晶丰明源半导体

BP2888

Non-isolation Two Way Buck LED Driver With Wall Switch Color Dimming

Description

The BP2888 is an internal integrated high-voltage power supply、two way buck LED driver with wall switch color dimming, and is suitable for 85Vac~265Vac universal input offline LED lighting.

The BP2888 can detect three switch status by DET pin, cold, warm, mixed color, and mixed color current can be controlled by adjusting RDIM1 / RDIM2 pin to realize different brightness.

The BP2888 operates in critical conduction mode，the output current does not change with the inductance and LED output voltage, and it achieves high precision output current control, and excellent line regulation and load regulation.

The BP2888 offers rich protection functions，including LED open/ short Protection，VCC under voltage protection, thermal shutdown function

The BP2888 is available in SOP-16 package

Features

- Integrated DET Switch Detection Circuit
- Internal 700V Power MOSFET
- Flexible Mixed Color Brightness Settings
- Wide Input Voltage
- ±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 Lighting
- LED Bulb
- Other LED Lighting

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Typical Application

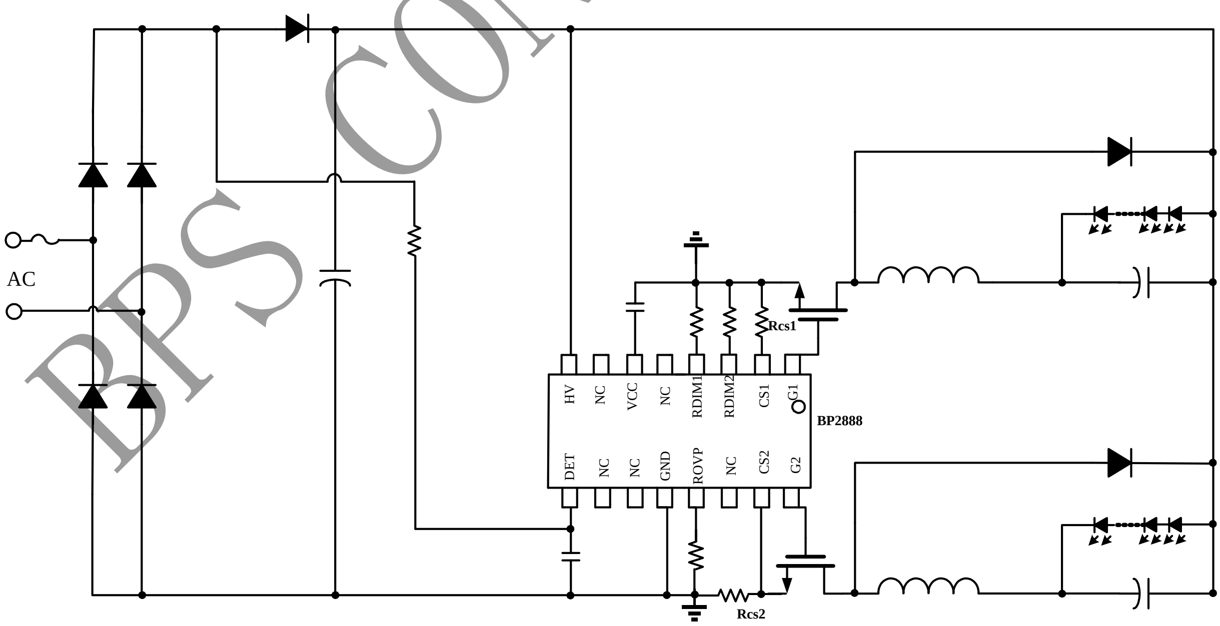

Figure 1. Typical application circuit for BP2888

Ordering Information

Part Number	Package	Operating Temperature	Packing Method	Marking
BP2888	SOP-16	-40 ℃to105 ℃	3000pcs/Reel	BP2888 XXXXXY XYY

