

### GENERAL DESCRIPTION

OB2511x is a high performance offline PSR power switch for low power AC/DC charger and adapter applications. It operates in primary-side sensing and regulation. Consequently, opto-coupler and TL431 could be eliminated. Proprietary Constant Voltage (CV) and Constant Current (CC) control is integrated as shown in the figure below.

In CC control, the current and output power setting can be adjusted externally by the sense resistor  $R_s$  at CS pin. In CV control, multi-mode operations are utilized to achieve high performance and high efficiency. In addition, good load regulation is achieved by the built-in cable drop compensation. Device operates in PFM in CC mode as well at large load condition and it operates in PWM with frequency reduction at light/medium load. The chip consumes very low operation current, it can achieve less than 75mW standby power.

OB2511x offers comprehensive protection coverage with auto-recovery features including Cycle-by-Cycle current limiting, VDD over voltage protection, short circuit protection, built-in leading edge blanking, VDD under voltage lockout (UVLO), OTP etc.

OB2511x is offered in CDFN8-7 package.

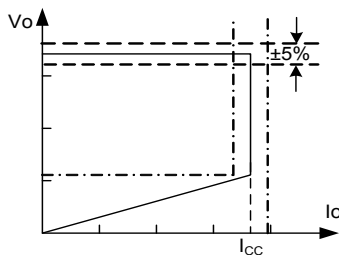


Fig.1. Typical CC/CV Curve

### FEATURES

- Primary-side sensing and regulation without TL431 and opto-coupler
- High precision constant voltage and current regulation at universal AC input
- Multi-mode PWM/PFM operation for efficiency improving
- Good dynamic response
- Programmable CV and CC regulation
- Built-in line voltage and primary winding inductance compensation
- Programmable cable drop compensation
- No need for control loop compensation
- Audio noise free operation
- Internal BJT switch
- Built-in leading edge blanking (LEB)
- Comprehensive protection coverage with auto-recovery
  - VDD over voltage protection
  - VDD under voltage lockout with hysteresis (UVLO)
  - Cycle-by-cycle current limiting
  - Feedback loop open protection
  - Output short circuit protection
  - Over temperature protection (OTP)

### APPLICATIONS

Low Power AC/DC offline SMPS for

- Cell Phone Charger
- Digital Cameras Charger
- Small Power Adapter
- Auxiliary Power for PC, TV etc.
- Linear Regulator/RCC Replacement

### TYPICAL APPLICATION

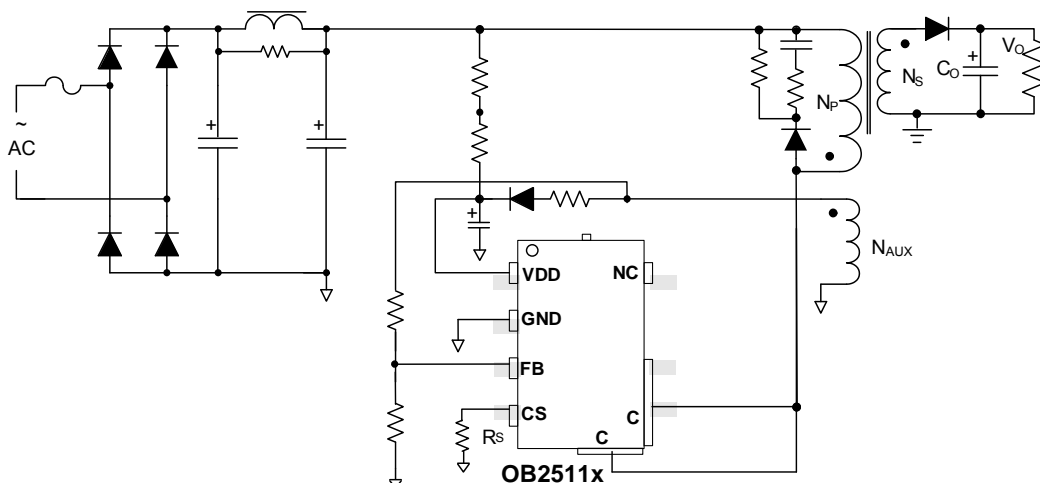
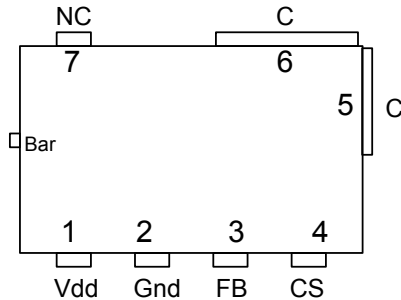


Fig. 2. Application Sch.

