BP2525X

Low Standby Power Non-isolated CV Converter

Description

The BP2525X is an ultra-low standby power non-isolated buck converter for constant output voltage application. The device is suitable for 85Vac~265Vac universal input non-isolated auxiliary power supply.

The BP2525X integrates a high voltage power MOSFET. With the proprietary output voltage and current control technique, it can get excellent CV regulation. The chip integrates smart high voltage startup and power supply circuit, so the auxiliary winding can be eliminated.

The BP2525X utilizes PWM & PFM multiple mode control, and patent method powering VCC by 3.3V output voltage, which contribute to very low standby power, high efficiency, excellent dynamic response and minimized audible noise.

The BP2525X is available in SOT33-5A package.

Features

- Standby power <20mW at 120Vac and 230Vac
- Fixed 3.3V and 5V output voltage
- Support direct 3.3V output without LDO
- Minimized audible noise
- Internal High Voltage Power MOSFET
- Integrated HV startup
- Excellent dynamic response for smaller output voltage ripple
- ±5% output CV accuracy
- Integrated soft startup function
- SOT33-5A package

Protection Function

- Over load protection
- Output short protection
- Over temperature protection
- Cycle by cycle Current limitation

Applications

- Standby power supply for smart lighting
- Other auxiliary power applications

Typical Application

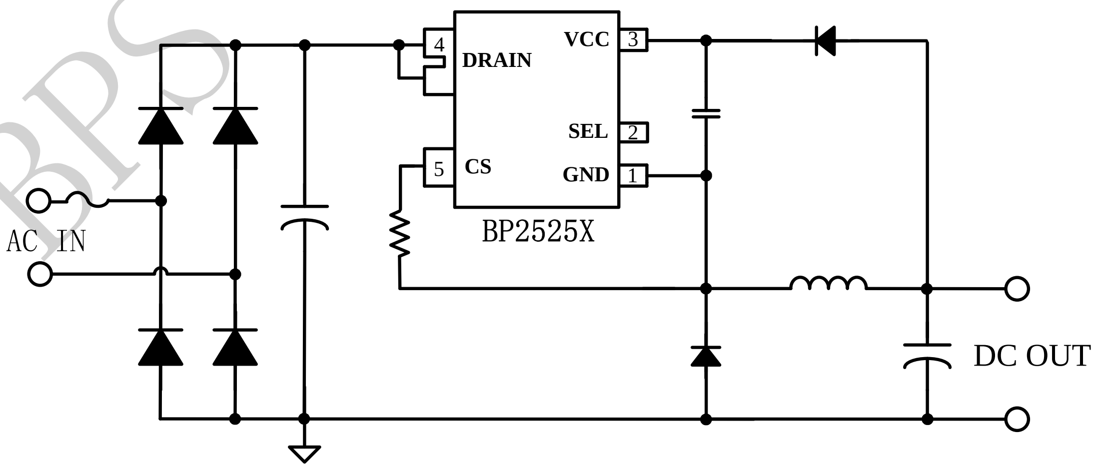
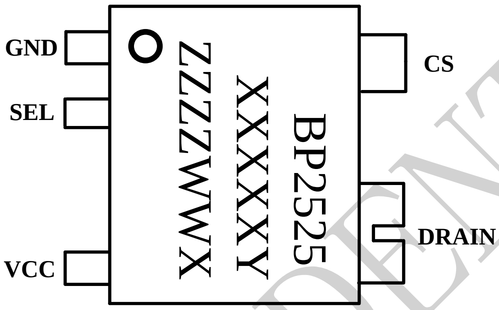


Figure 1. Typical application circuit for BP2525X

Ordering Information

Part Number	Package	Operating Temperature	Package Method	Marking
BP2525X	SOT33-5A	-40 ℃ to 105 ℃	Tape 7,500pcs/reel	BP2525 XXXXXY ZZZZWWX

Pin Configuration and Marking Information



XXXXXY: lot code
ZZZZ: Sign
WW: Week
X: MOSFET code

Figure 2. Pin configuration

Pin Definition

Pin No.	Name	Description
1	GND	Ground
2	SEL	Output voltage selection pin. To VCC: Vout= 3.3V; To GND Vout= 5V
3	VCC	Power supply pin
4	DRAIN	Drain of the integrated HV MOSFET
5	CS	Current Sense Pin. Connect a resistor to GND to sense the MOS current.

