



HW6313B

Description

The HW6313B is a high precision primary-side feedback and regulation controller for LED lighting, it operates in constant current control mode and is designed to work in inductor current discontinuous conduction mode and especially suitable for flyback convertor under universal input. The output power of system is recommended to less than 7W.

The HW6313B integrates 650V power MOSFET. Since adopting primary sense and feedback control technology, the secondary sense and feedback circuit is eliminated. The loop compensation components are also removed while maintaining stability overall operating conditions. It uses source driver architecture and demagnetization sensing technology, the operating current is very low, and it doesn't need the auxiliary winding for sensing the output current and supplying the chip. The low component counts and small system size are realized.

HW6313B chip with high accurate current sampling circuit, the constant current control technology, which can realize high accuracy LED constant current output and excellent line voltage adjustment rate. By adjusting the external resistor can accurately control the open circuit voltage of LED.

The HW6313B offers rich protection functions including LED open/short circuit protection, CS resistor short circuit protection, over-temperature

protection, VCC under voltage protection.

Features

- Built-in 650V Power MOSFET
- Constant current control without secondary sense and feedback circuit.
- No Auxiliary winding for sensing and supplying
- LED open circuit voltage can be adjusted by an external resistor
- Ultra low operating current to improve efficiency
- Universal input voltage
- $\pm 4\%$ LED current accuracy
- LED short and open circuit protection
- CS resistor short circuit protection
- VCC under-voltage protection
- Over temperature protection
- Available in SOP-8 package

Applications

- GU10/E27 LED bulb, spot light
- Other LED lighting





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Typical Application

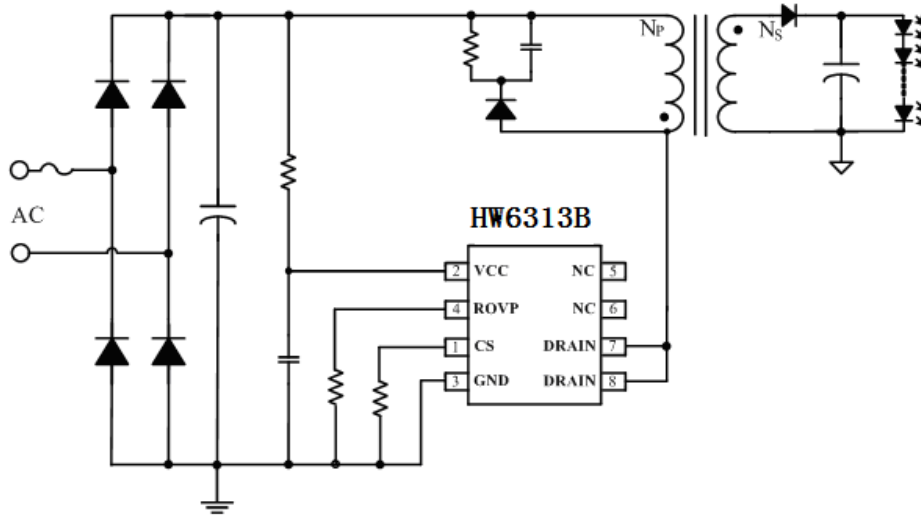


Figure 1. Typical application circuit for HW6313B

Ordering Information

Part Number	Package	Operating Temperature	Package Method	Marking
HW6313B	SOP8	-40 °C to 105 °C	Tape 2,500 Piece/Roll	HW6313B

Pin Configuration and Marking Information

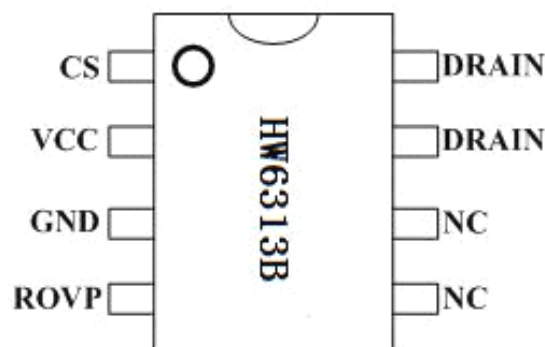


Figure 2. Pin configuration





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Pin Definition

Pin No.	Name	Description
1	CS	Current sense. This pin connects a current sense resistor to GND to detect the primary current of transformer.
2	VCC	Power supply
3	GND	Ground
4	ROVP	Open circuit voltage regulation end, resistance to Ground
5,6	NC	No connection, must be floated
7,8	DRAIN	Internal high voltage MOSFET Drain

