

### GENERAL DESCRIPTION

PR624X is a current Mode power switch, exhibit extra low standby power consumption (<100mW).

PWM switching frequency at normal operation is internally fixed. At no load or light load condition, It operates in hiccup mode to minimize switching loss. Lower standby power and higher conversion efficiency is thus achieved.

PR624X offers power on soft start control and rich protection coverage with auto-recovery features including VDD under voltage lockout (UVLO), VDD over voltage protection (OVP), Cycle-by-Cycle current limiting (OCP), over load protection (OLP), over temperature protection (OTP).

Excellent EMI performance is achieved with PR624X proprietary frequency hiccup technique. The frequency at below 22KHZ is minimized to avoid audible noise during operation.

PR624X is offered in both DIP-7L and SOP-7L package.

### FEATURES

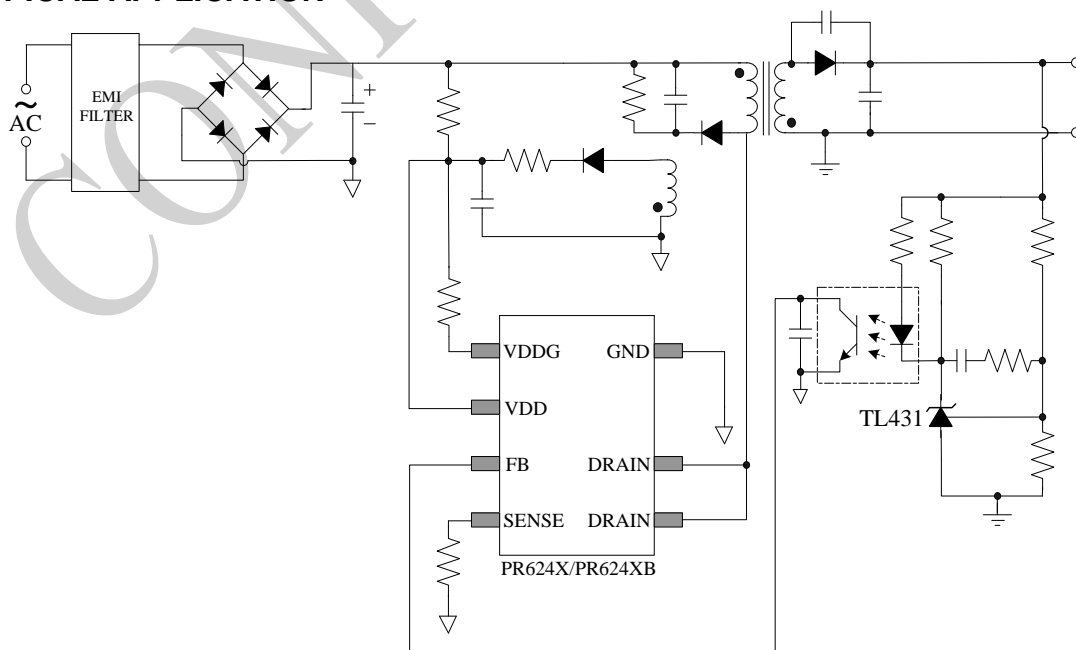
- Extra Low Standby (<100mW)
- Power on Soft Startup
- Frequency spreading to Minimize EMI
- Audible Noise Free Operation
- Fixed 50KHz/60KHz Switching Frequency
- Comprehensive Protection
  - VDD Under Voltage Lockout with Hysteresis (UVLO)
  - Cycle-by-cycle Over Current Protection (OCP)
  - Overload Protection (OLP) with Auto-recovery
  - Over Temperature Protection (OTP)
  - VDD Over Voltage Protection (OVP)

### APPLICATIONS

Offline AC/DC Flyback Converter For

- AC/DC Adapter
- PDA Power Supplies
- Digital Cameras and Camcorder Adapter
- VCR, SVR, STB, DVD&DVCD Player SMPS
- Set-Top Box Power
- Auxiliary Power Supply for PC and Server
- Open-frame SMPS

