BP3102

High Precision PSR Constant Current LED Driver

Description

The BP3102 is a high precision primary-side feedback and regulation controller for LED lighting, it operates in constant current control mode and is designed to work in inductor current discontinuous conduction mode and extremely suitable for flyback convertor under universal input, the output power of system should be less than 5W.

The BP3102 integrates 600V power MOSFET. Since adopting primary sense and feedback control technology, the secondary sense and feedback circuit is eliminated. The loop compensation components are also removed while maintaining stability overall operating conditions. The low component counts and low BOM cost are realized.

Since using the proprietary high accurate current sense method, the BP3102 realizes ±3% accuracy of LED current along with excellent line regulation and load regulation.

The BP3102 offers rich protection functions including LED short circuit protection, LED open circuit protection, die over-temperature protection, VCC over voltage protection, VCC under voltage protection and FB short circuit protection. All the protection features are auto-recovery.

Features

- Built-in 600V Power MOSFET
- Constant current control without secondary sense and feedback circuit.
- ±3% LED current accuracy
- Ultra low operating current to improve efficiency
- High resistance feedback resistor to improve efficiency
- Universal input voltage
- LED short and open circuit protection
- VCC under-voltage protection
- Feedback loop short circuit protection
- Current sense resistor open circuit protection
- Over temperature protection
- No external loop compensation component required
- Available in SOP-8 package

Applications

- GU10/E27 LED bulb, spot light
- Other LED lighting

Typical Application

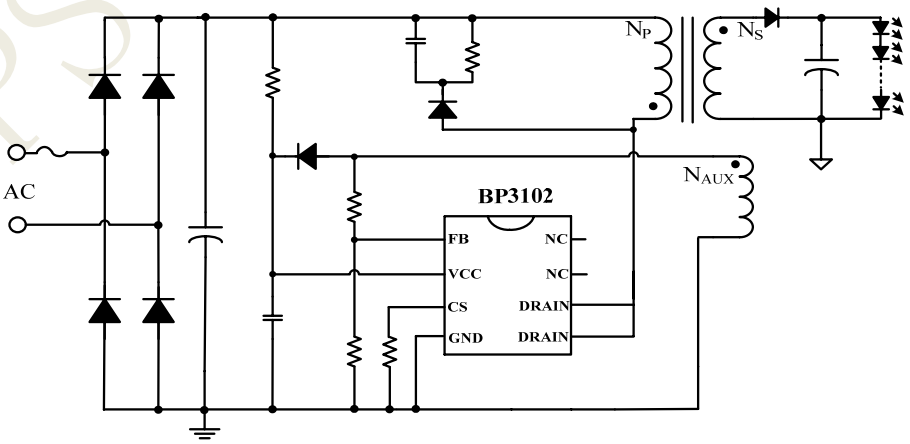


Figure 1. Typical application circuit for BP3102

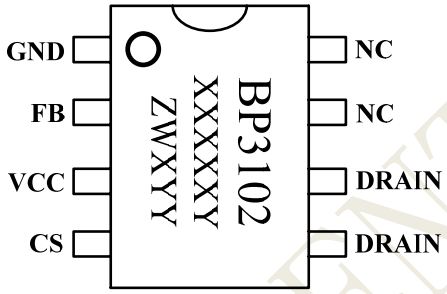
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Ordering Information

Part Number	Package	Operating Temperature	Package Method	Marking
BP3102	SOP8	-40℃ to 105℃	Tape 2,500 Piece/Roll	BP3102 XXXXXY ZWXYY

Pin Configuration and Marking Information



XXXXXY: lot code
Z: R（RoHS），G（GREEN)
W: Sign
X: Year
YY：Week

Figure 2. Pin configuration

Pin Definition

Pin No.	Name	Description
1	GND	Ground
2	FB	Feedback. This pin detects the output information from auxiliary winding.
3	VCC	Power supply
4	CS	Current sense. This pin connects a current sense resistor to GND to detect the primary current of transformer.
5,6	DRAIN	Internal high voltage MOSFET drain.
7,8	NC	No connection, must be floated

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Absolute Maximum Ratings (note1)

