晶丰明源半导体

# BP9116B

## High Precision PSR Constant Current LED Driver

## Description

The BP9116B 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 5W.

The device integrates a 650V power MOSFET. With very few external components, the converter achieves excellent constant current control. And it does not need auxiliary winding for powering the IC or voltage sensing, hence the system size and cost is greatly reduced.

Since using the proprietary high accurate current sense method, the BP9116B realizes ±6% accuracy of LED current along with excellent line and load regulation.

The BP9116B offers rich protection functions including LED open/short circuit protection, thermal regulation, $V_{CC}$ under voltage protection.

## Features

- Available in SOP-8 Package
- Internal 650V Power MOSFET
- Constant current control without secondary sense and feedback circuit.
- Integrated HV JFET for VCC Power Supply
- No Auxiliary winding for sensing and supplying
- Universal input voltage
- ±6% LED current accuracy
- LED short and open circuit protection
- VCC under-voltage protection
- Thermal regulation

## Application

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

## Typical Application

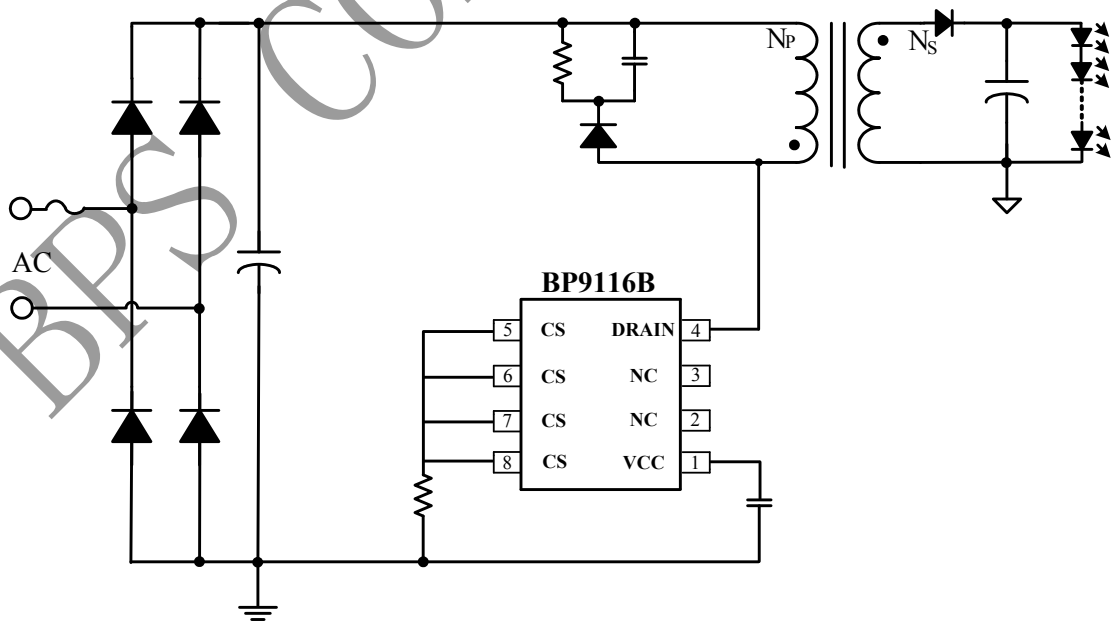



Figure 1. Typical application circuit for BP9116B

## Ordering Information

| Part Number | Package | Operating Temperature | Package Method | Marking |
|---|---|---|---|---|
| BP9116B | SOP-8 | -40 ℃to105 ℃ | 4,000 Piece/Reel | BP9116B<br>XXXXXY<br>XYY |

