

### Description

The BP3135 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 BP3135 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 patent pending 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.

Since using the proprietary high accurate current sense method, the BP3135 realizes  $\pm 5\%$  accuracy of LED current along with excellent line and load regulation.

The BP3135 offers rich protection functions including LED open/short circuit protection, CS resistor short circuit protection, thermal regulation, V<sub>CC</sub> under voltage protection.

### Typical Application

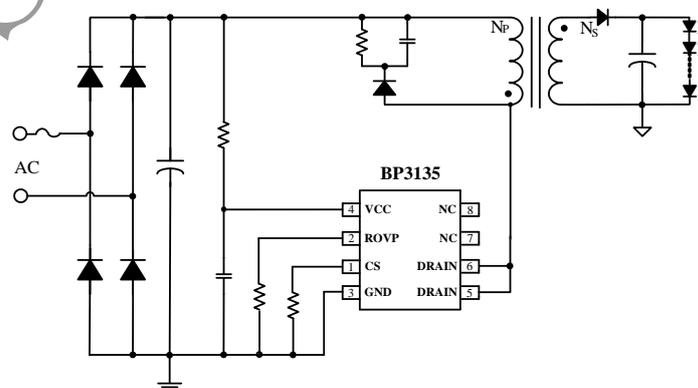


Figure 1. Typical application circuit for BP3135

### Features

- Built-in 650V Power MOSFET
- Constant current control without secondary sense and feedback circuit.
- No Auxiliary winding for sensing and supplying
- Ultra low operating current to improve efficiency
- Universal input voltage
- $\pm 5\%$  LED current accuracy
- LED short and open circuit protection
- CS resistor short circuit protection
- VCC under-voltage protection
- Thermal regulation
- Available in SOP-8 package

### Applications

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

### Ordering Information

| Part Number | Package | Operating Temperature | Packing Method           | Marking                 |
|-------------|---------|-----------------------|--------------------------|-------------------------|
| BP3135      | SOP8    | -40°C to 105°C        | Tape<br>4,000 Piece/Reel | BP3135<br>XXXXXY<br>WXY |

### Pin Configuration and Marking Information

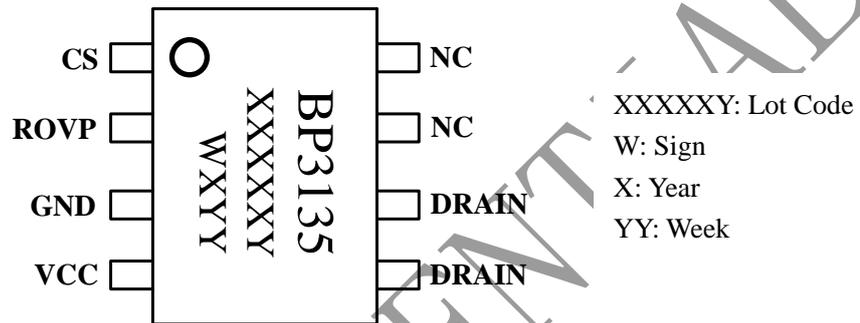


Figure 2. Pin configuration

### 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       | ROVP  | Connect a ROVP resistor to GND to set the LED open voltage.  |
| 3       | GND   | Ground   |
| 4       | VCC   | Power supply   |
| 5,6     | DRAIN | Internal high voltage MOSFET Drain   |
| 7,8     | NC    | No connection, must be floated   |

### 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              | Set the LED open voltage                 | -0.3~6     | V     |
| P <sub>DMAX</sub> | Power dissipation (note2)                | 0.45       | W     |
| θ <sub>JA</sub>   | Thermal resistance (Junction to Ambient) | 145        | °C/W  |
| T <sub>J</sub>    | Operating junction temperature           | -40 to 150 | °C    |
| T <sub>STG</sub>  | 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<sub>JMAX</sub>, θ<sub>JA</sub>, and environment temperature (T<sub>A</sub>). The maximum power dissipation is the lower one between P<sub>DMAX</sub> = (T<sub>JMAX</sub> - T<sub>A</sub>)/θ<sub>JA</sub> 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 <sub>OUT1</sub> | Output power (input voltage 230V±15%) | <10   | W    |
| P <sub>OUT2</sub> | Output power (input voltage 85V~265V) | <7    | W    |
| F <sub>OP</sub>   | System operating frequency            | <120  | kHz  |

