

GENERAL DESCRIPTION

PT4127H is a high-efficiency, high-precision step-down high-power LED constant current control chip.

PT4127H adopts a fixed frequency average current control mode, which has excellent line regulation and load regulation.

PT4127H can control the current of the high-power LED lamp by adjusting the external current sense resistor, so that the brightness of the LED lamp can reach the expected constant brightness.

PT4127H integrated PWM and linear dimming functions, the PWM dimming depth can reach 1%.

The PT4127H integrates LED short-circuit protection circuit and over-temperature protection circuit to reduce external components and improve the reliability of the system.

PT4127H is available in a SOT23-6 package.

FEATURES

- Wide input voltage range: 8V~150V
- Average current control mode
- High efficiency: up to 95%.
- Constant current accuracy: $\pm 4\%$.
- Support PWM dimming
- Linear dimming is supported
- CS reference: 200mV
- Fixed switching frequency: 140kHz
- Over-temperature automatic current adjustment function (TSC).
- Output short-circuit protection
- Inductor short-circuit protection
- SOT23-6 package

APPLICATIONS

- LED Headlights (H4)
- Vehicle brake lights
- Bicycles, electric vehicles, motorcycle lights
- Flashlight
- LED spotlights
- High-power LED lighting

TYPICAL APPLICATION CIRCUIT

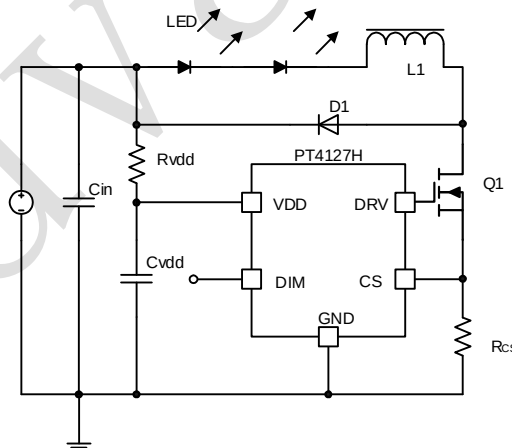
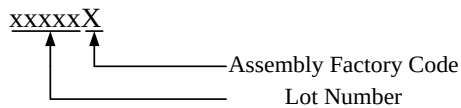


Figure 1 Typical Application Circuit

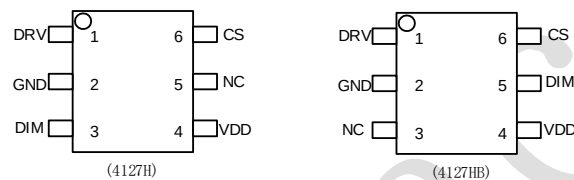
ORDERING INFORMATION

PACKAGE	ORDERING PART NUMBER	TRANSPORT MEDIA	MARKING
SOT23-6	PT4127HE23F	Tape and Reel 3000 units	4127H
SOT23-6	PT4127HBE23F	Tape and Reel 3000 units	4127HB

Note:



PIN ASSIGNMENT



PIN DESCRIPTIONS

PIN No. (PT4127H)	PIN No. (PT4127HB)	PIN NAMES	DESCRIPTION
1	1	DRV	The DRV pin is connected to an external MOSFET gate
2	2	GND	Chip ground
3	5	DIM	Dimming pin
4	4	VDD	Power supply pins for the chip's internal circuitry
5	3	NC	Not connected
6	6	CS	Current sense pin

ABSOLUTE MAXIMUM RATINGS (Note1)

SYMBOL	PARAMETER	VALUE	UNIT
VDD	The maximum VDD voltage	7	V
V _{max}	Voltage for DRV, DIM and CS pins	7	V
θ _{JA} (SOT23-6)	PN junction to ambient thermal resistance (Note 2)	220	°C/W
T _J	Operating junction temperature range	-40~150	°C
T _{STG}	Storage temperature range	-65~150	°C

RECOMMENDED OPERATING RANGE

SYMBOL	PARAMETER	VALUE	UNIT
VDD	Supply voltage	5.5	V
TOPT	Operating temperature	-40 ~ +85	°C

Note 1: The maximum limit value means that the chip may be damaged outside of this operating range. The recommended operating range is the range within which the device is functional, but it is not a complete guarantee that individual performance specifications will be met. Electrical parameters define the DC and AC parameters that the device will operate within range and under test conditions that guarantee specific performance specifications. The specification does not guarantee accuracy for parameters for which no upper or lower limit values are given, but typical values are reasonable reflections of device performance.

Note 2: PCB condition: double-sided, copper foil thickness 2Oz, copper pour area 2Inch², connecting 8 vias.