Absolute Maximum Ratings (note1)

Symbol	Parameters	Range	Units
V_{DS}(B D F)	Internal HV MOSFET drain to source voltage	-0.3~500	V
V_{DS}(CH)		-0.3~650	V
V_{cc}	Vcc voltage limitation	-0.3~7	V
I_{CC_MAX}	Vcc pin sink current limitation	10	mA
V_{CS}	CS pin voltage limitation	-0.3~6	V
V_{SEL}	SEL pin voltage limitation	-0.3~6	V
P_{DMAX}	Power dissipation (note 2)	0.4	W
θ_{JA}	Thermal resistance (Junction to Ambient)	155	℃/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*

Max Output Current Capability

Test condition：Input voltage 85Vac-265Vac *Pulse current last for <60S，Duty cycle<10%.

IC	Continuous current V_{OUT}=3.3V	Pulse current V_{OUT}=3.3V	Continuous current V_{OUT}=5V	Pulse current V_{OUT}=5V	MOSFET max peak current	Unit
BP2525B	200	300	200	300	500	mA
BP2525CH	280	450	280	450	650	mA
BP2525D	300	500	300	500	750	mA
BP2525F	500	700	500	700	1200	mA

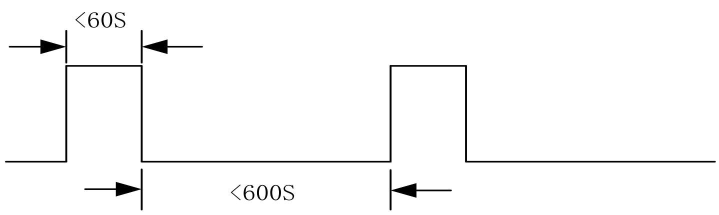


Figure 3. Pulse current waveform

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

Parameter	Symbol	Condition	Min	Typ	Max	units
Supply voltage						
V_{CC}	V_{CC} voltage	SEL= VCC	3.3	3.4	3.5	V
V_{CC}	V_{CC} voltage	SEL= GND	5.0	5.2	5.4	V
V_{CC_ON}	V_{CC} turn on voltage	Rising		3.5		V
V_{CC_OFF}	V_{CC} turn off voltage	Falling		2.8		V
V_{CC_HYS}	V_{CC} voltage Hysteresis			0.7		V
V_{CC_CHRG}	JFET Charge on voltage	V_{CC} Falling		2.9		V
V_{CLAMP}	V_{CC} Clamp voltage	I_{CLAMP}=2mA		6		V
V_{CC_OLP}	V_{CC} Over Load Protection voltage	Falling/Vout=3.3V		3.0		V
		Falling/Vout=5V		3.5		V
I_{OP}	V_{CC} Operating Current	Drain=40V		200	300	uA
I_{CC_START}	V_{CC} Startup Current	Drain=40V		2		mA
Oscillator						
F_{SW_MAX}	Maximum switching Frequency	Center Frequency	30	35	40	kHz
DC_{MAX}	Maximum duty cycle			64		%
Current Sensing						
V_{CS_TH}	Current Sense Threshold			200		mV
T_{LEB}	Lead Edge Blanking time			250		ns
T_{ILD}	Switch Off Delay time			100		ns
Power MOSFET						
B R_{DS_ON}	On-State Resistance	V_{OUT}=3.3V I_{DS} =50mA		17	21	Ω
CH R_{DS_ON}				16	19	Ω
D R_{DS_ON}				9	11	Ω
F R_{DS_ON}				5.6	7	Ω
I_{DSS}	Off-State Drain leakage current, including JFET Off-State leakage current	V_{CC}=5V, V_{DS}=500V			30	uA
B D F BV_{DSS}	Drain-Source Breakdown Voltage	V_{GS}=0V, Ids=250uA	500			V
CH BV_{DSS}			650			V
V_{DS_SUP}	Drain supply voltage		24			V
Thermal Shutdown						
T_{SD}	Thermal shutdown temperature			155		℃
T_{SD_HYS}	Thermal shutdown Hysteresis			40		℃

