OB3330

High Performance LED Lighting Driver

GENERAL DESCRIPTION

The OB3330 is power factor correction, primary-side-control LED lighting driver with advanced features to provide high efficiency control for lighting applications.

OB3330 features an internal start-up timer for stand-alone applications, an analog multiplier for power factor correction (PFC), zero current detectors (ZCD) to ensure transition mode (TM) operation, a current sensing comparator with built-in leading-edge blanking, and a totem pole output.

OB3330 offers great protection coverage including VCC under voltage lockout (UVLO), VCC over voltage protection, load voltage over voltage protection, Level selectable cycle-by-cycle current limiting, over temperature protection, LED open/short circuit protection and gate drive output clamping for external power MOSFET protection.

FEATURES

- Primary-Side Control with Single Stage PFC Topology
- Minimized BOM Count
- Transition Mode (TM) Operation to Achieve High Efficiency
- Analog multiplier for Power Factor Correction
- High Current Accuracy
- Cycle-by-Cycle Current Limiting (OCP)
- Selectable Threshold of OCP
- VCC Over Voltage Protection
- Output Over Voltage Protection
- Over-temperature Protection
- LED Open Circuit Protection
- LED Short Circuit Protection
- Soft-start
- VCC Under Voltage Lockout (UVLO)
- Ultra-low Start-up Current

APPLICATIONS

- LED Lighting
- Industrial and Commercial lighting
- Residential lighting

TYPICAL APPLICATION

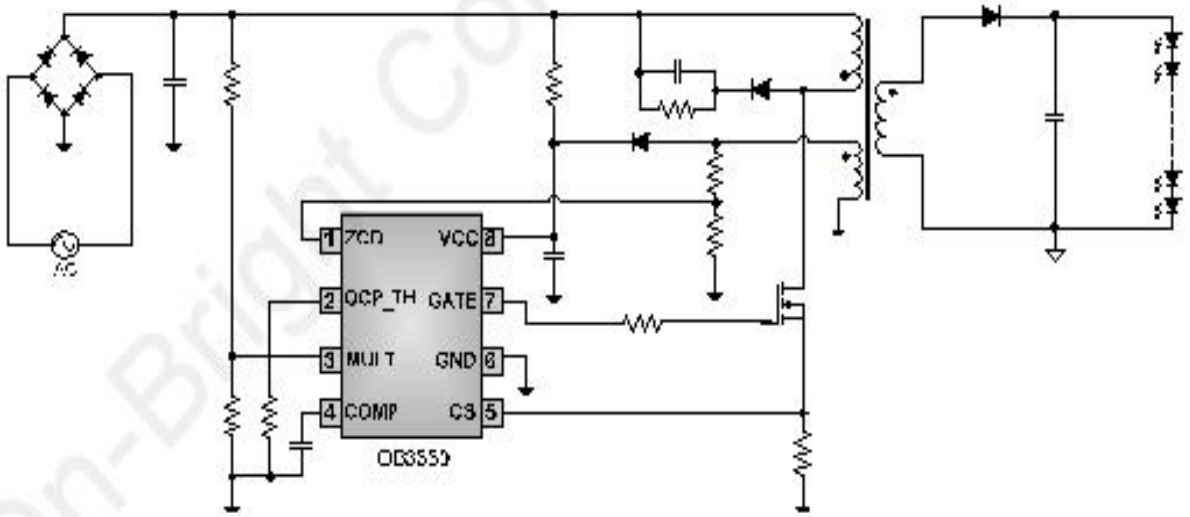


Figure1: OB3330 Typical Application Schematic

Absolute Maximum Ratings

Parameter	Value
VCC Input Voltage to GND	-0.3V to 40V
GATE to GND	-0.3V to 40V
I/O (except GATE) to GND	-0.3V to 7V
Operating Ambient Temp. T_A	-20℃ ~ 85℃
Operating Junction Temp. T_J	-40 ~150℃
Min/Max Storage Temp. T_{stg}	-55~150℃
Lead Temp. (10 Sec)	260 ℃

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.