### GENERAL INFORMATION

#### Pin Configuration



#### Absolute Maximum Ratings

Parameter	Value
OB2511x CB Voltage	800V
VDD Voltage	-0.3 to 20V
FB Input Voltage	-0.3 to 7V
CS Input Voltage	-0.3 to 7V
Min/Max Operating Junction Temperature T <sub>J</sub>	-40 to 150 °C
Operating Temperature T <sub>A</sub> Ambient	-20 to 85 °C
Min/Max Storage Temperature T <sub>stg</sub>	-55 to 150 °C
Lead Temperature (Soldering, 10secs)	260 °C

**Note:** Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute maximum-rated conditions for extended periods may affect device reliability.

#### Ordering Information

Part Number	Description
OB2511xWUP	CDFN8-7 Halogen-free, Tube
OB2511xWUPA	CDFN8-7, Halogen-free, T&R

#### Package Dissipation Rating

Package	R <sub>θJA</sub> (°C/W)
CDFN8-7	140

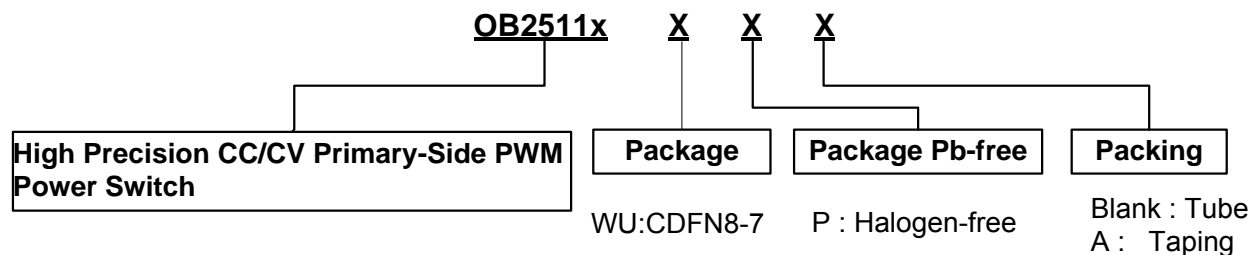
#### Recommended Operating Condition

Symbol	Parameter	Range
VDD	VDD Supply Voltage	5 to 16V

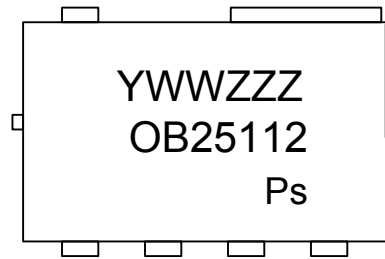
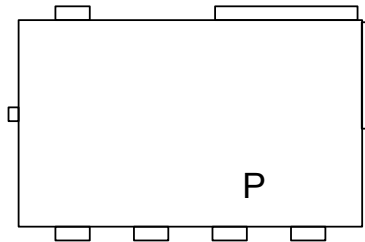
#### Recommended Output power Table

Product	Adapter <sup>Note1</sup>
	90V~264V
OB25111	2.5W
OB25112	3.5W
OB25113	5.0W
OB25114	7.5W

**Notes:** 1. Maximum practical continuous power in an adapter design with sufficient drain pattern as a heat sink, at 40°C ambient

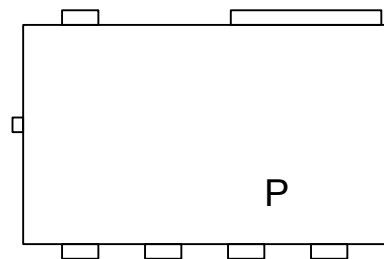
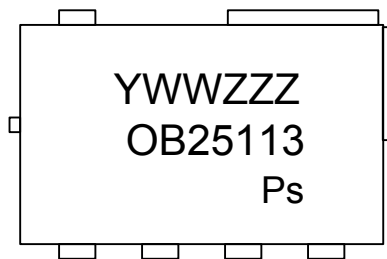


## Marking Information



Y  
W  
Z  
P  
S

Y:Year Code  
WW:Week Code(01-52)  
ZZZ:Lot Code  
P:Halogen-free Package  
S:Internal Code(Optional)



