BP3166XS

High Precision PSR Constant Current LED Driver

Description

The BP3166XS 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 especially suitable for flyback convertor under universal input of 85Vac~265Vac.

The BP3166XS integrates a power MOSFET, with patent pending MOSFET driving technique. It doesn't need the auxiliary winding for VCC supply. It can achieve excellent constant current performance with very few external components, so the system cost and size are minimized.

The BP3166XS offers rich protections to improve the system reliability, including LED short circuit protection, thermal regulation function.

Features

- No VCC capacitor and no starting resistance
- Integrated HV JFET for Power Supply
- No Auxiliary winding for sensing and supplying
- Universal input voltage
- ±5% LED Output Current Accuracy
- LED Short Protection
- LED Open Protection
- No flicker in parallel with several lamps
- Thermal regulation function
- Package：SOP7

Applications

- LED Bulb
- LED Candle Light
- Other LED Lighting

Typical Application

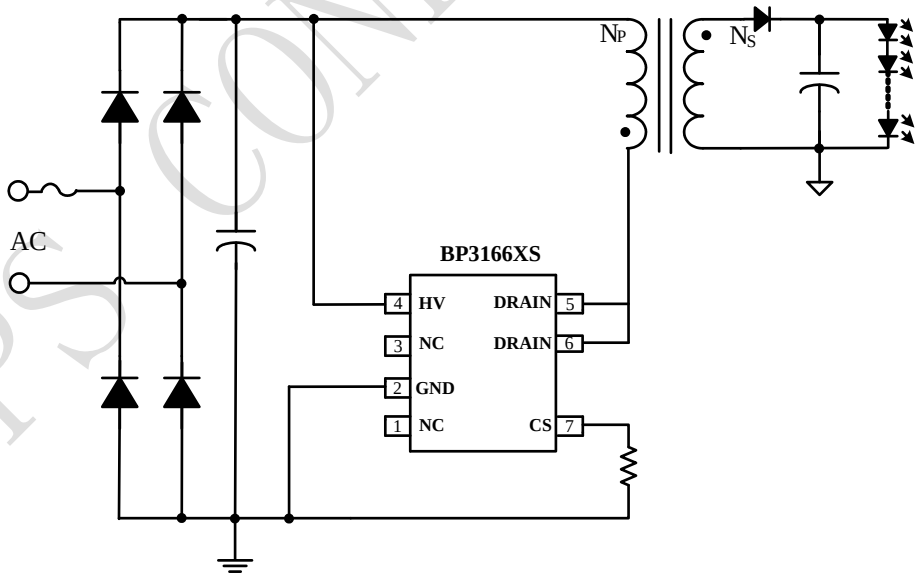
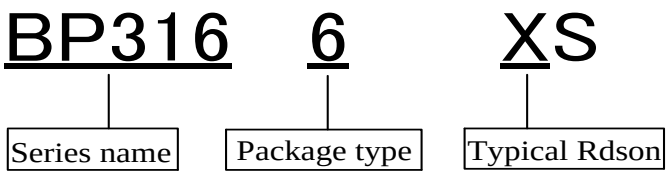


Figure 1. Typical application circuit for BP3166XS

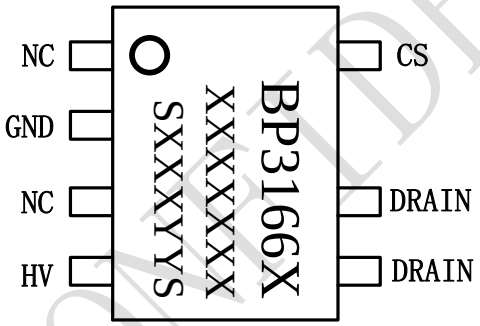
Naming rules



Ordering Information

Part Number	Package	Operating Temperature	Packing Method	Marking
BP3166XS	SOP7	-40℃ to 105℃	Tape 4,000 Piece/Reel	BP3166X XXXXXXX SXXXYYS

Pin Configuration and Marking Information



XXXXXXX: Lot code
SXXX: Sign
YY: Week

Figure 2. Pin configuration

Pin Definition

Pin Number	Name	Description
1	NC	No connection, must be floated
2	GND	Ground
3	NC	No connection, must be floated
4	HV	Internal high voltage JEFT
5, 6	DRAIN	Internal high voltage MOSFET Drain
7	CS	Current Sense Pin. Connect a sense resistor between this pin and GND.

