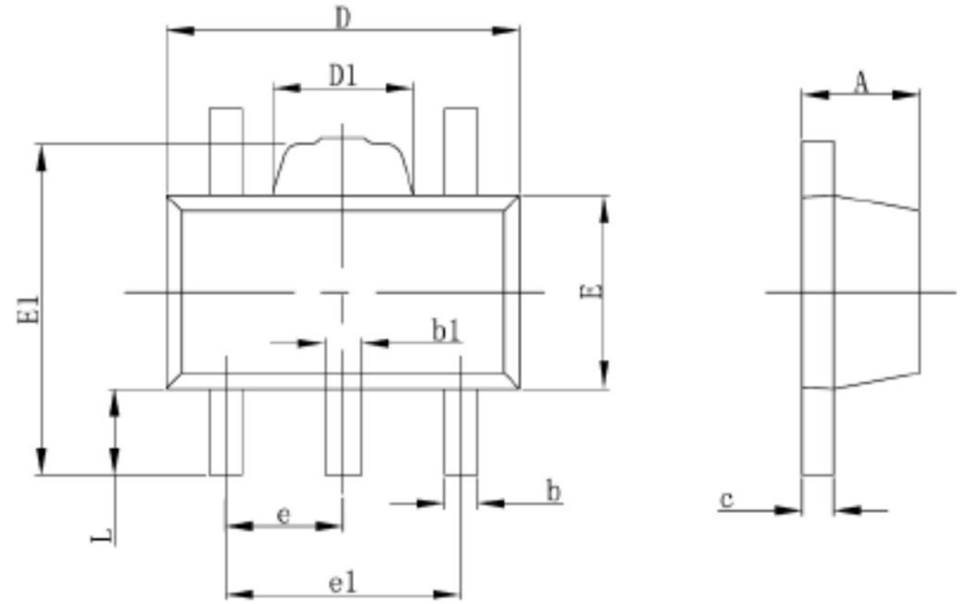
SW pin is at the fast switching node, so the PCB trace should be as short as possible. In addition, the GND pin of the chip should be grounded as well as possible.

Bypass capacitor, inductor, current sampling resistor

In PCB layout, the inductor should be as far away from the chip as possible to reduce the interference of the inductor on the chip. If the PCB size allows, lay as much copper as possible and connect it to the GND or VIN pin of the power supply to absorb the interference generated by the inductor. The shorter the traces at both ends of the current sampling resistor RCS, the better, to reduce the parasitic inductance of the traces and ensure the accuracy of current sampling. The bypass capacitor should be as close to the VIN pin of the chip as possible, and the traces should be short and thick.

Package

SOT89-5L



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.400	1.600	0.055	0.063
b	0.320	0.520	0.013	0.020
b1	0.360	0.560	0.014	0.022
c	0.350	0.440	0.014	0.017
D	4.400	4.600	0.173	0.181
D1	1.400	1.800	0.055	0.071
E	2.300	2.600	0.091	0.102
E1	3.940	4.250	0.155	0.167
e	1.500TYP		0.060TYP	
e1	2.900	3.100	0.114	0.122
L	0.900	1.100	0.035	0.043

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