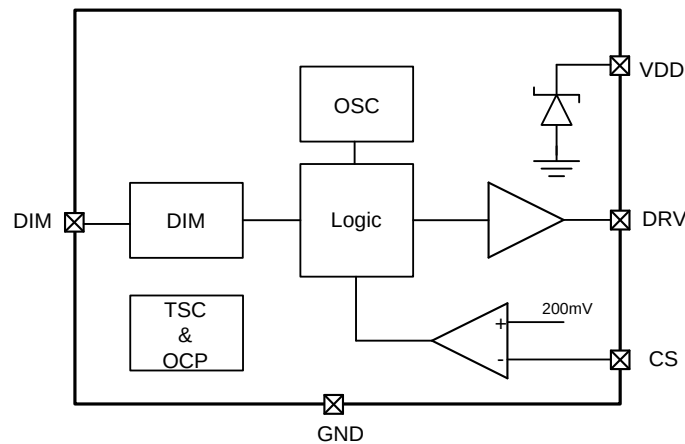
ELECTRICAL CHARACTERISTICS

(TA=25°C, unless otherwise specified)

SYMBOL	PARAMETER	TEST CONDITION	MIN	TYP	MAX	UNIT
VDD						
VDD _{UVLO_ON}	VDD startup voltage	VDD rises		4.1		V
VDD _{UVLO_OFF}	VDD shutdown voltage	VDD decreases		3.7		V
VDD	VDD voltage	IVDD≤2mA		5.5		V
I _Q	Quiescent current	VDD=5.5V, DRV is open		500	550	μA
I _{OP}	Operating current	VDD=5.5V, DRV connect to 500pF capacitor		2	10	mA
CS						
V _{CS}	CS reference	VDD=5V	192	200	208	mV
T _{LEB}	Leading edge blank time			200		ns
V _{CS_hiccup}	CS protection threshold			500		mV
T _{CS_hiccup}	Hiccup protection time			3		ms
V _{CS_latch}	Latch protection threshold			1		V
Switching Frequency						

F _{SW}	switching frequency			140		kHz
T _{ON_MIN}	Minimum on time			270		ns
PWM Dimming						
F _{PWM}	PWM dimming frequency		0.1		20	kHz
V _{PWM_H}	PWM high threshold		2.5			V
V _{PWM_L}	PWM low threshold				0.3	V
Linear Dimming						
V _{DIM_DC}	Linear dimming range		0.5		2.5	V
V _{DIM}	Internal operating voltage	DIM pin open		5.5		V
R _{DIM}	DIM pin internal pull-up resistor	DIM pin open		200		kΩ
I _{DIM_L}	leakage current	DIM pin is grounded		27.5		μA
DRV						
T _{RISE}	DRV rise time	DRV to 500pF capacitors		30	50	ns
T _{FALL}	DRV fall time	DRV to 500pF capacitors		30	50	ns
Over-temperature protection						
T _{SC}	Temperature compensated starting point			135		°C

SIMPLIFIED BLOCK DIAGRAM



OPERATION DESCRIPTION

PT4127H adopts a fixed frequency average current control method, and the current control accuracy is high, so that the LED can achieve the expected constant brightness.

Taking a typical application circuit as an example, when the power MOSFET is in the conduction state, the input voltage V_{IN} charges the inductor through the LED lamp, inductor L_1 , power MOSFET, and current sense resistor R_{CS} , and the current flowing through the inductor gradually increases with the charging time. The chip samples the voltage on the current sense resistor R_{CS} during the power MOSFET turn-on stage for average current detection. When the average voltage on the current sense resistor R_{CS} reaches the voltage set by the on-chip error amplifier, the control circuit shuts down the power MOSFET.

When the power MOSFET is turned off, the inductor is discharged through a loop consisting of an LED lamp, a freewheeling diode, and the inductor itself.

At the end of a switching cycle, the on-chip OSC clock signal causes the power MOSFET to return to the on-state and repeat the turn-on and turn-off processes.

Output Current Setting (R_{CS})

The LED output current can be precisely set

by the current sense resistor R_{CS} , where the output is 100% current:

$$I_{LED} (A) = \frac{0.2(V)}{R_{CS}(\Omega)}$$

Inductance selection (L_1)

In order to ensure the constant current characteristics and dimming depth of the system, the inductor current should work in current continuous mode, and the minimum inductance required is as follows:

$$L_1 \geq \frac{R_{CS} * V_{LED} * (1 - V_{LED} / V_{IN})}{F_{SW} * V_{REF} * n * 2}$$

R_{CS} is the current sense resistor, V_{LED} is the output lamp voltage, V_{IN} is the input voltage, V_{REF} is the reference level of 0.2V, and n is the linear dimming depth. When selecting an inductor, care should be taken to make the peak current of the inductor less than the saturation current of the inductor and leave a certain margin.

Dimming function

When the DIM port input voltage is 0.5V~2.5V, the chip realizes the linear dimming function, and turns off the output when the DIM port voltage is lower than 0.3V.

