

## GENERAL DESCRIPTION

OB2540 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, PFM operations are utilized to achieve high performance and high efficiency. In addition, good load regulation is achieved by the built-in cable drop compensation. The chip consumes very low operation current (typical 400uA), it can achieve low standby power and high efficiency.

OB2540 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), etc. OB2540 is offered in SOT23-6 package.

## FEATURES

- $\pm 5\%$  Constant Voltage Regulation at Universal AC input
- High precision Constant Current Regulation at Universal AC input
- Primary-side Sensing and Regulation Without TL431 and Opto-coupler
- Programmable CV and CC Regulation
- Built-in Primary winding inductance compensation
- Audio Noise Free Operation
- Programmable Cable Drop Compensation
- Driver BJT Switch
- Ultra Low Start-up Current (Typ. 1uA)
- VDD Over Voltage Protection
- Built-in Feedback Loop Open Protection
- Built-in Short Circuit Protection
- Built-in Leading Edge Blanking (LEB)
- Cycle-by-Cycle Current Limiting
- VDD Under Voltage Lockout with Hysteresis (UVLO)

## 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

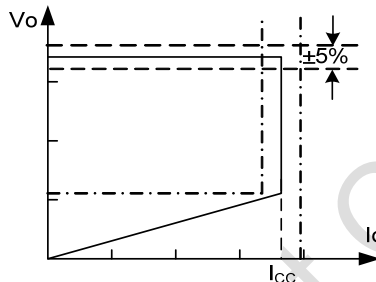
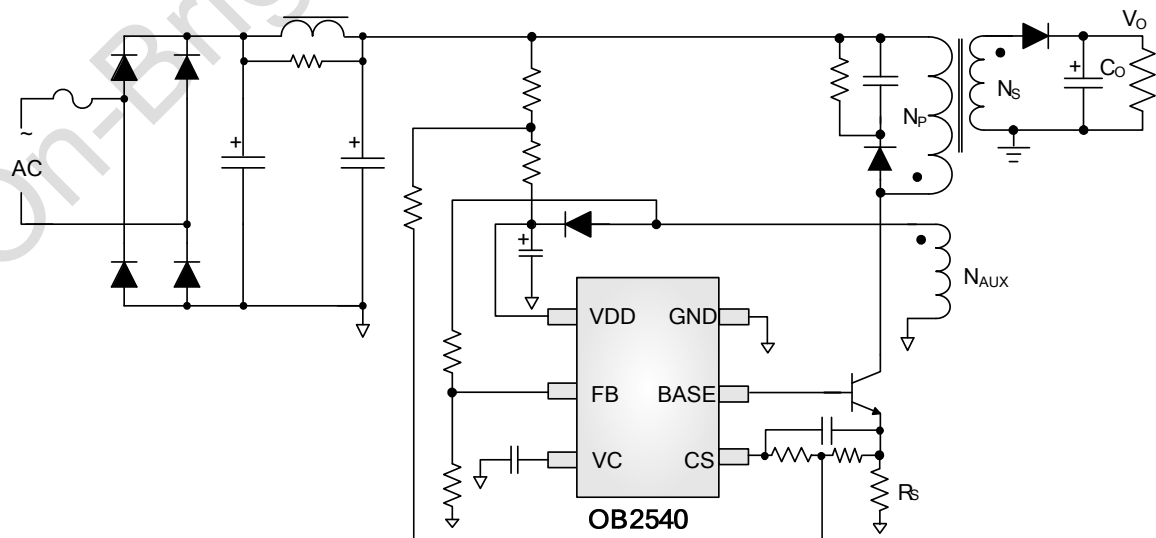