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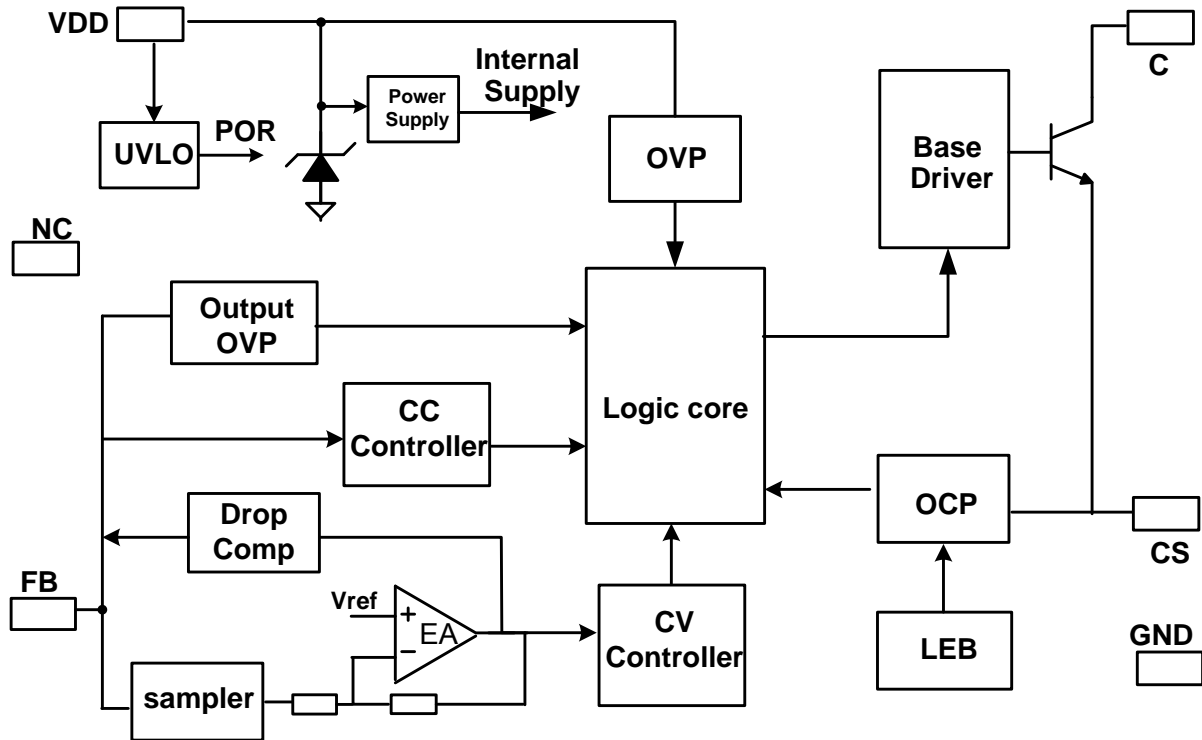
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## TERMINAL ASSIGNMENTS

Pin Num	Pin Name	I/O	Description
1	VDD	P	Power Supply
2	GND	P	Ground
3	FB	I	The voltage feedback from auxiliary winding. Connected to resistor divider from auxiliary winding reflecting output voltage.
4	CS	I	Current sense input
5、6	C	P	HV BJT collector pin.
7	NC		

Note: The bar mustn't be connected and keep 1.5mm distance from high voltage copper & traces

**BLOCK DIAGRAM**



### ELECTRICAL CHARACTERISTICS

(TA = 25°C, VDD=15V, if not otherwise noted)