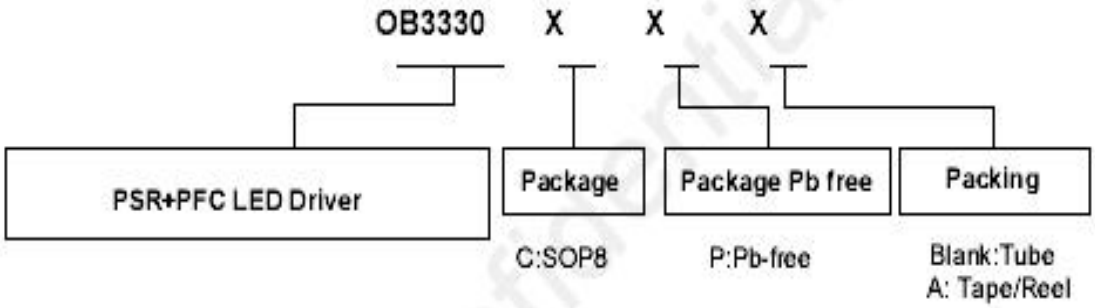
Recommended Operating Range

Parameter	Value
VCC Voltage	11V to 25V

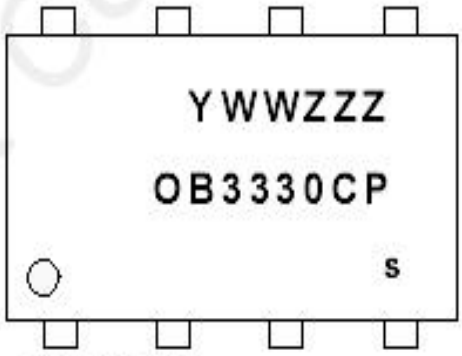
Ordering Information

Part Number	Description
OB3330CP	8 Pin SOP, Pb free in Tube
OB3330CPA	8 Pin SOP, Pb free in T&R

Note: All Devices are offered in Pb-free Package if not otherwise noted.



Marking Information



Y: Year Code

WW: Week Code (01-52)

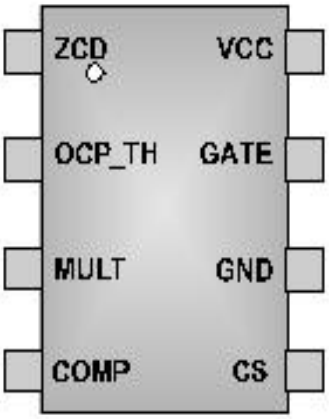
ZZZ: Lot Code

C: SOP8

P: Pb-free Package

S: Internal Code(Optional)

Pin Configuration for OB3330



Terminal Assignment for OB3330

Number	Pin Name	I/O	Pin Function
1	ZCD	I	Zero current detection pin. When activated, a new switching cycle starts. Connect this pin through a resistor divider from the auxiliary winding to ground. This pin is also used for output over voltage protection (OVP).
2	OCP_TH	I/O	OCP threshold level selecting pin. Connected an external resistor to ground to select the OCP threshold voltage.
3	MULT	I	Input of multiplier pin. Connected this pin to line voltage after bridge diodes via a resistor divider to provide sinusoidal reference voltage to the current loop.
4	COMP	I/O	Loop compensation pin. Connect a compensation network to stabilize the LED driver and achieve a constant LED driver current.
5	VCC	P	DC supply voltage pin.
6	GATE	O	Gate drive output pin.
7	GND	P	Ground pin.
8	CS	I	Current sense input pin.

