

Description

The BP2838G support a PWM dimming high precision buck constant current LED driver. The device operates in critical conduction mode and is suitable for 85Vac~265Vac universal input offline LED lighting.

The BP2838G integrates a 500V power MOSFET. With patent pending MOSFET driving technique, the operating current of the IC is very low. So it doesn't need the auxiliary winding for supplying the chip. It can achieve excellent constant current performance with very few external components, so the system cost and size are minimized.

The BP2838G utilizes patent pending current control method. It can achieve precise output current and excellent line regulation. The driver operates in critical conduction mode, the output current does not change with the inductance and LED output voltage.

The BP2838G offers rich protection functions to improve the system reliability, including LED open circuit protection, LED short circuit protection, VCC under voltage protection, CS resistor short circuit protection and thermal regulation function.

Features

- Internal 500V Power MOSFET
- Critical Conduction Mode Operation
- No Auxiliary Winding
- Ultra Low Operating Current
- ±5% LED Output Current Accuracy
- LED Open Protection
- LED Short Protection
- Current Sensing Resistor Short Protection
- VCC Under Voltage Protection
- Thermal Regulation Function
- Available in DIP-7 Package

Applications

- LED Tube
- LED Ceiling Light
- LED Bulb
- Other LED Lighting

Typical Application

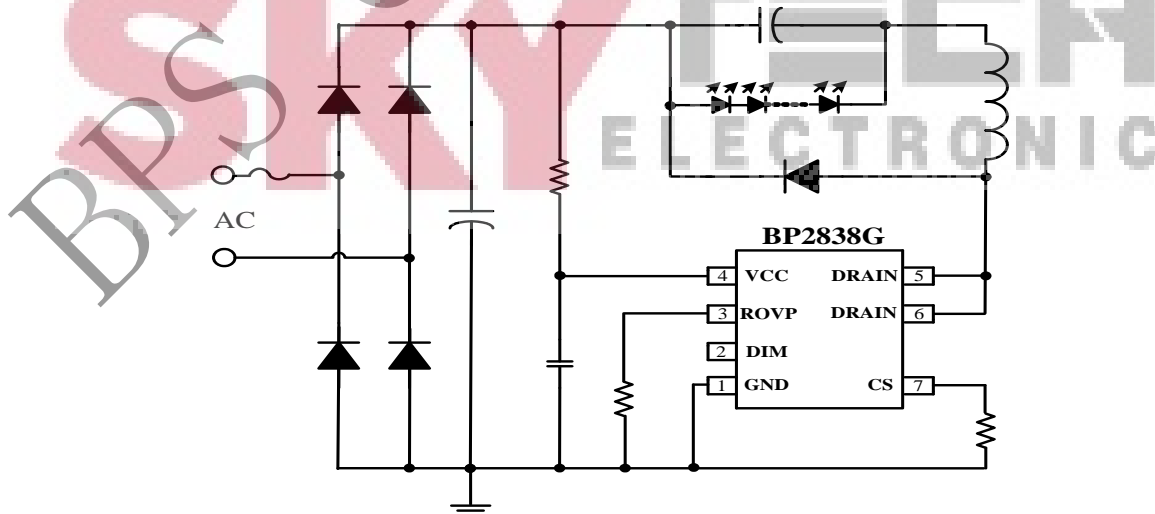


Figure 1. Typical application circuit for BP2838G

Ordering Information

| Part Number | Package | Operating Temperature | Packing Method | Marking |
|-------------|---------|-----------------------|-----------------------|---------------------------|
| BP2838G | DIP7 | -40 °C to 105 °C | Tube 50 Piece/Tube | BP2838G XXXXXY WWXY |

