

## Description

BP2872 is a non-isolated two buck offline LED driver with PWM dimming. The device operates in critical conduction mode and is suitable for 85Vac~265Vac universal input offline LED lighting.

BP2872 achieves the dimming function by external PWM controlling the P1 pin and P2 pin.

The driver operates in critical conduction mode, the output current does not change with the inductance and LED output voltage. It can achieve precise output current and excellent line regulation.

The BP2872 offers rich protection functions to improve the system reliability, including LED open circuit protection, LED short circuit protection, VCC under voltage protection and thermal shutdown function.

BP2872 is available in SOP-16 package

## Features

- Integrated PWM Dimming Circuit
- Integrated 700V High-voltage JFET Power Supply
- Ultra Low Operating Current
- $\pm 5\%$  LED Output Current Accuracy
- LED Open Protection
- LED Short Protection
- VCC Under Voltage Protection
- Thermal Shutdown Function
- Available in SOP-16 Package

## Applications

- LED ceiling lamp
- LED panel lights
- Other LED Lighting

## Typical Application

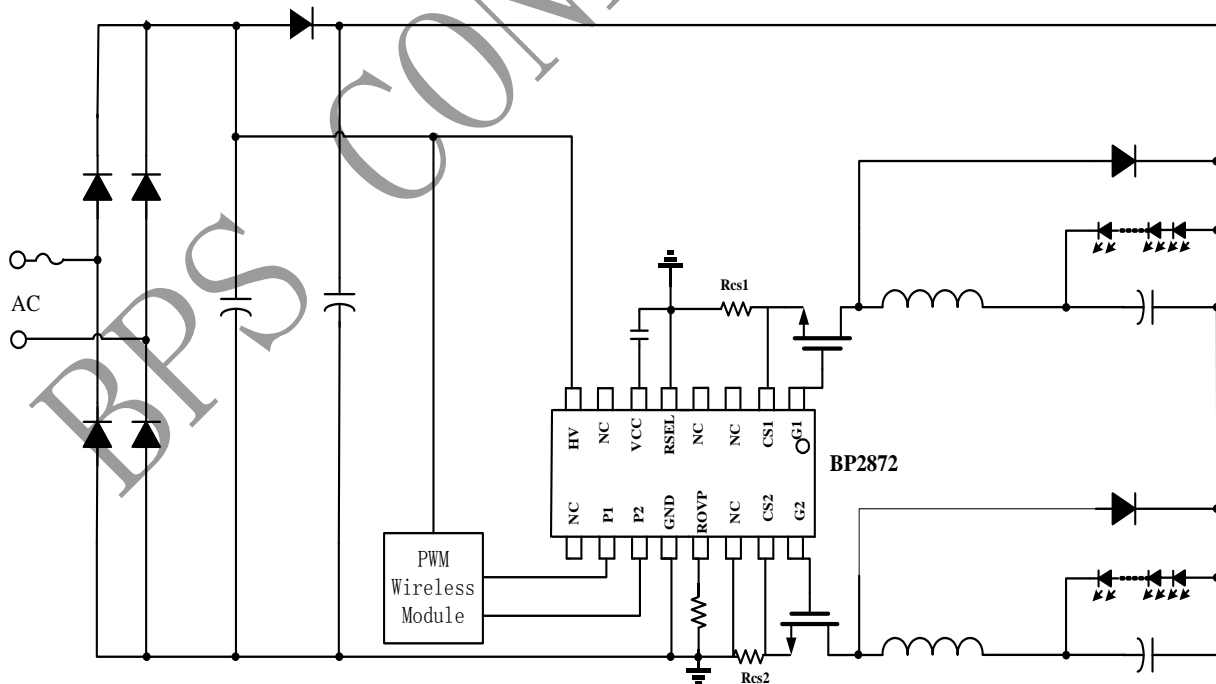


Figure 1. Typical application circuit for BP2872

## Ordering Information

Part Number	Package	Operating Temperature	Packing Method	Marking
BP2872	SOP-16	-40 °C to 105 °C	Tape 3,000 Piece/Reel	BP2872 XXXXXY YYY

## Pin Configuration and Marking Information

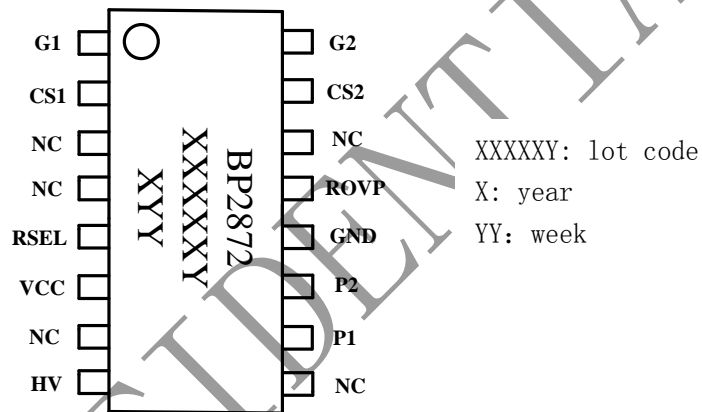


Figure 2. Pin configuration

## Pin Definition

Pin Number	Name	Description
1	G1	Internal buck controller 1 external MOS gate
2	CS1	Current sense Pin1. Connect a sense resistor between this pin and GND pin.
3,4,7,9,14	NC	No connection
5	RSEL	PWM mode select pin Should be connected to GND
6	VCC	Power supply pin
8	HV	High-voltage power supply pin
10	P1	PWM Pin1
11	P2	PWM Pin2
12	GND	Ground