Symbol	Parameters	Range	Units
V_{CC}	VCC pin input voltage	-0.3~20	V
FB	Feedback pin input voltage	-0.3~6	V
Drain	Internal MOSFET drain voltage	-0.3~600	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	℃/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	7.5 ~14.5	V
P_{OUT1}	Output power (input voltage 230V±15%)	<5	W
P_{OUT2}	Output power (input voltage 85V～265V)	<4	W

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Electrical Characteristics(Notes 4,5) (Unless otherwise specified, V_{CC}=12V and T_A=25 ℃)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
Supply Voltage Section						
V_{CC-th}	Turn on threshold voltage	V_{CC} rising	13	14	15	V
V_{UVLO}	Turn of threshold voltage			6.5		V
V_{OVP}	VCC over voltage protection level			16		V
V_{CC_clamp}	Zener diode clamped voltage	I_{CC}=10mA		19		V
Current Sense Section						
V_{CS-th}	Threshold voltage for peak current limit		490	500	510	mV
T_{LEB}	Leading edge blanking time for current sense			500		nS
T_{DELAY}	Switch off debounce time			200		nS
Operation Current Section						
I_{ST}	Start up current	V_{CC}= V_{CC-th}- 1V		25	50	uA
I_{OP}	Operating current	F_{OP}=40kHz		1.5		mA
Feedback Section						
V_{FB}	FB voltage sense level			1		V
T_{Demag_Min}	Minimum demagnetization time			4		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	%
Over Temperature Protection						
T_{SD}	Thermal shutdown threshold			150		℃
T_{SD-HYS}	Thermal shutdown hysteresis			20		℃

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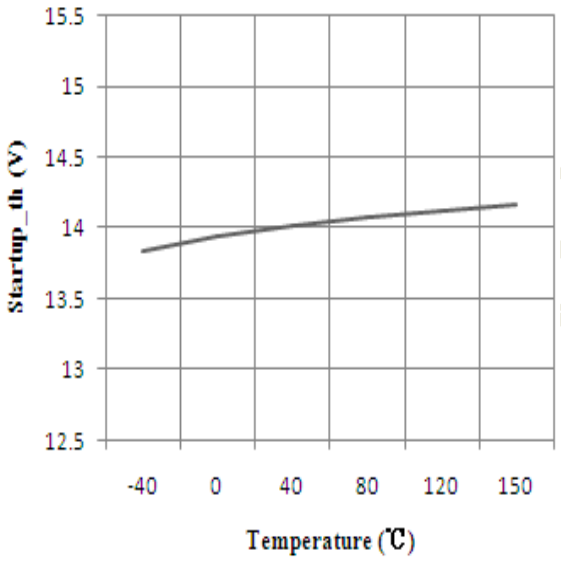
Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
MOSFET Section						
R_{DS_ON}	Static drain-source on-resistance	V_{GS}=10V/I_{DS}=0.5A		13		Ω
BV_{DSS}	Drain-source breakdown voltage	V_{GS}=0V/I_{DS}=250uA	600			V
I_{DSS}	Drain-source leakage current	V_{GS}=0V/V_{DS}=600V			200	nA

Note 4 : *production testing of the chip is performed at 25°C.*

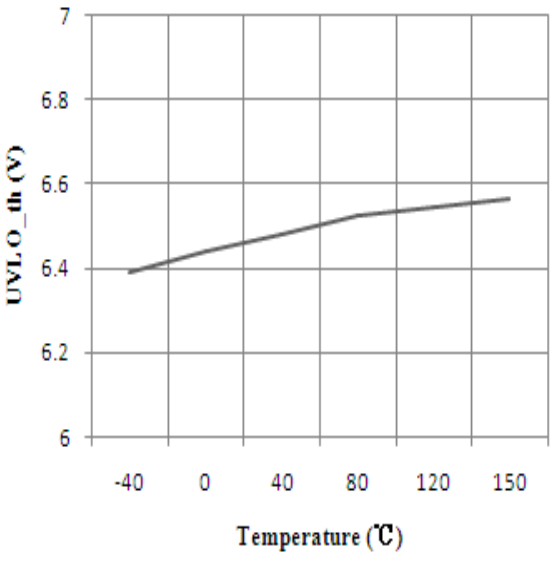
Note 5: *the maximum and minimum parameters specified are guaranteed by test, the typical value are guaranteed by design, characterization and statistical analysis*

