

GENERAL DESCRIPTION

OB2550 is a high performance offline PSR controller 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 30mW standby power to meet strict standby power standard.

OB2550 offers comprehensive protection coverage with auto-recovery features including Cycle-by-Cycle current limiting, VDD over voltage protection, feedback loop open protection, short circuit protection, built-in leading edge blanking, VDD under voltage lockout (UVLO), OTP etc. OB2550 is offered in SOT23-6 package.

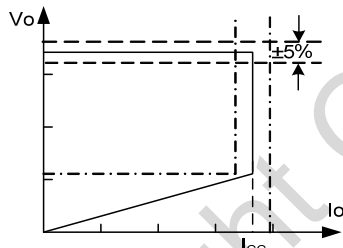
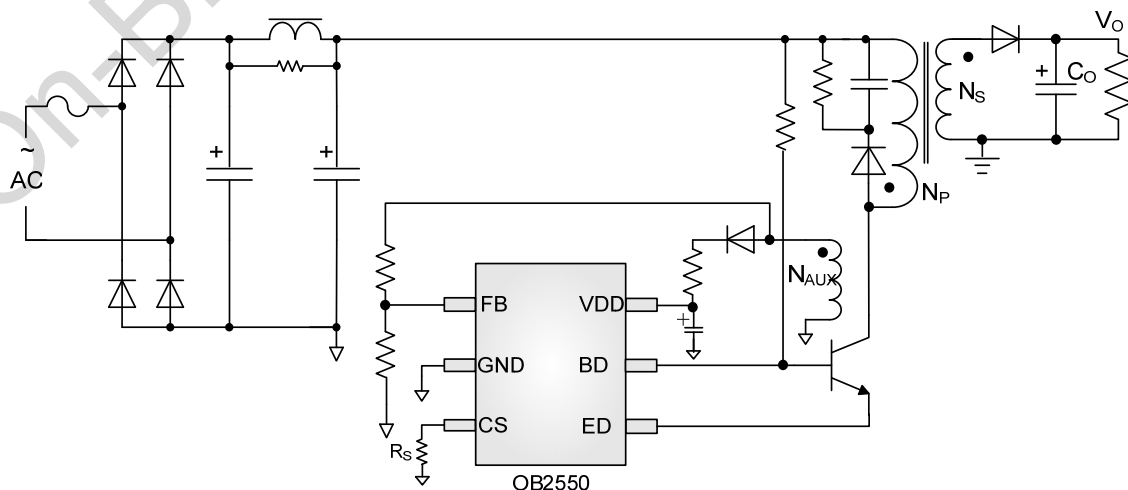


Figure.1. Typical CC/CV Curve

TYPICAL APPLICATION



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
- Meet 30mW no load standby power standard
- 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
- Precise Internal Over Temperature Protection
- Audio Noise Free Operation
- Drive BJT Switch
- Built-in Leading Edge Blanking (LEB)
- Ultra Low Start-up Current (Typ. 1uA) and Low Operating Current (Typ. 360uA)
- 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

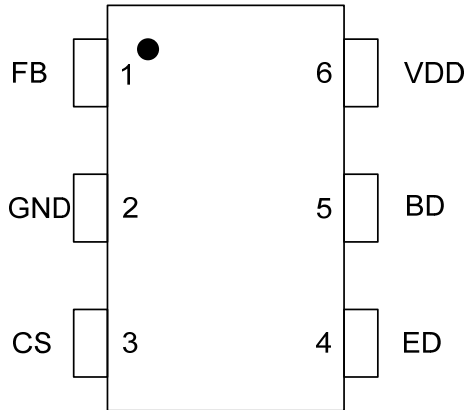
Low Power AC/DC offline SMPS for

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

GENERAL INFORMATION

Pin Configuration

The pin map is shown as below for SOT23-6.