**Electrical Characteristics (Notes 4, 5) (Unless otherwise specified,  $V_{CC}=14V$  and  $T_A=25^\circ C$ )**

| Symbol                             | Parameter   | Conditions                  | Min. | Typ. | Max. | Units      |
|------------------------------------|---|-----------------------------|------|------|------|------------|
| <b>Supply Voltage Section</b>      |   |                             |      |      |      |            |
| $V_{CC\_Clamp}$                    | $V_{CC}$ clamp voltage                            | 1mA                         |      | 17   |      | V          |
| $V_{CC\_ON}$                       | Turn on threshold voltage                         | $V_{CC}$ rising             |      | 14   |      | V          |
| $V_{CC\_UVLO}$                     | Turn off threshold voltage                        | $V_{CC}$ falling            |      | 9    |      | V          |
| $I_{ST}$                           | $V_{CC}$ startup current                          | $V_{CC}=V_{CC\_ON}-1V$      |      | 50   | 100  | $\mu A$    |
| $I_{OP}$                           | $V_{CC}$ operating current                        | $F_{OP}=70kHz$              |      | 100  | 150  | $\mu A$    |
| <b>Current Sense Section</b>       |   |                             |      |      |      |            |
| $V_{CS\_TH}$                       | Threshold voltage for peak current limit          |                             | 388  | 400  | 412  | mV         |
| $V_{CS\_SHORT}$                    | Current detection threshold for the short circuit | Output short circuit        |      | 200  |      | mV         |
| $T_{LEB}$                          | Leading edge blanking time for current sense      |                             |      | 500  |      | ns         |
| $T_{DELAY}$                        | Switch off delay time                             |                             |      | 200  |      | ns         |
| <b>Switching Frequency</b>         |   |                             |      |      |      |            |
| $F_{MIN}$                          | Minimum working frequency                         |                             |      | 5    |      | kHz        |
| $F_{MAX}$                          | Maximum working frequency                         |                             |      | 120  |      | kHz        |
| $V_{ROVP}$                         | Voltage of ROVP Pin                               |                             |      | 0.5  |      | V          |
| <b>Maximum Duty Cycle</b>          |   |                             |      |      |      |            |
| $D_{MAX}$                          | Maximum duty cycle                                |                             |      | 42   |      | %          |
| <b>MOSFET Section</b>              |   |                             |      |      |      |            |
| $R_{DS\_ON}$                       | Static drain-source on-resistance                 | $V_{GS}=15V/I_{DS}=0.5A$    |      | 9    |      | $\Omega$   |
| $BV_{DSS}$                         | Drain-source breakdown voltage                    | $V_{GS}=0V/I_{DS}=250\mu A$ | 650  |      |      | V          |
| $I_{DSS}$                          | Drain-source leakage current                      | $V_{GS}=0V/V_{DS}=650V$     |      |      | 1    | $\mu A$    |
| <b>Over Temperature Protection</b> |   |                             |      |      |      |            |
| $T_{SD}$                           | Thermal shutdown threshold                        |                             |      | 150  |      | $^\circ C$ |