Figure.1. Typical CC/CV Curve

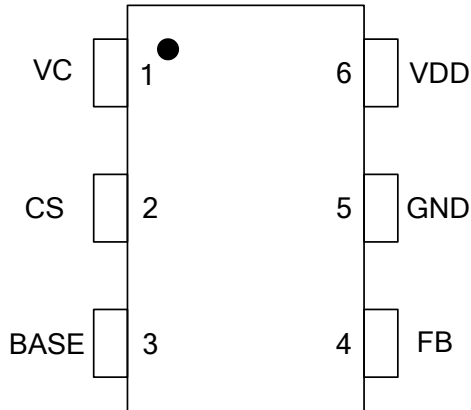
## TYPICAL APPLICATION



### GENERAL INFORMATION

#### Pin Configuration

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



#### Package Dissipation Rating

Package	R $\theta$ JA (°C/W)
SOT23-6	200

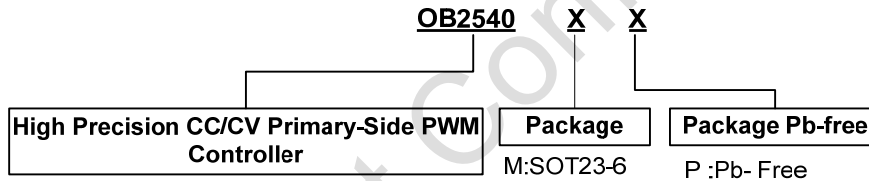
#### Absolute Maximum Ratings

Parameter	Value
VDD Voltage	-0.3 to 30V
VC Voltage	-0.3 to 7V
BASE Voltage	-0.3 to 7V
CS Input Voltage	-0.3 to 7V
FB Input Voltage	-0.3 to 7V
Min/Max Operating Junction Temperature T <sub>J</sub>	-40 to 150 °C
Min/Max Storage Temperature T <sub>stg</sub>	-55 to 150 °C
Lead Temperature (Soldering, 10secs)	260 °C