Pin Configuration and Marking Information

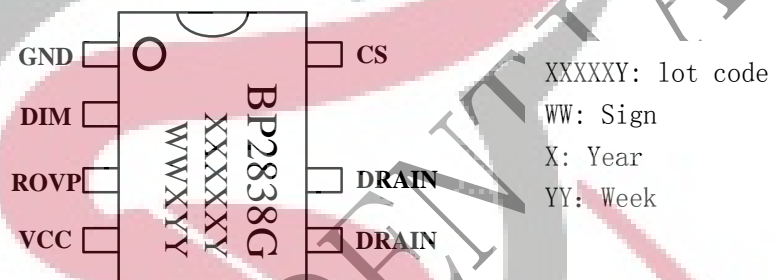


Figure 2. Pin configuration

Pin Definition

| Pin No. | Name | Description |
|---------|-------|---|
| 1 | GND | Ground |
| 2 | DIM | PWM dimming input, between PWM input single and DIM pin need series a 10k ohm resistor. |
| 3 | ROVP | Over Voltage Protection Setting Pin. Connect a resistor to GND |
| 4 | VCC | Power Supply Pin |
| 5,6 | DRAIN | Internal HV Power MOSFET Drain |
| 7 | CS | Current Sense Pin. Connect a sense resistor between this pin and GND pin. |

Absolute Maximum Ratings (note1)

| Symbol | Parameters | Range | Units |
|---------------------|--|------------|-------|
| I _{CC_MAX} | VCC pin maximum sink current | 5 | mA |
| DRAIN | Internal HV MOSFET drain voltage | -0.3~500 | V |
| CS | Current sense pin input voltage | -0.3~6 | V |
| DIM | PWM dimming single input pin | -0.3~6 | V |
| ROVP | Over-voltage setting pin voltage | -0.3~6 | V |
| P _{DMAX} | Power dissipation (note 2) | 0.9 | W |
| θ _{JA} | Thermal resistance (Junction to Ambient) | 80 | °C/W |
| T _J | Operating junction temperature | -40 to 150 | °C |
| T _{STG} | Storage temperature range | -55 to 150 | °C |
| | ESD (note 3) | 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

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

| 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} Turn On Threshold | V_{CC} Rising | | 14 | | V |
| V_{CC_UVLO} | V_{CC} Turn off Threshold | V_{CC} Falling | | 9 | | V |
| I_{ST} | V_{CC} Startup Current | $V_{CC}=V_{CC_ON}-1V$ | | 120 | 180 | μA |
| I_{OP} | V_{CC} Operating Current | $F_{OP}=70kHz$ | | 150 | 200 | μA |
| Current Sense Section | | | | | | |
| V_{CS_TH} | Threshold Voltage for Peak Current Limit | | 388 | 400 | 412 | mV |
| T_{LEB} | Leading Edge Blanking Time for Current Sense | | | 350 | | ns |
| T_{DELAY} | Switch Off Delay Time | | | 200 | | ns |
| Internal Time Control Section | | | | | | |
| T_{OFF_MIN} | Minimum OFF Time | | | 3 | | μs |
| T_{OFF_MAX} | Maximum OFF Time | | | 330 | | μs |
| T_{ON_MAX} | Maximum On Time | | | 40 | | μs |
| V_{ROVP} | ROVP Pin Voltage | | | 0.5 | | V |
| MOSFET Section | | | | | | |
| R_{DS_ON} | Static Drain-source On-resistance | $V_{GS}=10V/I_{DS}=1.5A$ | | 3 | | Ω |
| BV_{DSS} | Drain-Source Breakdown Voltage | $V_{GS}=0V/I_{DS}=250\mu A$ | 500 | | | V |
| I_{DSS} | Power MOSFET Drain Leakage Current | $V_{GS}=0V/V_{DS}=500V$ | | | 1 | μA |
| PWM Dimming | | | | | | |
| F_{DIM} | PWM Dimming Range | | 0.1 | | 1.0 | kHz |
| 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