Absolute Maximum Ratings (note1)

Symbol	Parameters	Range	Units
ICC_MAX	VCC pin maximum sink current	5	mA
DRAIN	Internal HV MOSFET drain voltage	-0.3~650	V
CS	Current sense pin input voltage	-0.3~6	V
ROVP	Open circuit voltage regulation	-0.3~6	V
P_DMAX	Power dissipation (note2)	0.45	W
θ_{JA}	Thermal resistance (Junction to Ambient)	145	°C/W
T _J	Operating junction temperature	-40 to 150	°C
T _{STG}	Storage temperature range	-55 to 150	°C
	ESD (note3)	2	KV

Note 1: Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. Under “recommended operating conditions” the device operation is assured, but some particular parameter may not be achieved. The electrical characteristics table defines the operation range of the device, the electrical characteristics is assured on DC and AC voltage by test program. For the parameters without minimum and maximum value in the EC table, the typical value defines the operation range, the accuracy is not guaranteed by spec.

Note 2: The maximum power dissipation decrease if temperature rise, it is decided by T_{JMAX} , θ_{JA} , and environment temperature (T_A). The maximum power dissipation is the lower one between $P_{DMAX} = (T_{JMAX} - T_A) / \theta_{JA}$ and the number listed in the maximum table.

Note 3: Human Body mode, 100pF capacitor discharge on 1.5K Ω resistor





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Recommended Operation Conditions

Symbol	Parameter	Range	Unit
POUT1	Output power (input voltage 230V±15%)	<10	W
POUT2	Output power (input voltage 85V~265V)	<7	W
FOP	System operating frequency	<120	KHz

Electrical Characteristics (Notes 4, 5) (Unless otherwise specified, V_{CC}=15V and T_A=25 °C)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
Supply Voltage Section						
V _{CC_CLAMP}	V _{CC} Clamp voltage	1mA		17		V
V _{CC_ON}	V _{CC} The starting voltage	V _{CC} rise		14		V
V _{CC_UVLO}	V _{CC} Undervoltage protection threshold	V _{CC} Decline		9		V
I _{ST}	V _{CC} Starting current	V _{CC} = V _{CC-ON} -1V		50	100	uA
I _{OP}	V _{CC} Working current	F _{OP} =70KHz		100	150	uA
Current Sense Section						
V _{CS_TH}	The current detection threshold		388	400	412	mV
V _{CS_SHORT}	Short circuit current detection threshold	Output short circuit		200		mV
T _{LEB}	Leading Edge Blanking Time			500		ns
T _{DELAY}	Switch off Delay Time			200		ns
Switching Frequency						
F _{MIN}	Minimum working frequency			5		KHz
F _{MAX}	Maximum working frequency			120		KHz





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V_{ROVP}	ROVP Voltage			0.5		V
Maximum Duty Cycle						
DMAX	Maximum duty cycle			42		%
Power MOSFET Section						
R_{DS_ON}	Static Drain-source On-resistance	$V_{GS}=15V/I_{DS}=0.5A$		9		Ω
BV_{DSS}	Drain-Source Breakdown Voltage	$V_{GS}=0V/I_{DS}=250\mu A$	650			V
I_{DSS}	Power MOSFET Drain Leakage Current	$V_{GS}=0V/V_{DS}=650V$			1	μA
Thermal Regulation Section						
T_{REG}	Thermal Regulation Temperature			150		$^{\circ}C$

Note 4: production testing of the chip is performed at 25°C.

Note 5: the maximum and minimum parameters specified are guaranteed by test, the typical value are guaranteed by design, characterization and statistical analysis.