Ordering Information

Part Number	Description
OB2550MP	SOT23-6, Pb-free, T&R

Package Dissipation Rating

Package	R θ JA (°C/W)
SOT23-6	200

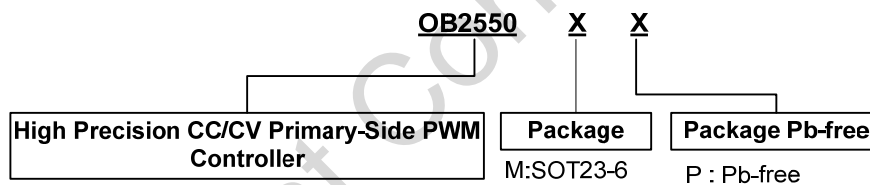
Absolute Maximum Ratings

Parameter	Value
VDD Voltage	-0.3 to 30V
FB Input Voltage	-0.3 to 7V
CS Input Voltage	-0.3 to 7V
ED Input Voltage	-0.3 to 24V
BD Input Voltage	-0.3 to 24V
Min/Max Operating Junction Temperature T _J	-40 to 150 °C
Min/Max Storage Temperature T _{stg}	-55 to 150 °C
Lead Temperature (Soldering, 10secs)	260 °C

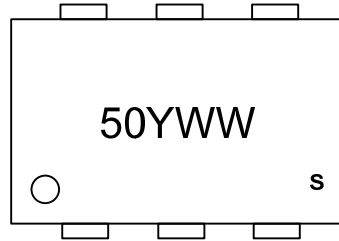
Note: Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to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

Recommended operating condition

Symbol	Parameter	Range
VCC	VCC Supply Voltage	9 to 22V
T _A	Operating Ambient Temperature	-20 to 85 °C



Marking Information

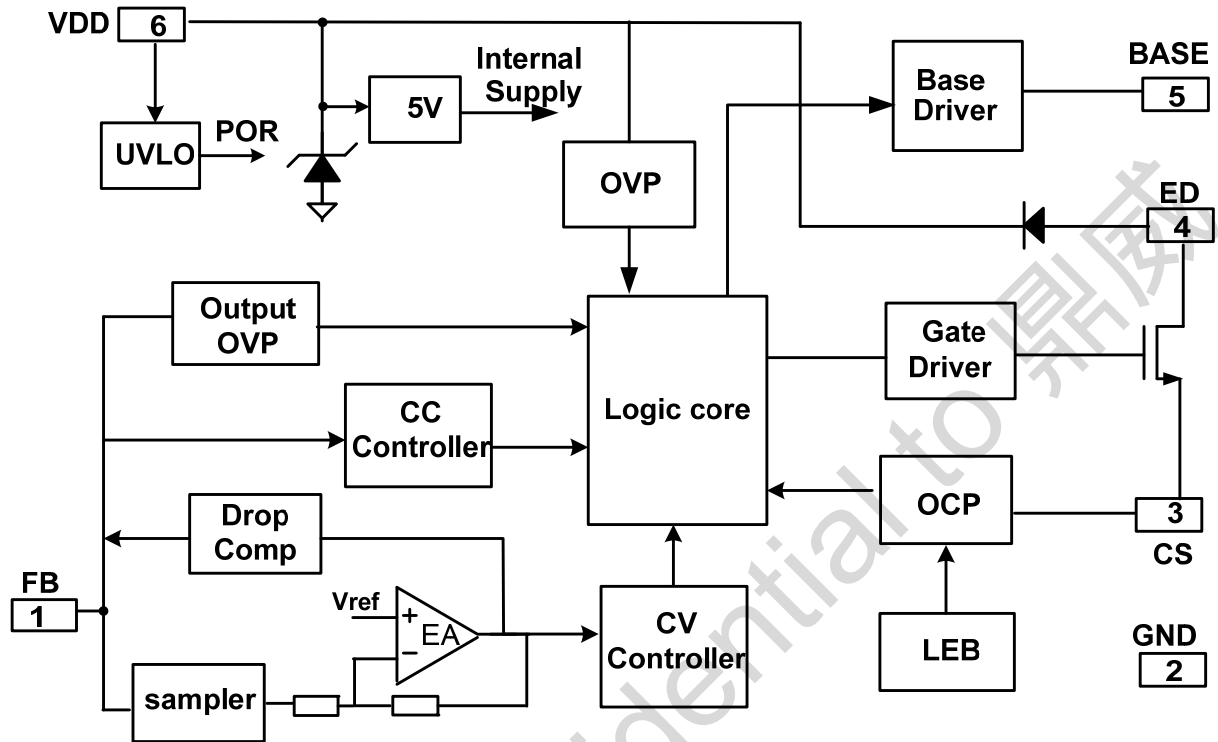


Y: Year Code
 WW: Week Code(01-52)
 S: Internal Code(Optional)

