

## GENERAL DESCRIPTION

OB5681x is a primary side regulation off-line LED lighting power switch which can achieve accurate LED current. It can achieve low system cost for an isolated lighting system by using bipolar drive power transistor and significantly simplify LED lighting system design by eliminating the secondary side feedback circuitry and VDD startup resistor.

LED current (CC control) can be adjusted by the external sense resistor connected between CS pin and GND pin.

OB5681x offers comprehensive protection coverage with auto-recovery features including LED open circuit protection, LED short circuit protection, Cycle-by-Cycle current limiting, built-in leading edge blanking, VDD under lockout (UVLO), thermal fold back, etc.

OB5681x is offered in SOP7 package.

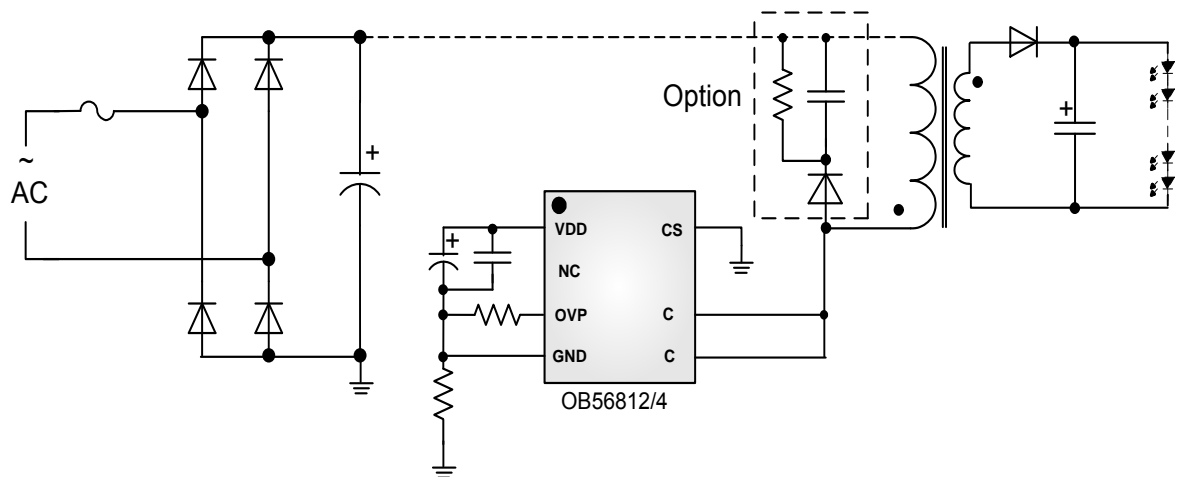
## FEATURES

- Built-in Startup Circuitry Without External Startup Resistor
- Integrated 800V BJT
- Low System Cost and High Efficiency
- Self Power Supply
- Integrated on/off Function by OVP Pin
- Fast Startup < 0.5s
- Primary-side Sensing and Regulation Without Auxiliary Winding, TL431 and Opto-coupler
- Cycle-by-Cycle Current Limiting
- Built-in Leading Edge Blanking
- LED Short Circuit Protection
- LED Open Circuit Protection
- VDD Under Lockout
- Thermal Foldback

## APPLICATIONS

- LED lighting

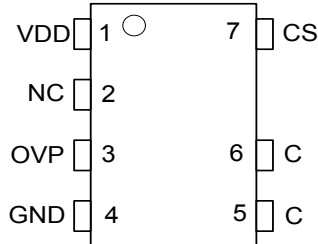
## TYPICAL APPLICATION



### GENERAL INFORMATION

#### Pin Configuration

The pin map is shown as below for SOP7.