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*

Internal Block Diagram

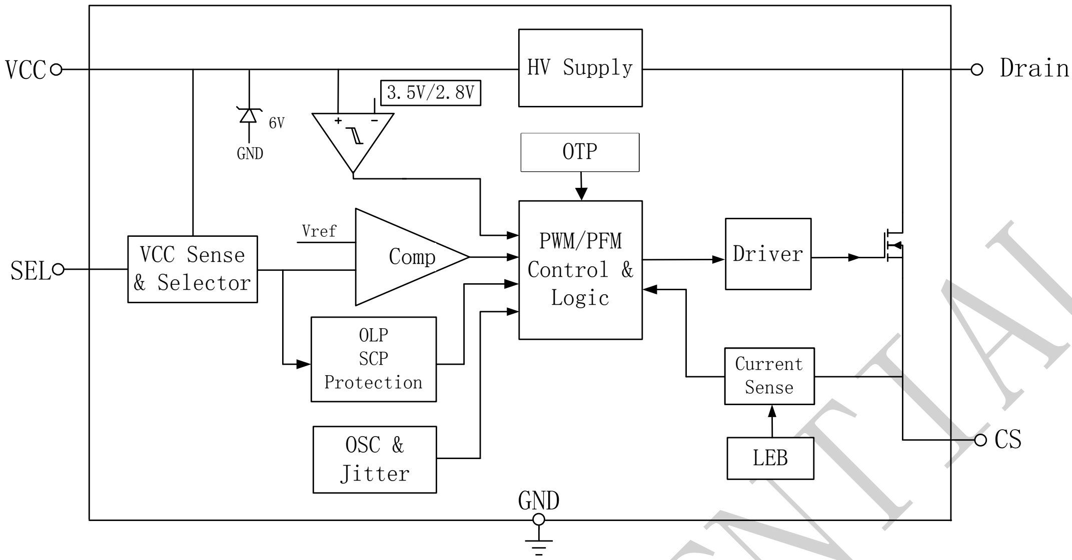


Figure 4. BP2525X Internal Block Diagram

Application Information

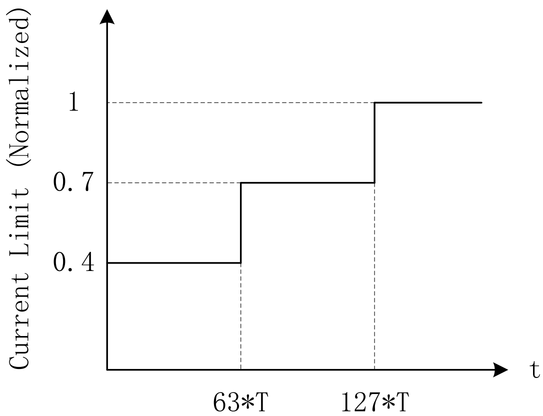
The BP2525X is an ultra-low standby power non-isolated Buck converter for CV application, The BP2525X works in multiple control mode providing high accurate constant voltage control. The device integrates a High Voltage power MOSFET and HV startup, so the BOM of the application is very simple. It is suitable for small auxiliary power application.

Start Up

After system is powered on, the VCC capacitor is charged up by the internal HV startup circuit directly. When the VCC pin voltage reaches the turn on threshold, the internal circuits start operating. The BP2525X integrates a 6V Zener diode inside to clamp the VCC voltage. At normal operation, the VCC is powered directly from output voltage, even the output is as low as 3.3V. So the standby power is very low, and the auxiliary winding is not needed to supply the IC.

Soft-Start

The BP2525X integrates a soft-start function. During the soft-start mode, the peak current of the power MOSFET increases to I_limit step by step, which can decrease the stress of switching MOSFET, and the soft-start function occurs at each startup period.



Inductor selection

BP2525X can work in kinds of modes such as Continuous Conduction Mode (CCM) or Discontinuous Conduction Mode (DCM), some parameters of inductor should be considered such as inductance, peak current, and average current. It is determined finally by the price, the size, and the system efficiency. Normally, choosing the smaller inductance can achieve better price, smaller size, and better dynamic response. However, it will cause larger peak current and lower system efficiency. Oppositely, larger inductance can cause higher system efficiency, smaller output ripple and worse dynamic response, it also needs larger size inductor. As overall consideration, suggesting to use CCM mode for this case , using the current ripple coefficient r no less than 25%, due to input and output voltage, system frequency, full load current, and ΔI_L, The inductance can be calculated as:

$$L = \frac{V_{out} \times (V_{IN} - V_{out})}{V_{IN} \times F \times \Delta I_L}$$

Where, $\Delta I_L = I_{out} * r$

Peak Current

According to current ripple coefficient r, peak current can be calculated as:

$$I_{L\_PEAK} = I_{O\_MAX} + \frac{\Delta I_L}{2}$$

$$I_{L\_VALLY} = I_{O\_MAX} - \frac{\Delta I_L}{2}$$

Where, I_{L_peak} is the peak current of the inductor. The max load current is also calculated by I_limit.