Functional Block Diagram

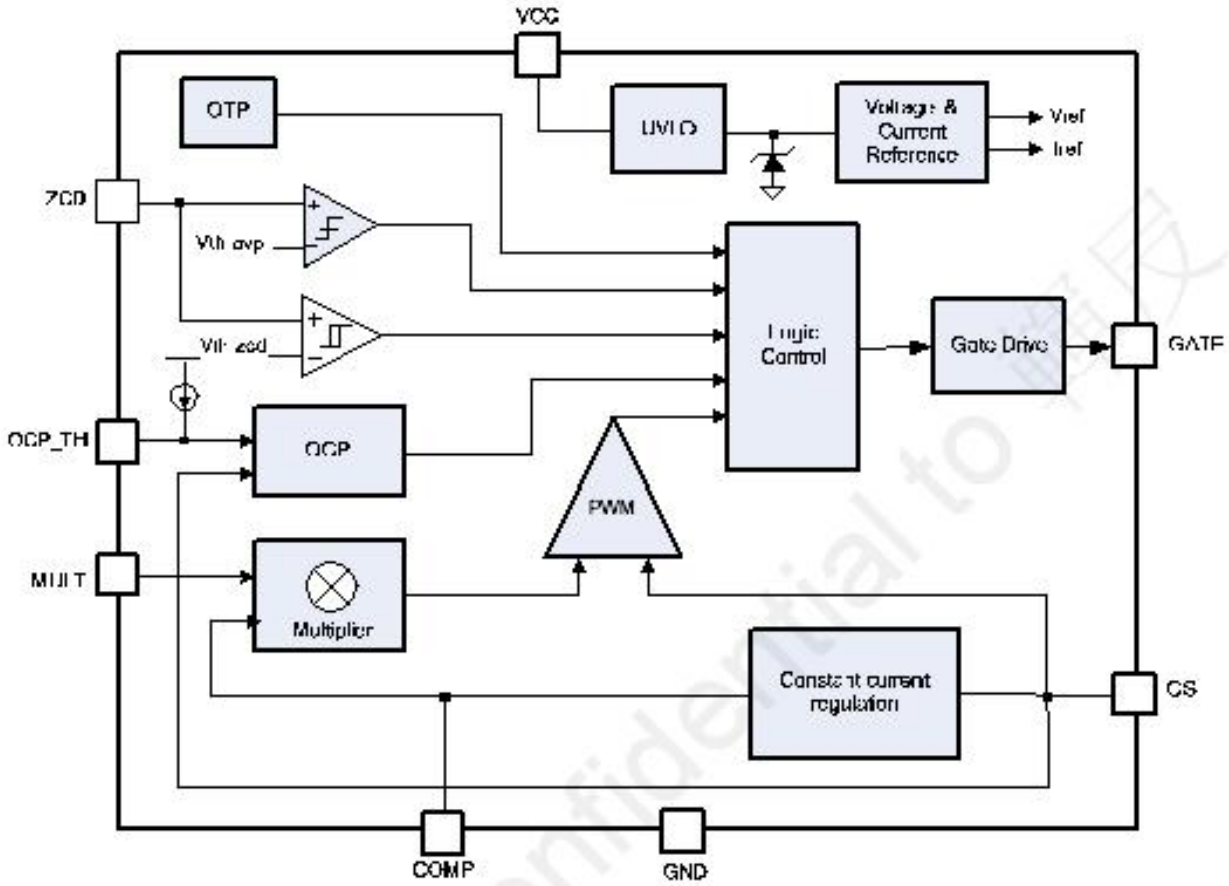


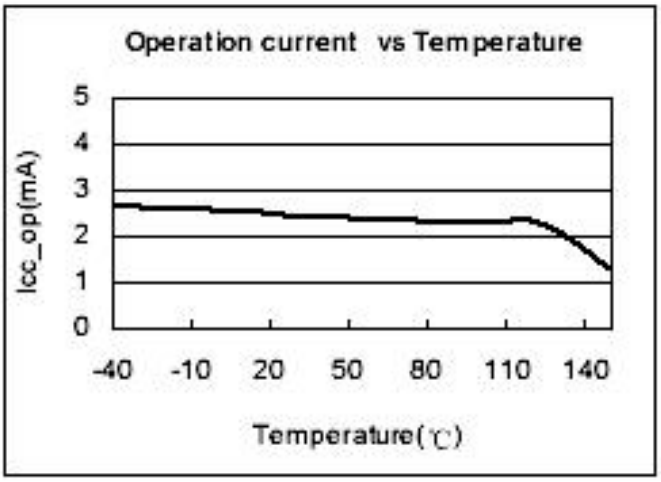
Figure2: OB3330 Functional Block Diagram

