BP3108

PSR LED Controller With Triac Dimming

Description

BP3108 is a primary side regulation (PSR) controller with triac dimming designed for high brightness LED driver. It's extremely suitable to be used in flyback converter operating in worldwide voltage range.

BP3108 works in discontinuous inductive current mode. The patented control method dramatically saves the system cost and size by eliminating all secondary feedback circuitry and loop control compensation circuitry. This control method also achieves excellent line and load regulation.

BP3108 integrates the triac dimming control circuit internally.Few external components are required to achieve wide triac dimming range and good dimming effect without visible flicker.

BP3108 integrates high precision current sense circuitry, which achieves ±3% LED current accuracy.

BP3108 offers rich protection features including LED short/open circuit protection, over-temperature protection, under-voltage lockout, VCC over voltage protection.

BP3108 is assembled in SOP-8 package.

Features

- Triac Dimming
- PSR constant current (CC) control，no secondary feedback circuit required
- ±3% LED current accuracy
- Ultra low operating current to improve efficiency
- Low power consumption on FB resistor network
- Worldwide voltage range
- LED short/open circuit protection
- V_{CC} over voltage protection
- Current sense resistor open circuit protection
- Over temperature protection
- No external loop compensation required

Applications

- Triac dimming LED lighting
- GU10/E27 LED bulb, spot light
- LED PAR30/PAR38, down light
- LED Tube
- Other LED lighting

Typical Application

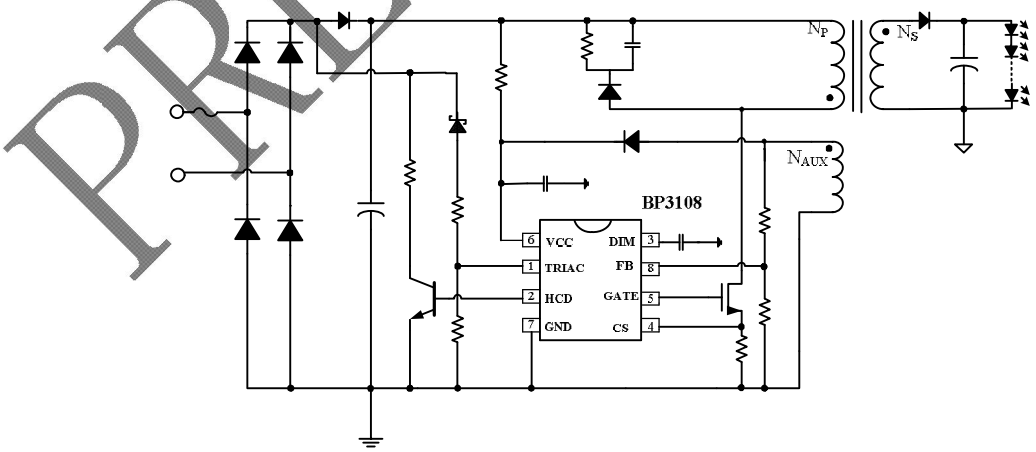
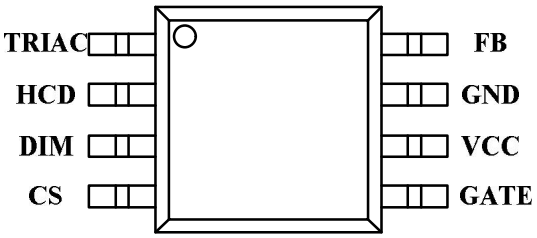


Figure 1 typical application circuit

Pin Configuration



Pin Description

Pin No.	Pin Name	Description
1	TRIAC	Triac dimmng voltage detect，PWM dimming signal input
2	HCD	Dimming BJT driver
3	DIM	Analog dimming.Connect 1uF capacitor to GND while triac dimming.
4	CS	The current sense pin used to sense the MOSFET current by means of an external sense resistor. The resistor is connected between CS and GND
5	GATE	The output gate driver for an external N-channel power MOSFET.
6	VCC	Power supply
7	GND	Signal and Power ground
8	FB	The voltage feedback from auxiliary winding.

