晶丰明源半导体

BP2812

Constant Current Controller For Non-isolated Buck LED Driver

Description

The BP2812 is a high precision constant current controller, designed for non-isolated buck LED driver. It can operate under universal AC input or 12V~600V DC input. The BP2812 integrates 600V power MOSFET, so it can achieve excellent constant current performance with very few external components

The BP2812 uses high precision current sense circuit and patent method for constant current control, to achieve high precision output current and excellent line regulation. The BP2812 operates in inductor current critical mode. The LED current is constant over wide range of inductance variation and the LED output voltage, so the load regulation is excellent.

The BP2812 uses patent source driver architecture. The operation current is 200uA only, so the auxiliary winding is not needed. It can simplify the system design and reduce the system cost.

The BP2812 offers rich protection functions, including LED short circuit protection, current sense resistor short circuit protection and over temperature protection.

Features

- Inductor Current Critical Mode, No Need to Compensate the Inductance Variation
- 600V MOSFET integrated
- Source Driver Structure, Not Need the Auxiliary Winding for VCC
- ±3% LED Current Accuracy
- Up to 93% System Efficiency
- LED Short Circuit Protection
- Current Sense Resistor Short Circuit Protection
- Over Temperature Protection
- Available in SOP-8 package

Applications

- LED Bulb
- LED Candle light
- LED Spot light
- Decorative LED lighting

Typical Application Circuit

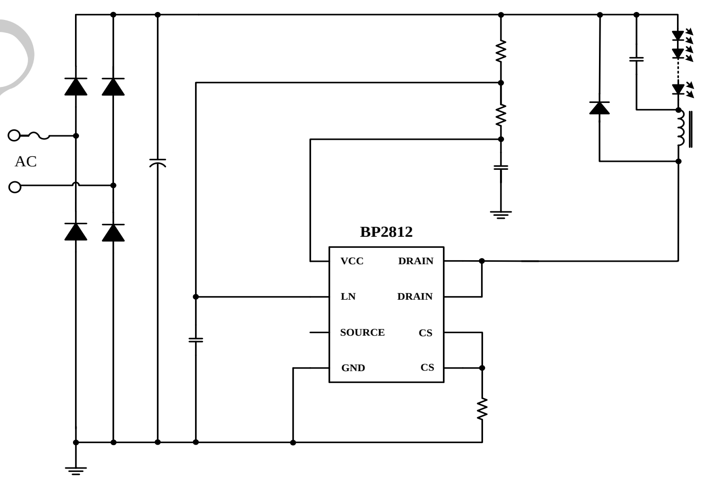
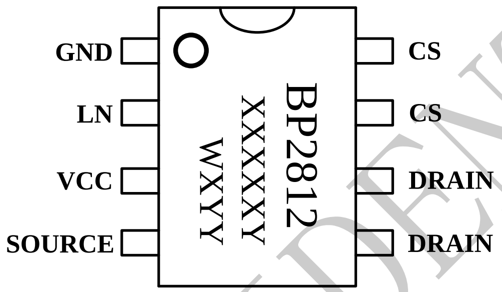


Figure 1. Typical Application Circuit

Ordering Information

Part Number	Package	Operating Temperature	Package Method	Marking
BP2812	SOP8	-40℃ to 105℃	Tape 2,500 Piece/Roll	BP2812 XXXXXY WXYY

Pin Configuration and Marking Information



XXXXXY: lot code
W: Sign
X: Year
YY: Week

Figure 2. Pin Configuration

Pin Definition

Pin No.	Name	Description
1	GND	Ground
2	LN	Line compensation sense input
3	VCC	Power supply, clamp to 12.5V by internal Zener diode
4	SOURCE	Internal HV power MOSFET source
5, 6	DRAIN	Internal HV power MOSFET drain
7, 8	CS	Current sense input, the sense resistor is connected from CS to ground

Absolute Maximum Ratings (note1)