#### Ordering Information

Part Number	Description
OB56812JP	SOP7, Halogen-free in Tube
OB56812JPA	SOP7, Halogen-free in T&R
OB56814JP	SOP7, Halogen-free in Tube
OB56814JPA	SOP7, Halogen-free in T&R

#### Package Dissipation Rating

Package	RθJA (°C/W)
SOP7	95

#### Absolute Maximum Ratings

Parameter	Value
C Voltage	-0.3 to 800V
VDD Voltage	-0.3 to 7V
CS Input Voltage	-1.0 to 7V
OVP Input Voltage	-0.3 to 7V
Min/Max Operating Junction Temperature T <sub>J</sub>	-40 to 150 °C
Operating Ambient Temperature T <sub>A</sub>	-40 to 85 °C
Min/Max Storage Temperature T <sub>stg</sub>	-55 to 150 °C
Lead Temperature (Soldering, 10secs)	260 °C

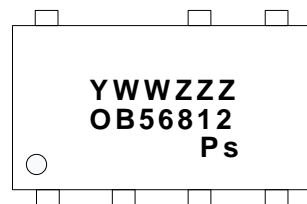
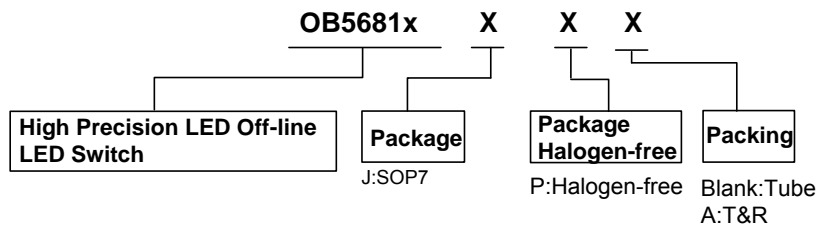
**Note:** Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure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

#### Output Power Table

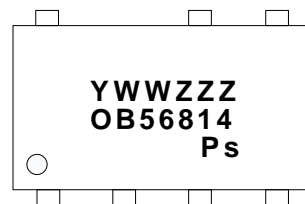
Product	220Vac±20% Input
OB56812JP	12W
OB56814JP	20W

**Note:** Maximum practical continuous power in an open frame design with sufficient drain pattern as a heat sink, at 50 °C ambient and 60 °C temperature rise. Higher output power is possible with extra added heat sink, air circulation and decrease output current to reduce thermal resistance.

#### Marking Information



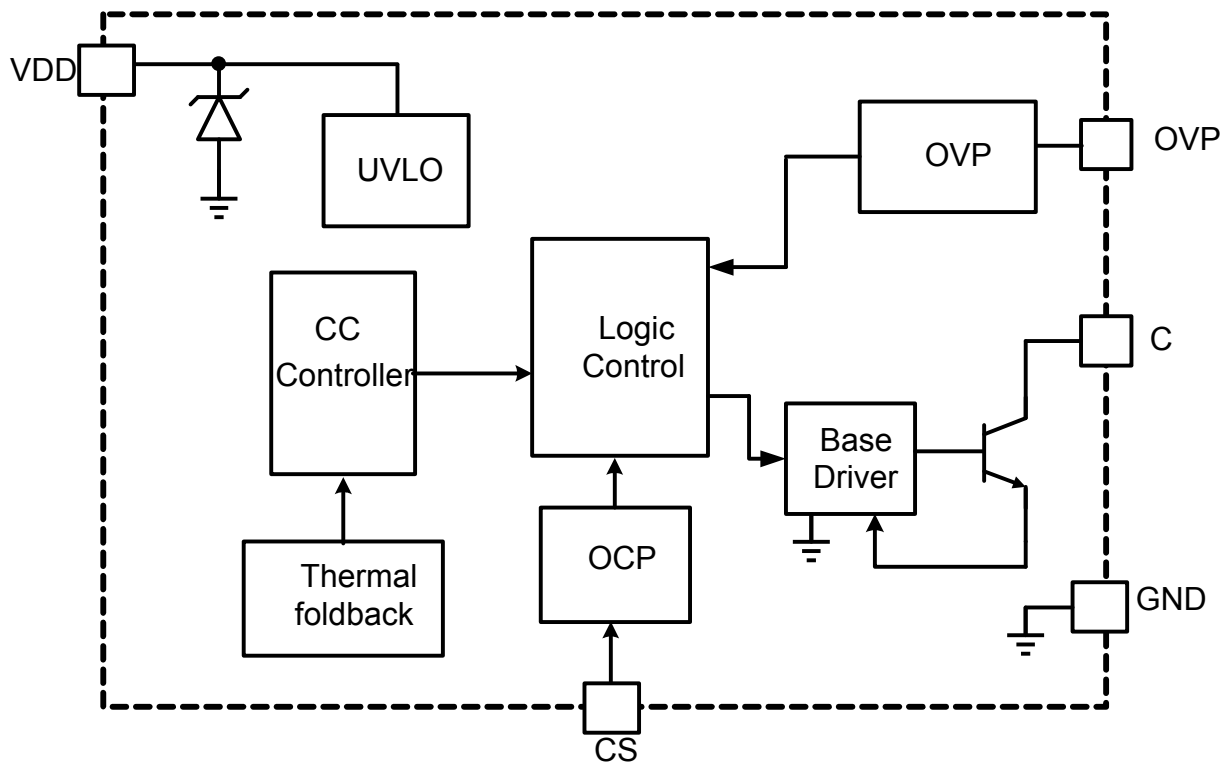
Y: Year Code  
 WW: Week Code (01-52)  
 ZZZ: Lot Code  
 P: Halogen-free Package  
 S: Internal Code(Optional)