Note 6: *refer to application information*

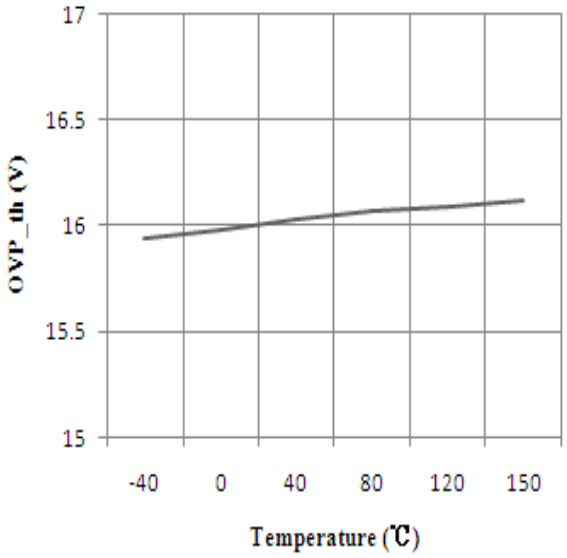
Typical Performance Characteristics



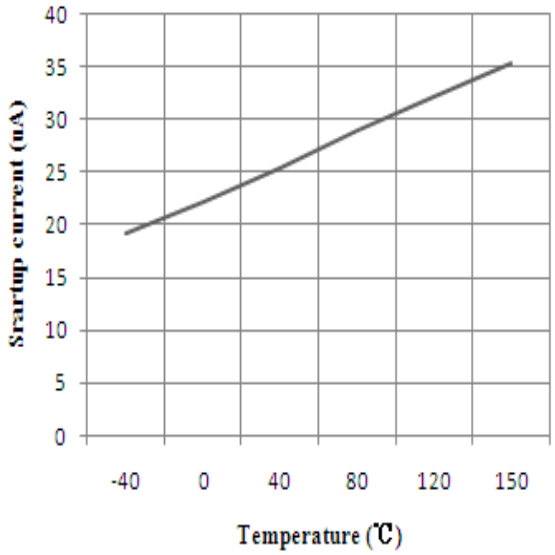
Turn on threshold VS. Temperature



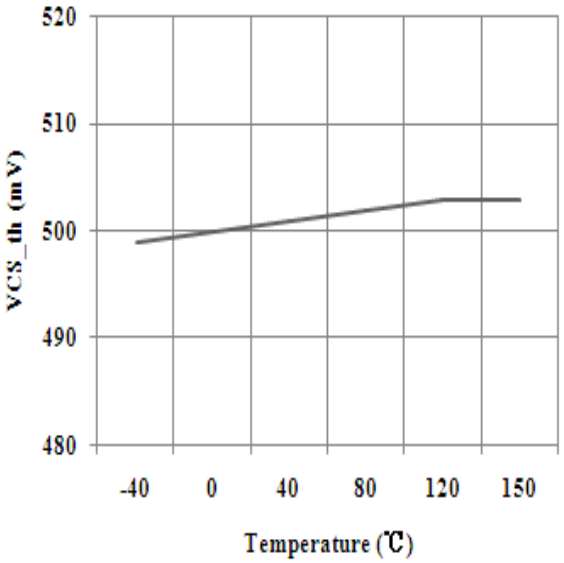
Turn off threshold VS. Temperature



OVP threshold VS. Temperature



start-up current VS. Temperature



VCS threshold VS Temperature

Internal Block Diagram

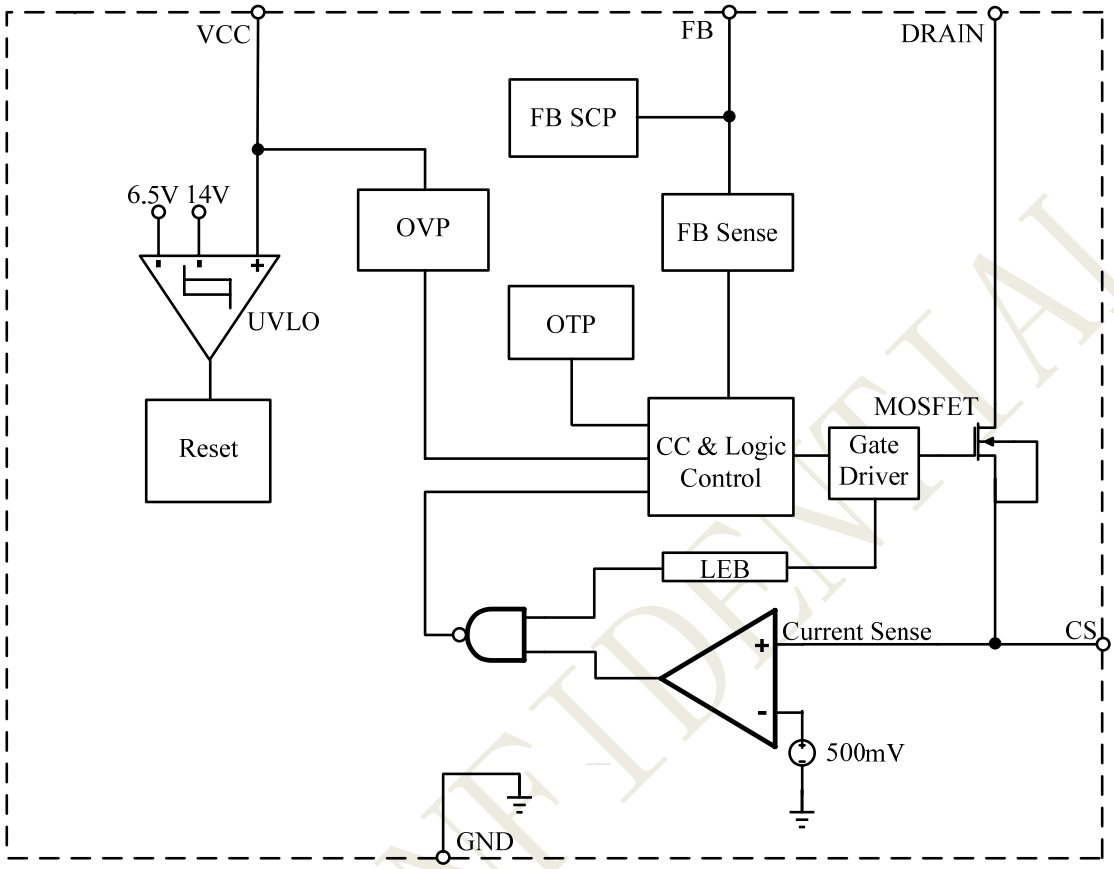


Figure 3. BP3102 Internal Block Diagram

Function Description

The BP3102 is a high performance power switch specially designed for LED lighting, it uses the patent constant current control technology of BPS. The BP3102 integrates a 600V power MOSFET. The accurate LED current can be realized without opto-coupler and TL431 feedback circuit while minimizing the external component count, lowering the total bill of material cost.

Start Up

The start-up current in BP3102 is designed to as low as 25uA. The V_{CC} capacitor will be charged through the start-up resistor when the system is powered on, once the voltage on V_{CC} reaches the start-up threshold, the BP3102 will start to operate, and then the V_{CC} is supplied by the auxiliary winding.

Constant Current Control

Cycle-by-Cycle current sense is offered in BP3102, the CS is connected to the current sense comparator, and the voltage on CS will be compared with the internal 500mV reference voltage, the MOSFET will be switched off when the voltage on CS reaches the threshold. The output of the comparator also includes a 500nS leading edge blanking time

The primary peak current is given by:

$$I_{P_PK} = \frac{500}{R_{CS}}(mA)$$

The current in LED can be calculated by the equation:

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

Where,

N_P: primary winding turns of transformer

N_S: secondary winding turns of transformer

I_{P_PK}: peak current in MOSFET

Feedback Network

The BP3102 senses the output information through the feedback network and the FB threshold voltage is set to 1V. The ratio of FB upper resistor to lower resistor is recommended to about 4.0. The FB upper resistor can be set to 300KΩ~750KΩ to improve efficiency of convertor.

The upper resistor on FB is also used for line compensation.

The ratio of line compensation can be calculated by the equation:

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

Where, R_{FBH} is the upper resistor of the feedback network.

