BP2329A

Non-isolated Buck APFC Offline LED Controller

Description

The BP2329A is a high precision non-isolated buck controller with active PFC, specially designed for universal input offline constant current LED lighting. The controller 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 BP2329A 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 BP2329A 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 controller is over temperature.

Features

- Active PFC for High Power Factor and Low THD
- System Efficiency up to 95%
- ±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 Tiny SOT23-6 Package

Applications

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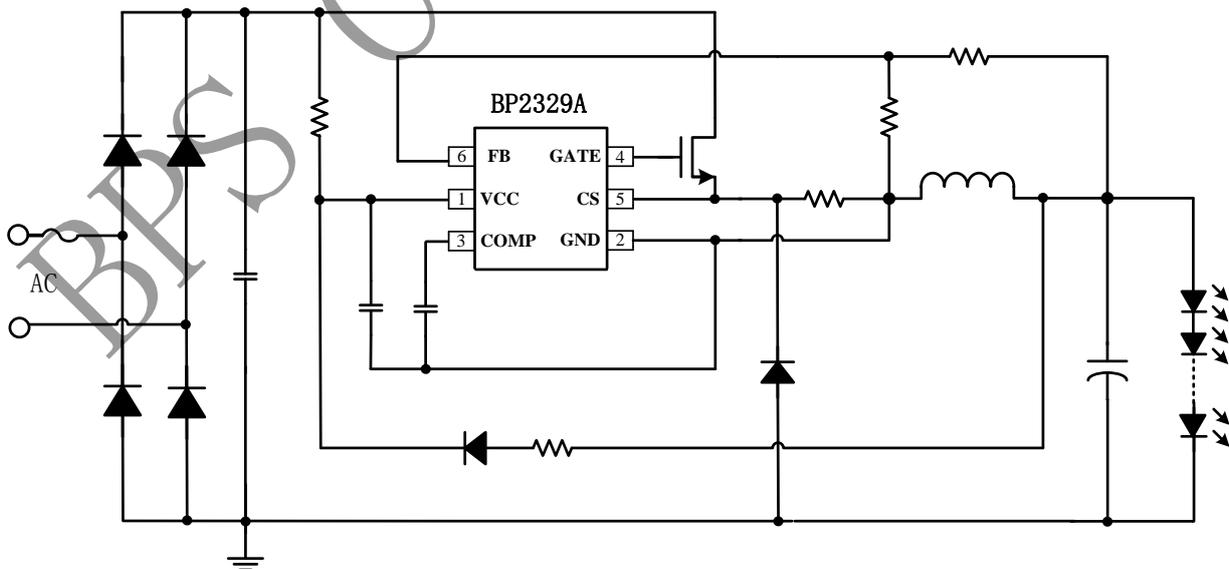- Other LED Lighting

Typical Application

Figure 1. Typical application circuit for BP2329A

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Ordering Information

Part Number	Package	Operating Temperature	Package Method	Marking
BP2329A	SOT23-6	-40 ℃ to 105 ℃	Tape 3,000 Piece/Roll	2329A

Pin Configuration
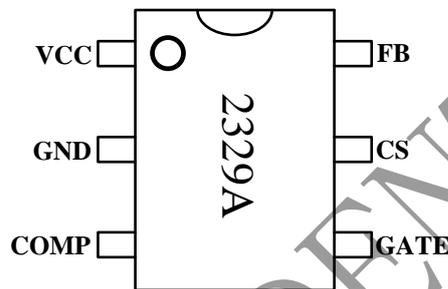
Figure 2. Pin configuration

Pin Definition

Pin No.	Name	Description
1	VCC	Power Supply Pin. Connect a bypass capacitor from this pin to GND.
2	GND	Ground.
3	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.
4	GATE	Gate Driver Pin. Connect this pin to the gate of external power MOSFET.
5	CS	Current Sense Pin. Connect a resistor to GND to sense the inductor current.
6	FB	Feedback Voltage Input Pin. This pin detects the inductor demagnetization signal and the output voltage.

Absolute Maximum Ratings (note1)

Symbol	Parameters	Range	Units
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
GATE	Gate driver pin voltage	-0.3~22	V
P_{DMAX}	Power dissipation (note2)	0.3	W
θ_{JA}	Thermal resistance (Junction to Ambient)	240	℃/W
T_J	Operating junction temperature	-40 to 150	℃
T_{STG}	Storage temperature range	-55 to 150	℃
	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 $P_{DMAX} = (T_{JMAX} - T_A)/ \theta_{JA}$ 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

Electrical Characteristics (Notes 4, 5) (Unless otherwise specified, V_{CC}=17V and T_A =25 ℃)