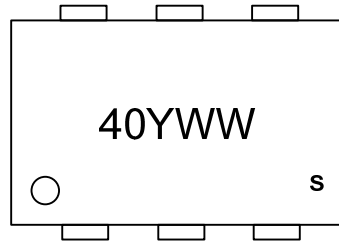
#### Ordering Information

Part Number	Description
OB2540MP	SOT23-6, Pb-free, T&R

**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.



### Marking Information

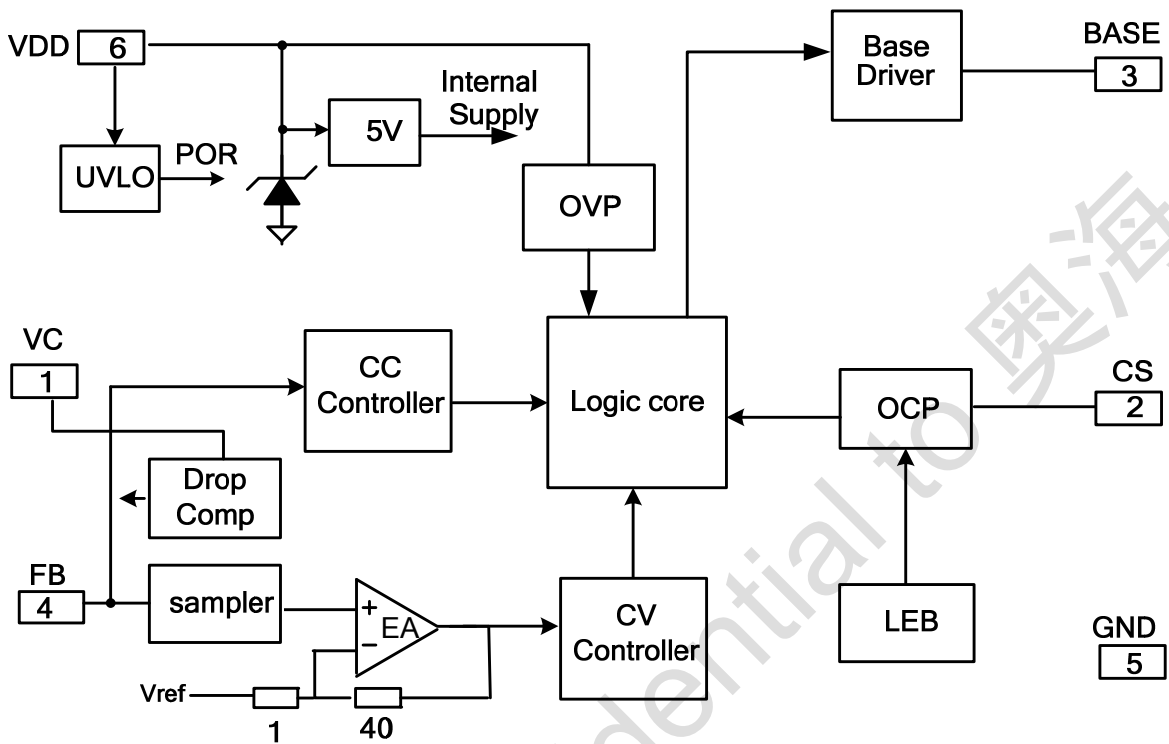


Y: Year Code  
 WW: Week Code(01-52)  
 S: Internal Code(Optional)

### TERMINAL ASSIGNMENTS

Pin Num	Pin Name	I/O	Description
1	VC	I	Low pass filter capacitor for cable compensation
2	CS	I	Current sense input.
3	BASE	O	Base drive with current limit for power BJT.
4	FB	I	The voltage feedback from auxiliary winding. Connected to resistor divider from auxiliary winding reflecting output voltage.
5	GND	P	Ground
6	VDD	P	Power Supply