Symbol	Parameters	Range	Units
V_{DRAIN}	Internal HV MOSFET drain voltage	-0.3~600	V
I_{CC_MAX}	VCC pin maximum sink current	5	mA
LN	Line compensation pin input voltage	-0.3~18	V
V_{SOURCE}	Internal HV MOSFET source voltage	-0.3~18	V
CS	Current sense pin input voltage	-0.3~6	V
P_{DMAX}	Power dissipation (note 2)	0.5	W
θ_{JA}	Thermal resistance (Junction to Ambient)	150	℃/W
T_J	Operating junction temperature	-40 to 150	℃
T_{STG}	Storage temperature range	-55 to 150	℃
	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 1.5KΩ resistor*

Recommended Operation Conditions

Symbol	Parameter	Range	Unit
I_{LED}	Output LED Current	< 135	mA

Electrical Characteristics (Notes 4, 5) (Unless otherwise specified, V_{CC}=12V and T_A=25 ℃)

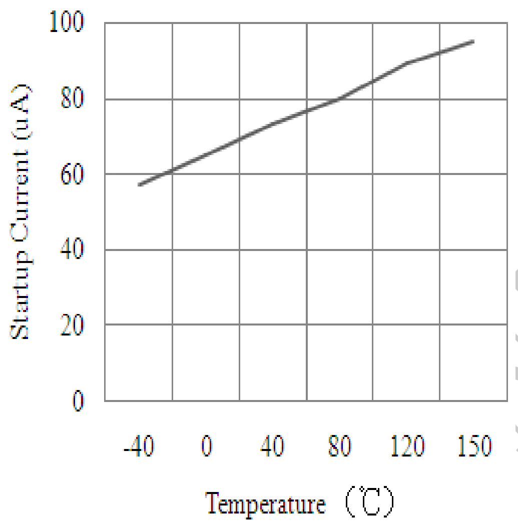
Symbol	Parameter	Conditions	Min	Typ	Max	Units
Supply Voltage Section						
V_{CC_CLAMP}	V_{CC} Clamping Voltage			12.5		V
I_{DD_CLAMP}	V_{CC} Clamping Current				5	mA
V_{CC_ST}	Vcc Start Up Voltage	V_{CC} Rise	7.5	8.3	9.1	V
V_{UVLO_HYS}	Vcc Under Voltage Latch Out Hysteresis	V_{CC} Falling		1		V
I_{ST}	Start Up Current	V_{CC}=V_{CC_ST} - 0.5V		70	150	uA
I_{OP}	Operation Current			200		uA
Current Sense Section						
V_{CS_TH}	Current Sense Voltage Threshold		390	400	410	mV
T_{LEB}	Leading Edge Blanking Time			350		ns
T_{DELAY}	Turn Off Delay Time			300		ns
Line Compensation Section						
$\Delta V_{CS}/\Delta(V_{LN}-V_{CC})$	Line Compensation Rate			-40		mV/V
Over Temperature Section						
T_{SD}	Thermal Shut Down Temperature			150		℃
T_{SD_HYS}	Thermal Shut Down Hysteresis			30		℃
Internal HV MOSFET						
R_{DS_ON}	Switch ON Resistance	V_{CC}=12V		10		Ω
V_{DS}	Drain to Source voltage		600			V
Internal Driver Section						
T_{OFF_MIN}	Minimum Demagnetization Time			4		us

Symbol	Parameter	Conditions	Min	Typ	Max	Units
T_{OFF_MAX}	Maximum Demagnetization Time			130		us
T_{ON_MAX}	Maximum Turn On Time			45		us

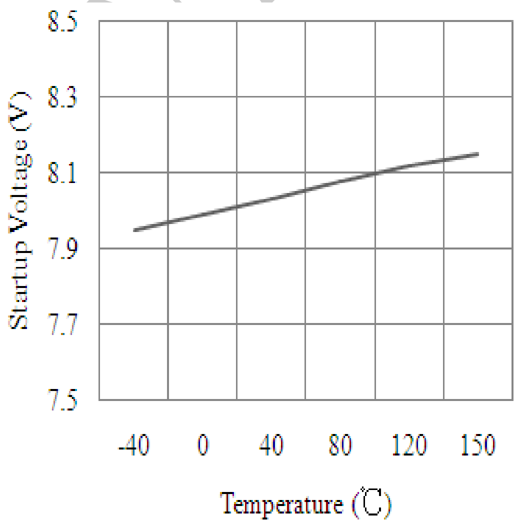
Note 4 : *production testing of the chip is performed at 25 ℃.*