Pin Configuration and Marking Information

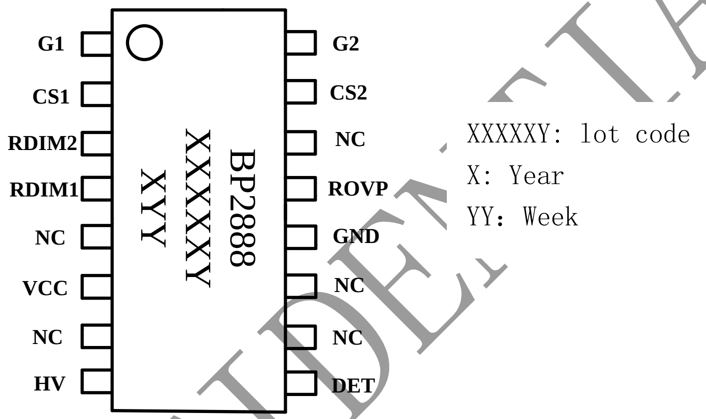

Figure 2. Pin configuration

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Pin Definition

Pin No.	Name	Description
1	G1	Internal BUCK controller2, external MOS Gate
2	CS1	Current sense pin1. Connect a sense resistor between this pin and GND pin.
3	RDIM2	Colour mixture current detection pin, combined with RDIM1 to achieve a variety of brightness
4	RDIM1	Colour mixture current detection pin, combined with RDIM2 to achieve a variety of brightness
5, 7, 10, 11, 14	NC	No Connection
6	VCC	Power supply pin
8	HV	High-voltage power supply pin
9	DET	Switch state detection pin
12	GND	Ground
13	ROVP	Over-voltage setting pin voltage

15	CS2	Current Sense Pin2. Connect a sense resistor between this pin and GND pin.
16	G2	Internal BUCK controller2 , 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
RDIM1，RDIM2	Mixed color current detection pin	-0. 3~6	V
DET	Switch state detection pin	-0. 3~8.5	V
DET	Switch state detection pin, clamp current	10	mA
P_{DMAX}	Power dissipation (note 2)	0. 85	W
θ_{JA}	Thermal resistance (Junction to Ambient)	90	℃/W
T_J	Operating junction temperature	-40 to 150	℃
T_{STG}	Storage temperature range	-55 to 150	℃

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.*

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Electrical Characteristics (Notes 3, 4) （Unless otherwise specified，V_{CC}=9 V，T_A=25 ℃）

Symbol	Parameter	Conditions	Min	Typ	Max	Units
Supply Voltage Section						
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		uA
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			500		ns
T_{DELAY}	Switch Off Delay Time			200		ns
Internal Time Control Section						
T_{OFF_MIN}	Minimum OFF Time			1.6		us
T_{ON_MAX}	Maximum On Time			40		us
T_{OFF_MAX}	Maximum OFF Time			420		us
T_{LEB_CS}	Leading Edge Blanking Time for Current Sense			0.5		us
T_{ZCD_MASK}	Demagnetization Detection Masking Time			1.6		us
T_{OVP_RST}	OVP Reset Time			280		ms
Driver Section						
I_{SOURCE_MAX}	Maximum Sourcing Current			180		mA
I_{SINK_MAX}	Maximum Sinking Current			600		mA
Thermal Regulation Section						
T_{SD}	Thermal Protection			150		℃
Switch Detection Section						
V_{DET_L2H}	DET High Level Detection			7		V
V_{DET_H2L}	DET LOW Level Detection			3.5		V
V_{DET_CLR}	DET Reset			0.5		V
V_{DET_CLAMP}	DET Clamp	5mA		7.5		V

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I_{DET_PD}	DET Sinking Current	DET>3.5V		600		uA
I_{DET_HOLD}	DET Holding Current	3.5V>DET>0.5V		5		uA