## Pin Configuration and Marking Information

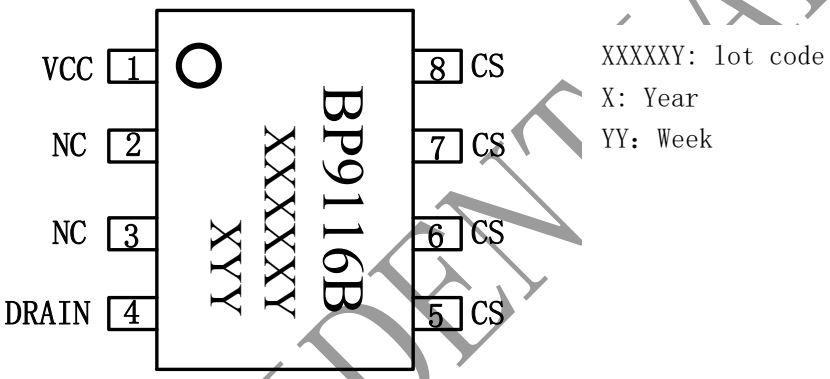



Figure 2. Pin configuration

## Pin Definition

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

## Absolute Maximum Ratings (note1)

| Symbol | Parameters | Range | Units |
|---|---|---|---|
| DRAIN | Internal HV MOSFET drain voltage | -0.3~650 | V |
| VCC | Power supply | -0.3~8.5 | V |
| $P_{DMAX}$ | Power dissipation (note2) | 0.45 | W |
| $\theta_{JA}$ | Thermal resistance (Junction to Ambient) | 145 | ℃/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 $T_{JMAX}$, $\theta_{JA}$, 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 |
|---|---|---|---|
| $P_{OUT}$ 1 | Output power (input voltage 85V~265V) | < 5 | W |
| $F_{OP}$ | System operating frequency | <100 | KHz |

## Electrical Characteristics (Notes 4, 5) (Unless otherwise specified, $V_{CC}$=7V and $T_A$=25 ℃)

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **Supply Voltage Section** | | | | | | |
| $V_{CC}$ | VCC operating voltage | Drain=100V | | 7.3 | | V |
| $V_{CC\_ON}$ | Turn on threshold voltage | $V_{CC}$ rising | | 6.6 | | V |
| $V_{CC\_UVLO}$ | Turn off threshold voltage | $V_{CC}$ falling | | 5.7 | | V |
| $I_{ST}$ | $V_{CC}$ startup current | $V_{CC}$= $V_{CC-ON}$ - 1V | | 0.6 | 1.2 | mA |
| $I_{cc}$ | $V_{CC}$ operating current | | | 140 | 200 | uA |
| **Current Sense Section** | | | | | | |
| $V_{CS\_TH}$ | Threshold voltage for peak current limit | | 580 | 600 | 620 | mV |
| $T_{LEB}$ | Leading edge blanking time for current sense | | | 500 | | ns |
| $T_{DELAY}$ | Switch off delay time | | | 200 | | ns |
| **Internal Time Control Section** | | | | | | |
| $T_{OFF\_MIN}$ | Minimum OFF Time | | | 5 | | us |
| $T_{OFF\_MAX}$ | Maximum OFF Time | | | 300 | | us |
| **MOSFET Section** | | | | | | |
| $R_{DS\_ON}$ | Static Drain-source On-resistance | $V_{GS}$=7V/$I_{DS}$=0.1A | | 18 | | Ω |
| $BV_{DSS}$ | Drain-Source Breakdown Voltage | $V_{GS}$=0V/$I_{DS}$=250uA | 650 | | | V |
| **Thermal Regulation Section** | | | | | | |
| $T_{REG}$ | Thermal Regulation Temperature | | | 140 | | ℃ |