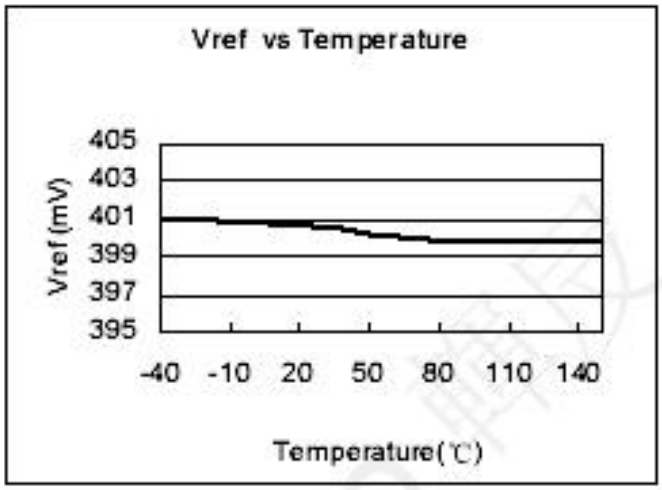
Electrical Characteristics

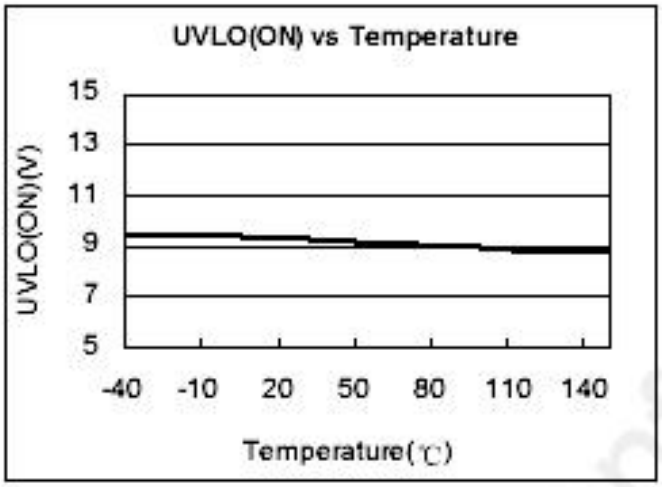
VCC=16V, T_A=25℃, if not otherwise noted.

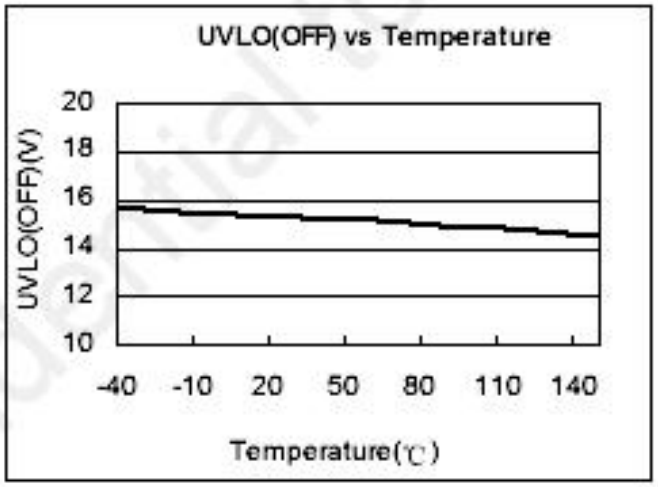
Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Supply Voltage Section						
I_VCC_ST	Standby Current	VCC=14V		5	15	uA
I_static	Static Current	VCC=16V, no switching		1.5	2	mA
UVLO(ON)	VCC Under Voltage Lockout Enter	VCC falling	8	9	10	V
UVLO(OFF)	VCC Under Voltage Lockout Exit	VCC rising	13.6	14.6	15.6	V
VCC_clamp	VCC Clamp Protection			32		V
VCC_OVP	VCC Over Voltage Protection			30		V
Current Sense Section						
T_leb	Lead Edge Blanking Time			300		nS
Td_oc	OCP Propagation Delay	From OCP comparator to Gate drive		100		ns
I_{OCP_TH}	Source current of OCP_TH PIN	VCC=16V	17	28	39	uA
Vth_OCP	Threshold voltage of over current protection	0V<V_{OCP_TH}<0.3V		2.1		V
		0.3V<V_{OCP_TH}<1.5V		1.8		V
		V_{OCP_TH}>1.5V		1.5		V
Multiplier Section						
Vmult	Linear Operating Range	COMP=3V	0 to 3			V
ΔVcs/ΔVmult	Output Max. Slope	MULT=from 0 to 0.5V, COMP=4V		2.8		V/V
K	Gain	MULT=1V, COMP=2.2V	0.6	0.75	0.9	1/V
ZCD Section						
Vovp	Output Over Voltage Protection	1us delay after turn off	3.8	4	4.2	V
Vzcd_low	ZCD Low Voltage Detection			0.9		V
Vth_dem_H	When ZCD rise up this voltage, demagnetization began			0.9		V
Vth_dem_L	When ZCD drop below this voltage, demagnetization finished			0.3		V
Gm amplifier section						
Vref	EA Reference Voltage		394	400	406	mV
Gm	EA Transconductance Gain			80		uS
Gain	DC gain		60	70		dB
Vout	Dynamic range		1.2~4.5			V
Vcomp_h	Upper clamp voltage				6	V
Vcomp_l	Lower clamp voltage			1.2		V
Isource_max	EA Maximum Source Current			100		uA
Isink_max	EA Maximum Sink Current			32		uA
Watch Dog Section						
Toff_max	Re-start timer period			55		us
Toff_min	Minimum off time			3.5		us
Ton_max	Maximum on time			50		us
OTP Section						
OTP_on	Over Temperature Protection		120	140	160	℃
Gate Drive Output Section						
Vol	Output Low Level	VCC=16V@ Iout=100mA			1.5	V
Voh	Output High Level	VCC=16V@ Iout=100mA	8			V
Vclamp	Output Clamping Voltage	Vcc=28V		11	12.5	V
Tr	Rising Edge Time	CL=1nF, 10~90%		80	150	nS
Tf	Falling Edge Time	CL=1nF, 10~90%		30	70	nS