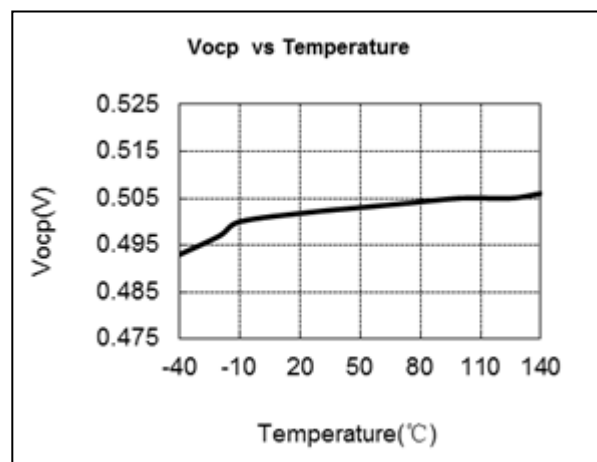
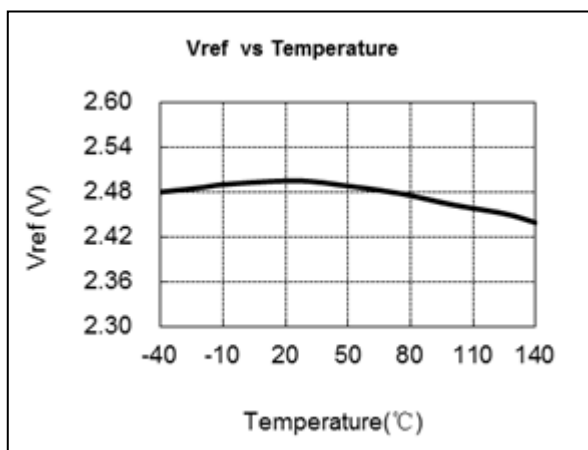
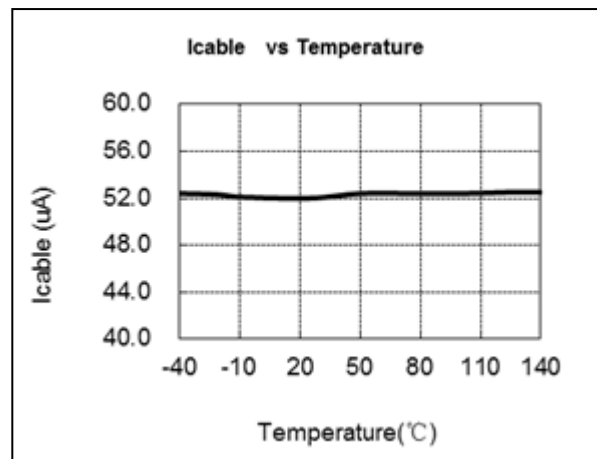
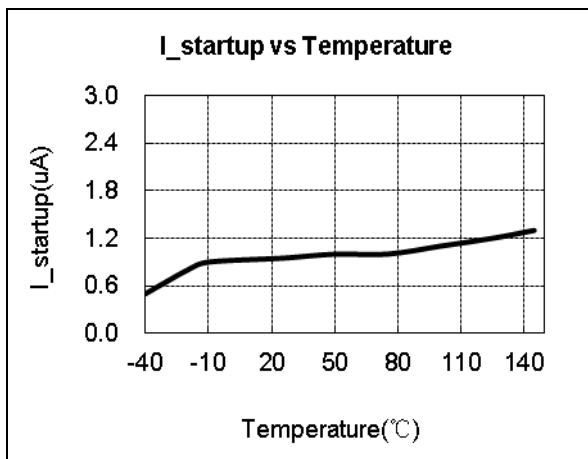
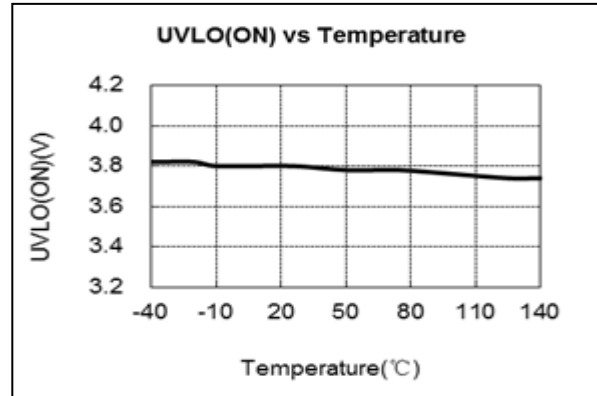
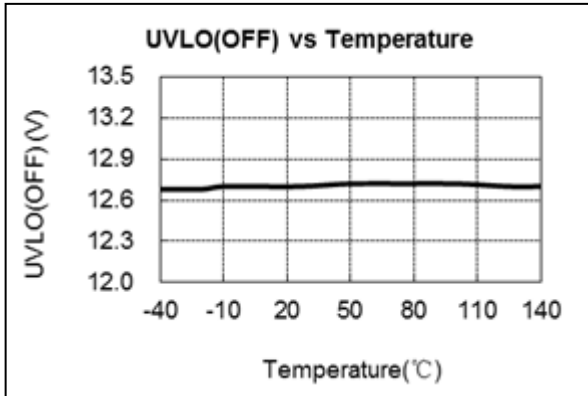
Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
<b>Supply Voltage (VDD) Section</b>						
I <sub>start-up</sub>	Start up current	VDD=UVLO_OFF-1V		1	3	uA
I <sub>op</sub>	Operation current without switching			0.77	1.0	mA
UVLO(OFF)	VDD under voltage lockout exit			13		V
UVLO(ON)	VDD under voltage lockout enter			3.7		V
VDD_OVP	VDD over voltage protection		16.5	18	19.5	V
VDD_max	Max. Operating Voltage				16	V
<b>Current Sense Input Section</b>						
TLEB+Td_oc	LEB time+ OCP propagation delay			0.43		us
Vth_ocp_min	Minimum over current threshold		485	500	515	mV
Vth_ocp_max	Maximum over current threshold			555		mV
Ton_max	Maximum Ton			40		us
<b>FB Input Section</b>						
Vref_fb	Reference voltage for feedback threshold		2.475	2.500	2.525	V
Tpause_min	Minimum Toff			2.0		us
F_min	Minimum frequency		450	500	550	Hz
F_max	Maximum frequency		90			KHz
Icomp_cable	Maximum cable compensation current			53		uA
<b>Output Over Voltage Protection</b>						
Vovp	Output Over voltage threshold		2.85	3.00	3.15	V
<b>On chip Over temperature Section</b>						
T_otp	Over temperature protection trigger point			165		°C
T_otp_rec	Over temperature protection recovery point			130		°C