Ordering Information

Order Number	Package	Operating Temperature	Packing Method	Marking
BP3108ESO8	SOP8	-40 °C to 85 °C	Tape and Reel 2,500 units	BP3108 xxxxxx xxx

Absolute Maximum Ratings (note1)

Symbol	Parameters	Value	Unit
V_{CC}	Power supply	-0.3~25	V
FB	The voltage feedback from auxiliary winding.	-0.3~6	V
CS	Current sense	-0.3~6	V
DIM	Analog dimming	-0.3~6	V
TRIAC	Triac dimmng voltage detect	-0.3~6	V
HCD	Dimming BJT driver	-0.3~6	V
Gate	Gate driver of external NMOS	-0.3~25	V
P_{DMAX}	Power dissipation (note2)	0.3	W
P_{TR}	Thermal resistance, SOP-8（θ_{JA}）	145	°C /W
T_J	Operating temperature	-40 to 150	°C
T_{STG}	Storage temperature	-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 $P_{DMAX} = (T_{JMAX} - T_A)/ \theta_{JA}$ and the number listed in the maximum table.*

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

Recommended Operation Condition

Symbol	Parameters	Value	Unit
V_{CC}	Power supply	7.5 ~14.5	V

Electrical Characteristics (V_{cc}=12V, T_A=25 °C unless otherwise stated)(note 4,5)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Supply voltage section						
V_{CC}	Input voltage		6.5	12	16	V
V_{CC-TH}	Start-up voltage	V_{CC} rising	13	14	15	V
V_{UVLO}	Under-voltage lockout threshold			6.5		V
V_{OVP}	Over voltage protection threshold			16		V
$V_{CC-CLAMP}$	V_{CC} clamp voltage	Ivcc=10mA		19		V
Current sense section						
V_{CS-TH}	Current sense threshold		495	500	505	mV
T_{LEB}	LEB time			500		ns
T_{DELAY}	Switch off delay			200		ns
Operation current section						
I_{ST}	Start up current	V_{CC}= V_{CC-TH} - 1V		25	50	uA
I_{OP}	Typical operation current	F_{OP}=40kHz		1.5		mA
FB section						
V_{FB}	FB voltage threshold			1		V
$V_{FB-CLAMP}$	FB clamp voltage	I_{FB}=2uA		1.5		V
$T_{DEMAG-MIN}$	Minimum demagnetization time			4.2		uS
$\Delta V_{CS}/\Delta I_{FBUP}$	Line compensation ratio	(note 6)		1.1		mV/uA
Maximum Duty cycle						
D_{MAX}	Maximum Duty Cycle			42		%
Triac Dimming section						
$R_{PULL-UP}$	TRIAC pull up resistor			2		MΩ
$R_{HCD-OFF}$	HCD switch off resistor			12		Ω
I_{HOLD}	HCD sourcing current			500		uA
I_{TRIAC}	TRIAC current			5		uA
V_{TRIAC}	TRIAC votaget dectect threhold			1.25		V
Analog Dimming section						
V_{DIMLOW}	Analog dimming low threshold			0.8		V
$V_{DIMHIGH}$	Analog dimming high threshold			3.5		V
$V_{DIM-HYS}$	Dimming low threshold hysteresis	V_{DIM}>V_{DIMLOW}		0.2		V

$V_{DIMPULL-UP}$	Dim pull resistor			150		KΩ
Over temperature protection						
T_{SD}	Thermal shutdown threshold			160		℃
T_{SD-HYS}	Thermal shutdown hysteresis			30		℃
Gate Driver section						
I_{SOURCE}	Gate sourcing current			100		mA
R_{DSOFF}	Gate switch off resistor			30		Ω

Note4 : *production testing of the chip is performed at 25 ° C.*

Note5: *the maximum and minimum parameters specified are guaranteed by test, the typical value are guaranteed by design, characterization and statistical analysis*