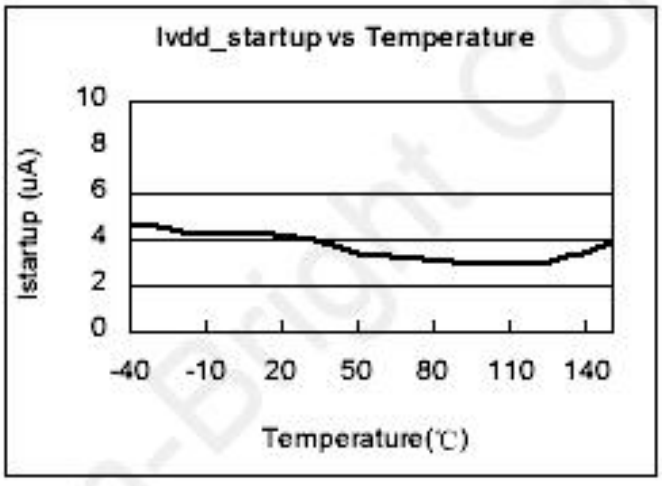
TYPICAL PERFOMANCE CHART

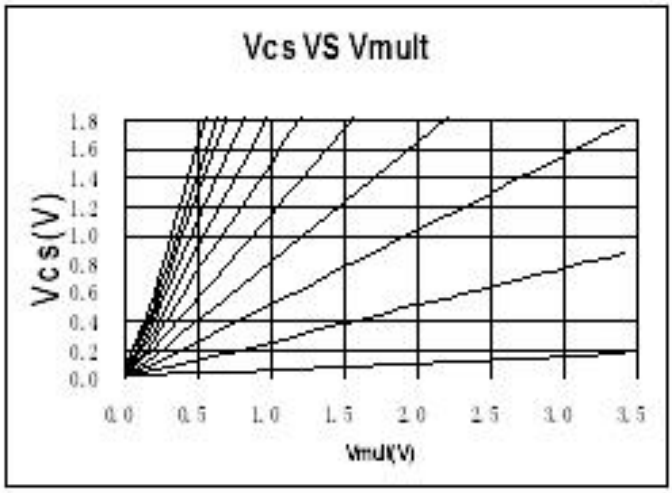












Function Description

General Operation

The OB3330 is a primary-side-control and high power factor flyback PWM controller specialized for LED lighting application. It operates in primary side sensing and regulation, thus opto-coupler and TL431 are not required. The transition mode control greatly reduces the switch turn-on loss, improves the conversion efficiency. It provides very good power factor.

The principle of operation can be understood by referring to the block diagram.

Startup

The typical startup current of OB3330 is 5uA when VCC pin is lower than the UVLO_off threshold. VCC is charged through the start up resistor from the AC line. A high value, low wattage startup resistor can be used to minimize the power loss.

UVLO

An under-voltage lockout protection features with a hysteresis of about 5.6V is provided for VCC. When the voltage at this pin exceeds a threshold of approximately 14.6V, the IC starts the normal operation. If the voltage at this pin drops below a threshold of approximately 9V, the IC stops switching operation. The IC resumes switching operation when the voltage at pin VCC recovers to a voltage above 14.6V.