**BLOCK DIAGRAM**

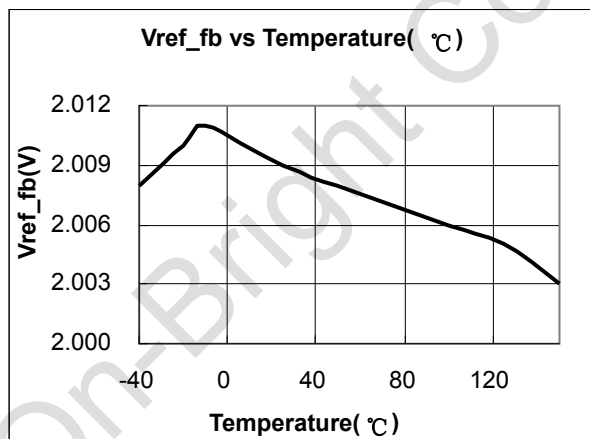
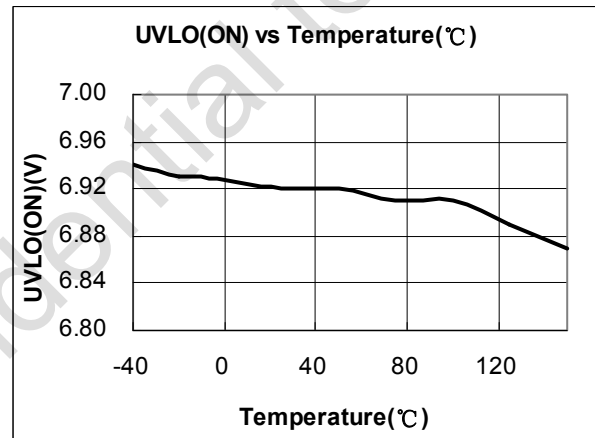
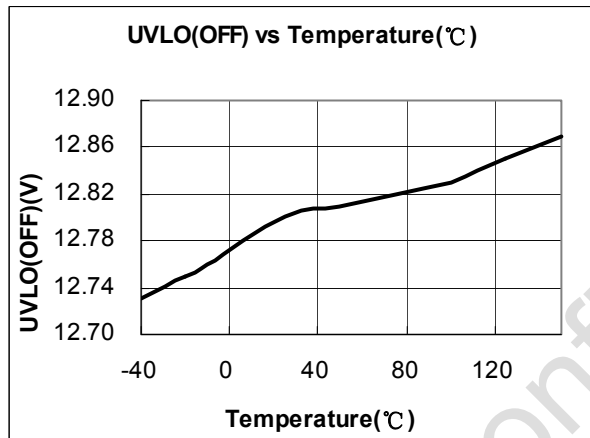
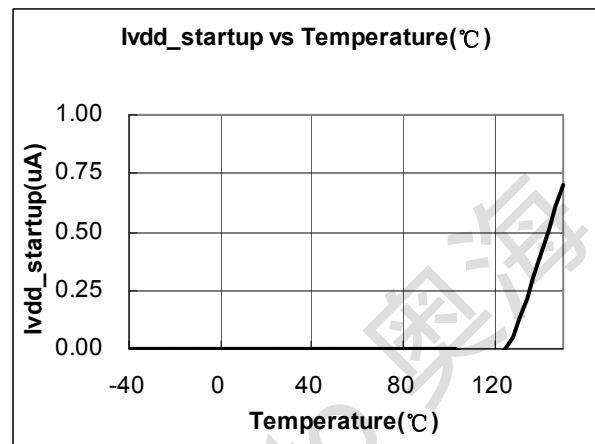
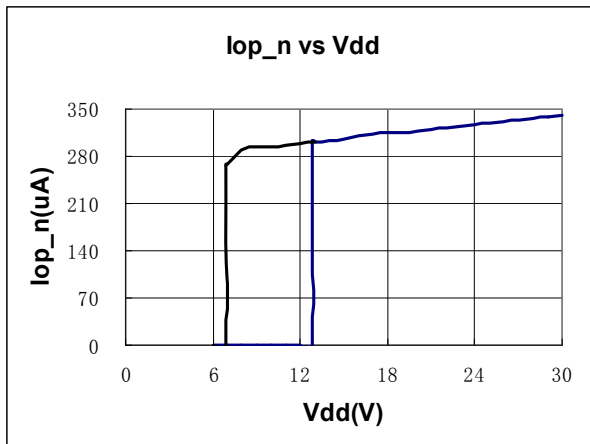


## ELECTRICAL CHARACTERISTICS

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

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
<b>Supply Voltage (VDD) Section</b>						
I <sub>start-up</sub>	Start up current	VDD=11V		1	3	uA
I <sub>static</sub>	Static current	VDD=15V		400	500	uA
UVLO(OFF)	VDD under voltage lockout exit		11.5	12.5	13.5	V
UVLO(ON)	VDD under voltage lockout enter		6.0	6.8	7.6	V
VDD_OVP	VDD over voltage protection		25	27	29	V
Max. Operating Voltage					25	V
<b>Current Sense Input Section</b>						
TLEB	LEB time			0.5		uS
Vth_ocp	Over current threshold		485	500	515	mV
Td_oc	OCP propagation delay	From ocp comparator to base drive		100		nS
Ics_max	Maximum source current to CS pin		41	45	49	uA
<b>FB Input Section</b>						
Vref_fb	Reference voltage for feedback threshold		1.98	2.00	2.02	V
Tpause_min				2.0		uS
Tpause_max	Maximum pause		575	640	705	uS
Icable	Maximum cable compensation current			27		uA
<b>BASE Drive Section</b>						
Is_max	Base sourcing maximum current		20	30	40	mA
Is_preoff	Base sourcing current after pre-off		0.5	1	1.5	mA
Rdson_l	Base drive low side on resistor			1		ohm

**CHARACTERIZATION PLOTS**



## OPERATION DESCRIPTION

OB2540 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.