**Note 4:** production testing of the chip is performed at  $25^\circ C$ .

**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

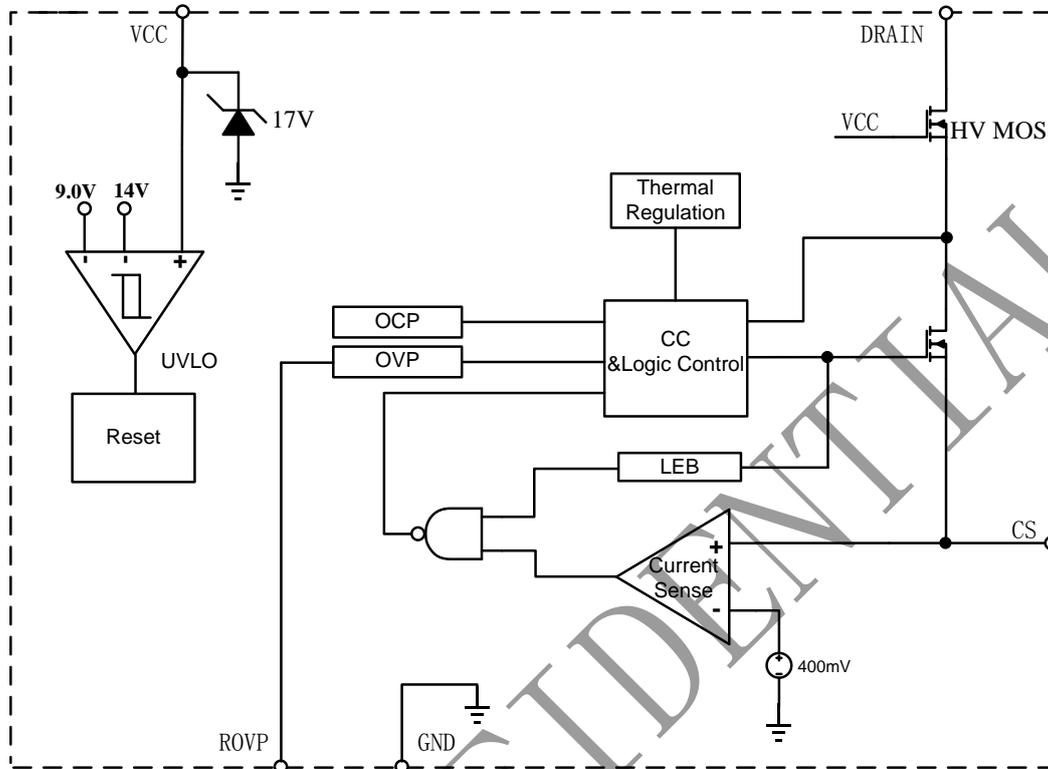


Figure 3. BP3135 Internal Block Diagram

### Function Description

The BP3135 is a high performance power switch specially designed for LED lighting, with patent constant current control technology. The BP3135 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 start-up current in BP3135 is designed to as low as 50uA. The V<sub>CC</sub> capacitor will be charged through the start-up resistor when the system is powered on. Once the V<sub>CC</sub> voltage reaches the start-up threshold, the BP3135 will start to switch. The BP3135 integrates a 17V zener for V<sub>CC</sub> 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 BP3135, 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 output of the comparator includes a 500ns leading edge blanking time.

The primary peak current is given by:

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

The current in LED can be calculated by the equation:

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



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 BP3135 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 120 kHz. 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 BP3135 to ensure the stability of system.

The switching frequency can be set by the formula:

$$f = \frac{N_P^2 \times V_{LED}}{8 \times N_S^2 \times L_P \times I_{LED}}$$

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

### Over Voltage Protection

The over voltage protection can be programmed by the ROVP pin resistor. The ROVP pin voltage is 0.5V.

When the LED is open circuit, the output voltage increases gradually, and the demagnetization time gets shorter. The demagnetization time at OVP--- $T_{OVP}$  can be calculated by the open circuit protection voltage:

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

Where,

$L_m$  is the inductance of primary inductor

$V_{CS}$  is the CS pin turn off threshold (400mV)

$N_{PS}$  is the turn ratio between primary and secondary

$V_{OVP}$  is the open circuit protection voltage

And then the  $R_{OVP}$  resistor value can be calculated by the equation:

$$R_{ovp} \approx 5 * T_{ovp} * 10^6 \quad (\text{kohm})$$

### Protection Function

The BP3135 has integrated rich protection functions, LED open/short protection, CS resistor short circuit protection,  $V_{CC}$  under voltage protection, over temperature protection, and so on. When the LED is open circuit, it will trigger over-voltage protection logic, the system stops switching immediately.

When the LED short circuit is detected, the system works at low frequency (5 kHz), and the CS pin turn off threshold is reduced to 200mV. So the system power consumption is very 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  $V_{CC}$  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.

The BP3135 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 150°C internally.

### PCB Layout

The following rules should be followed in BP3135 PCB layout:

Bypass Capacitor

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



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# BP3135

## High Precision PSR Constant Current LED Driver

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### ROVP Pin

The ROVP resistor should be as close as possible to the 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.

### Physical Dimensions