LED Constant Current Regulation

OB3330 use the primary side constant current control method to accurately control the LED current. The LED mean current can be approximated as:

$$I_{LED}[mA] = \frac{N}{2} * \frac{400[mV]}{R_{CS}[\Omega]}$$

N—Turn ratio of primary side winding to secondary side winding.

Rcs—the sensing resistor connected between the MOSFET source and GND.

Current Sensing

Cycle-by-Cycle current limiting (OCP) is offered in OB3330. The switch current is detected by a sense resistor connecting the CS pin to GND. An internal leading edge blanking circuit chops off the sense voltage spike at initial MOSFET on state due to Snubber diode reverse recovery so that the external RC filtering is no longer required. The current limit comparator is disabled and thus cannot turn off the external MOSFET during the blanking period. PWM duty cycle is determined by the current sense voltage and the voltage at pin COMP.

Threshold of OCP Selection

The threshold voltage level of OCP is selected by the voltage of OCP_TH pin. The OB3330 provides the source current equal to approximately 28uA through OCP_TH pin. So the proper resistor can be connected with the OCP_TH pin to GND in order to generate the voltage needed. If OCP_TH pin is connected with 33K resistor, the threshold voltage of OCP is about 1.8V; If OCP_TH pin is connected with 110K resistor, the threshold voltage of OCP is about 1.5V; If OCP_TH Pin is connected with GND directly, the threshold voltage of OCP is about 2.1V.

Voltage of OCP_TH Pin	Connecting State of OCP_TH	Threshold Voltage of OCP
3V	110K	1.5V
0.9V	33K	1.8V
0V	GND	2.1V

Zero Current Detection

OB3330 performs zero current detection (ZCD) through ZCD pin by monitoring the voltage activity on the auxiliary windings in series with external resistors. This voltage features a flyback polarity. When the stored energy of the flyback transformer is fully released to the output, the voltage at ZCD pin decreases. When ZCD pin voltage falls below 0.3V, an internal ZCD comparator is triggered and a new PWM switching cycle is initiated following the ZCD triggering.

Maximum and Minimum On-Time

The minimum on-time of the system is determined by the LEB time (typical 300ns). The IC limits the on-time to a maximum time of approximately 50us.

Maximum Frequency Clamp

According to Transition Mode (TM) Operation principle, the switching frequency is inversely proportional to the output power. Therefore, when the output power decreases, the switching frequency can become rather high without limiting. The maximum switching frequency in OB3330 is internally limited to approximately 300kHz.

Multiplier for Power Factor Correction

The built-in analog multiplier output limits the peak current of primary winding with respect to the AC half wave rectified input voltage. Through controlling the CS comparator threshold as the AC line voltage traverses sinusoidally from zero to peak line voltage, the load appears to be resistive to the AC line and close to unity power factor can be achieved.

Output OVP Protection

An output over-voltage condition is monitored independently by the voltage at pins ZCD. During normal operation, when the voltage at ZCD pin exceeds a threshold of approximately 4.0V, the over-voltage protection function is activated and the GATE is turned off immediately.

VCC OVP and Clamping Protection

VCC is supplied with transformer auxiliary winding output. It is clamped if VCC exceeds 35V. When VCC is higher than 30V, OVP protection is triggered and GATE is shut down, so the device enters power on startup sequence thereafter.

LED String Short Protection

When LED string is short, the positive plateau of auxiliary winding voltage is also near zero and the ZCD voltage is low. If the voltage at ZCD pin is lower than a threshold of approximately 0.9V and lasts more than 10ms, the IC will shut down.

LED String Open Protection

When the LED string open circuit happens, the positive plateau of auxiliary winding voltage increases and the ZCD voltage is high. If the voltage at ZCD pin is higher than a threshold of approximately 4V, OB3330 will shut down and restart again.