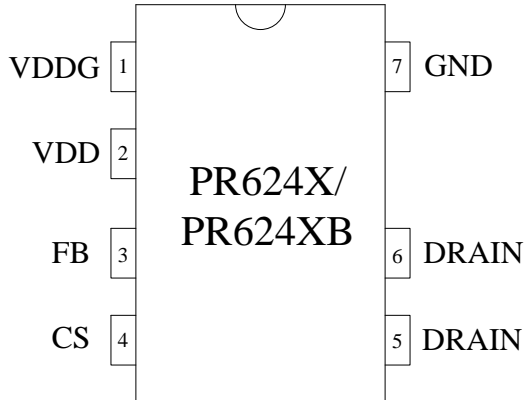
### TYPICAL APPLICATION



## GENERAL INFORMATION

### Pin Configuration

The PR624X/PR624XB is offered in both DIP-7L and SOP-7L package, shown as below.



### Absolute Maximum Ratings

Parameter	Value
Drain Voltage (off state)	-0.3 to BV <sub>dss</sub>
VDD DC Supply Voltage	-0.3 to 30V
VDDG DC Supply Voltage	-0.3 to 30V
VDD Zener Clamp Voltage <sup>Note</sup>	VDD_Clamp+0.1V
VDD DC Clamp Current	10 mA
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
Min/Max Storage Temperature T <sub>stg</sub>	-55 to 150 °C
Lead Temperature (Soldering, 10secs)	260°C

**Note:** VDD\_Clamp has a nominal value of 26.5V.

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 period may affect device’s reliability.

### Package Dissipation Rating

Package	R <sub>ja</sub> (°C/W)
DIP-7L	65
SOP-7L	150

## TERMINAL ASSIGNMENTS

Pin Num	Pin Name	I/O	Description
1	VDDG	P	Internal Gate Driver Power Supply
2	VDD	P	IC DC power supply Input
3	FB	I	Feedback input pin. The PWM duty cycle is determined by voltage level into this pin and the current-sense signal at Pin 4.
4	CS	I	Current sense input
5/6	DRAIN	O	HV MOSFET Drain Pin. The Drain pin is connected to the primary lead of the transformer.
7	GND	P	Ground

## RECOMMENDED OPERATING CONDITION

Symbol	Parameter	Min/Max	Unit
VDD	VDD Supply Voltage	10.5 to 23.5	V
T <sub>A</sub>	Operating Ambient Temperature	-20 to 85	°C