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**TERMINAL ASSIGNMENTS for OB56812/4JP**

Pin Num	Pin Name	I/O	Description
1	VDD	P	Power supply, connect 10uF~22uF capacitor to ground
2	NC		No connection
3	OVP	I/O	Over Voltage Protection configuration pin
4	GND	P	Ground
5-6	C	I/O	Collector of internal BJT
7	CS	I/O	Current sense pin

**BLOCK DIAGRAM**


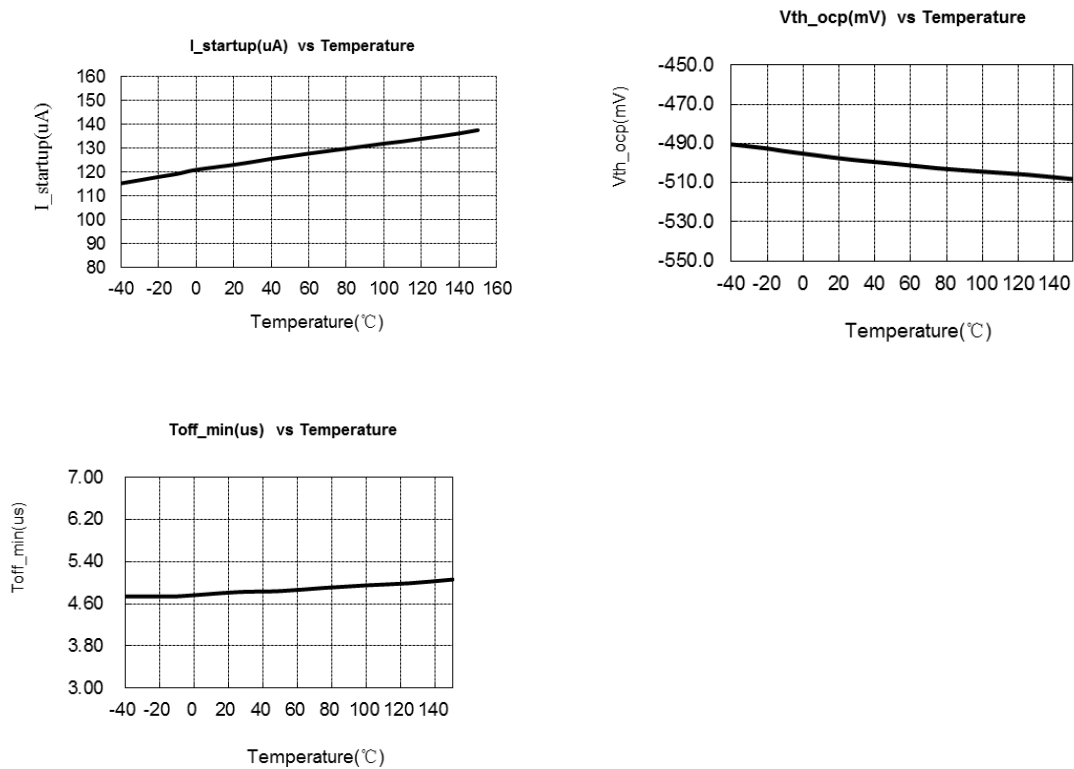
**ELECTRICAL CHARACTERISTICS**  
 (TA = 25°C if not otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
<b>Supply Voltage (VDD) Section</b>						
I_startup	Start up Current	VDD=4.5V		120		uA
UVLO(OFF)	VDD under voltage lockout exit			4.70		V
UVLO(ON)	VDD under voltage lockout enter			3.5		V
VDD_clamp	VDD clamp voltage			5.9		V
VDD_charge	VDD self supply voltage			4.5		V
<b>Current Sense Input Section</b>						
TLEB	Leading Edge Blanking time			0.6		us
Vth_ocp	Over current threshold		-515	-500	-485	mV
Toff_max	Maximum off time			600		us
Ton_max	Maximum on time			43		us
Tdem_blk	Demagnetize blanking time			2.3		us
<b>OVP Section</b>						
Toff_min	Minimum off time	Rovp=10Kohm		5		us
		Rovp=floating		4.7		us
Vovp_on	Enable chip			300		mV
Vovp_off	Disable chip			200		mV
<b>Thermal Section</b>						
Tthermal	Thermal regulation threshold			140		°C