Note6: *refer to application information*

Application Information

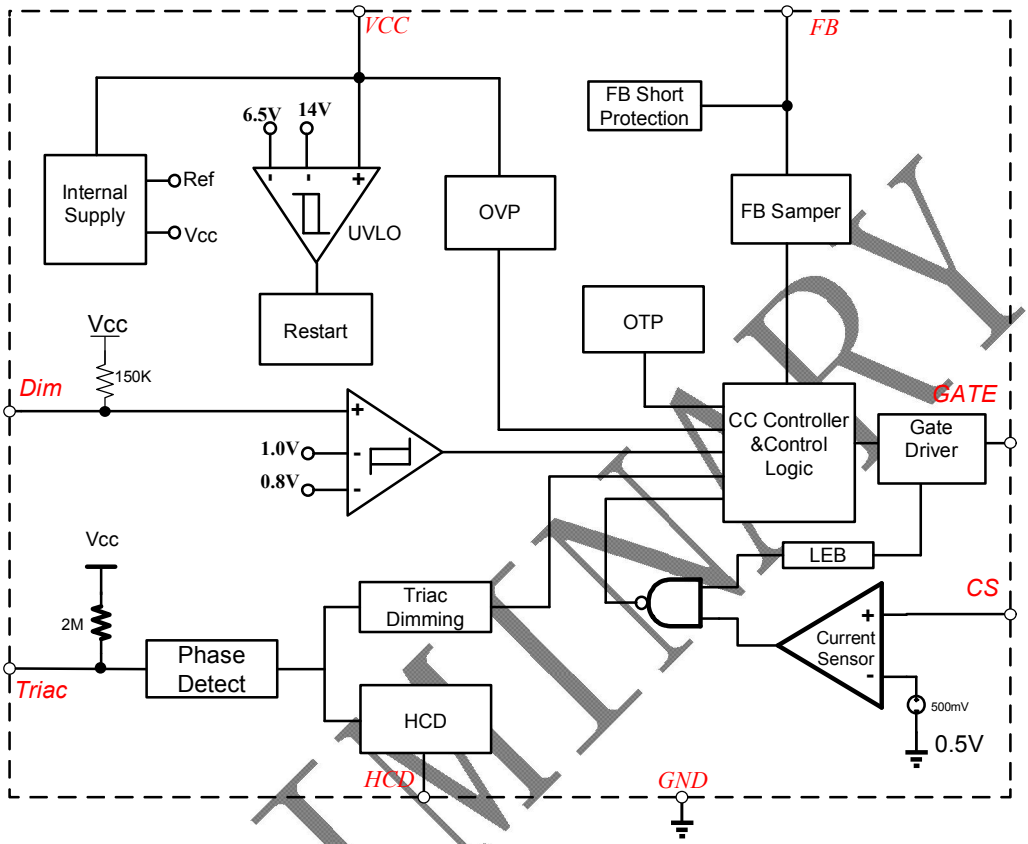


Figure 2 BP3108 block diagram

BP3108 is a high performance AC/DC controller with triac dimming specially designed for LED lighting. The patented triac dimming control and CC control method dramatically saves the system cost and size by eliminating all secondary feedback circuitry and loop control compensation circuitry. Few external components are required to achieve wide triac dimming range and good dimming effect without visible flicker.

1 Start up

The start-up current is designed to be low, only 25uA start-up current is required for the device. After the system is powered on, the Vcc capacitor is charged through the start-up resistor, once the Vcc voltage reaches the start-up threshold (14V typically), the chip start to operate. During normal operation, The Vcc is supplied via the auxiliary winding.

2 Constant current control

Cycle-by-Cycle current limiting is offered .The CS is connected to non-inverting inputs of the current sense comparator. The inverting terminal of comparator is tied to an internal 500mV reference. The comparator is constantly comparing the CS voltage to the internal 500mV.Once the output of comparator goes high, the GATE output goes low.

The primary peak current is given by:

$$I_P = 500(\text{mV}) / R_{CS}(mA)$$

The outputs of the comparators also include a typical 500ns（typ.） blanking time which prevents spurious

turn-offs of the external MOSFET due to the turn-on spike normally.

The LED current is decided by the internal constant current control, which is given by:

$$I_{OUT} = \frac{I_P}{4} \times \frac{N_P}{N_S}$$

Np is turns of transformer primary winding, Ns is turns of transformer secondary winding, Ip is the peak current of the primary side

3 Feedback network

The chip senses the output voltage and output current through the feedback network. The FB sense threshold is 1V. We recommend to set the feedback upper resistor to 300KΩ~750KΩ to improve system efficiency.

The FB upper resistor is also used to adjust the Vcs threshold to compensation the input voltage change. It is given by:

$$\Delta V_{CS} = -1.1 \times 10^6 * \frac{V_{AUX}}{R_{FBH}} (mV)$$

R_{FBH} is the upper resistor of the feedback network

4 Gate drive

The driver structure of BP3108 is optimized. Too strong drive current results in bad EMI while too weak driver cause big switch loss of power MOS. A good trade-off is achieved in the internal driver with suitable strength.

