晶丰明源半导体

BP9927E

Non-isolated Buck Offline LED Driver

Description

BP9927E is a high precision Buck constant current LED driver. The device operates in critical conduction mode and is suitable for 85Vac~265Vac universal input offline LED lighting.

The BP9927E integrates a 500V power MOSFET. With patent pending MOSFET driving technique, the operating current of the IC is as low as 140uA. 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.

BP9927E utilizes patent pending current control method. It can achieve precise output current and excellent line regulation. The driver operates in critical conduction mode, the output current does not change with the inductance and output voltage.

The BP9927E offers rich protections to improve the system reliability, including LED open circuit protection, LED short circuit protection, VCC under voltage protection and thermal regulation function.

Features

- Internal 500V Power MOSFET
- Integrated HV JFET for VCC Power Supply
- Critical Conduction Mode Operation
- Low Operating Current
- ±5% LED Output Current Accuracy
- LED Open Protection
- LED Short Protection
- VCC Under Voltage Protection
- Thermal Regulation Function
- Available in DIP8 Package

Applications

- LED Tube
- LED Ceiling Light
- LED Bulb
- Other LED Lighting

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Typical Application

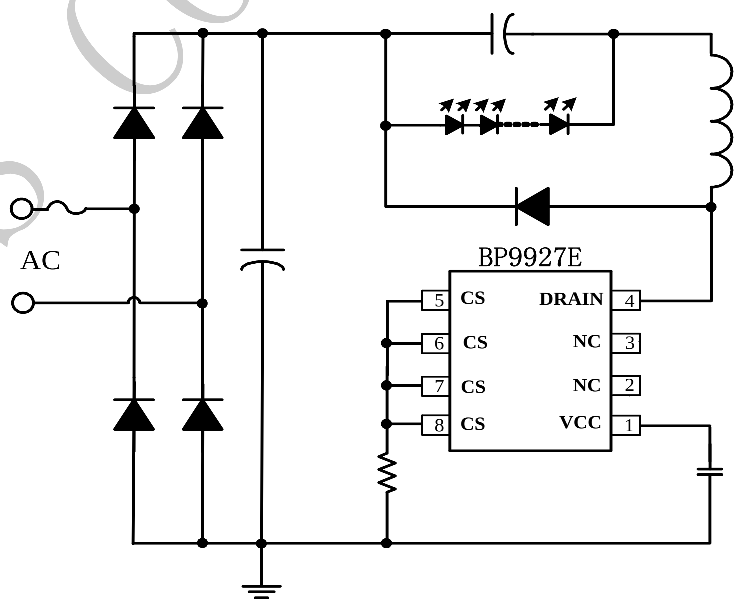

Figure 1. Typical application circuit for BP9927E

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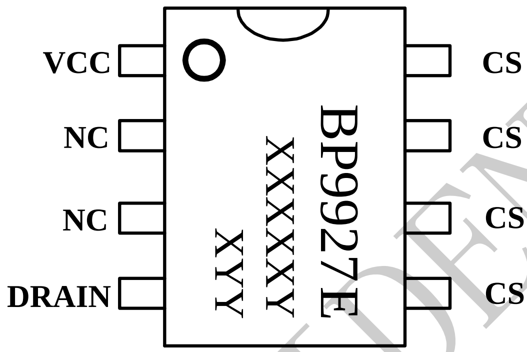
Ordering Information

Part Number	Package	Operating Temperature	Packing Method	Marking
BP9927E	DIP8	-40 ℃ to 105 ℃	Tube 50 Pcs/Tube	BP9927E XXXXXY XYY

Pin Configuration and Marking Information



XXXXXY: Lot Code
X: Year
YY: Week

Figure 2. Pin configuration

Pin Definition

Pin No.	Name	Description
1	VCC	Power Supply Pin.
2, 3	NC	No Connection
4	DRAIN	Internal HV Power MOSFET Drain.
5, 6, 7, 8	CS	IC GND Pin, also for Current Sense. Connect a sense resistor between this pin and power GND.