<b>Power BJT Section</b>						
Parameter Product	Vcbo(V) <sup>Note1</sup>			Ic (A)		
	Collector-base breakdown voltage			Collector Peak Current		
	Min.	Typ.	Max.	Min.	Typ.	Max.
OB56812JP	800					0.5
OB56814JP	800					1

Note1: Test condition: Ic=1mA, Ie=0

## TYPICAL PERFORMANCE CHART



## OPERATION DESCRIPTION

OB5681x is a cost effective PSR power switch optimized for off-line LED lighting applications. Based on flyback converter topology working in DCM mode, it operates in primary side sensing and regulation. It significantly simplifies the LED lighting system design by eliminating the secondary side feedback circuitry and VDD startup resistor. Proprietary built-in CC control can achieve high precision LED current meeting LED lighting application requirements.

### Start up Control

Startup process is realized by charging VDD capacitor. When VDD voltage reaches up to UVLO (OFF), the system starts to operate. A 5.9V (typical) clamp circuit is applied to clamp VDD voltage. The typical startup current of OB5681x is 120uA. An internal VDD power self supply unit is integrated in OB5681x. After startup, if the voltage of VDD lowers than 4.5V, VDD power self supply unit charges up the VDD voltage automatically. A 1uF ceramic capacitor should be connected between VDD pin and ground when chip work at extremely low temperature.

### Principle of CC Operation

To support OB5681x proprietary CC control, system needs to be designed in DCM mode for flyback system (Refer to Typical Application Diagram on page1) and the minimum reflected voltage  $V_{RO\_MIN}$  should be more than 35V.

The minimum reflected voltage  $V_{RO\_MIN}$  is given by

$$V_{RO\_MIN} = N \cdot V_{O\_MIN} \quad (1)$$

Where N is the ratio of transformer between primary winding and secondary winding,  $V_{O\_MIN}$  is the minimum output voltage.

The LED output current  $I_{LED}$  is given by:

$$I_{LED} = \frac{1}{2} L_P \cdot F_{SW} \cdot I_{PK}^2 / V_O \quad (1)$$

Where  $L_P$  indicates the inductance of primary winding,  $I_{PK}$  is the peak current of primary winding,  $V_O$  is LED load output voltage.

Refer to the equation 1, the change of the primary winding inductance results in the change of the constant output current. 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

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

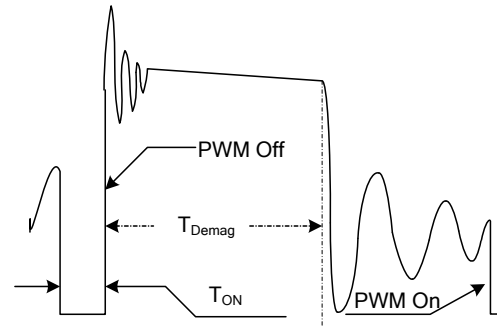


Figure.1 Primary voltage waveform

Since  $T_{Demag}$  is direct proportional to the inductance, as a result, the product of  $L_P$  and  $F_{SW}$  is constant, thus output current will not change as primary winding inductance changes. The output LED current is

$$I_{LED} = \frac{1}{4} N \frac{|V_{th\_ocp}|}{R_{CS}} \quad (3)$$

Where  $V_{th\_ocp}$  is over current threshold.