TERMINAL ASSIGNMENTS

Pin Num	Pin Name	I/O	Description
1	FB	I	The voltage feedback from auxiliary winding. Connected to resistor divider from auxiliary winding reflecting output voltage.
2	GND	P	Ground
3	CS	I	Power Mosfet source
4	ED	O	Enable driver.
5	BD	O	Base drive with current limit for power BJT.
6	VDD	P	Power Supply

BLOCK DIAGRAM

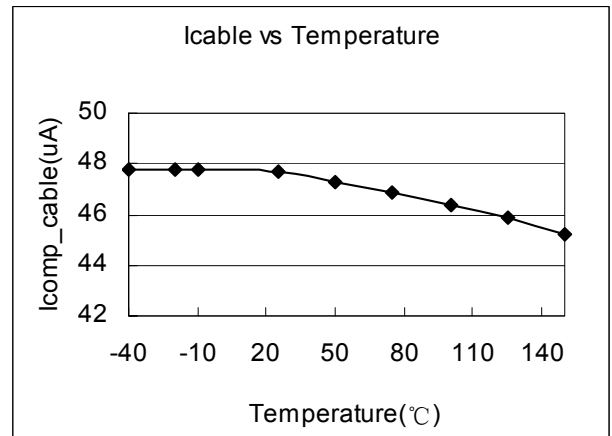
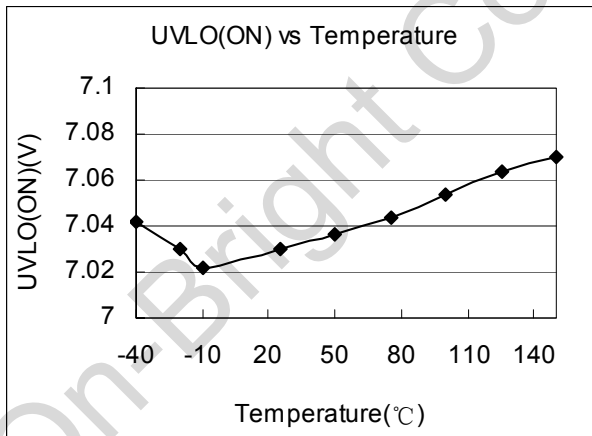
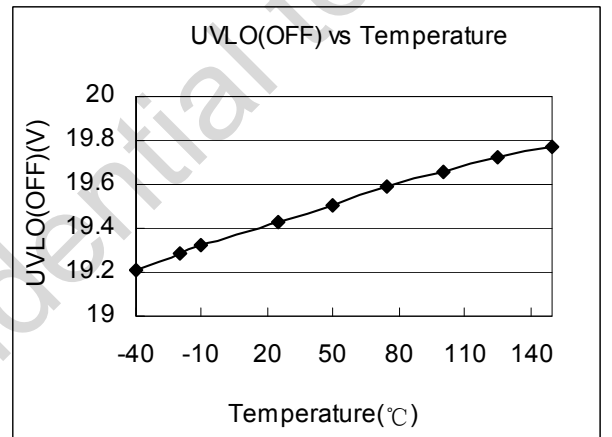
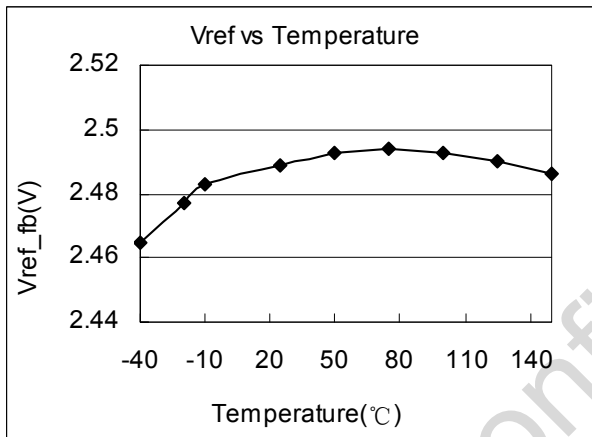
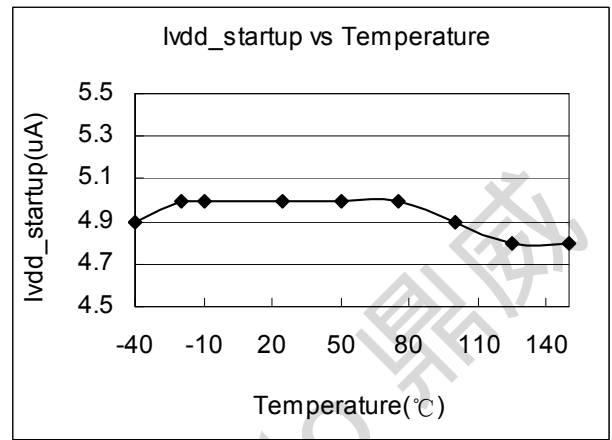
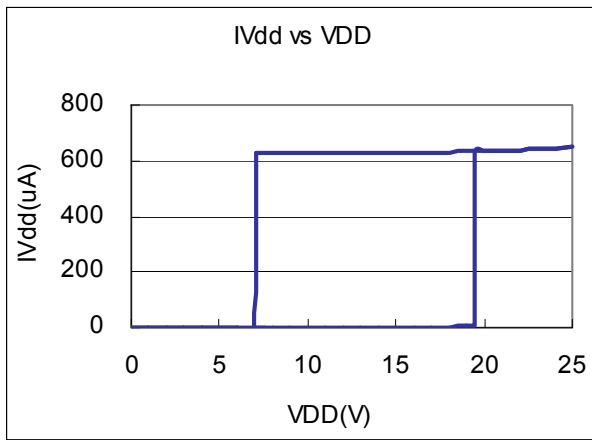