Sense Resistor Selection

BP2525X can setting the peak induction current by sense resistor. Different MOSFET has different peak current limitation. The value of R_{CS} also needs to consider the load current and its ripple, and leave some margin.

The R_{CS} can be calculated by:

$$R_{CS} = \frac{220\ (mV)}{I_{limit}\ (mA)}$$

Please note the CS voltage limit is a little higher than 200mV threshold due to the comparator delay.

Bulk CAP

The Bulk cap is used as a filter. As the input current is discontinuous, it needs Bulk cap to absorb the input AC current and provide a stable input voltage. Meanwhile, the bulk cap needs to sustain enough current ripple. The RMS of input current is calculated as:

$$I_{IN\_RMS} = I_{O\_MAX} \times \sqrt{D \times (1 - D)}$$

$$D = \frac{V_{OUT}}{V_{IN}}$$

To decrease the input noise, suggesting that the input Bulk cap uses low ESR electrolytic cap.

Output CAP

Output cap is used as a filter for output voltage, it also supplies current to the output load. If the output current is stable, the output ripple is mainly caused by the ESR and capacitance:

$$V_{RIPPLE} = V_{RIPPLE\_ESR} + V_{RIPPLE\_C}$$

When the output cap is used with ceramic cap, the output ripple is mainly caused by capacitance. Ignoring ESR, the output ripple calculation can be simplified as:

$$V_{RIPPLE\_C} = \frac{\Delta I_L}{8 \times C_{OUT} \times fsw}$$

When the output cap is used with Tantalum cap or electrolytic cap, the output ripple is mainly caused by ESR. The output ripple calculation can be simplified as:

$$V_{RIPPLE\_ESR} = \Delta I_L \times ESR$$

CV LOOP

The BP2525X sets the output voltage to 3.3V or 5V by connecting SEL pin to VCC or GND. The IC controls the output voltage by sensing the VCC voltage, the sense resistors are fixed internal the IC.

$$V_{OUT}=V_{CC}+ Vdiode\_VCC- Vdiode\_Flywheel$$

If need to adjust the output voltage, we can series a diode or Zener with the VCC diode.

Multiple Mode Control

The BP2525X utilizes multiple mode control of PWM & PFM, which contribute to high efficiency at light load and full load, speedup the dynamic response and minimize audible noise.

Over-load and Short-circuit protection

In the event of a fault condition such as output overload, output short-circuit, the BP2525X enters into auto-restart operation. When the VCC voltage is lower than the setting threshold over about 160ms, the over-load/short protection occurs. During the protection station, the internal oscillator counts a 1.6S fixed time, if the error is removed, the system will work normally again; If not, the fault mode keeps on.

Other protection function

BP2525X also integrates several other protection functions, such as over temperature protection and cycle by cycle current limitation.

PCB Layout Guide

The following rules should be followed in BP2525X PCB layout:

Bypass Capacitor

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

GND pin

Keep connection between GND pin and inductor as short and wide as possible.