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Absolute Maximum Ratings (note1)

Symbol	Parameters	Range	Units
DRAIN	Internal HV MOSFET drain voltage	-0.3~500	V
I_{DMAX}	Maximum Drain Current@ T_J=100℃	900	mA
VCC	Power Supply voltage	-0.3~8.5	V
P_{DMAX}	Power dissipation (note 2)	0. 9	W
θ_{JA}	Thermal resistance (Junction to Ambient)	80	℃/W
T_J	Operating junction temperature	-40 to 150	℃
T_{STG}	Storage temperature range	-55 to 150	℃
	ESD (note 3)	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
$I_{LED\ max}$	Maximum Output LED current	350	mA
$V_{LED\ min}$	Minimum LED Loading Voltage	>10	V

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Electrical Characteristics (Notes 4, 5) (Unless otherwise specified, V_{CC}=7V and T_A=25 ℃)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
Supply Voltage Section						
V_{CC}	V_{CC} Operating Voltage	Drain=100V		7.3		V
V_{CC_ON}	V_{CC} Turn On Threshold	V_{CC} Rising		6.6		V
V_{CC_UVLO}	V_{CC} Turn off Threshold	V_{CC} Falling		5.7		V
I_{ST}	V_{CC} Startup Current	V_{CC}= $V_{CC\text{-}ON}$ - 1V		0.8	1.2	mA
I_{OP}	V_{CC} Operating Current			140	200	uA
Current Sense Section						
V_{CS_TH}	Threshold Voltage for Peak Current Limit		580	600	620	mV
T_{LEB}	Leading Edge Blanking Time for Current Sense			500		ns
T_{DELAY}	Switch Off Delay Time			200		ns
Internal Time Control Section						
T_{OVP}	Open circuit detection time			4.0		us
T_{OFF_MAX}	Maximum OFF Time			300		us
T_{ON_MAX}	Maximum On Time			40		us
MOSFET Section						
R_{DS_ON}	Static Drain-source On-resistance	V_{GS}=7V/I_{DS}=0.1A		6.2		Ω
BV_{DSS}	Drain-Source Breakdown Voltage	V_{GS}=0V/I_{DS}=250uA	500			V
Thermal Regulation Section						
T_{REG}	Thermal Regulation Temperature			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*