Absolute Maximum Ratings (note1)

Symbol	Parameters	Range		Units
HV	high voltage power supply JFET	650		V
DRAIN	high voltage MOSFET Drain	AS	BS	V
		650	650	
I_{PK-MAX}	Maximum leakage current @ TJ=100℃	AS	BS	A
		0.25	0.45	
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		Units
No.		AS	BS	
P_{OUT} 1	Output power (input voltage 230V±15%)	< 5	< 7	W
P_{OUT} 2	Output power (input voltage 85V～265V)	< 3	< 5	W
F_{OP}	System operating frequency	65~70		kHz
V_{OR_MIN}	The output reflect to primary voltage	>24		V

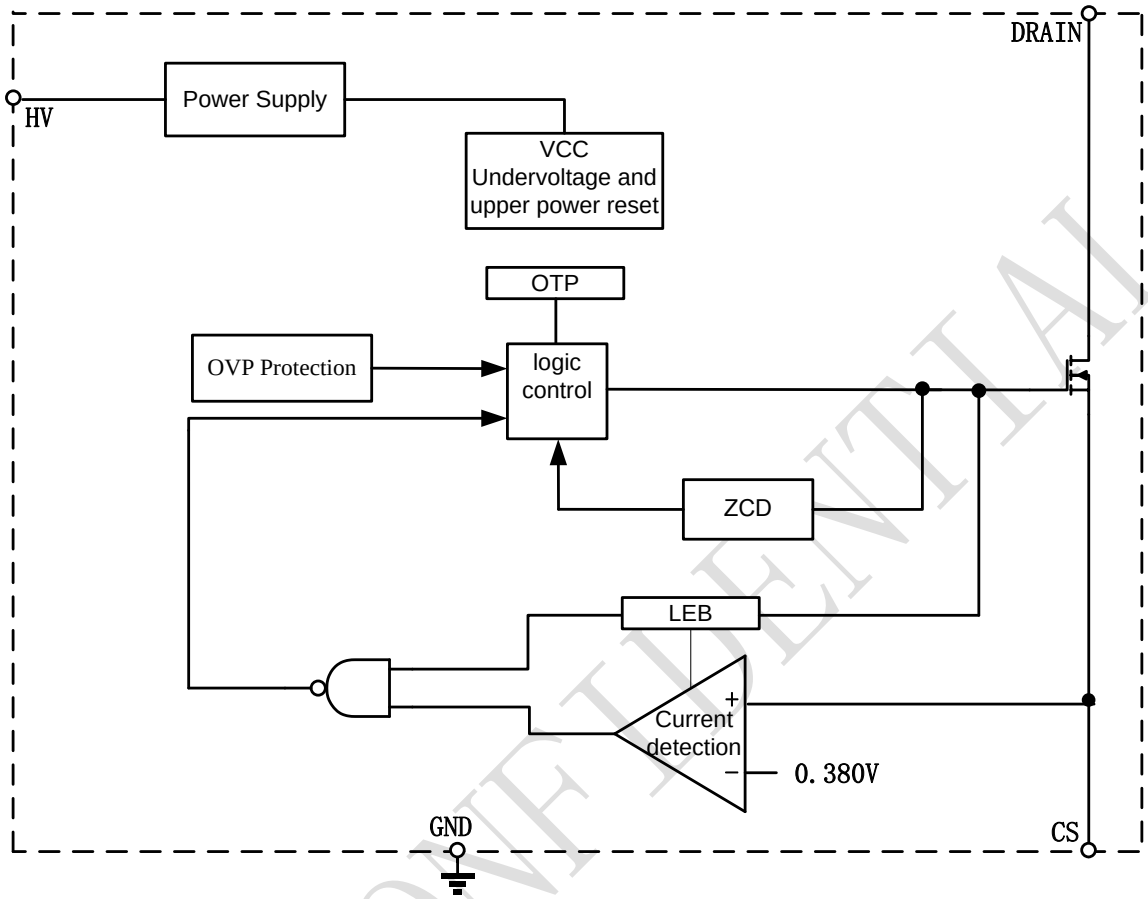
Electrical Characteristics (Notes 4, 5) (Unless otherwise specified, T_A=25 ℃)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units
Supply Voltage Section						
I_{cc}	V_{CC} operating current	Fop=3.3kHz		200		uA
Current Sense Section						
V_{CS_TH}	Threshold voltage for peak current limit		371	380	389	mV
T_{LEB}	Leading edge blanking time for current sense			500		ns
T_{DELAY}	Switch off delay time			200		ns
Internal time control						
T_{OFF_Min}	Minimum demagnetization time			3		us
T_{OFF_MAX}	Maximum demagnetization time			300		us
T_{OVP}	OVP resetting time			4.4		us
MOSFET Section						
AS R_{DS_ON}	Static drain-source on-resistance	V_{GS}=10V /IDS=0.1A		25		Ω
BS R_{DS_ON}				14		Ω
BV_{DSS}	Drain-source breakdown voltage	V_{GS}=0V /I_{DS}=250uA	AS / BS: 650			V
I_{DSS}	Drain-source leakage current	V_{GS}=0V /V_{DS}=650V, V_{DS}=600V	-1		1	uA
Over Temperature Protection						
T_{REG}	Thermal shutdown threshold	IC surface		140		℃

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



Application Information

The BP3166XS is a high precision primary-side feedback and regulation controller for LED lighting, The device integrates a power MOSFET. With very few external components, the converter achieves excellent constant current control. And it does not need auxiliary winding for powering the IC or voltage sensing, hence the system size and cost is greatly reduced.