### ● Startup Current and Start up Control

Startup current of OB2540 is designed to be very low so that VDD could be charged up above UVLO threshold and starts up quickly. A large value startup resistor can therefore be used to minimize the power loss in application.

### ● Audio Noise Free Operation

The switching frequency vs loading curve is optimized to achieve audio noise free operation from no loading to full loading. The Operating current of OB2540 is as low as 400uA. Good efficiency and very low standby power is achieved with the low operating current.

### ● CC/CV Operation

OB2540 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, OB2540 will regulate the output current constant regardless of the output voltage drop.

### ● Principle of Operation

To support OB2540 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.

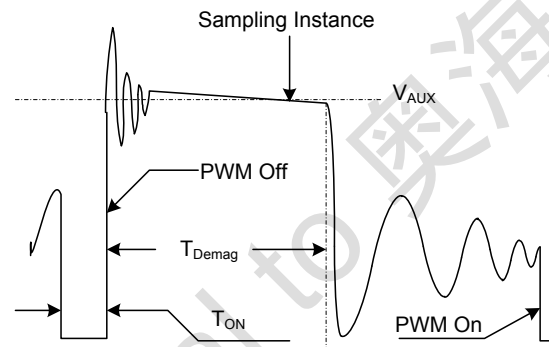


Figure.2. Auxiliary voltage waveform

Via a resistor divider connected between the auxiliary winding and FB (pin 4), 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 (2.0V) 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 OB2540, the CC point and maximum output power can be externally adjusted by external current sense resistor Rs at CS pin as illustrated in typical application diagram. The larger Rs, the smaller CC point is, and the smaller output power becomes, and vice versa as shown in Figure.3.

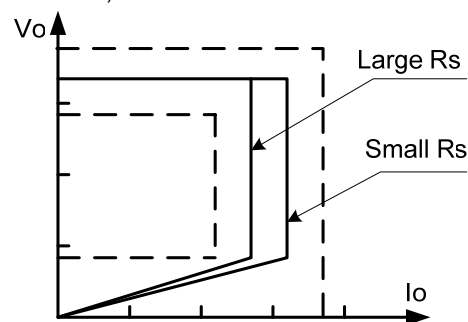


Figure.3. Adjustable output power by changing Rs

### ● CC Operation switching frequency

The switching frequency of OB2540 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  $\pm 10\%$  variation of the primary winding inductance can be compensated.

### ● Programmable Cable drop Compensation

In OB2540, 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.

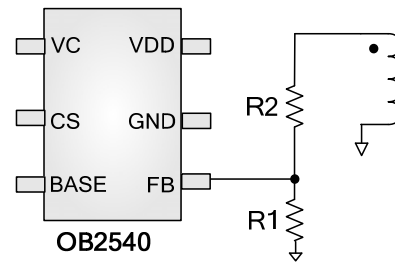
The percentage of maximum compensation is

$$\frac{\Delta V}{V_{out}} = \frac{I_{cable} \times (R1 // R2) \times 10^{-6}}{2} \times 100\%$$

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

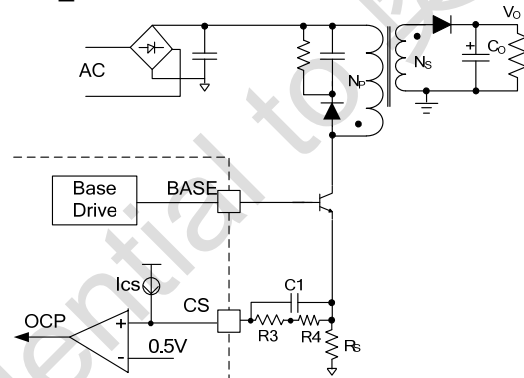
For example:  $R1=6Kohm, R2=24Kohm$ , the percentage of maximum compensation is

$$\frac{\Delta V}{V_{out}} = \frac{27 \times (6000 // 24000) \times 10^{-6}}{2} \times 100\% = 6.48\%$$



### ● CS modulation to improve dynamic response

At light or no load, an internal current  $I_{cs}$  is flowing into CS pin; the current  $I_{cs}$  is modulated with the output loading, the maximum current  $I_{cs}$  is limited to  $I_{cs\_max}$ .