The DIM port can realize the PWM dimming function, and the high level of the DIM port should exceed 2.5V during PWM dimming. The DIM port supports ultra-small duty cycle PWM

Step-down LED Current Controller

dimming, when the PWM signal is low, the output is off, and when the PWM signal is high, the output is on. When floating, the port defaults to a high level input.

Overheat adjustment function

PT4127H has an overtemperature regulation function, which gradually reduces the output current value when the chip overheats ($> T_{SC}$), so as to control the output power and temperature rise, so that the chip temperature is kept at a constant value, so as to improve the reliability of the system. The system detects the chip temperature in real time, and when the chip temperature drops below T_{SC} , the system output current returns to normal.

Short-circuit protection

When the inductance is short-circuited in the system, the current flowing through the power MOSFET increases instantaneously, and when the V_{CS} voltage touches the V_{CS_LATCH} , the chip immediately stops working and latch, and needs to be re-powered on to work normally after the fault is removed.

When the LED short circuit occurs in the system, the V_{CS} voltage is greater than V_{CS_HICCUP} for 3 times, and the chip immediately stops working and enters HICCUP mode. Hiccups last 3ms. The chip then restarts automatically.

MOS Switch Selection (Q1)

First of all, it is necessary to consider the breakdown voltage of the MOSFET switch, which is generally required to be more than 1.5 times

higher than the maximum input voltage. Secondly, the I_{DS} current of the MOSFET switch is selected according to the magnitude of the driving LED current and the maximum peak current of the inductor. Generally, the I_{DS} of MOSFET switches should be more than 2-4 times the maximum peak current of the inductor. In addition, the $R_{DS(on)}$ of the on-resistance of the MOSFET switch should be smaller, and the smaller the $R_{DS(on)}$, the smaller the power dissipation on the MOS switch, and the higher the system conversion efficiency.

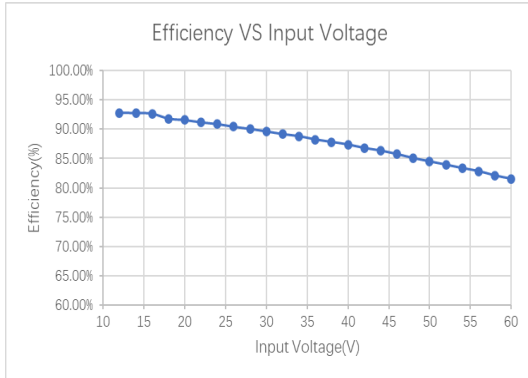
In addition, for high-voltage applications, attention should be paid to the selection of MOS switches with gate on-threshold voltages within 2.5V. The operating supply voltage of the chip determines the DRV drive voltage. The maximum driving voltage of the PT4127H is 5.5V, so it should be ensured that the internal resistance of the MOS switch is low enough when the VGS voltage is 5.5V.

Layout Considerations

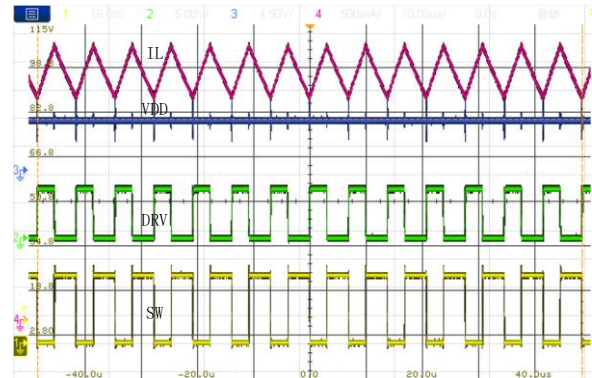
The hot loops and gate drive loops of the main power of the system should be as small as possible. The CS traces should be as far away as possible from the drive traces and the main power hot circuit traces to avoid interference. The connection of the current sense resistor RCS to the CS pin and GND pin of the chip should be as short and thick as possible to reduce the influence of the parasitic resistance of the wire on the accuracy of the output current.

TYPICAL PERFORMANCE CHARACTERISTICS

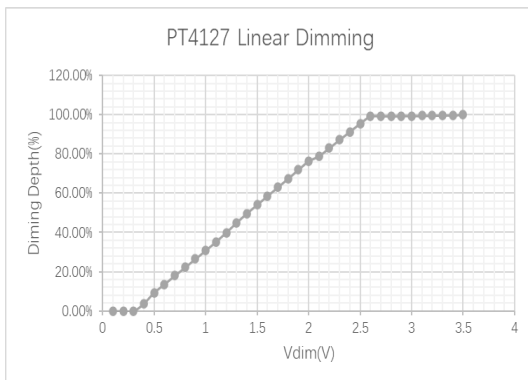
Unless otherwise specified, $V_{in}=24V$, $V_o=3*3V_{LED}$, $I_{out}=1A$, $T_a=25^{\circ}C$