Start Up

After system powered on, through the HV pin the internal power supply voltage reaches the startup threshold, the chip control circuit starts to work. When the chip is operating normally, the required operating current is still supplied through the internal JFET.

Constant Current Control

Cycle by Cycle current sense is adopted in BP3166XS, the CS pin is connected to the current sense comparator, and the voltage on CS pin is compared with the internal threshold reference voltage. The MOSFET will be switched off when the voltage on CS pin reaches the threshold. The CS comparator includes a 500ns leading edge blanking time.

The primary peak current is given by:

$$I_{P\_PK} = \frac{380}{R_{CS}} mA$$

The current in LED can be calculated by the equation:

$$I_{LED} = \frac{I_{P\_PK}}{4} \times \frac{N_P}{N_S}$$

Where,
N_P: Primary winding turns of transformer
N_S: Secondary winding turns of transformer
I_{P_PK}: Peak current in the MOSFET

Operating Switching Frequency

The BP3166XS 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 50%. The maximum frequency of the proposed setup is 65kHz~ 70kHz. If the frequency is set too high, it will affect the number of maximum series LED lamps. If set too low, the LED open circuit voltage will be too high.

The maximum and minimum switching frequency is limited in BP3166D 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, L_P is the primary winding inductance of transformer.

Protection function

The BP3166XS has multiple protection functions, including LED open/short protection, over temperature protection, etc.

When the LED opens, the system will trigger the overvoltage protection logic and lock the system to stop the switch. After 10ms, the system reset and begin to work again.

When LED short, the system works at 3.3kHz low frequency, so power consumption is very low.

The BP3166XS through the over-temperature adjustment circuit to detect the chip junction temperature, when the junction temperature exceeds 140 ℃, the chip into the over-temperature regulation state, gradually reduce the output current, thus controlling the output power and temperature, the chip temperature control at a certain value to improve System reliability.

Over Voltage Protection

IC default Tovp=4.4 us.

When the LED is open , 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:

$$Tovp \approx \frac{Lp \times Vcs}{Nps \times Rcs \times Vovp}$$

Where，
Lp is the inductance of primary inductor
Vcs is the CS pin turn off threshold (380mV)
Nps is the turn ratio between primary and secondary
Vovp is the open circuit protection voltage

PCB Layout

The following rules should be followed in BP3166XS PCB layout:

Ground Path

The power ground path for current sense should be short, and the power groundV 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.

NC Pin

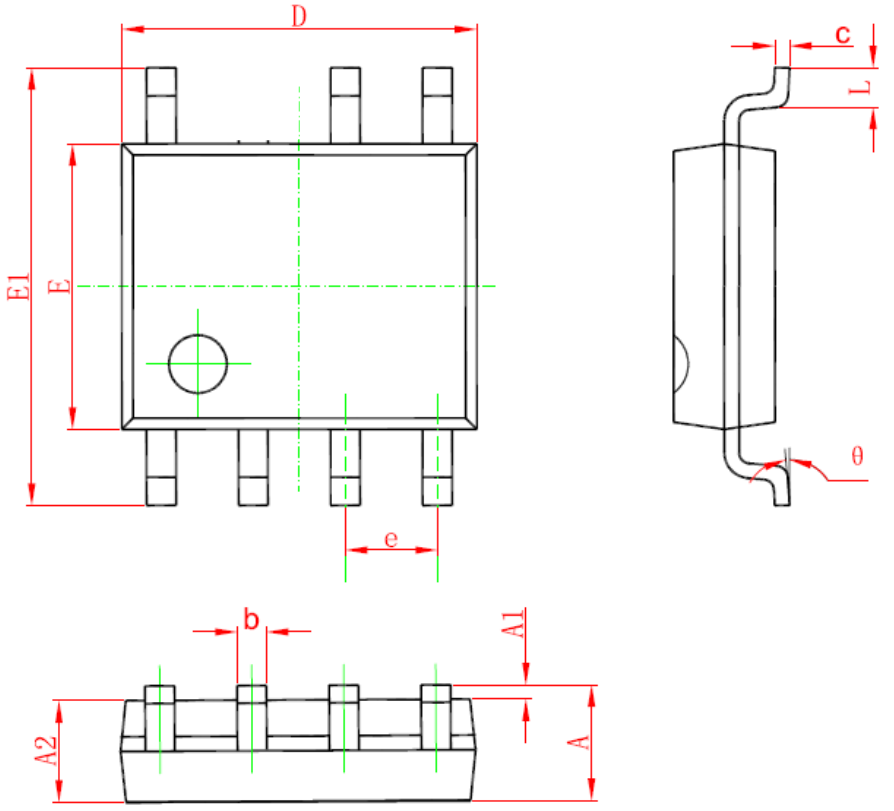
NC pin is for safety space.

Drain pin

To increase the copper area of drain for thermal consideration.

Physical Dimensions

SOP7 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°