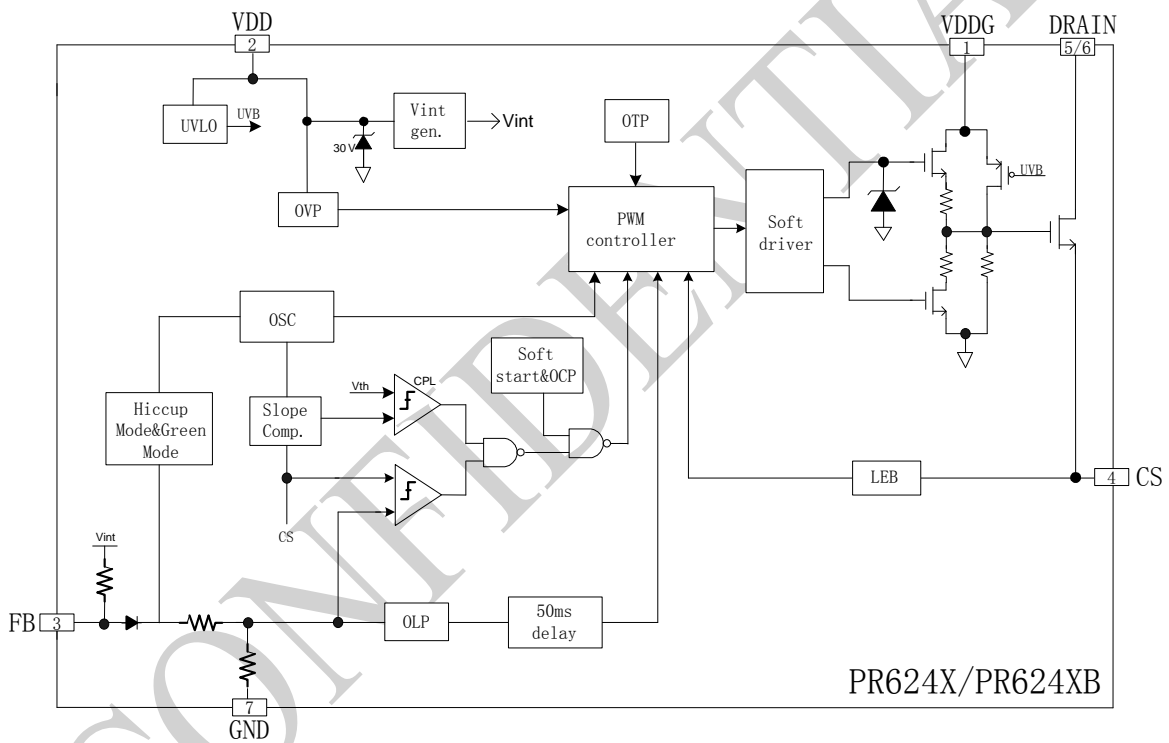
## Output Power Table

	Package	230VAC $\pm 15\%$	85-265VAC
		Open Frame <sup>1</sup>	Open Frame <sup>1</sup>
PR6241T/PR6241BT	DIP-7L	10W	8.5W
PR6244S/PR6244BS	SOP-7L	10W	8W
PR6244T/PR6244BT	DIP-7L	15W	12W
PR6248T/PR6248BT	DIP-7L	21W	18W
PR6249T/PR6249BT	DIP-7L	28W	24W

Notes:

1. Maximum practical continuous power in an open frame design with sufficient drain pattern as a heat sink, at 50°C ambient.