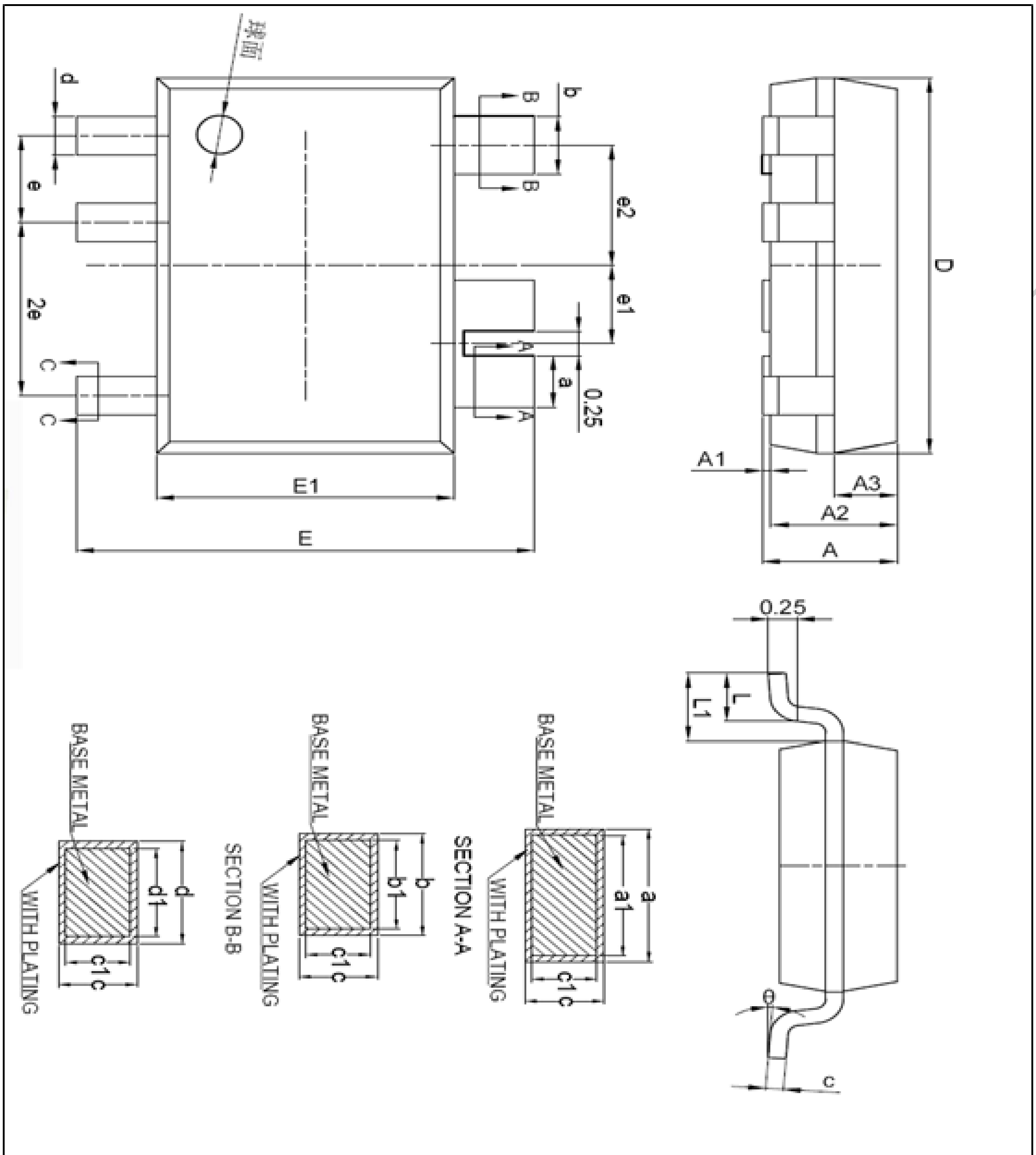
The Area of Power Loop

The area of main current loop should be as small as possible to reduce EMI radiation, such as the bus capacitor, the IC Drain, Rcs and GND, the inductor and the output cap loop; And the inductor, the output cap and the output diode loop.

DRAIN Pin

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

Physical Dimensions



SYMBOL	MILLIMETER MIN	MILLIMETER NOM	MILLIMETER MAX
A	—	—	1.30
A1	0.05	—	0.15
A2	1.05	1.10	1.15
A3	0.50	0.55	0.65
a	0.52	—	0.60
a1	0.51	0.54	0.57
b	0.58	—	0.66
b1	0.57	0.60	0.63
c	0.15	—	0.19
c1	0.14	0.15	0.16
d	0.38	—	0.46
d1	0.37	0.40	0.43
D	3.80	3.90	4.00
E1	2.50	2.60	2.70
E	3.80	4.00	4.20
e		0.90BSC	
e1		0.81 BSC	
e2		1.25 BSC	
L	0.40	0.50	0.60
L1		0.70REF.	
θ	0	—	8°