At no load, the actual CS threshold is

$$V_{csth\_no\_load} = 0.5 - (I_{cs\_max}) \times (R3 + R4) \quad (V)$$

Above  $V_{csth\_no\_load}$  is not considered AC line compensation.

### ● Current Sensing and Leading Edge Blanking

Cycle-by-Cycle current limiting is offered in OB2540. 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 30mA).

### ● Protection Control

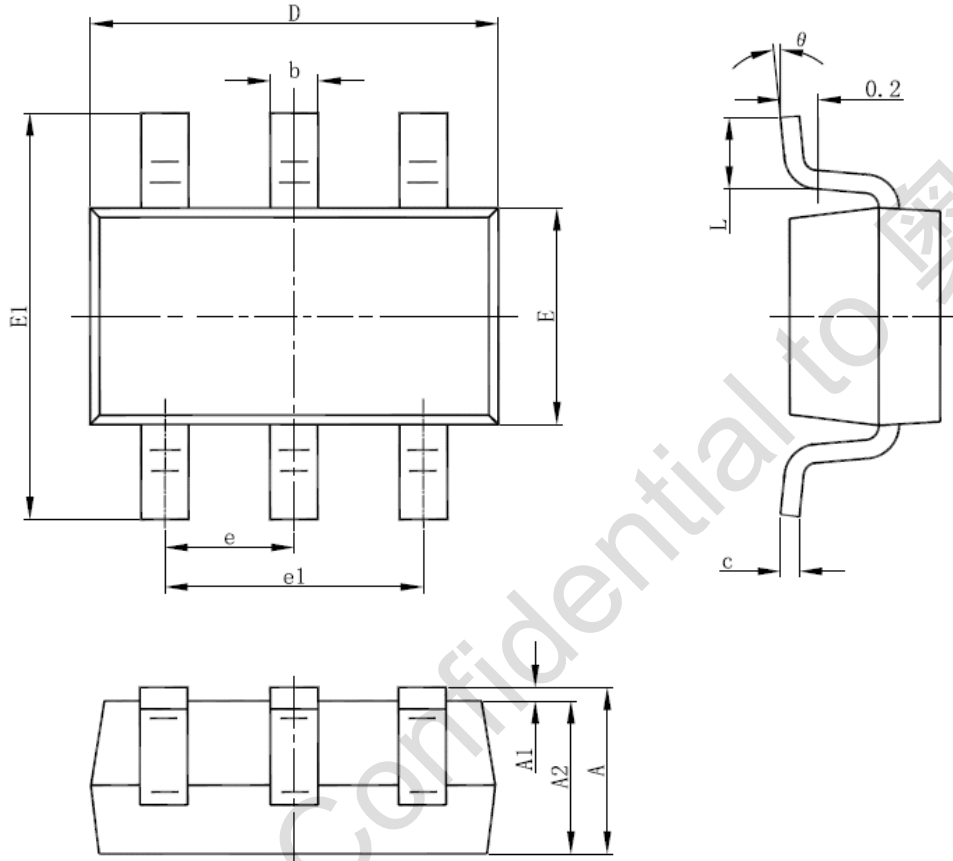
Good power supply system reliability is achieved with its rich protection features including Cycle-by-Cycle current limiting (OCP), VDD over voltage protection, feedback loop open protection, short circuit protection and Under Voltage Lockout on VDD (UVLO).

VDD is supplied by transformer auxiliary winding output. The output of OB2540 is shut down when VDD drops below UVLO (ON) and the power converter enters power on start-up sequence thereafter.



**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
θ	0°	8°	0°	8°

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