### Adjustable CC point and Output Power

In OB5681x, the CC point and maximum output power can be externally adjusted by external current sense resistor  $R_{CS}$  at CS pin as illustrated in Typical Application Diagram. The output power is adjusted through CC point change. The larger  $R_{CS}$ , the smaller CC point is, and the smaller output power becomes.

### Operation Switching Frequency

The switching frequency of OB5681x is adaptively controlled according to the load conditions and the operation modes. No external frequency setting components are required.

For flyback operating in DCM, The operation frequency is given by

$$F_{SW} = \frac{V_O \cdot N^2}{8 \cdot L_P \cdot I_{LED}} \quad (4)$$

The switching frequency at maximum output power is recommended 40kHz~75kHz.

### Current Sensing and Leading Edge Blanking

Cycle-by-Cycle current limiting is offered in OB5681x. 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.

### LED Short Circuit Protection

OB5681x detects the states of LED. When LED string short circuit occurs, the switching frequency is reduced to the minimum switching frequency with maximum  $T_{off}$  time. OB5681x resumes normal operation after the fault condition is removed.

### Programmable LED Open Circuit Protection / OVP

The OB5681x provide programmable output over voltage protection when LED string is open. The threshold voltage of OVP is set by the minimum off time (Toff\_min), when the off time of OB5681x is less then the Toff\_min OB5681x stops switching and re-detect the LED string status after 150ms (typical). If the fault condition is removed, OB5681x resumes normal operation. Otherwise, the above operation is repeated. The minimum off time (Toff\_min) is given by

$$T_{off\_min} = \frac{L_P \cdot V_{th\_ocp}}{N \cdot V_{OVP} \cdot R_{CS}} \quad (5)$$

Where Vovp is threshold voltage of OVP.

A resistor Rovp is connected between the OVP pin and ground. The minimum off time (Toff\_min) can be adjusting the resistance of Rovp, the resistance is given by

$$R_{OVP} = \frac{0.05}{T_{off\_min}} \quad (6)$$

And the resistance range of Rovp should be 5K~16K for Toff\_min setting.

When OVP pin floating, Toff\_min is set to 4.7us internally.

The OB5681x OVP pin provides on/off function, when the voltage of OVP pin less than 0.2V (typical), OB5681x stops switching.

### Thermal Foldback

OB5681x provides thermal foldback function to control LED output current. The LED current

will reduce with the temperature rise up. When the temperature is over 140 °C (typical), the output current follows the thermal foldback function scheme. When the temperature is below 140 °C (typical), the output current returns to the full level.

### PCB layout Consideration

The green wiring of R1, C2, C3, GND(U1), Rcs connected between each other must be shortest and separately.

The red wiring of ground CS(U1) must be connected to ground(Rcs) pin, and the wiring shortest and separately. The ground(Rcs) pin connected to ground(C1) must be shortest as separately.

The purple wiring must be shortest as possible.

The pink wiring is high voltage and frequency interference route, must shortest and keep away other routes as possible.

All components connected to U1 should be nearly around.

Minimize the area of the following power loops.

- The power loops of D1/2(K) → C1+ → D3/4(A).
- The power loops of C1+ → Tnp → C(U1) → Rcs → C1-.
- The power loops of Tns+ → D1 → Co → Tns-.

Other considerations are described in detail in the figure 2 below.