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_{CC_UVLO}	V_{CC} Startup Current	V_{CC} Rising, $V_{CC}= V_{CC\_ON}$ - 1V		33	50	uA
I_{CC}	V_{CC} Operating Current	F_{OP}=10kHz, Load=100pF		300	500	uA
Feedback Section						
V_{FB_FALL}	FB Falling Edge Threshold Voltage	FB Falling		0.2		V
V_{FB_HYS}	FB Hysteresis Voltage	FB Rising		0.15		V
V_{FB_OVP}	FB Over Voltage Protection Threshold			1.6		V
T_{ON_MAX}	Maximum On Time			20		us
T_{OFF_MIN}	Minimum Off Time			3		us
T_{OFF_MAX}	Maximum Off Time			100		us
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

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_{COMP_HI}	COMP High Clamp voltage			4.0		V
Driver Section						
I_{SOURCE_MAX}	GATE pin Maximum Sourcing Current			200		mA
I_{SINK_MAX}	GATE pin Maximum Sinking Current			500		mA
Thermal Regulation Section						
T_{REG}	Thermal Regulation Temperature			150		℃

Note 4: production testing of the chip is performed at 25 ℃.

Note 5: the maximum and minimum parameters specified are guaranteed by test, the typical value are guaranteed by design, characterization and statistical analysis
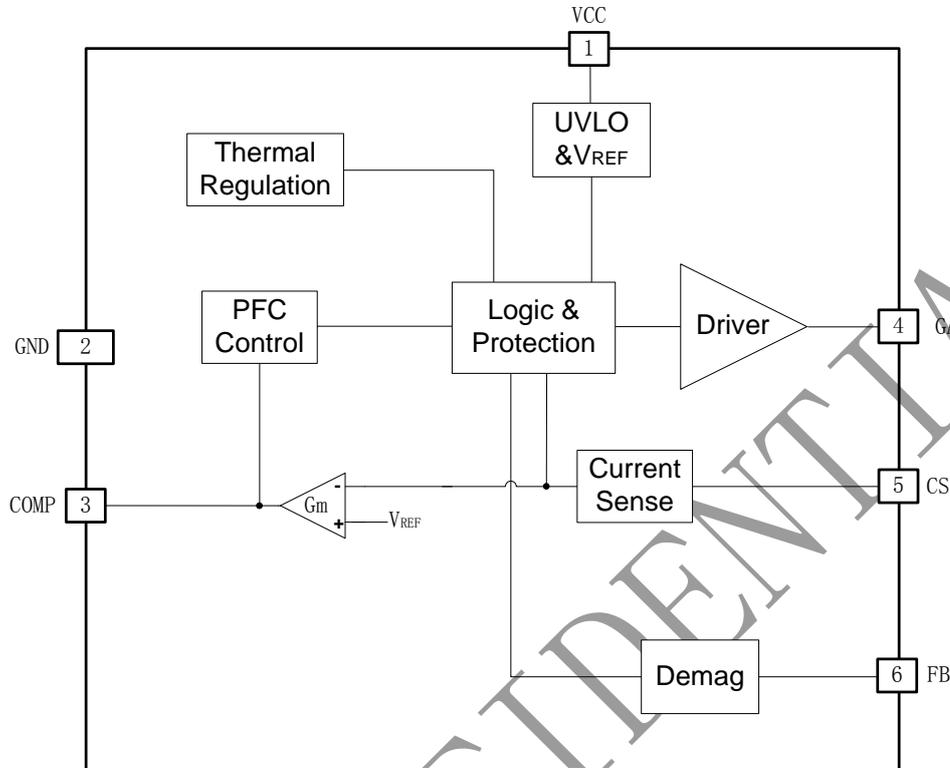
Internal Block Diagram

Figure 3. BP2329A Internal Block Diagram

Application Information

The BP2329A is a high precision Active PFC controller for non-isolated buck offline constant current LED lighting. Operating in critical conduction mode, the controller 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 BP2329A starts the MOSFET driver. 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 BP2329A 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:

$$I_{OUT} \approx \frac{V_{REF}}{Rcs}$$

Where,

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

Rcs: The current sensing resistor value

3 Feedback Network

The BP2329A senses the output current zero crossing information through the feedback network, the FB falling threshold voltage is set to 0.2V with 0.15V hysteresis. The FB pin is also used to detect output OVP, the threshold voltage is 1.6V. The ratio of FB upper resistor to lower resistor can be set as:

$$\frac{R_{FBL}}{R_{FBL} + R_{FBH}} = \frac{1.6V}{V_{OVP}}$$

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
It is recommended that the FB lower resistor set to 5KΩ--10KΩ.

4 Thermal Regulation

The BP2329A 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℃ internally.

5 Protection Functions

The BP2329A 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 BP2329A 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 and MOSFET DRAIN trace, otherwise the FB pin OVP function might have risk to be mis-triggered by the system noise.

Physical Dimensions

SOT-23-6L PACKAGE OUTLINE DIMENSIONS

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°