## BLOCK DIAGRAM



**ELECTRICAL CHARACTERISTICS**

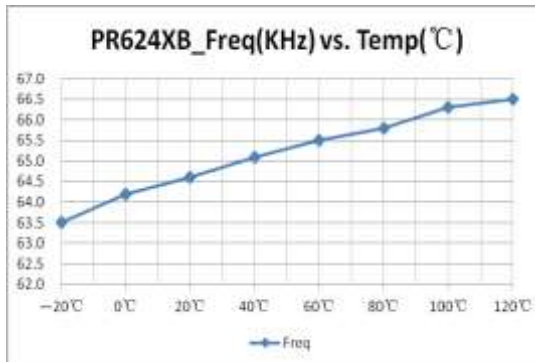
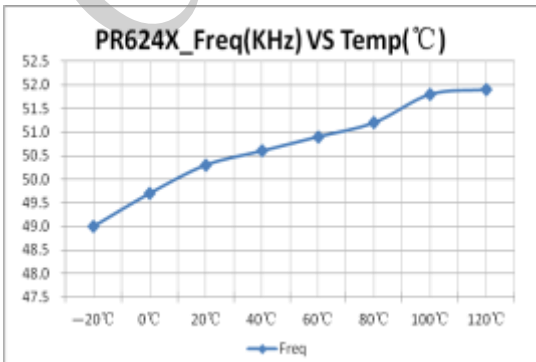
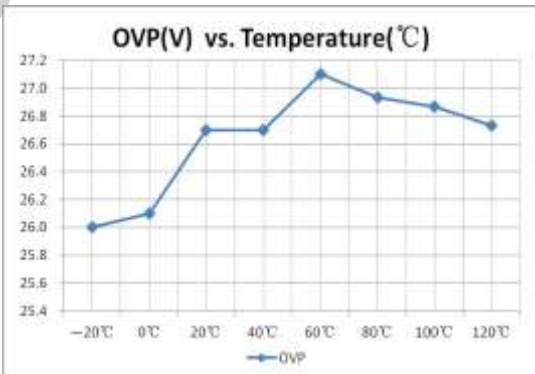
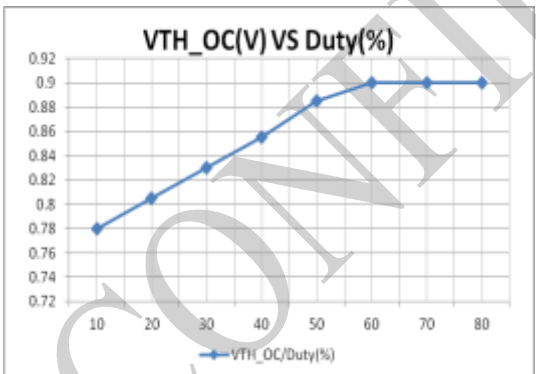
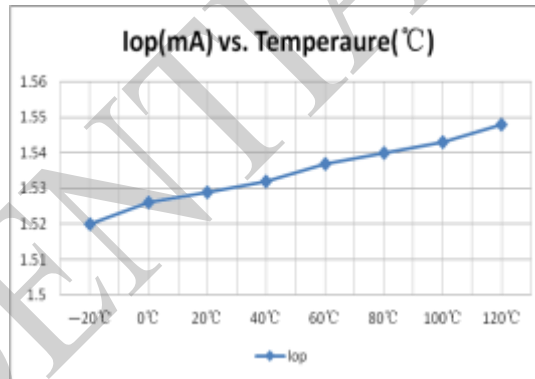
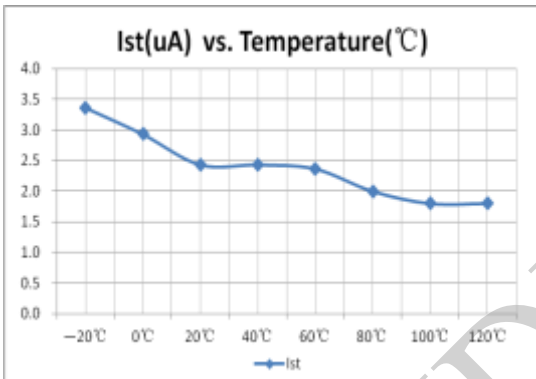
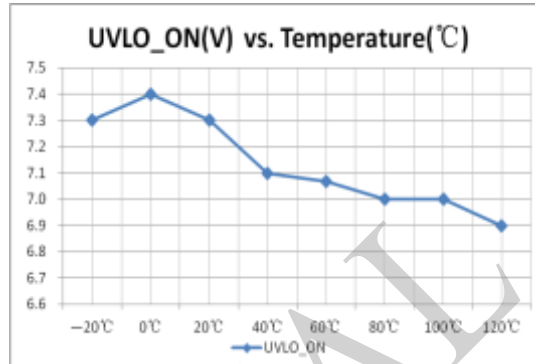
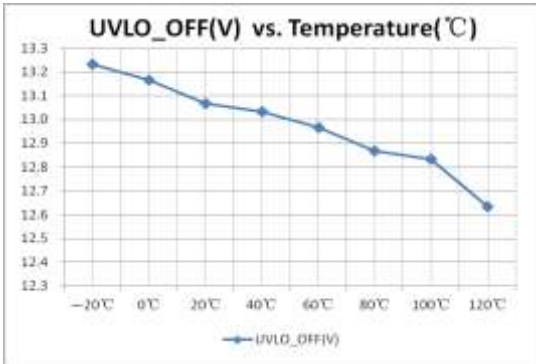
(TA = 25°C, VDD=15V, unless otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
<b>Supply Voltage (VDD)</b>						
Ist	VDD Start up Current	VDD=UVLO_OFF-1 V, measure leakage current into VDD		5	20	μA
I_VDD_Operation	Operation Current	V <sub>FB</sub> =3V		1.5	3.0	mA
	Hiccup Mode Current	VDD=15V, V <sub>FB</sub> =1V		0.8		mA
UVLO(ON)	VDD Under Voltage Lockout Enter		6.5	7.5	8.5	V
UVLO(OFF)	VDD Under Voltage Lockout Exit (Recovery)		12.0	13.0	14.0	V
Vpull_up	Pull-up PMOS active			13		V
VDD_Clamp		I <sub>VDD</sub> =10mA		30.0		V
OVP_ON	Over voltage protection voltage	FB=3V Ramp up VDD until gate clock is off	25.0	26.5	28.0	V
<b>Feedback Input Section(FB Pin)</b>						
VFB_Open	VFB Open Loop Voltage			4.6		V
Avcs	PWM input gain ΔVFB/ΔVCS			1.71		V/V
Maximum duty cycle	Max duty cycle		75	80	85	%
Vref_green	The threshold enter green mode			1.7		V
Vref_HH	The threshold exit hiccup mode			1.35		V
Vref_HL	The threshold enter hiccup mode			1.25		V
I <sub>FB_Short</sub>	FB pin short circuit current	Short FB pin to GND and measure current		250		μA
VTH_PL	Power Limiting FB Threshold Voltage			3.5		V
TD_PL	Power limiting Debounce Time		40	50	60	mSec
Z <sub>FB_IN</sub>	Input Impedance			16		Kohm
<b>Current Sense Input(CS Pin)</b>						
SST	Soft start time			5		ms
T_blanking	Leading edge blanking time			320		ns
Z <sub>SENSE_IN</sub>	Input Impedance			40		Kohm
T <sub>D_OC</sub>	Over Current Detection and Control Delay	From Over Current Occurs till the gate driver output starts to turn off		120		nSec
V <sub>TH_OC</sub>	Current Limiting Threshold Voltage with zero duty cycle			0.76		V