13	ROVP	Over voltage protection setting Pin. Connect a resistor to GND
15	CS2	Current sense Pin2. Connect a sense resistor between this pin and GND pin.
16	G2	Internal buck controller 2 external MOS gate

## Absolute Maximum Ratings (note1)

Symbol	Parameters	Range	Units
HV	High-voltage power supply pin	-0.3~600	V
CS1, CS2	Current sense pin	-0.3~6	V
G1, G2	MOS gate drive pin	-0.3~20	V
ROVP	Over voltage protection setting pin	-0.3~6	V
RSEL	PWM mode select pin	-0.3~6	V
P1, P2	PWM pin	-0.3~6	V
P <sub>DMAX</sub>	Power dissipation (note 2)	0.85	W
$\theta_{JA}$	Thermal resistance (Junction to Ambient)	90	°C/W
T <sub>J</sub>	Operating junction temperature	-40 to 150	°C
T <sub>STG</sub>	Storage temperature range	-55 to 150	°C

**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>,  $\theta_{JA}$ , and environment temperature (T<sub>A</sub>). 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.

**Electrical Characteristics (Notes 3, 4)** (Unless otherwise specified,  $V_{CC}=15V$  and  $T_A=25^\circ C$ )

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>Supply Voltage Section</b>						
$V_{CC\_HIGH}$	$V_{CC}$ Operating Voltage			9.9		V
$V_{CC\_LOW}$	$V_{CC}$ Operating Voltage			9.5		V
$V_{CC\_ON}$	$V_{CC}$ Turn On Threshold	$V_{CC}$ Rising		8.9		V
$V_{CC\_UVLO}$	$V_{CC}$ Turn Off Threshold	$V_{CC}$ Falling		7.45		V
$I_{cc}$	$V_{CC}$ Operating Current	$F_{sw}=2.5kHz$		300		$\mu A$
<b>Current Sense Section</b>						
$V_{CS\_TH}$	Threshold Voltage for Peak Current Limit		388	400	412	mV
$T_{LEB}$	Leading Edge Blanking Time for Current Sense			500		ns
$T_{DELAY}$	Switch Off Delay Time			200		ns
<b>Internal Time Control Section</b>						
$T_{OFF\_MIN}$	Minimum OFF Time			1.6		$\mu s$
$T_{ON\_MAX}$	Maximum On Time			40		$\mu s$
$T_{OFF\_MAX}$	Maximum OFF Time			420		$\mu s$
$T_{LEB\_CS}$	Leading Edge Blanking Time for Current Sense			0.5		$\mu s$
$T_{ZCD\_MASK}$	Demagnetization Detection Masking Time			1.6		$\mu s$
$T_{OVP\_RST}$	OVP Reset Time			280		ms
<b>Driver Section</b>						
$I_{SOURCE\_MAX}$	Maximum Sourcing Current			180		mA
$I_{SINK\_MAX}$	Maximum Sinking Current			600		mA
<b>Thermal protection</b>						
$T_{SD}$	Thermal Shutdown			150		$^\circ C$
<b>PWM 调光</b>						
$V_{PWM\_ON}$	PWM Detect High Level	$V_{PWM}$ Rising	3			V
$V_{PWM\_OFF}$	PWM Detect Low Level	$V_{PWM}$ Falling			2.2	V

Note 3: production testing of the chip is performed at 25°C.

Note 4: the maximum and minimum parameters specified are guaranteed by test, the typical value are guaranteed by design, characterization and statistical analysis