ELECTRICAL CHARACTERISTICS

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

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Supply Voltage (VDD) Section						
I _{start-up}	Start up current	VDD=UVLO_OFF-1V		5	15	uA
I _{static}	Static current			0.65	1.0	mA
UVLO(OFF)	VDD under voltage lockout exit		18.4	19.4	20.4	V
UVLO(ON)	VDD under voltage lockout enter		6.5	7.1	7.8	V
VDD_OVP	VDD over voltage protection		26.5	28.0	29.5	V
Max. Operating Voltage					26	V
Current Sense Input Section						
TLEB	LEB time			0.5		us
V _{th_ocp_min}	Minimum over current threshold		485	500	515	mV
V _{th_ocp_max}	Maximum over current threshold			555		mV
V _{cs_mini}	Minimum CS threshold			100		mV
T _{on_max}	Maximum Ton			50		us
T _{d_oc}	OCP propagation delay			100		ns
FB Input Section						
V _{ref_fb}	Reference voltage for feedback threshold		2.475	2.50	2.525	V
T _{pause_min}	Minimum Toff			2.0		us
F _{min}	Minimum frequency		720	800	880	Hz
I _{comp_cable}	Maximum cable compensation current		44	48	52	uA
BASE Drive Section						
I _{s_max}	Base sourcing maximum current		20	30	40	mA
I _{s_preoff}	Base sourcing current after pre-off			1.5		mA
R _{dson_l}	Base drive low side on resistor			1.0	2	ohm
I _{ED_leak}	Before startup, ED pin leakage current	VED=VDD-1V		0	1	uA
Output Over Voltage Protection						
V _{OVP}	Output Over voltage threshold		2.85	3.0	3.15	V
On chip Over temperature Section						
T _{otp}	Over temperature protection trigger point		150	165	180	°C
T _{otp_rec}	Over temperature protection recovery point		115	130	145	°C

CHARACTERIZATION PLOTS

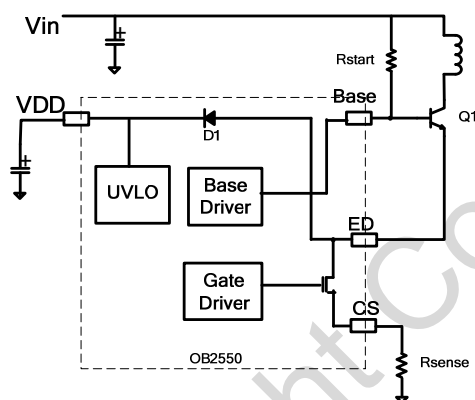


OPERATION DESCRIPTION

OB2550 is a cost effective PSR controller 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.

- **Fast Start up Control**

Startup current of OB2550 is designed to be very low so that VDD could be charged up above UVLO threshold and starts up quickly. The startup resistor Rstart from the rectified high voltage DC rail supplies current to the base of the NPN transistor Q1. An amplified emitter current charge VDD capacitor through diode D1 from ED pin to VDD pin. Thus, a large value startup resistor can therefore be used to minimize the power loss in application.