<b>Power BJT Section</b>									
Parameter Product	V <sub>ceo</sub> (V) <sup>Note1</sup>			V <sub>cbo</sub> (V) <sup>Note2</sup>			I <sub>c</sub> (A)		
	Collector-emitter breakdown voltage			Collector-base breakdown voltage			Collector Current		
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.
OB25111		450		800				0.25	
OB25112		450		800				0.35	
OB25113		450		800				0.50	
OB25114		450		800				0.8	

Note1: Test condition:  $I_c=10\text{mA}$ ,  $I_b=0$

Note2: Test condition:  $I_c=10\text{mA}$

### CHARACTERIZATION PLOTS



### OPERATION DESCRIPTION

OB2511x is a cost effective PSR power switch optimized for off-line low power AC/DC applications including battery chargers. It operates in primary side sensing and regulation, thus opto-coupler and TL431 are not required. Proprietary built-in CV and CC control can achieve high precision CC/CV control meeting most charger application requirements.

#### Startup Current and Startup Control

Startup current of OB2511x is designed to be very low so that VDD can be charged up quickly. A large value startup resistor can therefore be used to minimize the power loss in application.

#### Operating Current

The operating current of OB2511x is as low as 550uA (typical). Good efficiency and low standby power is achieved with the low operating current.

#### CC/CV Operation

OB2511x is designed to produce good CC/CV control characteristic as shown in the Fig.1. In charger applications, a discharged battery charging starts in the CC portion of the curve until it is nearly full charged and smoothly switches to operate in CV portion of the curve. The CC portion provides output current limiting. In CV operation, the output voltage is regulated through the primary side control. In CC operation mode, OB2511x will regulate the output current constant regardless of the output voltage drop.

#### Principle of Operation

To support OB2511x proprietary CC/CV control, system needs to be designed in DCM mode for flyback system (Refer to Typical Application Diagram on page1).

In the DCM flyback converter, the output voltage can be sensed via the auxiliary winding. During BJT turn-on time, the load current is supplied from the output filter capacitor, Co. The current in the primary winding ramps up. When BJT turns off, the energy stored in the primary winding is transferred to the secondary side such that the current in the secondary winding is

$$I_S = \frac{N_P}{N_S} \cdot I_P \quad (1)$$

The auxiliary voltage reflects the output voltage as shown in Figure.2 and it is given by

$$V_{AUX} = \frac{N_{AUX}}{N_S} \cdot (V_O + \Delta V) \quad (2)$$

Where  $\Delta V$  indicates the drop voltage of the output Diode.

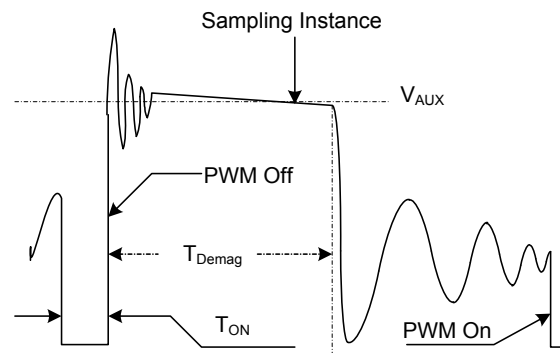


Fig. 3. Auxiliary voltage waveform

Via a resistor divider connected between the auxiliary winding and FB, the auxiliary voltage is sampled and hold during the demagnetization cycle. The sampling instance is variable according to the demagnetization width. The output voltage can be monitored when the secondary current is small. Thus  $\Delta V$  can be ignored. The sampled voltage is compared with reference voltage  $V_{ref\_EA}$  and the difference is amplified by the error amplifier. The error amplifier output reflects the load condition and controls the switching off time to regulate the output voltage, thus constant output voltage can be achieved.

When the sampled voltage is below  $V_{ref\_EA}$  and the error amplifier output reaches its maximum, the switching frequency is controlled by the sampled voltage to regulate the output current, thus the constant output current can be achieved.

#### Adjustable CC Point and Output Power

In OB2511x, the CC point and maximum output power can be externally adjusted by external current sense resistor  $R_s$  at CS pin as illustrated in typical application diagram. The larger  $R_s$ , the smaller CC point is, and the smaller output power becomes, and vice versa as shown in Figure.4.