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Vocp_clamping	Current limiting threshold at maximum Duty			0.90		V
<b>Oscillator</b>						
F <sub>osc</sub>	Normal Oscillation Frequency @ FB=3V	PR624X	45	50	55	KHz
		PR624XB	60	65	70	KHz
Δf <sub>OSC</sub>	Frequency jittering			+/-4		%
F <sub>shuffling</sub>	Shuffling frequency			25		Hz
Δf <sub>Temp</sub>	Frequency Temperature stability			2		%
Δf <sub>VDD</sub>	Frequency Voltage Stability			1		%
F <sub>Hiccup</sub>	Hiccup Mode Switch Frequency			22		KHz
<b>MOSFET Section</b>						
BV <sub>dss</sub>	MOSFET Drain-Source Breakdown voltage		600			V
R <sub>dson</sub>	Static, I <sub>d</sub> =1.0A	PR6241/PR6241B		8.0	9.5	Ω
		PR6244S/PR6244BS		5.0	5.8	Ω
		PR6244/PR6244B		5.0	5.8	Ω
		PR6248/PR6248B		3.0	3.6	Ω
		PR6249/PR6249B		2.0	2.5	Ω
<b>On Chip OTP</b>						
OTP	Over temperature protection trip point with Recommended PCB layout.			145		°C

**CHARACTERIZATION PLOTS**

VDD = 15V, TA = 25°C condition applies if not otherwise noted.



## OPERATION DESCRIPTION

PR624X/PR624XB is a highly integrated current mode PWM Power Switch optimized for high performance, extra low standby power consumption and cost effective offline flyback converter applications. The 'hiccup mode' control greatly reduces the standby power consumption (less than 50mW) and helps the design easily to meet the international power conservation requirements.

### Startup Current and Start up Control

Startup current of PR624X/PR624XB is designed to be very low so that VDD could be charged up above UVLO threshold level and device starts up quickly. A large value startup resistor can therefore be used to minimize the power loss yet achieve a reliable startup in application. For AC/DC adaptor with universal input range design, a 2 M $\Omega$ , 1/8 W startup resistor could be used together with a VDD capacitor to provide a fast startup and yet low power dissipation design solution.

### Operating Current

The Operating current of PR624X/PR624XB is 1.5mA. Good efficiency is achieved with this low operating current together with the 'hiccup mode' control features. The operation current is greatly reduced at no/light conditions such that extra low standby (less than 50mW) can be achieved.

### Soft Start

PR624X/PR624XB features an internal typical 5ms soft start to soften the electrical stress occurring in the power supply during startup. It is activated during the power on sequence. As soon as VDD reaches UVLO (OFF), the primary winding current is controlled to be gradually increased to the maximum level. Every restart up is followed by a soft start.