- **Operating Current**

The Operating current of OB2550 is as low as 650uA. Good efficiency and 30mW standby power is achieved with the low operating current.

- **CC/CV Operation**

OB2550 is designed to produce good CC/CV control characteristic as shown in the Figure. 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, OB2550 will regulate the output current constant regardless of the output voltage drop.

- **Principle of Operation**

To support OB2550 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 ΔV indicates the drop voltage of the output Diode.

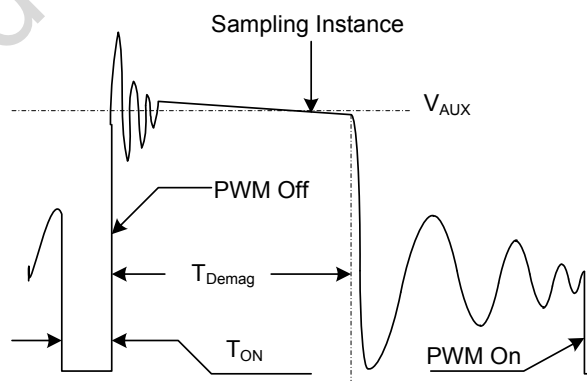


Figure.2. Auxiliary voltage waveform

Via a resistor divider connected between the auxiliary winding and FB (pin 1), the auxiliary voltage is sampled at the middle of the de-magnetization and it is hold until the next sampling. The sampled voltage is compared with Vref (2.5V) and the error is amplified. 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 Vref and the error amplifier output reaches its minimum, 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 OB2550, 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.3.

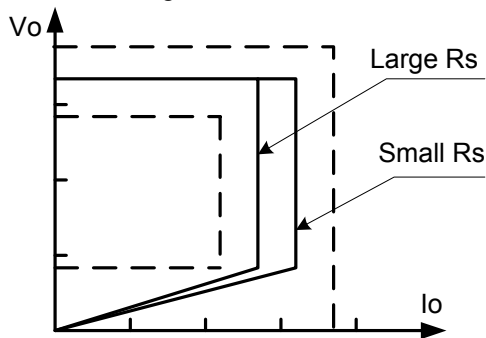


Figure.3. Adjustable output power by changing R_s

● **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 OB2550, a proprietary OCP compensation block is integrated and no external components are needed. The OCP threshold in OB2550 is a function of the switching ON time. For the ON time less than 3.7us, the OCP threshold changes linearly from 500mV to 555mV. For the ON time larger than 3.7us, the OCP threshold is clamped to 555mV, as shown in Figure 4.

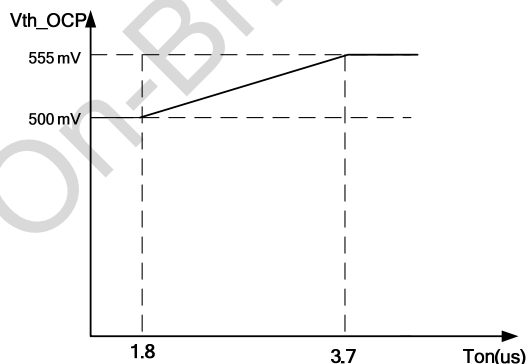


Figure.4. On time OCP compensation

● **Operation switching frequency**

The switching frequency of OB2550 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 inductance, 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 OB2550, 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.

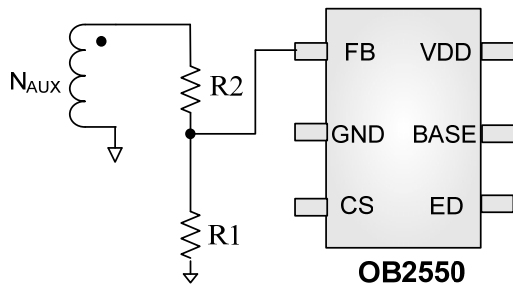
The percentage of maximum compensation is

$$\frac{\Delta V}{V_{out}} = \frac{I_{comp_cable} \times R1 \times 10^{-6}}{2.5} \times 100\%$$

ΔV is load compensation voltage and V_{out} is output voltage;

For example: $R1=6.2Kohm$, the percentage of maximum compensation is

$$\frac{\Delta V}{V_{out}} = \frac{47 \times 6200 \times 10^{-6}}{2.5} \times 100\% = 11.6\%$$



- **Current Sensing and Leading Edge Blanking**

Cycle-by-Cycle current limiting is offered in OB2550. 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.