Internal Block Diagram

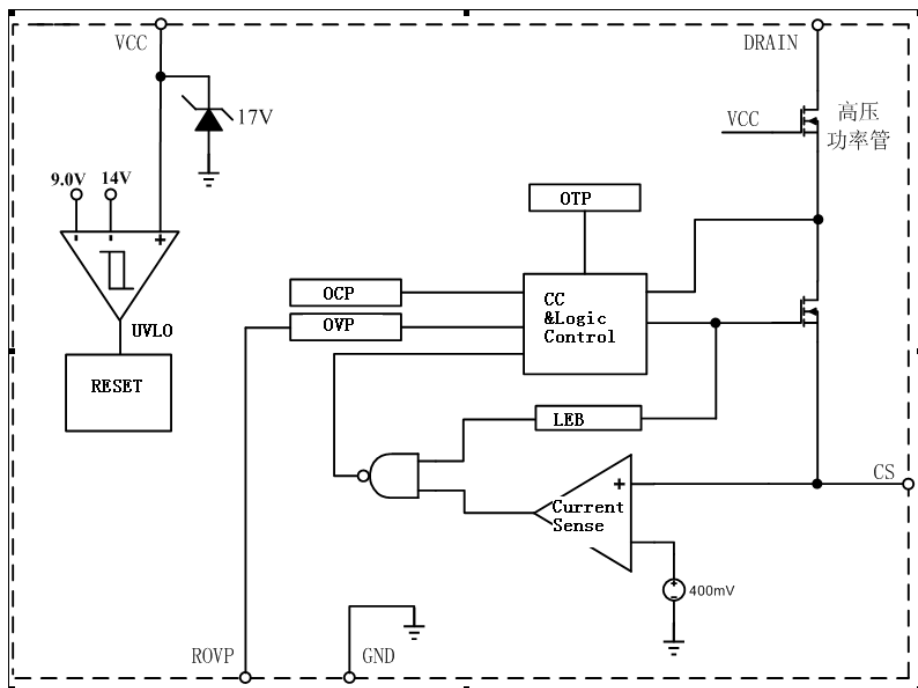


Figure 3. HW6313B Internal Block Diagram





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Application Information

The HW6313B is a high performance power switch specially designed for LED lighting, with patent constant current control technology. The HW6313B integrates a 650V power MOSFET. The accurate LED current can be realized without opto-coupler, TL431 feedback circuit and auxiliary winding while minimizing the external component count, lowering the total bill of material cost.

Start Up

The VCC capacitor will be charged through the start-up resistor when the system is powered on. Once the VCC voltage reaches the start-up threshold, the HW6313B will start to switch. The HW6313B integrates a 17V zener for VCC clamping. Due to the ultra-low operating current, the auxiliary winding is not needed to supply the IC.

Constant Current Control

Cycle-by-Cycle current sense is adopted in HW6313B, the CS is connected to the current sense comparator, and the voltage on CS will be compared with the internal 400mV reference voltage, the MOSFET will be switched off when the voltage on CS reaches the threshold.

The primary peak current is given by:

$$I_{P_PK} = \frac{400}{R_{CS}} (mA)$$

Among them, RCS is the current sampling resistor.

The output of the comparator includes a 500ns leading edge blanking time.

The current in LED can be calculated by the equation:

$$I_{LED} = \frac{I_{P_PK}}{4} \times \frac{N_P}{N_S}$$

Where

NP: primary winding turns of transformer

NS: secondary winding turns of transformer

IP_PK: peak current in MOSFET

Operating Switching Frequency

The HW6313B is designed to work in discontinuous conduction mode and no external loop compensation component is required while maintaining stability. The maximum duty cycle is limited to 42%. The maximum switching frequency at normal operation is suggested to set around 120KHz. The minimum switching frequency is limited in HW6313B to ensure the stability of system.

The switching frequency can be set by the formula:





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$$f = \frac{N_p^2 \times V_{LED}}{8 \times N_s^2 \times L_p \times I_{LED}}$$

Where, L_p is the primary winding inductance of transformer.

Overvoltage protection resistor

Open circuit voltage can be set through the ROVP pin resistance, the ROVP pin voltage is 0.5V.

When LED is open, gradually increase the output voltage, the demagnetizing time becomes shorter. So can need according to the open circuit protection voltage settings, to calculate the demagnetizing time T_{ovp} .

$$T_{ovp} \approx \frac{L_m \times V_{cs}}{N_{ps} \times R_{cs} \times V_{ovp}}$$

Among them,

L_m is the primary inductance

V_{cs} is a CS shutdown threshold (400mV)

N_{ps} is the primary and secondary sides of transformer turns ratio

V_{ovp} is required for overvoltage protection set

Then according to the T_{ovp} time to calculate the resistance value of the R_{ovp} , the formula is as follows:

$$R_{ovp} \approx 16 * T_{ovp} * 10^6 \quad (\text{kohm})$$

Protection Function

The HW6313B has integrated rich protection functions, LED open/short protection, CS resistor short circuit protection, VCC under voltage protection, over temperature protection, and so on. When the LED is open circuit, it will trigger over-voltage protection logic and latch, the system stops switching immediately.

