

Description

The BP2328AJ is a high precision non-isolated buck driver with active PFC, specially designed for universal input offline constant current LED lighting. The driver with on-chip PFC circuit achieves high power factor and low THD. Operating in critical conduction mode, the power MOSFET switching loss is reduced and the inductor is fully utilized.

The BP2328AJ integrates a 600V power MOSFET. With few external components, the LED output current can be precisely controlled.

The BP2328AJ utilizes patent pending floating ground structure. The inductor current is sensed during the whole switching cycle. So it achieves high precision output current control, and excellent line regulation and load regulation.

The BP2328AJ offers rich protection functions to improve the system reliability, including LED open circuit protection, LED short circuit protection, VCC under voltage protection, CS resistor open circuit protection and cycle by cycle current limit. All the protection functions are auto-recovery. The system reliability is further improved by the thermal regulation function. The output current is reduced when the driver is over temperature.

Features

- Active PFC for High Power Factor and Low THD
- Internal 600V Power MOSFET
- System Efficiency up to 95%
- $\pm 3\%$ LED Output Current Accuracy
- Excellent Line and Load Regulation
- Critical Conduction Mode Operation
- Ultra Low (33uA) Start Up Current
- Ultra Low (300uA) Operating Current
- LED Short/Open Protection
- Current Sensing Resistor Open Protection
- Cycle by Cycle Current Limit
- VCC Under Voltage Protection
- Auto Fault Recovery
- Thermal Regulation Function
- Available in SOP8 Package

Applications

- GU10/E27 LED Bulb, Spot Light
- PAR30, PAR38 Lamp
- T8/T10 LED String
- Other LED Lighting

Typical Application

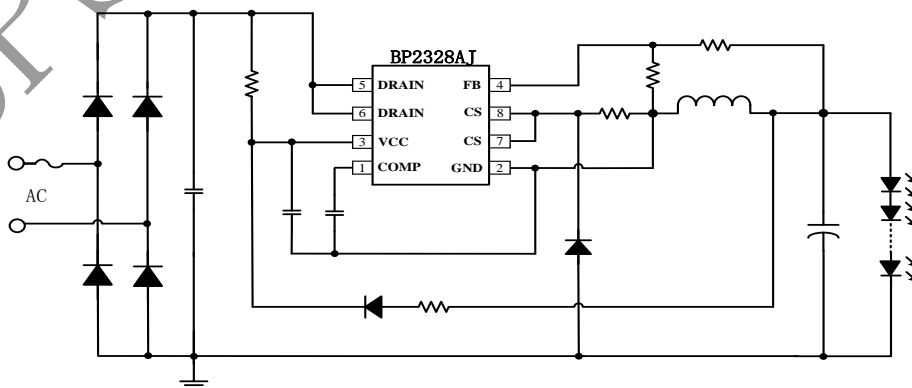


Figure 1. Typical application circuit for BP2328AJ

Ordering Information

Part Number	Package	Operating Temperature	Packing Method	Marking
BP2328AJ	SOP8	-40 °C to 105 °C	Tape 4,000 Pcs/Reel	BP2328A XXXXXY WXYJ

Pin Configuration and Marking Information

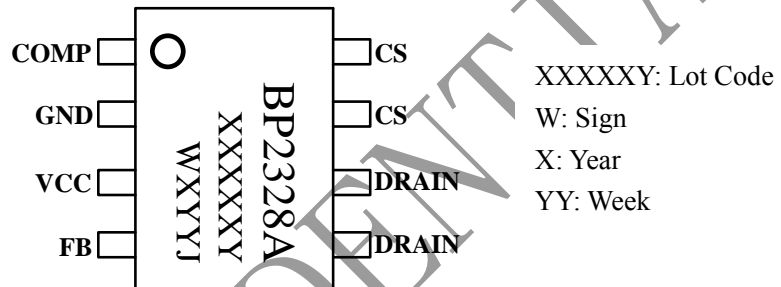


Figure 2. Pin configuration

Pin Definition

Pin No.	Name	Description
1	COMP	Loop Compensation Node. This pin connects a capacitor to GND for stabilization of the control loop, achieving accurate LED current, high Power Factor and low THD.
2	GND	Ground.
3	VCC	Power Supply Pin. Connect a bypass capacitor from this pin to GND.
4	FB	Feedback Voltage Input Pin. This pin detects the inductor demagnetization signal and the output voltage.
5,6	DRAIN	Internal HV Power MOSFET Drain.
7,8	CS	Current Sense Pin. Connect a resistor to GND to sense the inductor current.