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Internal Block Diagram

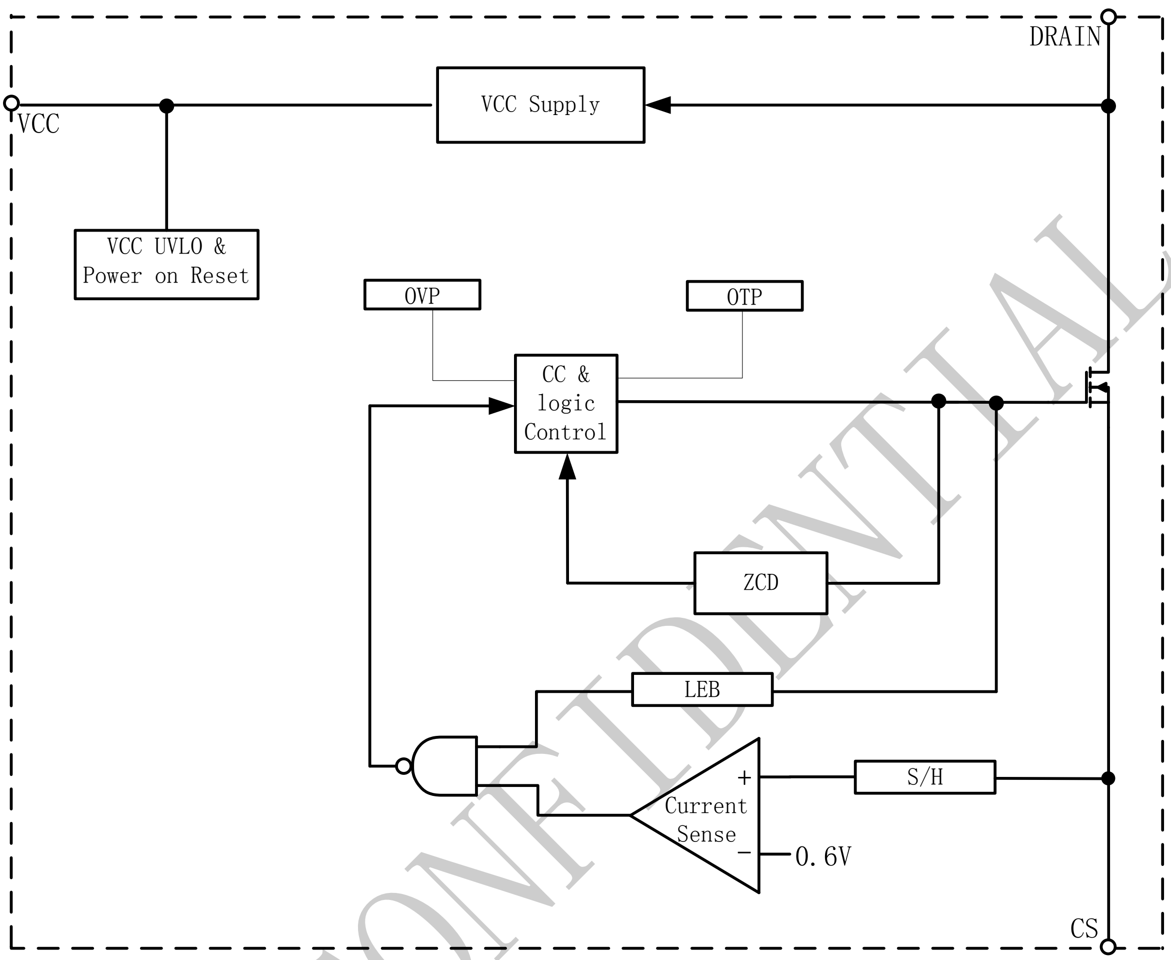

Figure 3. BP9927E Internal Block Diagram

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Application Information

The BP9927E is a high performance non-isolated Buck converter specially designed for LED lighting. The device integrates a 500V 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 up, the VCC pin capacitor is charged up by internal HV JEFT. When the VCC pin voltage reaches the turn on threshold, the internal circuits start operating. The HV JEFT will still supply operating current when the IC is working and keep the VCC voltage at 7.3V.

Constant Current Control

Cycle by Cycle current sense is adopted in BP9927E, the CS pin is connected to the current sense comparator, and the voltage on CS pin is compared with the internal 600mV 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 peak inductor current is given by:

$$I_{PK} = \frac{600}{R_{CS}}(mA)$$

Where, R_{CS} is the current sense resistor value.

The current in LED can be calculated by the equation:

$$I_{LED} = \frac{I_{PK}}{2}$$

Where, I_{PK} is the peak current of the inductor.

Inductor Selection

The BP9927E works under inductor current critical conduction mode. When the power MOFET is switched on, the current in the inductor rises up from zero, the on time of the MOSFET can be calculated by the equation:

$$t_{on} = \frac{L \times I_{PK}}{V_{IN} - V_{LED}}$$

Where,
L is the inductance value
V_{IN} is the DC bus voltage after the rectifier bridge
V_{LED} is the voltage on the LED

After the power MOSFET is switched off, the current in the inductor decreases. When the inductor current reaches zero, the power MOSFET is turned on again by IC internal logic. The off time of the MOSFET is given by:

$$t_{off} = \frac{L \times I_{PK}}{V_{LED}}$$

The inductance can be calculated by the equation:

$$L = \frac{V_{LED} \times (V_{IN} - V_{LED})}{f \times I_{PK} \times V_{IN}}$$

The f is the system switching frequency, which is proportional to the input voltage. So the minimum switching frequency is set at lowest input voltage, and the maximum switching frequency is set at highest input voltage.

The minimum and maximum off time of BP9927E is set at 4.0us and 300us, respectively. Referring to the equation of t_{OFF} calculation, if the inductance is too small, the t_{OFF} may be smaller than the minimum off time, system will trigger the OVP protection. If the inductance is too large, the t_{OFF} may be larger than the maximum off time, the system will operate in continuous conduction mode and the output current will be higher than the designed value. So it is important to choose a proper inductance.