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

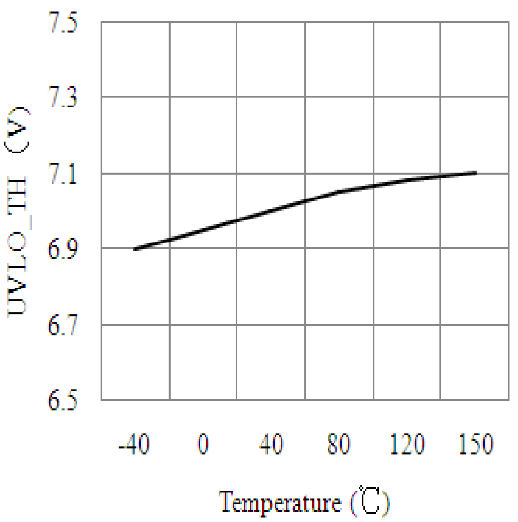
Typical Parameter Characteristics



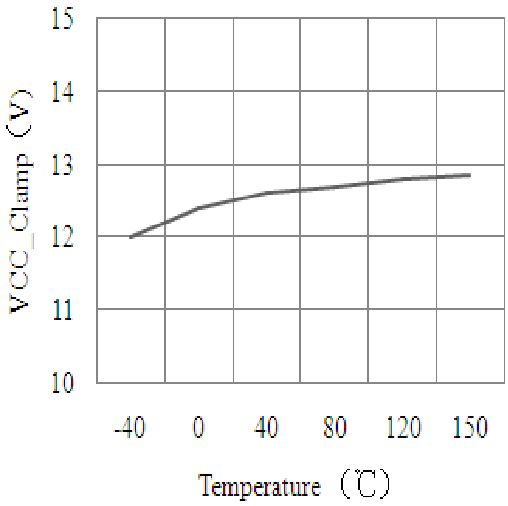
Startup Current vs. Temperature



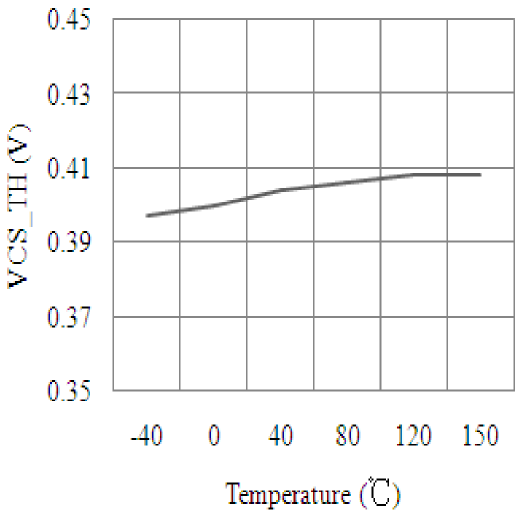
Startup Voltage vs. Temperature



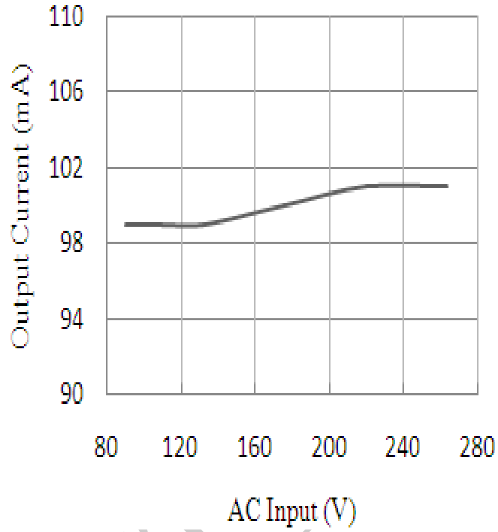
UVLO Threshold vs. Temperature



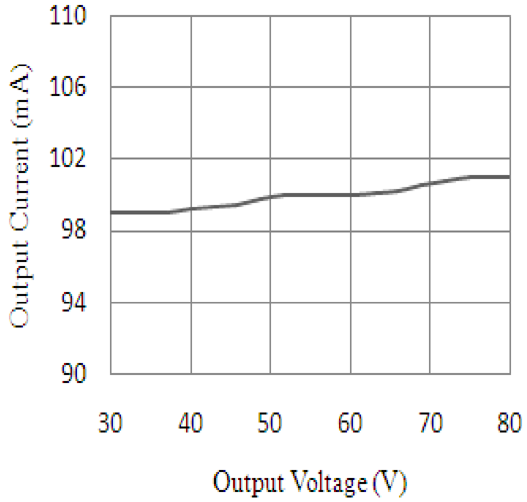
V_{CC} Clamping Voltage vs. Temperature



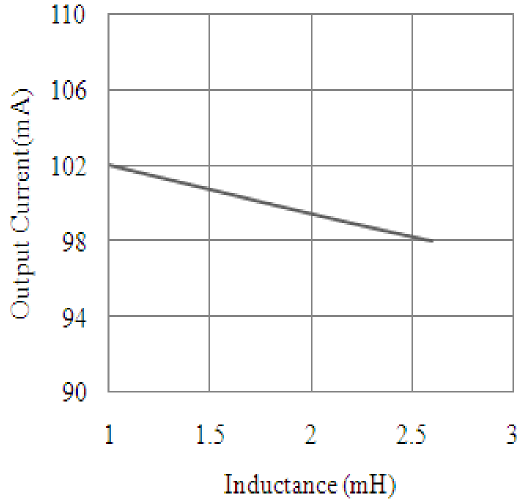
Current Sense Threshold vs. Temperature



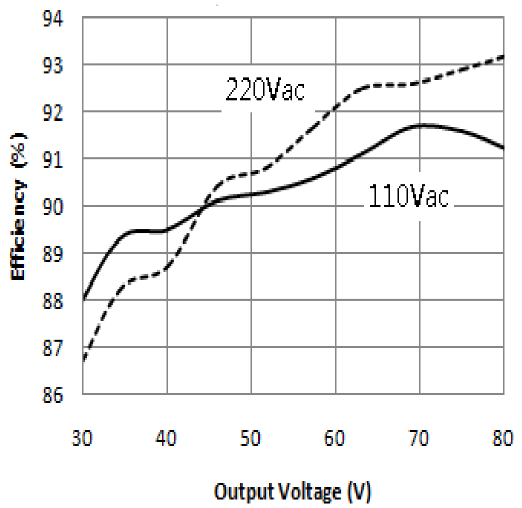
Line Regulation



Load Regulation



Output Current vs. Inductance



Efficiency Vs Load

Internal Block Diagram

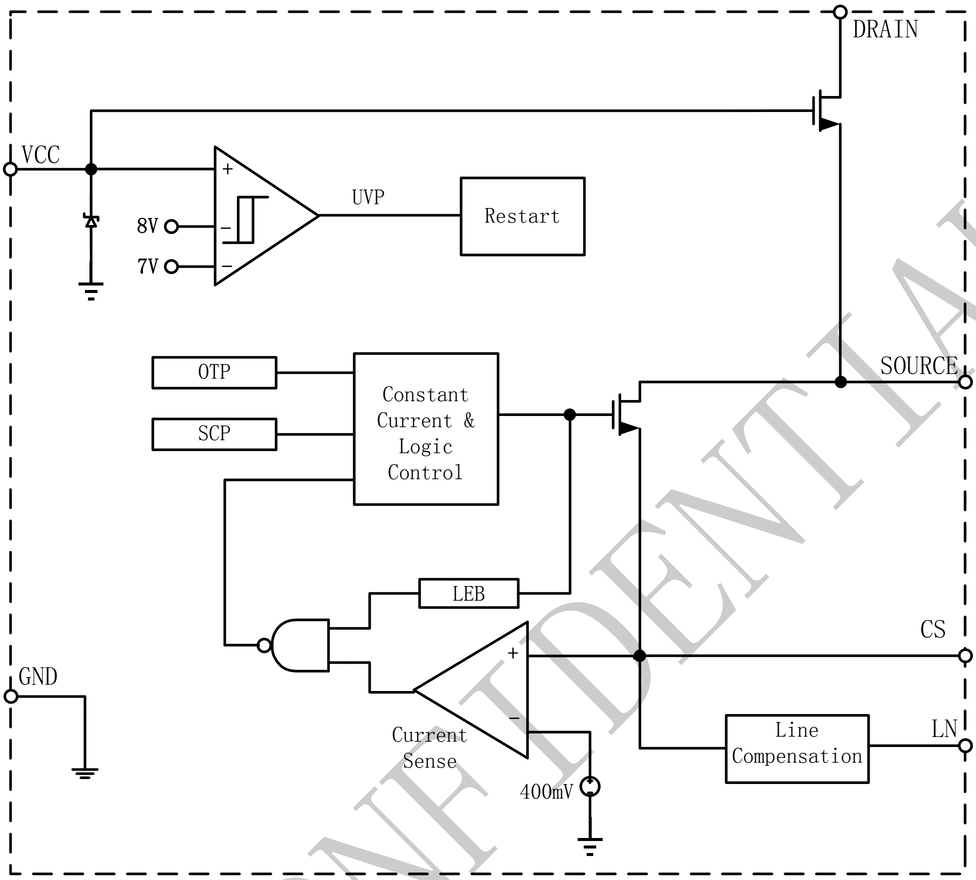


Figure 3. BP2812 Internal Block Diagram

Function Description

BP2812 is a constant current controller, designed for driving non-isolated buck LED power supply. BP2812 integrates 600V power MOSFET, and it uses patent constant current control method and source driver structure, excellent constant current characteristic is achieved with low counts components. Low cost and high efficiency of system is realized.