### Frequency spreading for EMI improvement

The frequency spreading (switching frequency modulation) is implemented in PR624X/PR624XB. The oscillation frequency is modulated so that the tone energy is spread out. The spread spectrum minimizes the conduction band EMI and therefore eases the system design.

### Green Mode Operation

PR624X/PR624XB provides green-mode control to reduce the switching frequency in light-load and no-load conditions.  $V_{FB}$ , which is derived from the voltage feedback loop, is taken as the reference. Once  $V_{FB}$  is lower than

the threshold voltage ( $V_{ref\_green}$ ), switching frequency is continuously decreased to the minimum green-mode frequency of around 22 KHz.

### Extended Hiccup Mode Operation

At light load or zero load condition, most of the power dissipation in a switching mode power supply is from switching loss on the MOSFET, the core loss of the transformer and the loss on the snubber circuit. The magnitude of power loss is in proportion to the switching frequency. Lower switching frequency leads to the reduction on the power loss and thus conserves the energy.

The switching frequency is internally adjusted at no load or light load condition. The switching frequency is reduced at light/no load condition to improve the conversion efficiency. At light load or no load condition, the FB input drops below hiccup mode threshold voltage ( $V_{ref\_H\_L}$ ) and device enters Hiccup Mode control. The gate driver output switches only when FB voltage is higher than the threshold voltage ( $V_{ref\_H\_H}$ ) to output an on state. Otherwise the gate drive remains at off state to minimize the switching loss and reduces the standby power consumption to the greatest extend.

The switching frequency control also eliminates the audible noise at any loading conditions.

### Oscillator Operation

The switching frequency is internally fixed at 50KHz/60KHz. No external frequency setting components are needed for PCB design simplification.

### Current Sensing and Leading Edge Blanking

Cycle-by-Cycle current limiting is offered in PR624X/PR624XB current mode PWM control. The switching current is detected by a sense resistor connected to the CS pin. An internal leading edge blanking circuit chops off the sensed voltage spikes due to snubber diode reverse recovery and surge gate current of power MOSFET at initial internal power MOSFET on state. The current limiting comparator is disabled and cannot turn off the internal power MOSFET during the blanking period. The PWM duty cycle is determined by the current sense input voltage and the FB input voltage.

**Internal Synchronized Slope Compensation**

Built-in slope compensation circuit adds voltage ramp onto the current sense input voltage for PWM generation. This greatly improves the close loop stability at CCM and eliminates the subharmonic oscillation and thus reduces the output ripple voltage.

**Driver**

The internal power MOSFET in PR624X/PR624XB is driven by a dedicated gate driver for power switching control. Too weak the gate driver results in higher conduction and switch loss of power MOSFET while too strong gate driver results in the compromise of EMI.

A good tradeoff is achieved through the built-in totem pole gate design with well controlled output strength and dead time control. The low idle loss and good EMI system design is achieved with this dedicated control scheme.