Absolute Maximum Ratings (note1)

Symbol	Parameters	Range	Units
V _{DS}	Internal HV MOSFET Drain to Source voltage	-0.3~600	V
I _{CC_MAX}	VCC pin maximum sink current	10	mA
COMP	Compensation pin voltage	-0.3~6	V
FB	Feedback pin input voltage	-0.3~6	V
CS	Current sense pin input voltage	-0.3~6	V
P _{DMAX}	Power dissipation (note2)	0.45	W
θ _{JA}	Thermal resistance (Junction to Ambient)	145	°C/W
T _J	Operating junction temperature	-40 to 150	°C
T _{STG}	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_{JMAX}, θ_{JA}, and environment temperature (T_A). The maximum power dissipation is the lower one between P_{DMAX} = (T_{JMAX} - T_A) / θ_{JA} 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
V _{CC}	Power supply voltage	8.5 ~ 20	V
I _{LED 1}	Output LED current @ V _{out} =72V (Input voltage 176V~265V)	< 300	mA
I _{LED 2}	Output LED current @ V _{out} =36V (Input voltage 176V~265V)	< 420	mA



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BP2328AJ

Non-isolated Buck APFC Offline LED Driver

Electrical Characteristics (Notes 4, 5) (Unless otherwise specified, $V_{CC}=17V$ and $T_A=25^\circ C$)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
Supply Voltage Section						
V_{CC_ON}	V_{CC} Turn On Threshold	V_{CC} Rising		17		V
V_{CC_UVLO}	V_{CC} Turn Off Threshold	V_{CC} Falling		7.8		V
V_{CC_CLAMP}	V_{CC} Clamp Voltage			20		V
I_{ST}	V_{CC} Startup Current	V_{CC} Rising, $V_{CC}=V_{CC_ON}-1V$		33	50	μA
I_{CC}	V_{CC} Operating Current	$F_{OP}=10kHz,$		300	500	μA
Feedback Section						
V_{FB_FALL}	FB Falling Edge Threshold Voltage	FB Falling		0.2		V
V_{FB_HYS}	FB Hysteresis Voltage	FB Rising		0.3		V
V_{FB_OVP}	FB Over Voltage Protection Threshold			1.7		V
T_{ON_MAX}	Maximum On Time			24		μs
T_{OFF_MIN}	Minimum Off Time			3		μs
T_{OFF_MAX}	Maximum Off Time			90		μs
Current Sense Section						
V_{CS_LIMIT}	CS Peak Voltage Limitation			1.5		V
T_{LEB_CS}	Leading Edge Blanking Time for Current Sense			350		ns
T_{DELAY}	Switch off Delay Time			200		ns
Compensation Section						
V_{REF}	Internal Reference Voltage		0.194	0.2	0.206	V
V_{COMP_LO}	COMP Low Clamp Voltage			1.5		V
V_{COMP}	COMP Linear Operating Voltage Range		1.5		3.9	V
V_{COMP_HI}	COMP High Clamp Voltage			4.0		V



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Symbol	Parameter	Conditions	Min	Typ	Max	Units
Power MOSFET						
R _{DS_ON}	Static Drain-source On-resistance	V _{GS} =10V/I _{DS} =0.5A		1.8		Ω
BV _{DSS}	Drain-Source Breakdown Voltage	V _{GS} =0V/I _{DS} =250uA	600			V
I _{DSS}	Power MOSFET Drain Leakage Current	V _{GS} =0V/V _{DS} =600V			1	uA
Thermal Regulation Section						
T _{REG}	Thermal Regulation Temperature			150		°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