Start up

The Vcc will be charged through the startup resistor when the system is powered on. When the voltage on Vcc reaches the startup voltage threshold, the controller starts to switching. The Vcc voltage of BP2812 is clamped to 12.5V by internal Zener diode.

Constant Current Control and Output Current Setting

The BP2812 uses patent constant current control method, excellent constant current is achieved with low counts components. The BP2812 senses the peak current in inductor cycle by cycle. The CS Pin is connected to the input of internal current comparator, and compared with the internal 400mV reference voltage. The external power MOSFET will be turned off when the CS pin voltage reaches the voltage threshold. The comparator has a 350ns LEB timer to avoid mis-trigger.

The peak current in the inductor is given by:

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

The Rcs is the resistance of current sense resistor

The current in LED can be calculated by the following equation:

$$I_{LED} = \frac{I_{PK}}{2}$$

The I_{PK} is the peak current in inductor

Line Compensation

The BP2812 integrates line compensation function. The line voltage is sensed by the voltage difference between LN and Vcc pin. And the internal reference voltage of Vcs is compensated by a value proportional to the sensed line voltage. The excellent line regulation is achieved.

The line compensation coefficient is given by the following equation:

$$\Delta V_{CS} = -40 \times 10^{-3} \times (V_{LN} - V_{CC})$$

The V_{CS} is the reference voltage of the internal current sense comparator.

The V_{LN} is the voltage on LN pin.

The V_{CC} is the voltage on Vcc pin.

Source Driver Structure

The BP2812 uses the patent source driver structure. The typical operation current is as low as 200uA, the auxiliary winding is not need. So the system design is simple and the cost is low.

Inductance Calculation

The BP2812 is designed to work in inductor current critical mode, the energy will be stored in the inductor when the MOSFET is turned on. The turn on time is given by:

$$t_{on} = \frac{L \times I_{PK}}{V_{IN} - V_{LED}}$$

The L is the inductance.