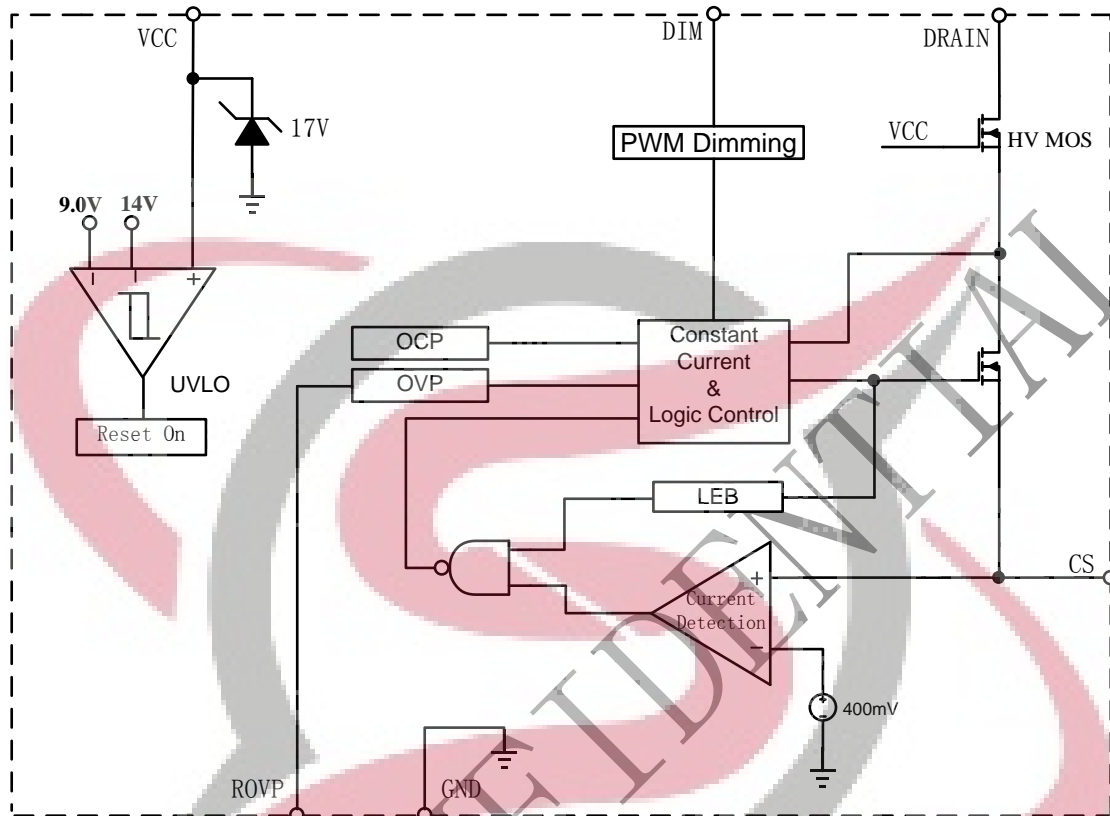


Figure 3. BP2838G Internal Block Diagram

Application Information

The BP2838G is a high performance non-isolated Buck converter specially designed for LED lighting. The device integrates a 500V 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 the start up resistor. When the VCC pin voltage reaches the turn on threshold, the internal circuits start operating. The BP2838G integrates a 17V zener diode to clamp the VCC voltage. 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 BP2838G, the CS pin is connected to the current sense comparator, and the voltage on CS pin is compared with the internal 400mV reference voltage. The MOSFET will be switched off when the voltage on CS pin reaches the threshold. The CS comparator includes a 350ns 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 BP2838G 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

I_{PK} is the peak inductor current

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 BP2838G is set at 3us and 330us, 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.

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:

$$T_{ovp} \approx \frac{L \times V_{cs}}{R_{cs} \times V_{ovp}}$$

Where,

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

V_{OVP} is the open circuit protection voltage

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

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



晶丰明源半导体

BP2838G

PWM Dimming Non-isolated Buck Offline LED Driver

Protection Function

The BP2838G offers rich protection functions to improve the system reliability, including LED open/short protection, CS resistor 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. After the system enters into the over voltage protection, the V_{CC} voltage will decrease until it reaches the UVLO threshold, then the system will re-start again. If the fault condition is removed, the system will recover to normal operation.

When the LED short circuit is detected, the system works at low frequency (3kHz), So the system power consumption is very low. At some catastrophic fault condition, such as CS resistor shorted or inductor saturated, the internal fast fault detection circuit will be triggered, the system stops switching immediately. If the fault condition is removed, the system will recover to normal operation.

PWM Dimming

The BP2838G allows PWM dimming. Under the mode of PWM dimming, DIM side high level need to be more than 0.5V. At the DIM end on a 0.1kHz – 1kHz PWM signal, LED the average current will change according to the PWM duty ratio from 0% to 100%. Between PWM input single and DIM pin need series a 10k ohm resistor.

Thermal Regulation

The BP2838G 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 BP2838G 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.

Rovp resistor

Over voltage protection settings need to be close to chip Rovp pin.

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