***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

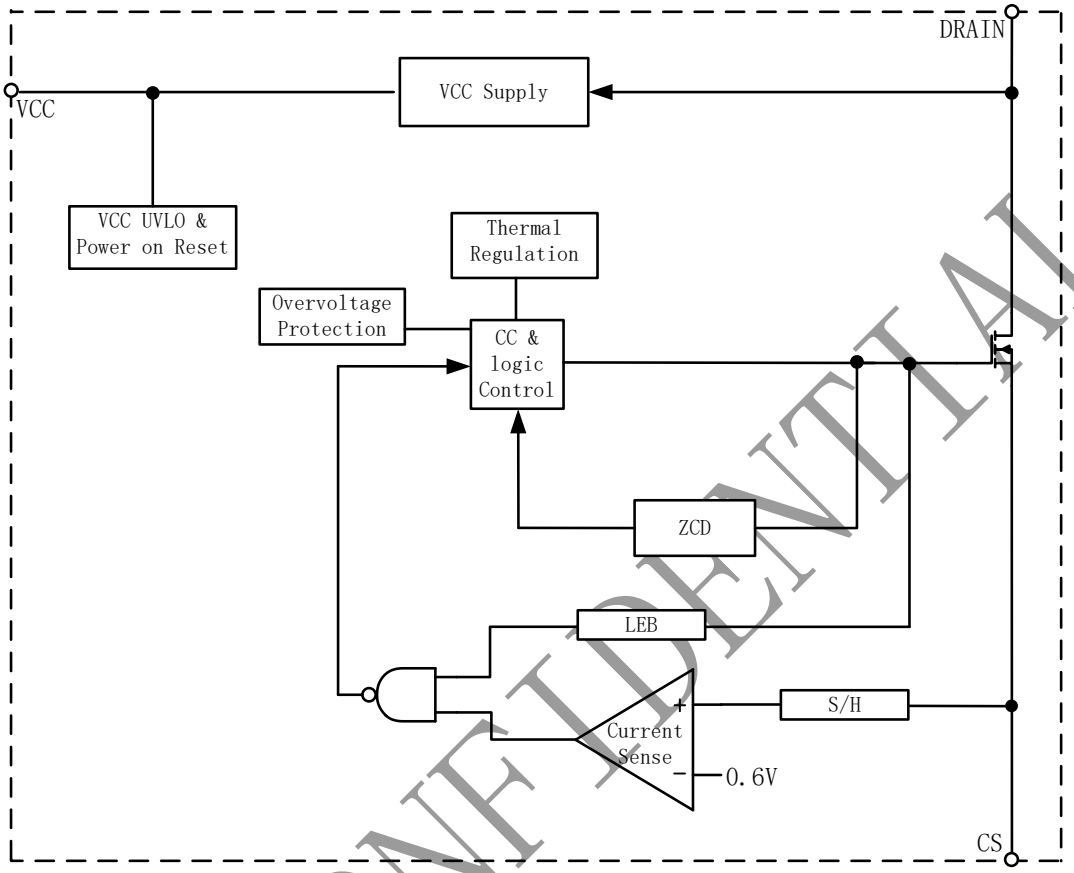



Figure 3. BP9116B Internal Block Diagram

## Application Information

The BP9116B is a high precision primary-side feedback and regulation controller for LED lighting. The device integrates a 650V power MOSFET. With very few external components, the converter achieves excellent constant current control. And it does not need auxiliary winding for powering the IC or voltage sensing, hence the system size and cost is greatly reduced.

### Start Up

After system powered up, the VCC pin capacitor is charged up by internal HV JEFT. When the VCC pin voltage reaches the turn on threshold, the internal circuits start operating. The HV JEFT will still supply operating current when the IC is working and keep the VCC voltage at 7.3V.

### Constant Current Control

Cycle-by-Cycle current sense is adopted in BP9116B, the CS is connected to the current sense comparator, and the voltage on CS will be compared with the internal 600mV reference voltage, the MOSFET will be switched off when the voltage on CS reaches the threshold. The output of the comparator includes a 500ns leading edge blanking time.

The primary peak current is given by:

$$I_{PK} = \frac{600}{R_{CS}}(mA)$$

The primary peak current is given by:

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

Where,

$N_P$: primary winding turns of transformer

$N_S$: secondary winding turns of transformer

$I_{P\_PK}$: peak current in MOSFET

**Operating Switching Frequency**

The BP9116B 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 below 100KHz. If the maximum frequency is set too high, it will affect the number of maximum series LED lamps. If set too low, the LED open circuit voltage will be too high.