The Ipk is the peak current in inductor.

The V_{IN} is the input rectified voltage.

The V_{LED} is the voltage on LED.

When the power MOSFET is turned off, the

inductor current will decrease from the peak current to zero. The turn off time is given by:

$$t_{off} = \frac{L \times I_{PK}}{V_{LED}}$$

The MOSFET will be turned on again when it detects the inductor current goes to zero.

The inductance can be calculated by the following equation:

$$L = \frac{V_{LED} \times (V_{IN} - V_{LED})}{f \times I_{PK} \times V_{IN}}$$

The f is the system switching frequency, which is proportional to the input voltage. So the minimum switching frequency is set at lowest input voltage, and maximum switching frequency is set at highest input voltage.

The BP2812 internally set the minimum off time to 4us and maximum off time to 130us. When the inductance is very small, the t_{off} may goes below the minimum off time and the inductor current becomes discontinuous. So the output LED current will be smaller than the setting value. If the inductance is too large, the t_{off} may goes beyond the maximum off time and the inductor current becomes continuous. And the output LED current will be larger than the setting value. So it's very important to select a right inductance.

The BP2812 also internally set the maximum on time to 40us. When the input voltage is very low or LED output voltage is very high, the t_{on} may goes beyond the maximum on time. The power MOSFET will be turned off even the inductor current still below the setting value. So the output LED current will be smaller than the setting value.

Protection Functions

The BP2812 has many protection functions, including LED short circuit protection, current sense resistor short circuit protection and over temperature protection. All of the protection functions are designed to auto-recover.

The over temperature protection circuitry in the BP2812 monitors the die junction temperature after start up. When the temperature rises to 150℃, the power MOSFET will be shut down immediately and maintains at switch off condition until the temperature on die falls 30℃ below the thermal protection trigger point.

PCB Layout

The following guidelines should be followed in BP2812 PCB layout:

Bypass Capacitor

The bypass capacitor on V_{CC} pin should be as close as possible to the VCC and GND pins.

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 node of the bus capacitor.

The Area of Power Loop

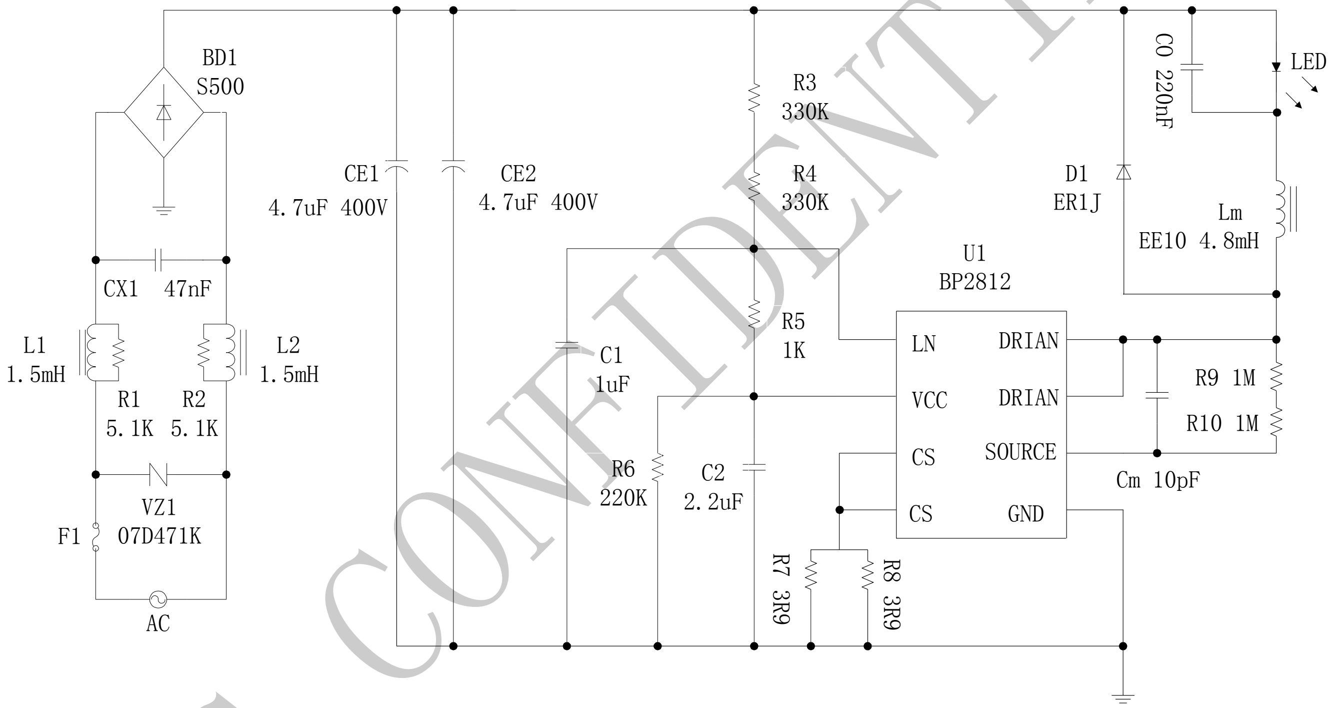
The area of main current loop should be as small as possible to reduce EMI radiation. And the controller should be placed away from the heat generator, such as the power diode.