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*

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Internal Block Diagram

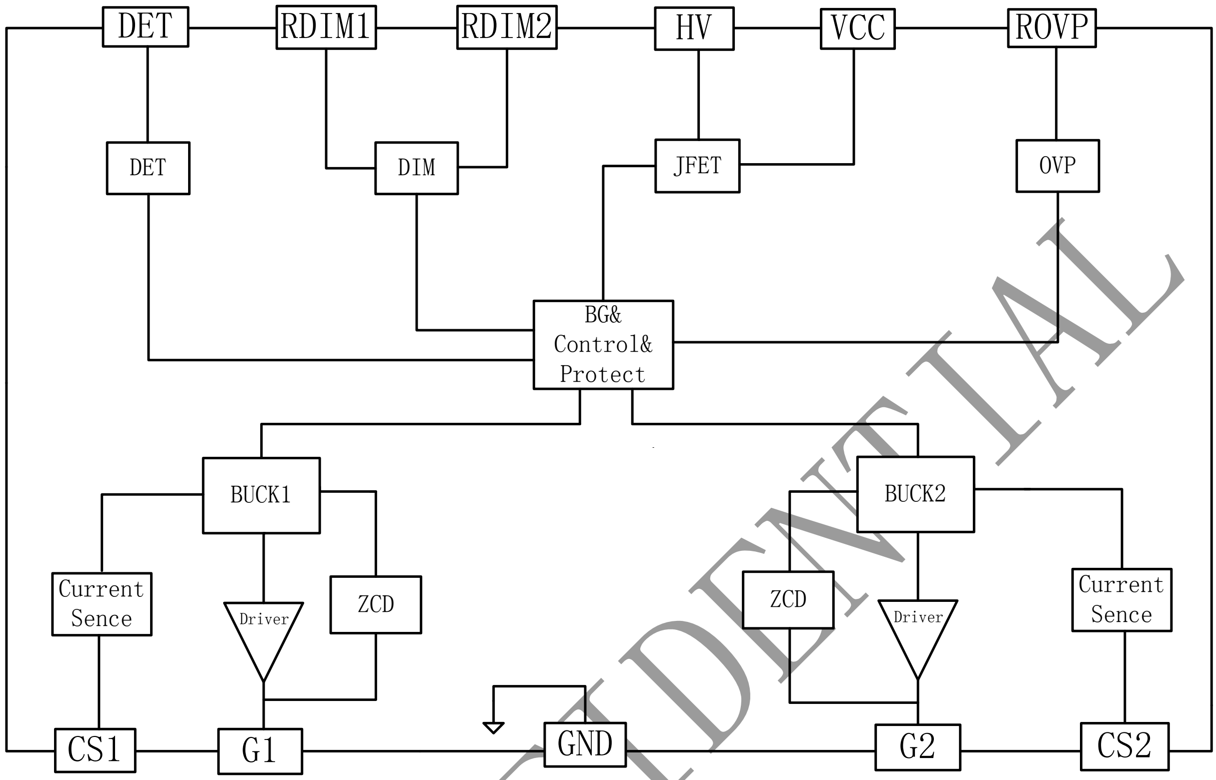

Figure 3. BP2888 Internal Block Diagram

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Application Information

The BP2888 is an Internal integrated high-voltage power supply、two way buck LED driver with wall switch color dimming, and is suitable for 85Vac~265Vac universal input offline LED lighting.

The BP2888 can detect three switch status by DET pin, cold, warm, mixed color, and mixed color current can be controlled by adjusting RDIM1 / RDIM2 pin to realize different brightness.

Start Up

After system powered up, the Vcc pin capacitor is charged up by internal HV JFET. 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 assembled in BP2888, the CS1/CS2 pin is connected to the current sense comparator, and the voltage on CS1/SC2 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:

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

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 BP2888 works under inductor current critical conduction mode. When the power MOFET 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 BP2888 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.

Wall Switch Color Dimming

BP2888 have three modes:（shown in the table）, by ON/OFF the wall switch ,the status can vary from mode1 to mode3.In mode 3,output current can be set by RDID1/RDIM2.（shown in the table）.The initial status of BP2888 is mode 1. After startup ,the wall switch ON/OFF times determines the working status, the BP2888 will cycle around mode 1、2、3.When the DET voltage drops below 0.5V or the VCC voltage falls below UVLO, the BP2888 will be reset. The next time it turns on, the BP2888 return to the default initial mode 1.

After the DET increases to 7V, the system starts to operate. When the DET drops to 3.5V, the switch is detected to be off and the DET pull-down current is 5uA. When the DET voltage falls below 0.5V, BP2888 will be reset. The BP2888 will switch to the next mode if the wall switch turns off during the memory time.