The maximum and minimum switching frequency is limited in BP9116B to ensure the stability of system.

The switching frequency can be set by the formula:

$$f = \frac{Np^2 \times V_{LED}}{8 \times Ns^2 \times Lp \times I_{LED}}$$

Where, $L_P$ is the primary winding inductance of transformer.

**Protection Function**

The BP9116B offers rich protection functions including LED open/short circuit protection, thermal regulation, $V_{CC}$ under voltage protection.

When the LED is open circuit, the output voltage increases gradually, and the demagnetization time gets shorter.When the demagnetization time is less 5us set by chip, chip will trigger the OVP.

When the LED short circuit is detected, the system works at low frequency (3kHz), so the system power consumption is very low.

**Thermal Regulation**

The BP9116B integrates thermal regulation function. When the system is over temperature, the output current is gradually reduced; the output power and thermal dissipation are also reduced. The system temperature is regulated and the system reliability is improved. The thermal regulation temperature is set to 140℃ internally.

**PCB Layout**

The following rules should be followed in BP9116B PCB layout:

Bypass Capacitor

The bypass capacitor on $V_{CC}$ pin should be as close as possible to the $V_{CC}$ Pin.

CS Resister

The CS resistor should be as close as possible to the CS pin, and makes the connection to the $V_{CC}$ bypass capacitor as short as possible.

The Area of Power Loop

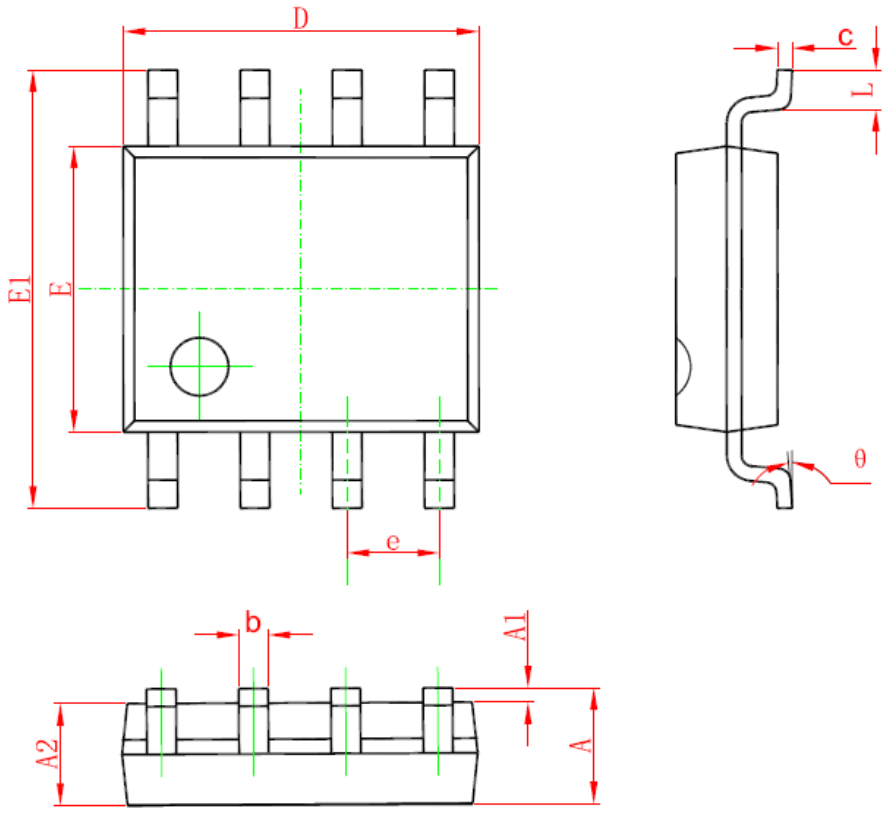
The area of main current loop should be as small as possible to reduce EMI radiation, such as the inductor, the power MOSFET, the output diode and the bus capacitor loop.

CS Pin

To increase the copper area of CS pin for better thermal dissipation.

## 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° |