5 Operation switching frequency

The system work in DCM mode，the maximum duty cycle is 42%； Normally the system frequency is recommended to be set between 40KHz-48KHz to get better EMI result. The maximum operating frequency should be lower than 80KHz, while the minimum system frequency should be higher than 20KHz.The operation frequency is given by:

$$f = \frac{N_P{}^2 * V_{LED}}{8 * N_S{}^2 * L_P * I_{LED}}$$

Lp is inductance of primary winding.

The chip limits the maximum system frequency and the minimum system frequency to ensure the system stability.

6 Protection control

Good power supply system reliability is achieved with its rich protection features.

Once the Vcc voltage is higher than 16V (typ.), the device shut down the MOSFET and goes into auto-start mode until the over-voltage is removed. Another 19V clamp circuitry is offered to prevent the chip from damage on abnormal situation.

The thermal shutdown circuitry senses the die temperature. The threshold is set at 160℃ typical with a 30℃ hysteresis. When the die temperature rises above this threshold (160 ℃) the power MOSFET is disabled and remains disabled until the die temperature falls by 30 ℃, at which point the MOSFET is re-enabled.

Once LED short circuit or LED open circuit is detected, the system enters into low standby mode in which the system consumes very low power and the output status is monitored continuously. The chip goes back to normal operation automatically after the abnormal situation is removed.

7 Triac dimming

BP3108 integrates the triac dimming control circuit internally .The patented triac dimming control and phase detect technology is compatiable to most triac dimmer.

8 PCB Layout

The following rules should be followed in BP3108 PCB layout.

Bypass capacitor

The Vcc bypass capacitor should be as close to the Vcc pin as possible.

Current sense (CS) resistor

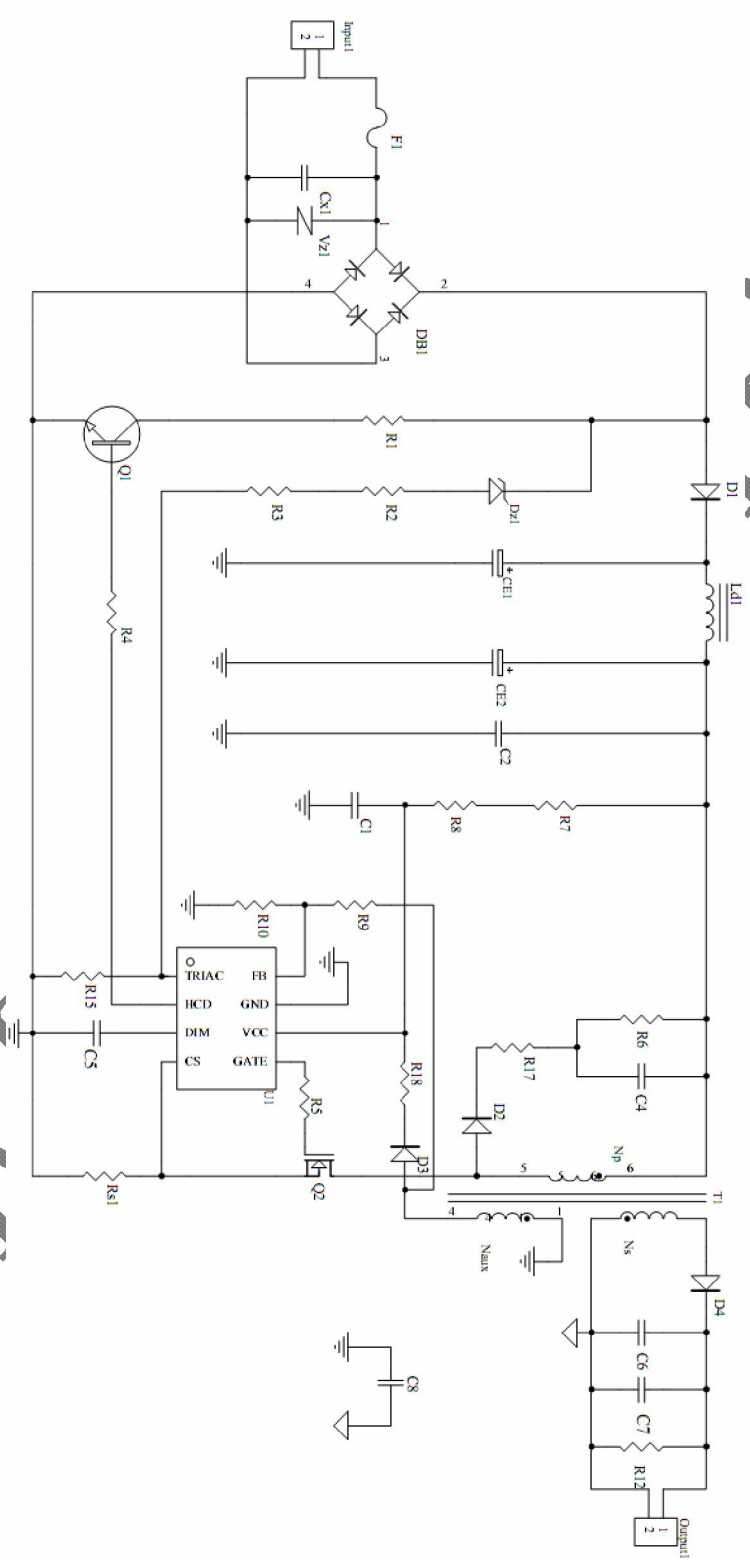
The CS resistor ground should be as close to the chip ground as possible to reduce the ground noise coupled, which improves the quality of the sensing signal.