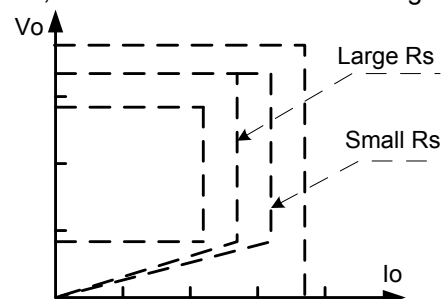


Fig. 4. Adjustable output power by changing  $R_s$

#### On Time OCP Compensation

The variation of max output current in CC mode can be rather large if no compensation is provided. The OCP threshold value is self adjusted higher at higher AC voltage. This OCP threshold slope adjustment helps to compensate the increased output current limit at higher AC voltage. In



OB2511x, a proprietary OCP compensation block is integrated and no external components are needed. The OCP threshold in OB2511x is a function of the switching ON time. For the ON time less than 4.0us (typical), the OCP threshold changes linearly from 500mV (typical) to 555mV (typical). For the ON time larger than 4.0us (typical), the OCP threshold is clamped to 555mV (typical), as shown in Figure 5.

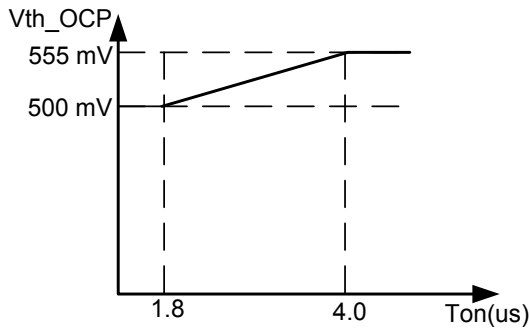


Fig 5. On time OCP compensation

### Operation Switching Frequency

The switching frequency of OB2511x is adaptively controlled according to the load conditions and the operation modes.

For flyback operating in DCM, The maximum output power is given by

$$P_{O_{MAX}} = \frac{1}{2} L_p F_{SW} I_p^2 \quad (3)$$

Where  $L_p$  indicate the inductance of primary winding and  $I_p$  is the peak current of primary winding.

Refer to the equation 3, the change of the primary winding inductance results in the change of the maximum output power and the constant output current in CC mode. To compensate the change from variations of primary winding inductance, the switching frequency is locked by an internal loop such that the switching frequency is

$$F_{SW} = \frac{1}{2T_{Demag}} \quad (4)$$

Since  $T_{Demag}$  is inversely proportional to the switching frequency, as a result, the product  $L_p$  and  $f_{sw}$  is constant, thus the maximum output power and constant current in CC mode will not change as primary winding inductance changes. Up to  $\pm 7\%$  variation of the primary winding inductance can be compensated.

### Programmable Cable Drop Compensation

In OB2511x, cable drop compensation is implemented to achieve good load regulation. An offset voltage is generated at FB pin by an internal current flowing into the resistor divider. The current is proportional to the switching off time, as a result,

it is inversely proportional to the output load current, thus the drop due to the cable loss can be compensated. As the load current decreases from full-load to no-load, the offset voltage at FB will increase. It can also be programmed by adjusting the resistance of the divider to compensate the drop for various cable lines used.

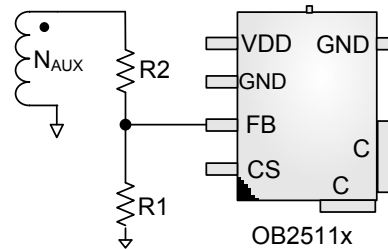
The percentage of maximum compensation is

$$\frac{\Delta V}{V_{out}} = \frac{I_{comp\_cable} \times R_1 // R_2 \times 10^{-6}}{2.5} \times 100\%$$

$\Delta V$  is load compensation voltage and  $V_{out}$  is output voltage;

For example:  $R_1//R_2=5.1\text{Kohm}$ , the percentage of maximum compensation is

$$\frac{\Delta V}{V_{out}} = \frac{53 \times 5100 \times 10^{-6}}{2.5} \times 100\% = 10.8\%$$



### Current Sensing and Leading Edge Blanking

Cycle-by-Cycle current limiting is offered in OB2511x. The switch current is detected by a sense resistor into the CS pin. An internal leading edge blanking circuit chops off the sensed voltage spike at initial power BJT on state so that the external RC filtering on sense input is no longer needed.

### Protection Control

Good power supply system reliability is achieved with its rich protection features including Cycle-by-Cycle current limiting (OCP), Output over voltage protection, VDD over voltage protection, short circuit protection, Under Voltage Lockout on VDD (UVLO) and over temperature protection (OTP).

VDD is supplied by transformer auxiliary winding output. The output of OB2511x is shut down when VDD drops below UVLO (ON) and the power converter enters power on start-up sequence thereafter.

To prevent the circuit being damaged under abnormal conditions, OB2511x provides over thermal protection function. When the die temperature rises above over temperature threshold  $T_{otp}$ , the OB2511x will shut down the base output and then latch the power supply off. The controller will remains latched until the die temperature drops below the recovery threshold  $T_{otp\_rec}$  and the OB2511x will reset at the same



time.