When the LED short circuit is detected, the system works at low frequency ($F_{op}=5\text{KHz}$), CS Shutdown threshold is reduced to 200mV, so the power consumption is low. At some catastrophic fault condition, such as shorted CS resistor or flyback transformer saturation, the internal fast fault detection circuit will trigger and latch, the system stops switching immediately.

After the system enters into fault latch condition, the VCC voltage will fall until it reaches UVLO threshold. Then the system will re-start again. If the fault condition is removed, the system will recover to normal operation.





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Over temperature adjustment function

HW6313B has over temperature protection function, when the temperature exceeds 150 °C, the system will start over temperature protection function, so as to ensure the reliability of the system.

PCB Layout

The following rules should be followed in HW6313B PCB layout:

Bypass Capacitor

The bypass capacitor on VCC should be as close as possible to the VCC pin and GND pin.

ROVP resistor

Open circuit voltage setting resistor needs to be close to the chip ROVP pin.

Ground Path

The power ground path for current sense should be short, and the power ground path should be separated from small signal ground path before the negative of the bulk capacitor.

The Area of Power Loop

The area of main current loop should be as small as possible to reduce EMI radiation, such as the primary current loop, the snubber circuit and the secondary rectifying loop.

NC Pin

The NC pin must be left floating to satisfy the requirement of creepage distance.

Drain pin

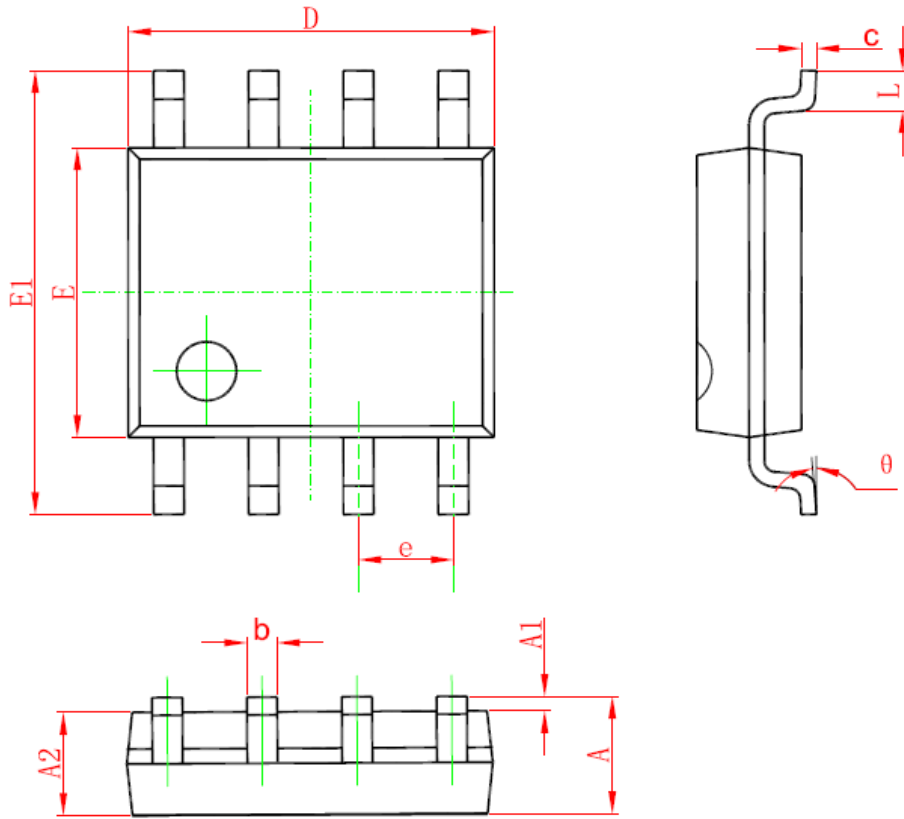
To increase the copper area of drain for thermal consideration.





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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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3. Please do not exceed the absolute maximum ratings of the device when circuit designing.
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