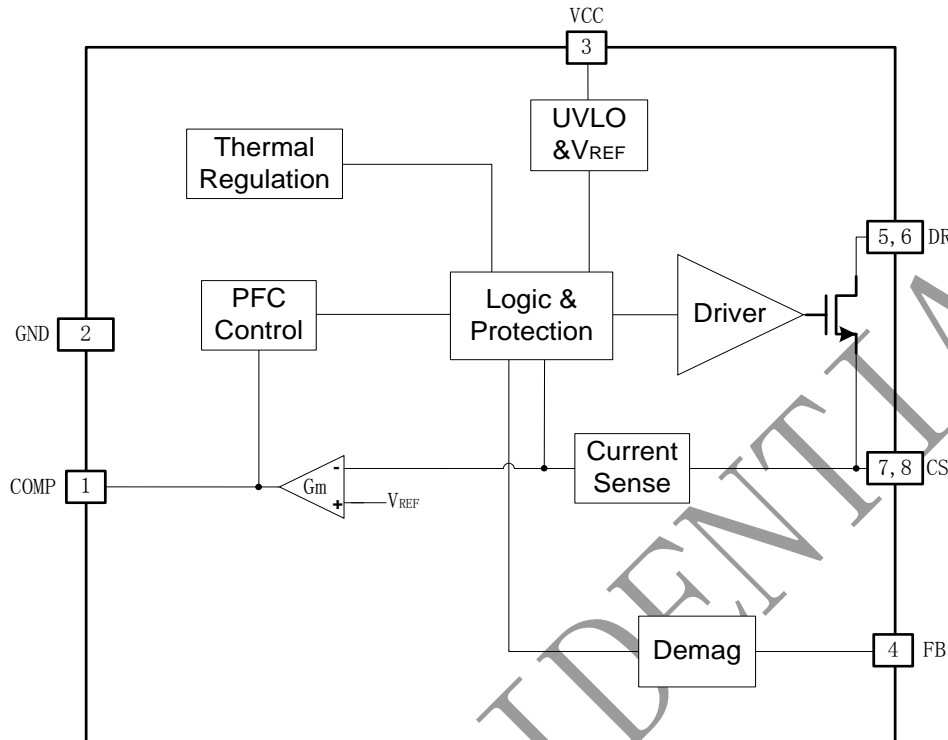


Figure 3. BP2328AJ Internal Block Diagram

Application Information

The BP2328AJ is a high precision Active PFC driver integrating 600V power MOSFET, specially designed for non-isolated buck offline constant current LED lighting. Operating in critical conduction mode, the driver achieves high power factor, low THD and high efficiency.

1 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 working. The COMP pin voltage is pulled up to 1.5V quickly, then the BP2328AJ starts switching. The system works at 10kHz frequency at the beginning, the COMP voltage rises up gradually, and the inductor peak current also rises up. The LED current hence achieves a soft start without overshoot. After the output voltage is built up, the VCC power is supplied by the output voltage through a diode.

2 Constant Current Control

The BP2328AJ utilizes patent pending floating ground structure. The inductor current is sensed during the whole switching cycle, thus it achieves high precision output current control and also excellent line and load regulation.

The current in LED can be calculated by the equation:

$$I_{OUT} \approx \frac{V_{REF}}{R_{CS}}$$

Where,

V_{REF} : Internal reference voltage, typically 0.2V

R_{CS} : The current sensing resistor value

3 Feedback Network

The BP2328AJ senses the output current zero crossing information through the feedback network,



the FB falling threshold voltage is set to 0.2V with 0.3V hysteresis. The FB pin is also used to detect output OVP, the threshold voltage is 1.7V. The ratio of FB upper resistor to lower resistor can be set as:

$$\frac{R_{FBL}}{R_{FBL} + R_{FBH}} = \frac{1.7V}{V_{OVP}}$$

Where,

R_{FBL} : The lower resistor of the feedback network

R_{FBH} : The upper resistor of the feedback network

V_{OVP} : Output over voltage setting point

The minimum V_{OVP} should be set about 1.3Vo. It is recommended that the FB lower resistor is set to 2K Ω -5K Ω paralleled with a 100pF ceramic capacitor.

4 Thermal Regulation

The BP2328AJ 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.

5 Protection Functions

The BP2328AJ offers rich protection functions to improve the system reliability.

When the LED is open circuit, the output voltage will gradually rise up. The output voltage is sensed by the FB pin when power MOSFET is turned off. When FB voltage reaches the OVP threshold, it will trigger fault logic and the system stops switching.

When the LED is shorted circuit, the system will work under 10kHz switching frequency. Meanwhile, the output voltage is low and the VCC pin cannot be charged up by the output voltage, so the VCC pin voltage will gradually decrease and finally reaches the UVLO threshold.

After the system enters into fault condition, the VCC voltage will decrease until it reaches UVLO threshold. Then the system will re-start again. If the fault

condition is removed, the system will resume normal operation.

When the output is short circuit or the inductor is saturated, the CS peak voltage will be relatively high. When CS voltage reaches the internal limitation (1.5V), the power MOSFET will be turned off instantaneously. This cycle by cycle current limitation can help protecting the power MOSFET, the inductor and the output diode.

6 PCB Layouts

The following guidelines should be followed in BP2328AJ PCB layout:

Bypass Capacitor

The bypass capacitor on VCC pin should be as close as possible to the VCC and GND pins.

Ground Path

The power ground path for current sense resistor should be short and wide, and it should be as close as possible to the IC ground (pin 2), otherwise the LED output current accuracy maybe affected. The IC signal ground for COMP and FB components should be connected to the IC GND pin with short traces and should be away from the power ground path.

The Area of Power Loop

The area of main current loop should be as small as possible to reduce EMI radiation.

FB Pin

The feedback resistor divider should be as close as possible to the FB pin, and the trace must keeps away from dynamic node of the inductor (DRAIN pin trace), otherwise the FB pin OVP function might have risk to be mis-triggered by the system noise.

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