**Protection Controls**

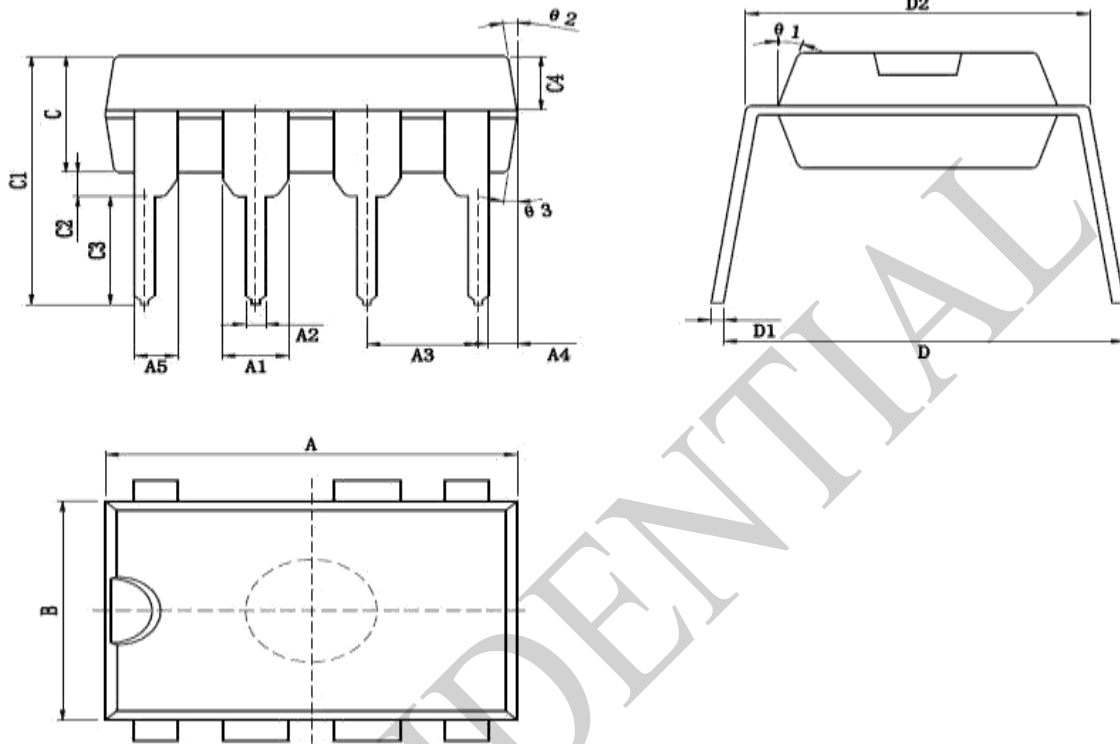
Good power supply system reliability is achieved with auto-recovery protection features including VDD under voltage lockout (UVLO), VDD over voltage protection (OVP), Cycle-by-Cycle current limiting (OCP), over load protection (OLP), over temperature protection (OTP). The OCP is line voltage compensated to achieve constant output power limit over the universal input voltage range.

At overload condition, when FB input voltage exceeds power limit threshold value for more than TD\_PL, control circuit shuts down the converter. It restarts when VDD voltage drops below Vth\_recovery.