Application Example

1. Specification

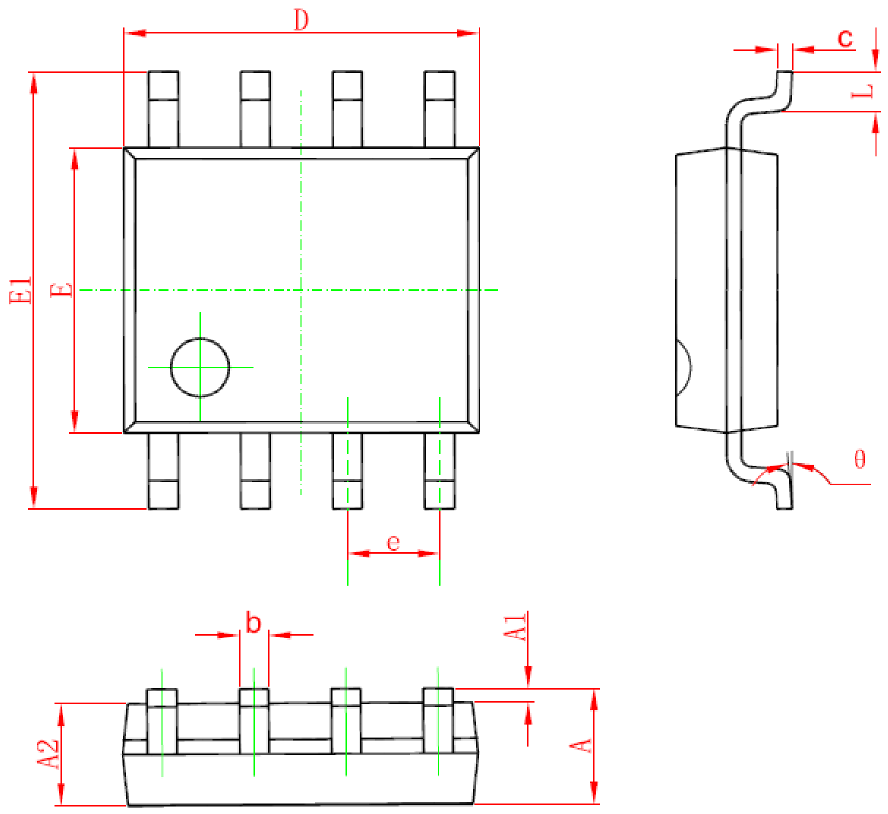
Input Voltage：85Vac ~ 264Vac
Output LED Voltage：20V ~ 56V
Output LED Current：100mA

2. Schematic



Physical Dimensions

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°