

### 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.

### Typical Application

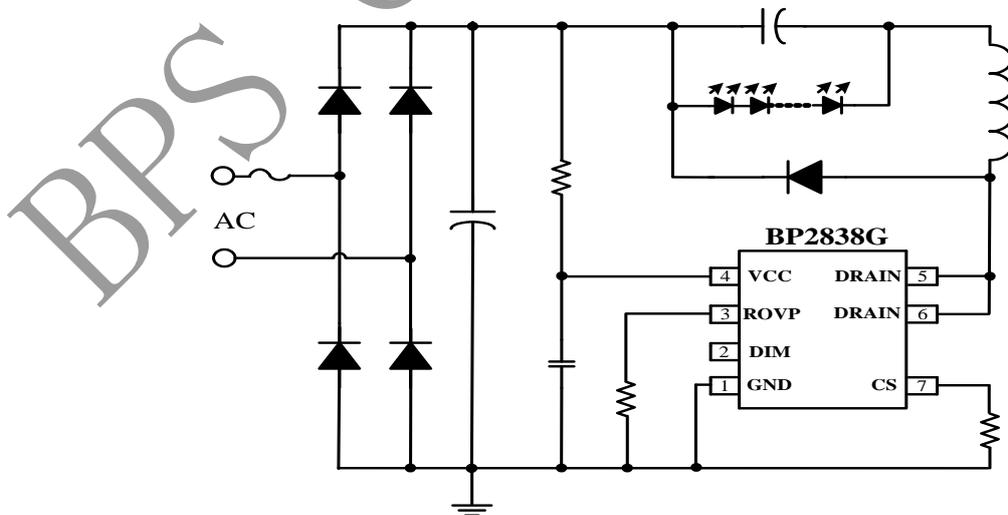


Figure 1. Typical application circuit for BP2838G

### 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

## 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

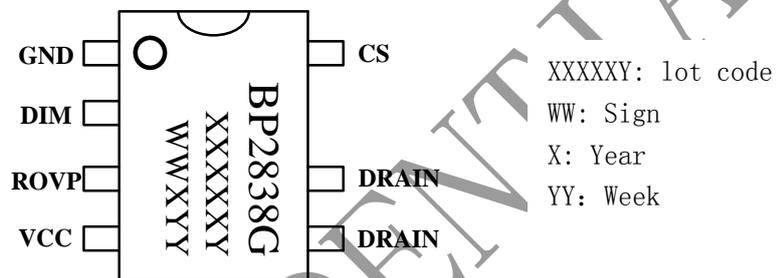


Figure 2. Pin configuration

## 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 <sub>CC_MAX</sub>	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 <sub>DMAX</sub>	Power dissipation (note 2)	0.9	W
θ <sub>JA</sub>	Thermal resistance (Junction to Ambient)	80	°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 (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<sub>JMAX</sub>, θ<sub>JA</sub>, 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.

**Note 3:** Human Body mode, 100pF capacitor discharge on 1.5kΩ resistor



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# BP2838G

PWM Dimming Non-isolated Buck Offline LED Driver

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

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>Supply Voltage Section</b>						
$V_{CC\_CLAMP}$	$V_{CC}$ 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	$\mu A$
$I_{OP}$	$V_{CC}$ Operating Current	$F_{OP}=70kHz$		150	200	$\mu A$
<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			350		ns
$T_{DELAY}$	Switch Off Delay Time			200		ns
<b>Internal Time Control Section</b>						
$T_{OFF\_MIN}$	Minimum OFF Time			3		$\mu s$
$T_{OFF\_MAX}$	Maximum OFF Time			330		$\mu s$
$T_{ON\_MAX}$	Maximum On Time			40		$\mu s$
$V_{ROVP}$	ROVP Pin Voltage			0.5		V
<b>MOSFET Section</b>						
$R_{DS\_ON}$	Static Drain-source On-resistance	$V_{GS}=10V/I_{DS}=1.5A$		3		$\Omega$
$BV_{DSS}$	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	$\mu A$
<b>PWM Dimming</b>						
$F_{DIM}$	PWM Dimming Range		0.1		1.0	kHz
<b>Thermal Regulation Section</b>						
$T_{REG}$	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





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:

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

**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