Operation Switching Frequency

The BP3102 is designed to work in discontinuous conduction mode and no external loop compensation component is required while maintaining stability. The maximum duty cycle is limited to 42%. The maximum switching frequency should be set to less than 100KHz and the minimum switching frequency should be set to more than 20KHz. The maximum and minimum switching frequency is limited in BP3102 to ensure the stability of system.

The switching frequency can be set by the formula:

$$f = \frac{Np^2 \times V_{LED}}{8 \times Ns^2 \times Lp \times I_{LED}}$$

Where, LP is the primary winding inductance of transformer.

Protection Function

The BP3102 has several protection functions. The internal MOSFET will be shut down immediately when the voltage on V_{CC} reaches the threshold of OVP and the device will not recover until the protection condition is removed. A 19V zener diode is designed in the BP3102 to prevent the chip damage from the abnormal situation.

The thermal shutdown circuitry in the BP3102 senses the die temperature after start up, and the thermal protection threshold is set to 150℃ with a 20℃ hysteresis. When the temperature on die of BP3102 rises and reaches the threshold, the power MOSFET will be shut down immediately and maintained switch off until the temperature on die falls 20 ℃ from thermal protection trigger point.

The system will work in low consumption mode when the output LED short circuit or open circuit is detected, while the BP3102 continuous to detect output status until the LED recover to normal condition, and then the device will be operate in normal mode.

PCB Layout

The following rules should be followed in BP3102 PCB layout:

Bypass Capacitor

The bypass capacitor on V_{CC} should be as close as possible to the V_{CC} 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 the negative 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 primary current loop, the snubber circuit and the secondary rectifying loop.

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NC Pin

The NC pin must be left floating to satisfy the requirement of creepage distance.

Drain pin

To increase the copper area of drain for thermal consideration.

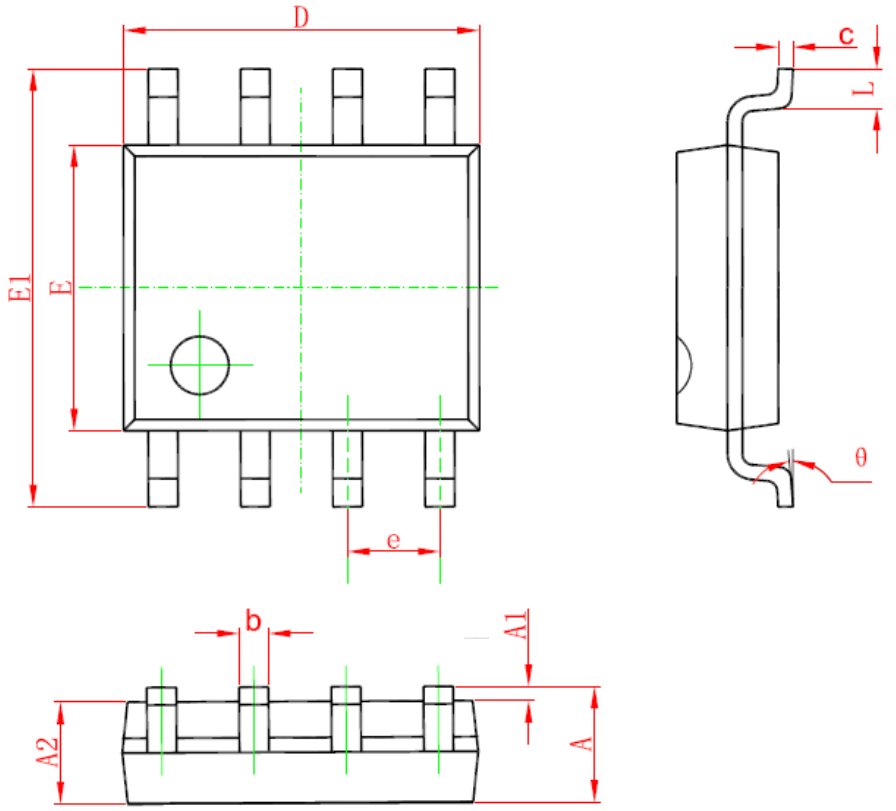
FB Pin

The feedback divider should be as close as possible to FB Pin and the node must keep away from dynamic node of transformer.

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Physical Dimensions

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°