Mode selection：

MODE	BUCK1	BUCK2
1	ON	OFF
2	OFF	ON
3	ON	ON

In mode 3,output current can be set by RDID1/RDIM2.（shown in the table）

Mixed color brightness selection：

RDIM1	0Ω		39kΩ		NC
RDIM2	0Ω	NC	0Ω	NC	NC
I_{OUT}	65%	100%	85%	50%	75%

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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:

$$Tovp \approx \frac{L \times Vcs}{Rcs \times Vovp} \quad (us)$$

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:

$$Rovp \approx \frac{100}{Tovp} * 10^{-3} \quad (k\ ohm)$$

Protection Function

The BP2888 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 BP2888 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℃ internally, hysteresis of 20 degrees

PCB Layout

The following rules should be followed in BP2888 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.

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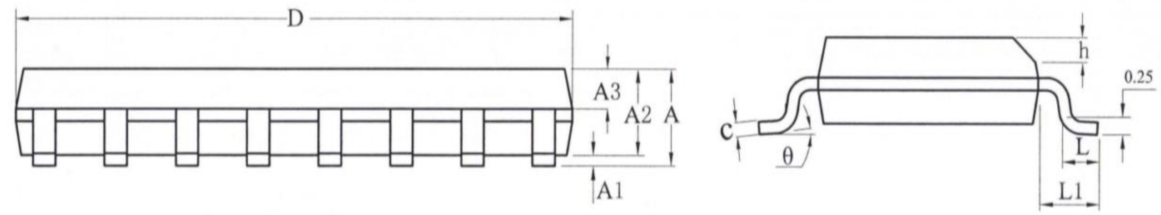
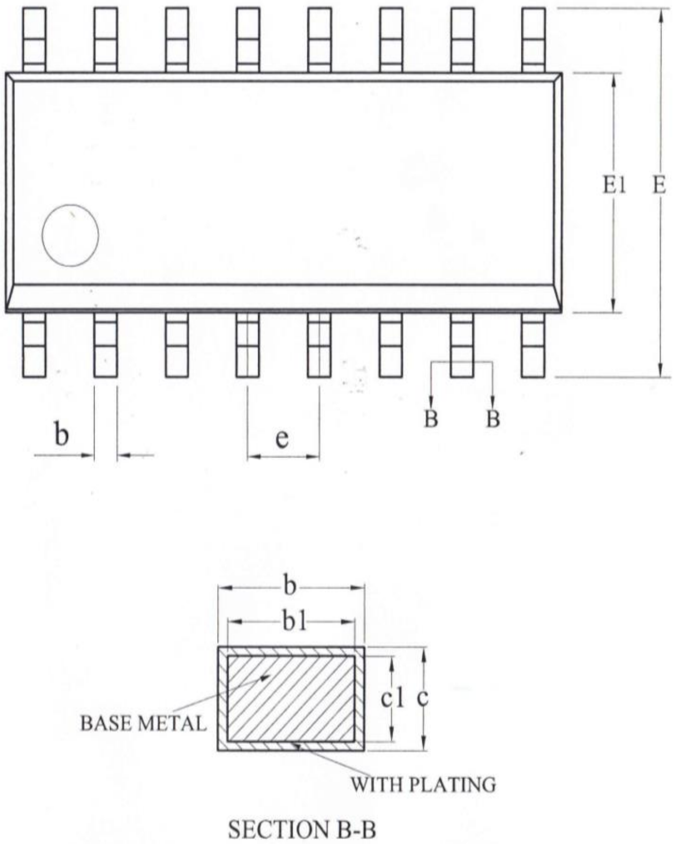
Physical Dimensions





	SYMBOL	MILLIMETER		
		MIN	NOM	MAX
	A	—	—	1.75
	A1	0.10	—	0.225
	A2	1.30	1.40	1.50
	A3	0.60	0.65	0.70
	b	0.39	—	0.48
1	b1	0.38	0.41	0.44
2	c	0.20	—	0.25
	c1	0.19	0.20	0.21
3	D	9.80	9.90	10.00
	E	5.80	6.00	6.20
4	E1	3.80	3.90	4.00
	e	1.27BSC		
	h	0.25	—	0.50
	L	0.50	—	0.80
	L1	1.05REF		
	θ	0	—	8°