Thermal Shutdown

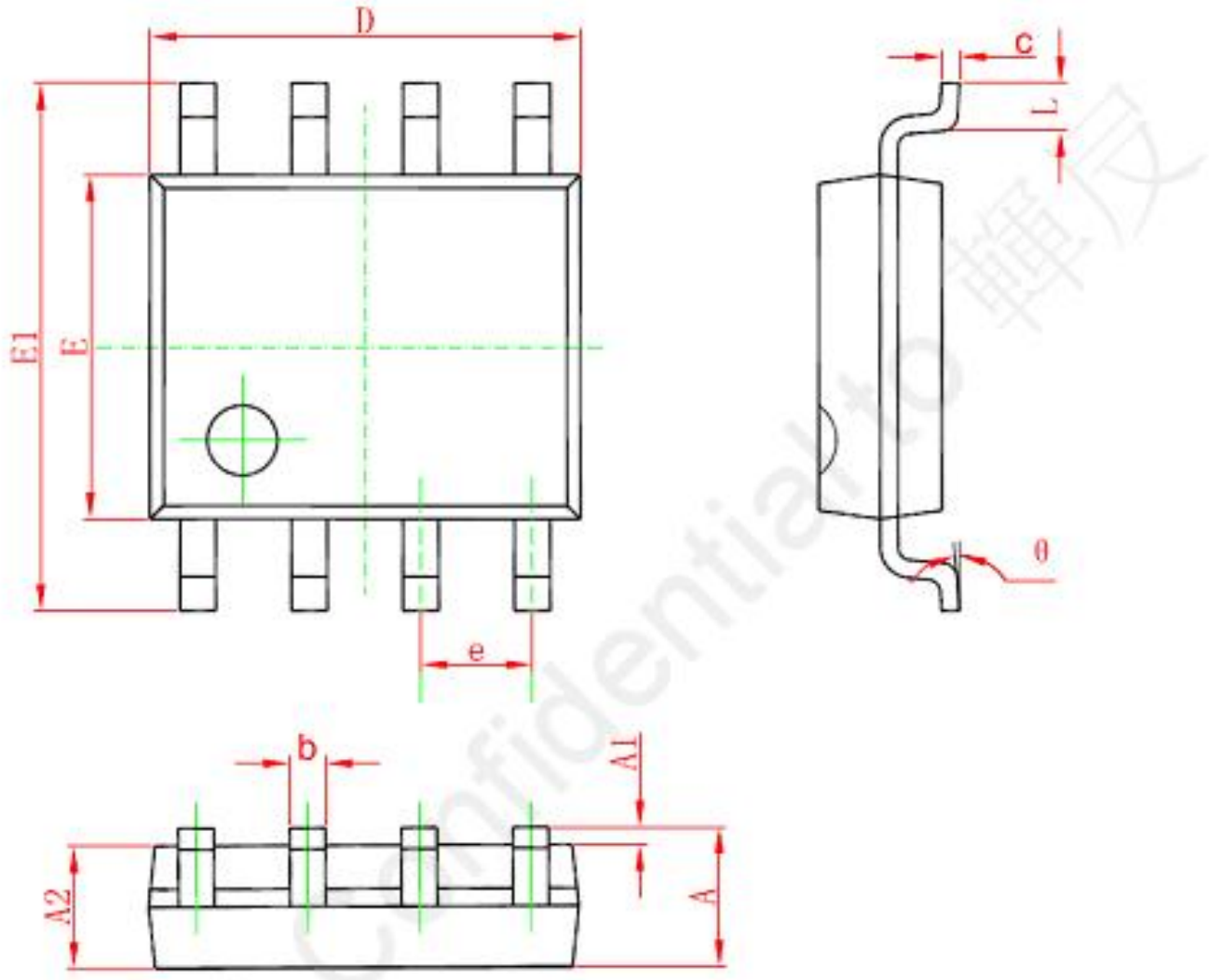
OB3330 provides an on chip thermal shutdown. The IC will stop switching when the junction temperature exceeds the thermal shutdown temperature, typically 140 °C.

Gate Drive Output

OB3330 Gate is connected to an external MOSFET gate for power switch control. Too weak the gate drive strength results in higher conduction and switch loss of MOSFET while too strong gate drive output compromises the EMI.
A good tradeoff is achieved through the built-in totem pole gate design with right output strength and dead time control. The low idle loss and good EMI system design is easier to achieve with this dedicated control scheme. The built-in 11V clamp at the gate output protects the MOSFET gate from high voltage stress.

PACKAGE MECHANICAL DATA

SOP8 PACKAGE OUTLINE DIMENSIONS



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	3.800	4.000	0.150	0.157
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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