### PCB Layout Consideration

The following rules should be followed in OB2511x PCB Layout:

- **The Area of Power Loop:** The area of the 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 (Red wire as shows in Fig.6). Drain pin increases the copper area of the drain terminal for heat dissipation (Green region as shows in Fig.7). And the PCB trace must be wide and short for thermal consideration.
- **Bypass Capacitor and FB divider resistor:** The bypass capacitor on VDD and the FB divider resistor should be placed as close as possible to pin out. And the negative node of VDD capacitor and the FB down resistor should be connected directly to the IC GND pin before single point connected to the negative node of the output capacitor. (White region as shows in Fig.7)
- **Ground Path:** The GND path of the input power loop and IC controller path should be separated and connected at the negative terminal of input capacitor by single point, such as power sense resistor, the negative of the auxiliary winding and the IC GND. (White region as shows in Fig.7)

### ■ CDFN Package:

The rules are considered using CDFN package:

- Wave orientation of CDFN package would be the best parallel to the Pin6 pad for making sure the first soldering of Pin6.( Wave orientation as shows in Fig.8)
- The soldering pad of Pin1 & Pin 2& Pin3 & Pin4 would append delay solder to pad in order to reduce insufficient solder.
- The copper area connected to the Pin6 & Pin5 provides the heatsink to keep OB2511X temperature below 110°C.(The copper area as shows in Fig.9)
- The minimum distance between the high voltage copper area edge of Pin6 & Pin5 and the edge of other traces and components is more than 1mm, suggesting 1.5mm.
- The Bar must not be connected and keep the minimum distance 1.5mm away from the high voltage copper area edge.
- If the definition of Pin7 is NC, the pad of Pin7 would be connected to the pad of Pin6 in order to increase copper area. But the minimum distance between copper area and others traces is suggested 1.5mm.(Such as pink line width 1.5mm in Fig.9)