Over Voltage Protection

When LED is open, gradually increase the output voltage, the demagnetization time becomes shorter, so we can set up the open circuit voltage protection through the demagnetization time,
the open circuit protection voltage V_{OVP} and the demagnetization time T_{OVP}:

$$V_{OVP} \approx \frac{L * V_{CS}}{R_{CS} * T_{OVP}}$$

T_{OVP}=4.0us。

Protection Function

The BP9927E offers rich protection functions to improve the system reliability, including LED open/short protection, V_{CC} under voltage protection, thermal regulation.

When the LED short circuit is detected, the system works at low frequency (3 kHz), so the system power consumption is very low.

Thermal Regulation

The BP9927E 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

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improved. The thermal regulation temperature is set to 140℃ internally.

PCB Layout

The following rules should be followed in BP9927E PCB layout:

Bypass Capacitor

The bypass capacitor on V_{CC} pin should be as close as possible to the V_{CC} Pin.

CS Resister

The CS resistor should be as close as possible to the CS pin, and makes the connection to the V_{CC} bypass capacitor as short as possible.

The Area of Power Loop

The area of main current loop should be as small as possible to reduce EMI radiation, such as the inductor, the power MOSFET, the output diode and the bus capacitor loop.

CS Pin

To increase the copper area of CS pin for better thermal dissipation.

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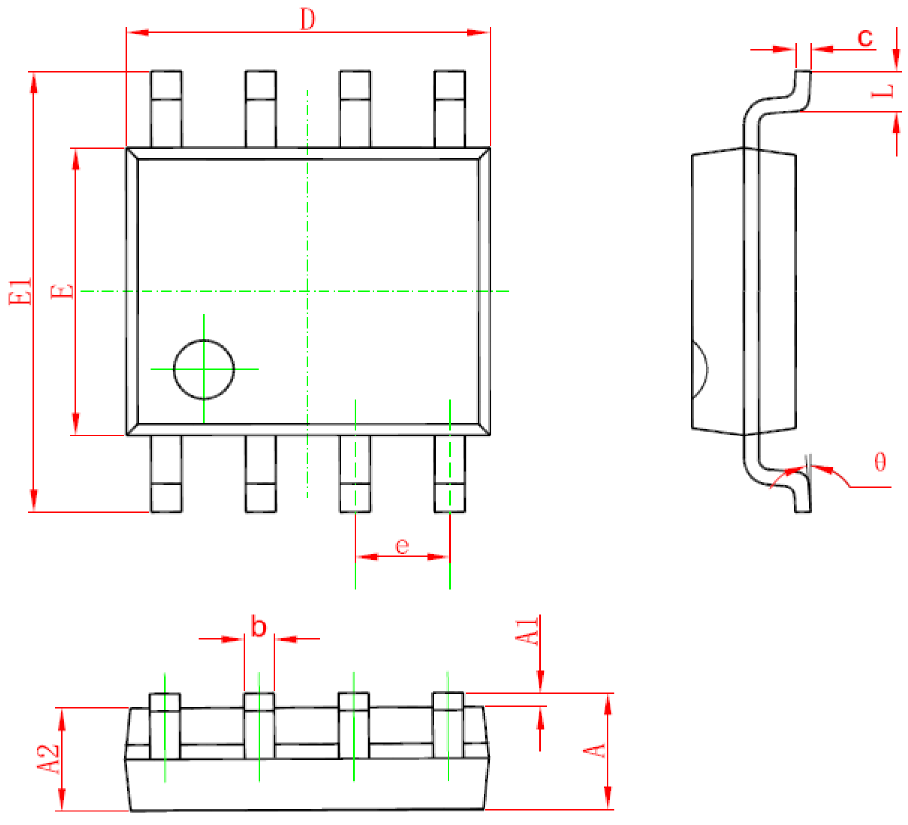
Physical Dimensions

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°