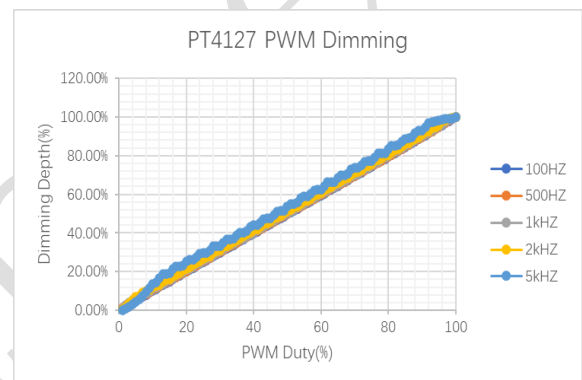
System Efficiency



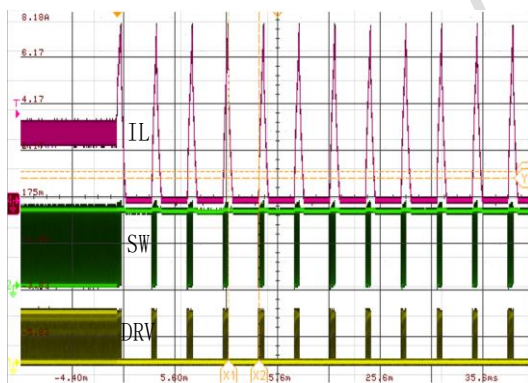
Operating Waveform



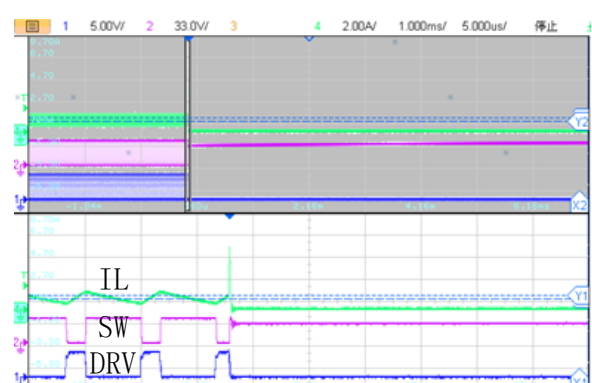
Linear dimming curve



PWM dimming curve



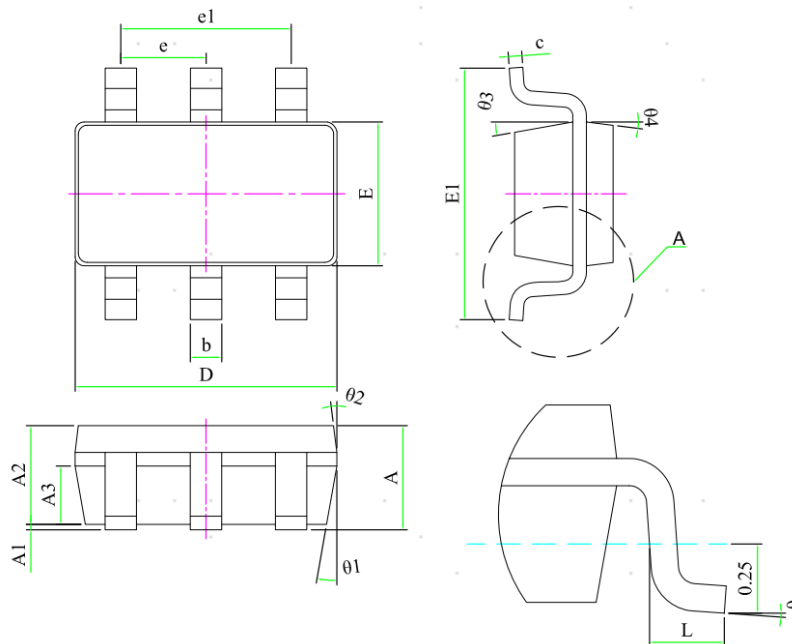
LED Short Circuit



Inductor short circuit

PACKAGE INFORMATION

SOT23-6



SYMBOL	MIN	NOM	MAX
A	1.05	1.15	1.25
A1	0.00	0.05	0.10
A2	1.05	1.10	1.15
A3	0.60	0.65	0.70
D	2.82	2.92	3.02
E	1.50	1.60	1.70
E1	2.65	2.80	2.95
L	0.30	0.45	0.60
b	0.28	0.35	0.42
c	0.10	0.15	0.20
e	0.95 BSC		
e1	1.80	1.90	2.00
θ	0°	-	8°
θ1	10°	-	14°
θ2	8°	-	12°
θ3	10°	-	14°
θ4	8°	-	12°

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