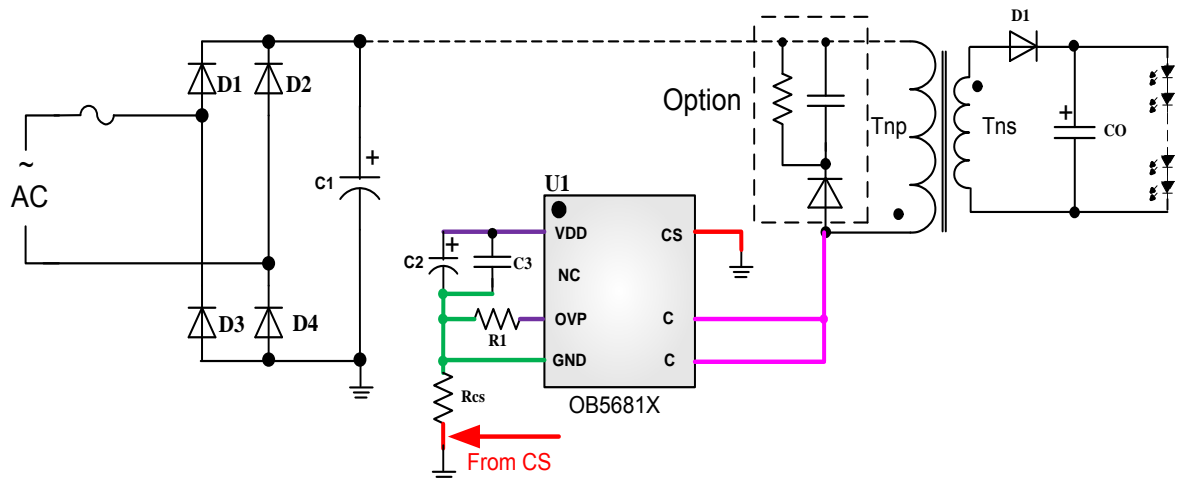
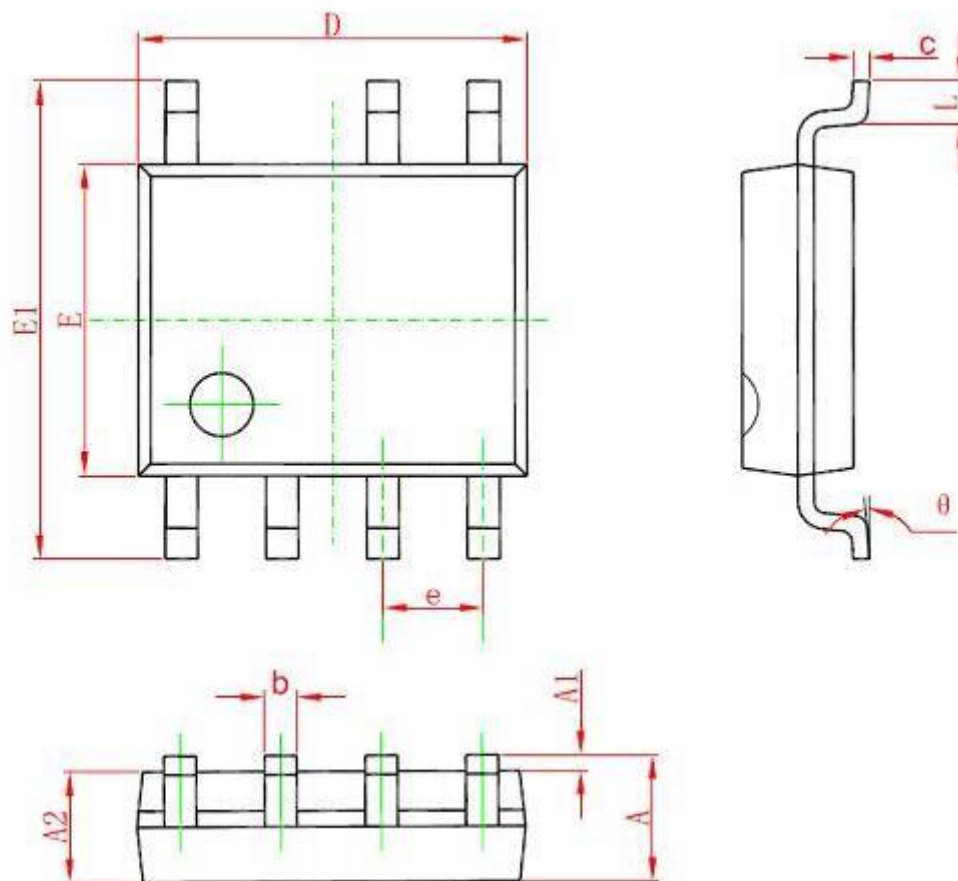


Figure.2 PCB layout guide

**PACKAGE MECHANICAL DATA**
**SOP7**


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.650	0.049	0.065
b	0.310	0.510	0.012	0.020
c	0.100	0.250	0.004	0.010
D	4.700	5.150	0.185	0.203
E	3.700	4.100	0.146	0.161
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°



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