- **Base Drive**

The drive is a push pull stage with supply voltage VDD. It provides the driving current for the external power bipolar transistor. The output signal is current limit to I_{s_max} (typical

35mA).

- **Protection Control**

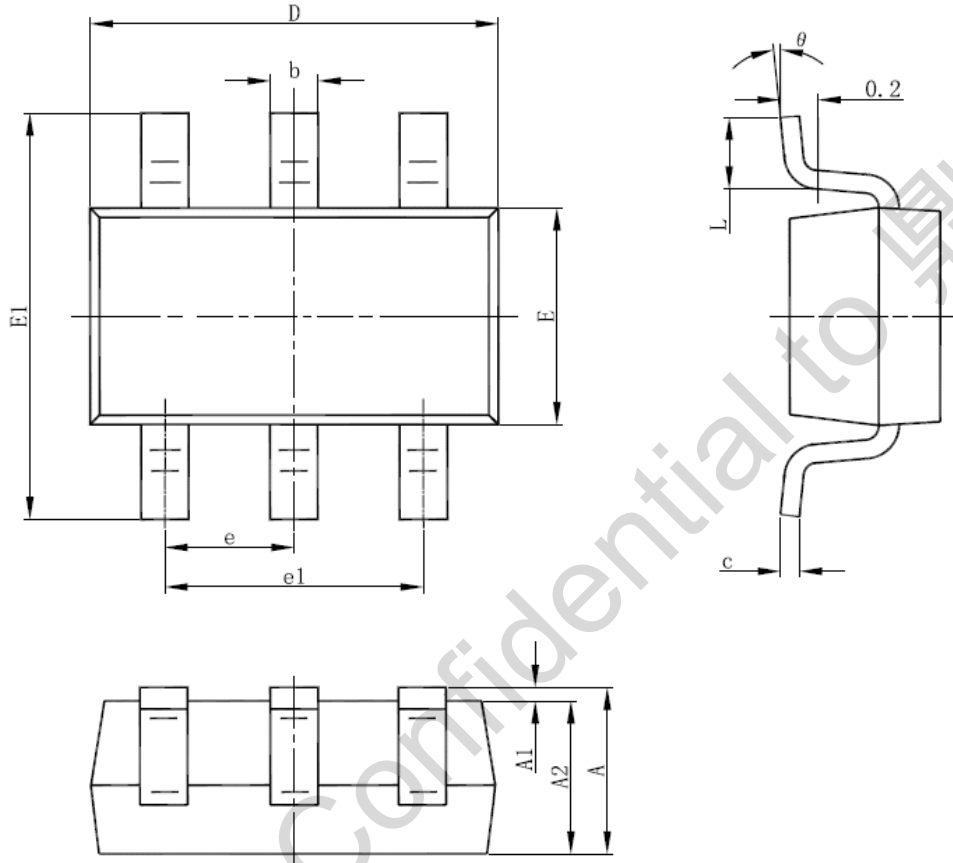
Good power supply system reliability is achieved with its rich protection features including Cycle-by-Cycle current limiting (OCP), Output over voltage protection, VDD over voltage protection, short circuit protection, Under Voltage Lockout on VDD (UVLO) and over temperature protection (OTP).

VDD is supplied by transformer auxiliary winding output. The output of OB2550 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, OB2550 provides over thermal protection function. When the die temperature rises above over temperature threshold T_{otp} , the OB2550 will shut down the gate output and then latch the power supply off. The controller will remain latched until the die temperature drops below the recovery threshold T_{otp_rec} and the OB2550 will reset at the same time.

PACKAGE MECHANICAL DATA

SOT-23-6L PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.000	1.450	0.039	0.057
A1	0.000	0.150	0.000	0.006
A2	0.900	1.300	0.035	0.051
b	0.300	0.500	0.012	0.020
c	0.080	0.220	0.003	0.009
D	2.800	3.020	0.110	0.119
E	1.500	1.726	0.059	0.068
E1	2.600	3.000	0.102	0.118
e	0.950 (BSC)		0.037 (BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
theta	0°	8°	0°	8°

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