Current path area

The area of current path should be as small as possible to reduce EMI radiation, such as the primary current loop from the primary inductor to the MOSFET and the secondary current loop from the secondary inductor to the output rectifier.

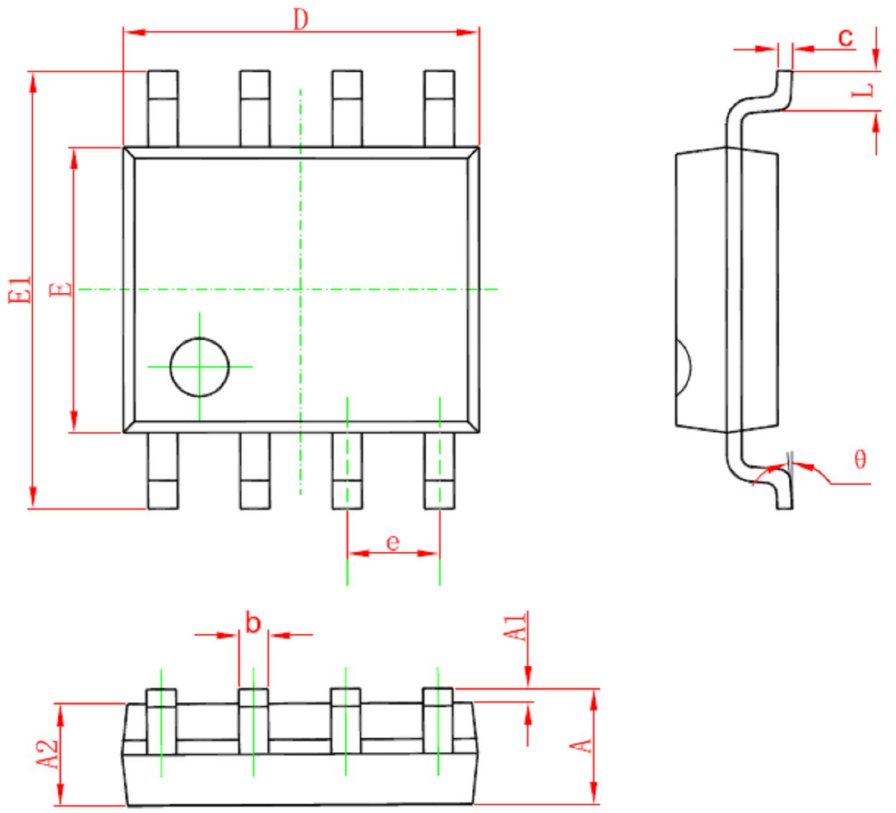
Application Example

Input voltage range：85V-264V with triac dimmin



Package Information

SOP8 PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270(BSC)		0.050(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°