### Internal Block Diagram

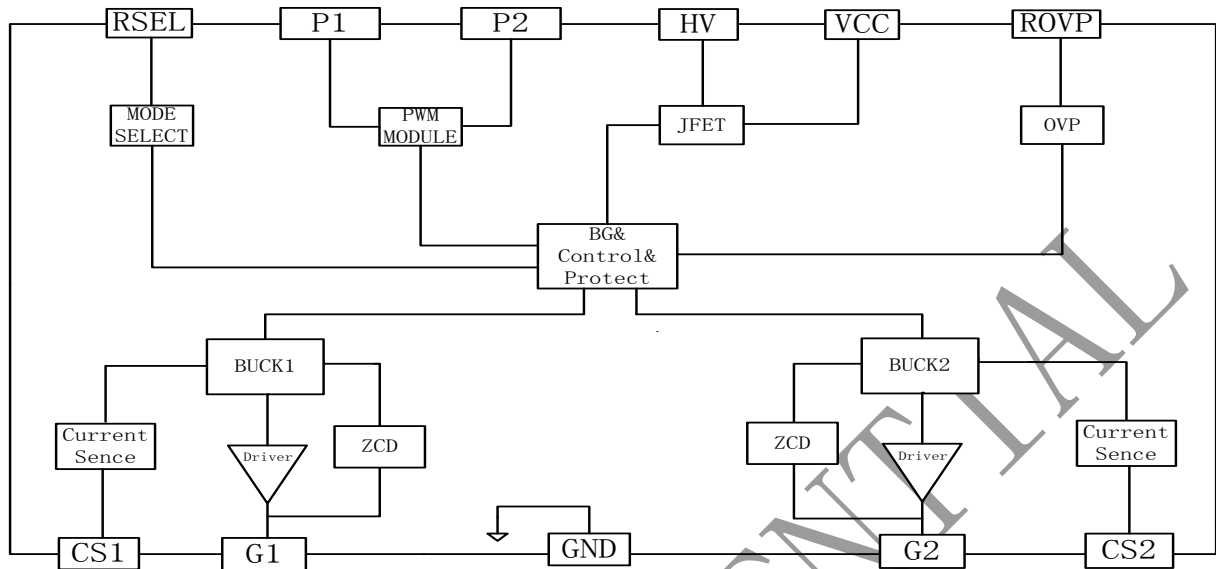


Figure 3. BP2872 Internal Block Diagram

### Application Information

BP2872 is a non-isolated two buck offline LED driver with PWM dimming. The device operates in critical conduction mode and is suitable for 85Vac~265Vac universal input offline LED lighting. BP2872 achieves the dimming function by external PWM controlling the P1 pin and P2 pin.

#### 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.

When the VCC voltage is higher than VCC\_HIGH, system will turn off the JFET and stop charging.

When the VCC voltage is lower than VCC\_LOW, system will turn on the JFET and charge the Vcc.

#### Constant Current Control

Cycle by Cycle current sense is adopted in BP2872, the CS1/CS2 pin is connected to the current sense comparator, and the voltage on CS1/CS2 pin is compared with the internal 400mV reference voltage.

The MOSFET will be switched off when the voltage on CS1/CS2 pin reaches the threshold. The CS1/CS2 comparator includes a 500ns leading edge blanking time.

The peak inductor current is given by:

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

Where,  $R_{CS}$  is the current sense resistor value.

The current in LED can be calculated by the equation:

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

Where,  $I_{PK}$  is the peak current of the inductor.

#### Inductor Selection

The BP2872 works under inductor current critical conduction mode. When the power MOSFET is switched on, the current in the inductor rises up from

zero, the on time of the MOSFET can be calculated by the equation:

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

Where,

L is the inductance value

$V_{IN}$  is the DC bus voltage after the rectifier bridge

$V_{LED}$  is the voltage on the LED

After the power MOSFET is switched off, the current in the inductor decreases. When the inductor current reaches zero, the power MOSFET is turned on again by IC internal logic. The off time of the MOSFET is given by:

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

The inductance can be calculated by the 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 the maximum switching frequency is set at highest input voltage.

The minimum and maximum off time of BP2872 is set at 1.6us and 420us, respectively. Referring to the equation of  $t_{OFF}$  calculation, if the inductance is too small, the  $t_{OFF}$  may be smaller than the minimum off time, system will operate in discontinuous conduction mode and the output current will be smaller than the designed value. If the inductance is too large, the  $t_{OFF}$  may be larger than the maximum off time, the system will operate in continuous conduction mode and the output current will be higher than the designed value. So it is important to choose a proper inductance.

### PWM Dimming

The BP2872 supports PWM dimming. In the PWM dimming mode, the DIM pin must be greater than 2.8V. After applying a 100Hz to 5kHz PWM signal at the DIM pin, the LED average current will vary from 0% to 100% depending on the PWM duty cycle.

### Over Voltage Protection

The over voltage protection can be programmed by the ROVP pin resistor. The ROVP pin current is 50uA.

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

$$Tovp \approx \frac{L \times Vcs}{Rcs \times Vovp}$$

Where,

Vcs is the CS pin turn off threshold (400mV)

Vovp is the open circuit protection voltage

And then the Rovp resistor value can be calculated by the equation:

$$Rovp \approx \frac{93}{Tovp} * 10^{-3} \quad (\text{kohm})$$

### Protection Function

The BP2872 offers rich protection functions to improve the system reliability, including LED open/short protection,  $V_{CC}$  under voltage protection, thermal regulation. When the LED is open circuit, the system will trigger the over voltage protection and stop switching. The system will wait 280ms and then re-switch

When the LED short circuit is detected, the system works at low frequency (2.5kHz). So the system power consumption is very low.



The BP2872 integrates overheat protection function. When the system is over temperature, it will stop the switch. So the reliability is improved. The shutdown temperature is set to 150°C internally, hysteresis of 20 degrees

## PCB Layout

The following rules should be followed in BP2872 PCB layout:

### Bypass Capacitor

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

### 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 connecting to the negative node 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 inductor, the power MOSFET, the output diode and the bus capacitor loop.

### Drain Pin

To increase the copper area of DRAIN pin for better thermal dissipation. However too large copper area may compromise EMI performance.

Physical Dimensions