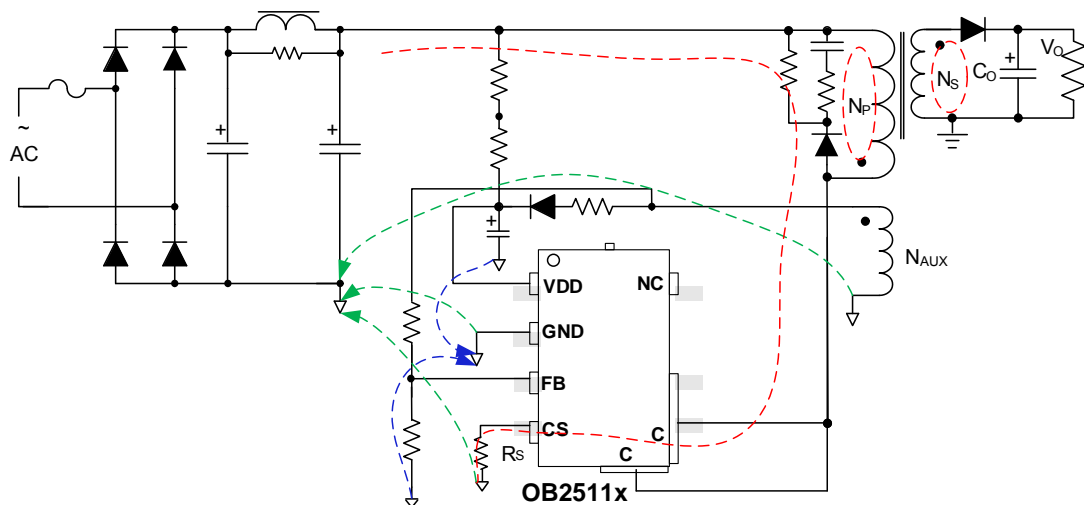


Fig.6 Flyback Schematic with OB2511x

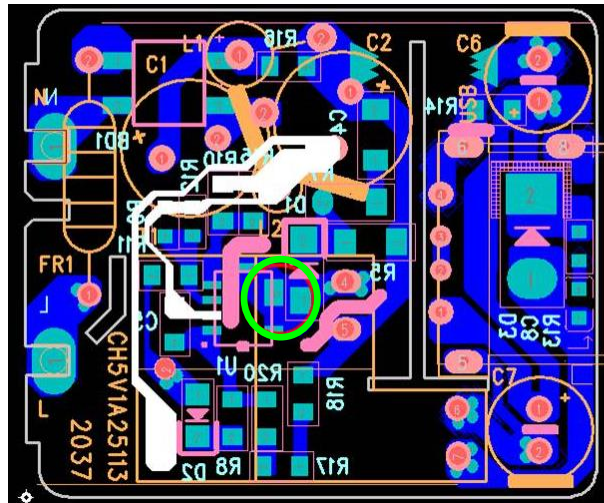


Fig.7 Recommend PCB Layout of OB2511x

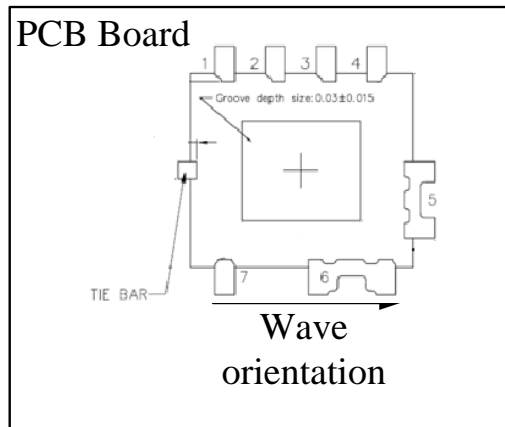


Fig.8 Wave orientation

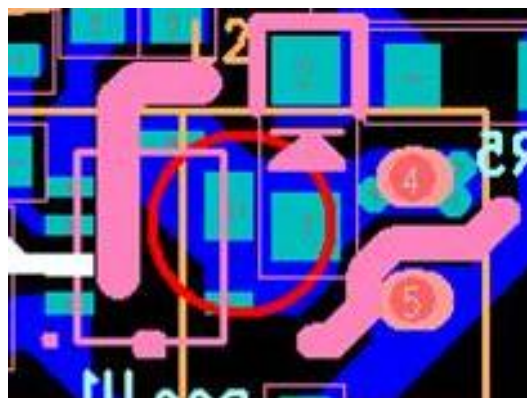
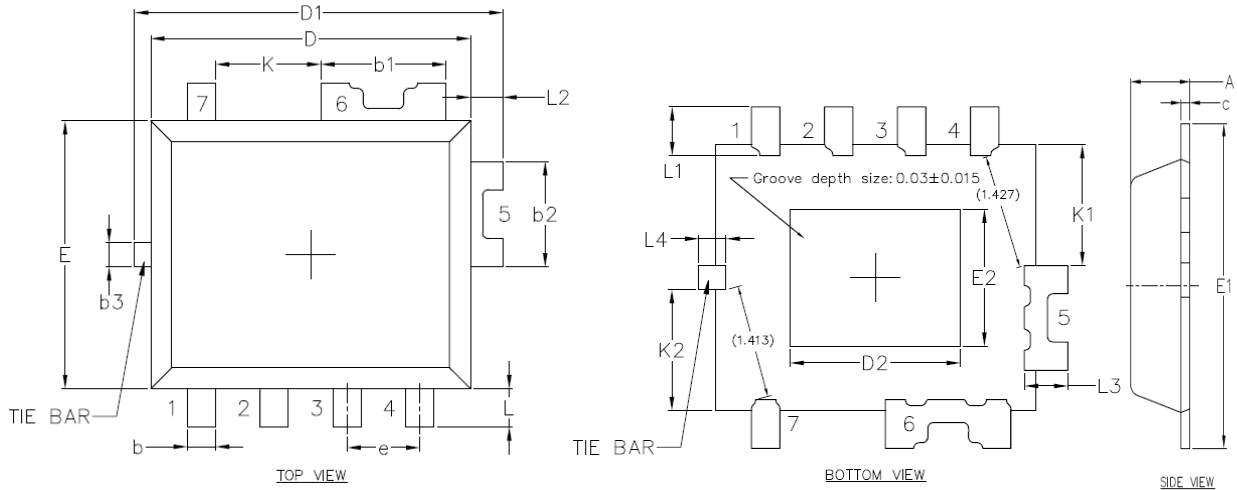


Fig.9 The enlarged view of Cooper Area

**PACKAGE MECHANICAL DATA**  
**CDFN8-7 PACKAGE OUTLINE DIMENSIONS**



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.95	1.05	0.037	0.041
b	0.30	0.40	0.012	0.016
b1	1.50	1.60	0.059	0.063
b2	1.25	1.35	0.049	0.053
b3* <small>Note</small>	0.20	0.35	0.008	0.014
c	0.10	0.20	0.004	0.008
D	3.90	4.00	0.154	0.157
D1	4.40	4.70	0.173	0.185
E	2.95	3.35	0.116	0.132
E1	3.84	4.34	0.151	0.171
e	0.85	0.95	0.033	0.037
L	0.42	0.52	0.017	0.020
L1	0.61 REF.		0.024 REF.	
L2	0.30	0.45	0.012	0.018
L3	0.54 REF.		0.021 REF.	
L4	0.34 REF.		0.013 REF.	
K	1.25	1.35	0.049	0.053
K1	1.28	1.63	0.050	0.064
K2	1.28	1.63	0.050	0.064

\*Note: Not recommended to connect this pin with PCB by soldering or any other conductive material.

## IMPORTANT NOTICE

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