## Package Dimensions

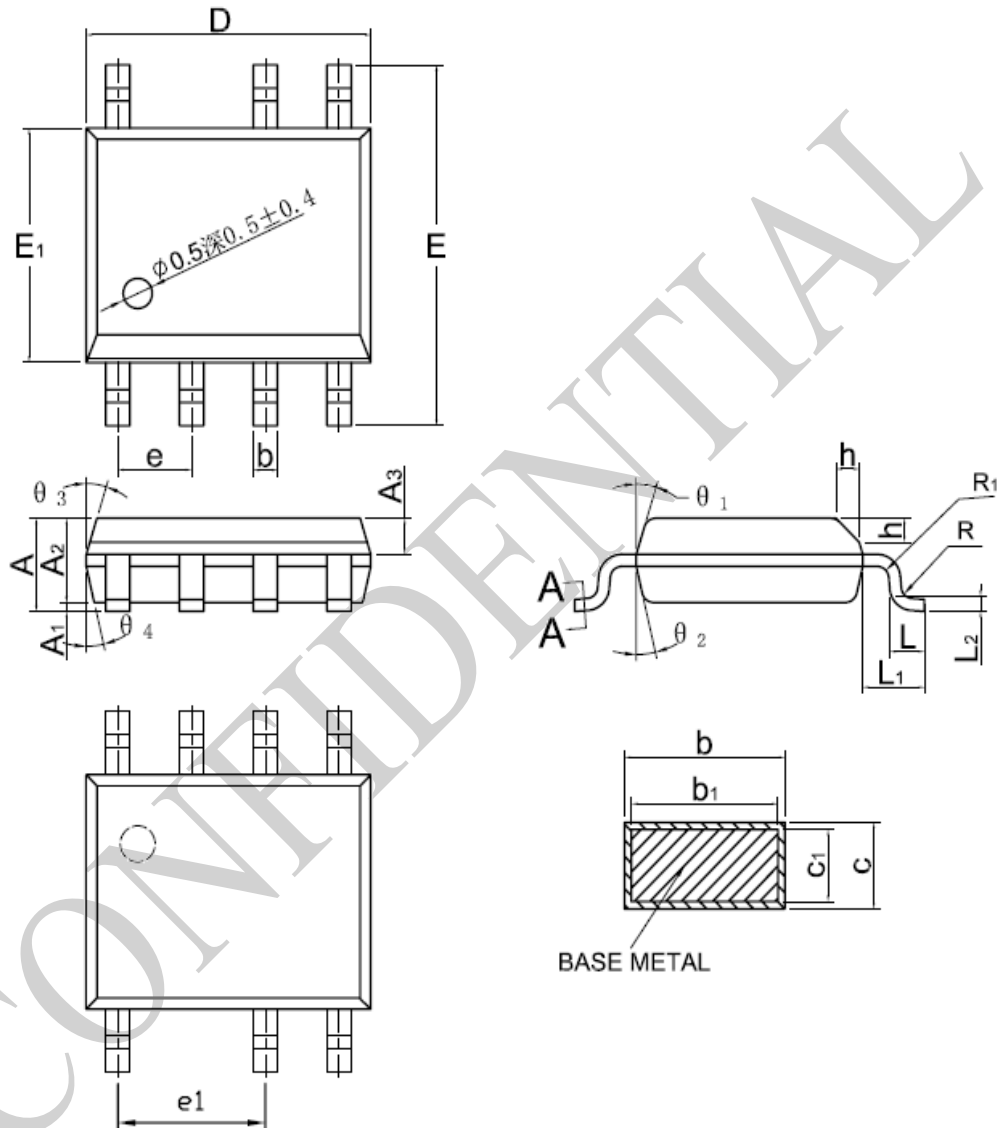
### DIP-7L



### Dimensions

Dimensions Symbol	Min (mm)	Max (mm)	Dimensions Symbol	Min (mm)	Max (mm)
A	9.00	9.20	C2	0.5TYP	
A1	1.474	1.574	C3	3.20	3.40
A2	0.41	0.51	C4	1.47	1.57
A3	2.44	2.64	D	8.20	8.80
A4	0.51TYP		D1	0.244	0.264
A5	0.99TYP		D2	7.62	7.87
B	6.10	6.30	theta 1	17° TYP4	
C	3.20	3.40	theta 2	10° TYP4	
C1	7.10	7.30	theta 3	8° TYP	

## SOP-7L



## Dimensions

Symbol	Millimeter			Inch		
	Min.	Normal.	Max.	Min.	Normal.	Max.
A	1.35	1.55	1.75	0.053	0.061	0.069
A <sub>1</sub>	0.10		0.25	0.004		0.01
A <sub>2</sub>	1.25	1.40	1.65	0.049	0.055	0.065
A <sub>3</sub>	0.50	0.60	0.70	0.020	0.024	0.028
b	0.39		0.49	0.015		0.019
b <sub>1</sub>	0.28		0.48	0.011		0.018
c	0.10		0.25	0.004		0.01
c <sub>1</sub>	0.10		0.23	0.004		0.009
D	4.8	4.9	5.0	0.189	0.193	0.197
E	5.8	6.0	6.2	0.228	0.236	0.244
E <sub>1</sub>	3.8	3.9	4.0	0.150	0.154	0.157
e	1.27BSC					
e <sub>1</sub>	2.54BSC					
L	0.45		1.0	0.018		0.039
L <sub>1</sub>	1.04REF					
L <sub>2</sub>	0.25BSC					
R	0.07			0.003		
R <sub>1</sub>	0.07			0.003		
h	0.3	0.4	0.5	0.012	0.016	0.020
θ	0°		8°	0°		8°
θ <sub>1</sub>	11°	17°	19°	11°	17°	19°
θ <sub>2</sub>	11°	13°	15°	11°	13°	15°
θ <sub>3</sub>	15°	17°	19°	15°	17°	19°
θ <sub>4</sub>	11°	13°	15°	11°	13°	15°