

Buck/Boost 36V 2A DC-DC LED Driver

GENERAL DESCRIPTION

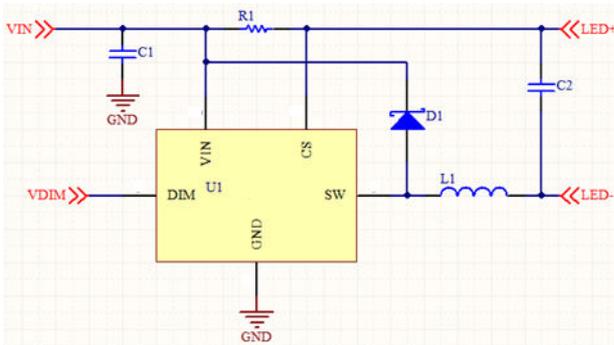
The UCT4172 is a high-efficiency, DC-to-DC Buck/Boost switching regulator dedicate for LED driver applications. The device operates at an input supply from 3.5V to 36V and provides an externally adjustable output current of up to 2A. The device operates at fixed 500KHz switching frequency, which makes it much ease to choose the external inductor. The UCT4172 is able to dim either by a DC Voltage or by a PWM signal from 100Hz to 20KHz.

The UCT4172 can construct Buck, Boost, or Buck/Boost structure for LED applications.

The UCT4172 has built-in Soft-Start, Under-voltage Lockout, Current Limiting, Over-Voltage Protection, Thermal Regulation and Thermal Shutdown protections to prevent the device from damage in the fault condition.

The UCT4172 is available in ESOP8 package.

TYPICAL APPLICATION CIRCUIT



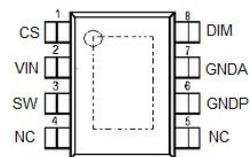
FEATURES

- Wide Operating voltage: 3.5~36V
- High Output Current: Up to 2A
- High Efficiency: Up to 97%
- High Accuracy: $\pm 3\%$
- Excellent Line Regulation: $\pm 1\%$ with the whole operating voltage
- 500KHz Fixed Switching Frequency
- Adjustable LED Current
- DC Voltage or PWM Dimming
- Buck, Boost, or Buck/Boost Structure
- Inherent Open-Circuit Protection
- Thermal Regulation and Shutdown
- UVLO, Soft-Start, Current Limit, OVP
- ESOP8 Package

APPLICATIONS

- LED Lighting

PIN ASSIGNMENT



PIN DESCRIPTION

PIN NO	SYMBOL	DESCRIPTION
1	CS	Current Sense Input
2	VIN	Power Supply Input.
3	SW	Switch Output
4	NC	Not Connected
5	NC	Not Connected
6	GNDP	Power Ground. Internally Connected With GNDA
7	GNDA	Analog Ground. Internally Connected With GNDP
8	DIM	Dimming and Chip Enable Input
Exposed-PAD		Ground. Internally Connected With GNDP and GNDA

ABSOLUTE MAXIMUM RATINGS(Note 1)

SYMBOL	ITEMS	VALUE	UNIT
V_{IN}	Input Voltage	-0.3~40	V
VSW	SW Pin	~0.3~44	V
VIN-VCS	CS Pin to VIN	-0.3~6.0	V
V_{IO}	All Other I/O Pins	-0.3~6.0	V
P_{DMAX}	Power Dissipation	2.5	W
P_{TR1}	Thermal Resistance, ESOP8, θ_{JA}	40	°C/W
P_{TR2}	Thermal Resistance, ESOP8, θ_{JC}	12	°C/W
T_J	Junction Temperature	-40~125	°C
Tstg	Storage Temperature	-55~150	°C
Tsolder	Package Lead Soldering Temperature	260°C, 10s	

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Recommended Operating Range indicates conditions for which the device is functional, but do not guarantee specific performance limits. Electrical Characteristics state DC and AC electrical specifications under particular test conditions which guarantee specific performance limits. This assumes that the device is within the Operating Range. Specifications are not guaranteed for parameters where no limit is given, however, the typical value is a good indication of device performance.

RECOMMENDED OPERATING RANGE

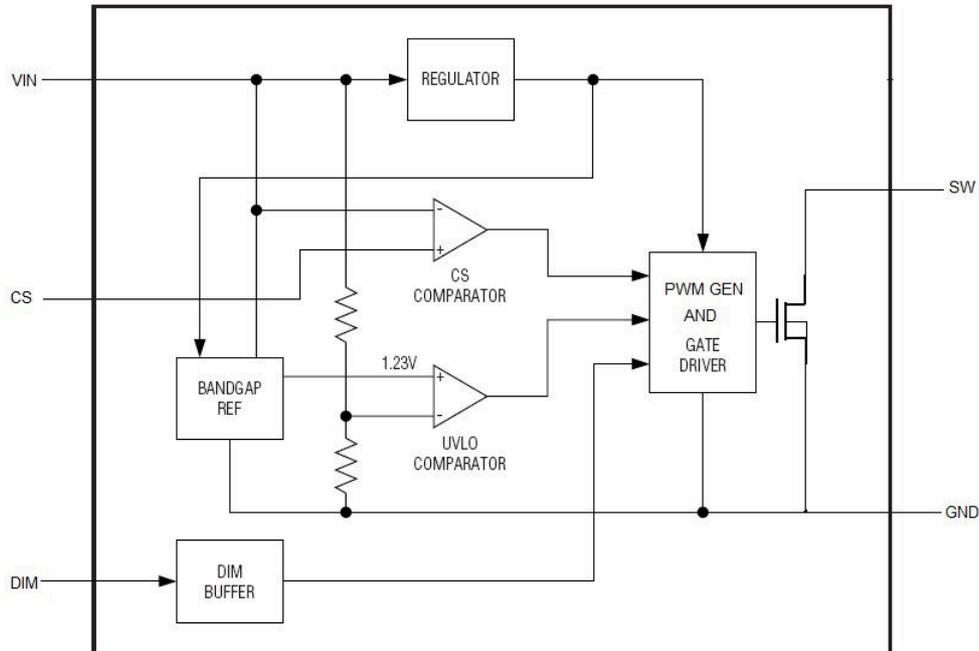
SYMBOL	ITEMS	VALUE	UNIT
V_{IN}	VIN Supply Voltage	3.5to 36	V
T_{OPT}	Operating Temperature	-40 to +85	°C

ELECTRICAL CHARACTERISTICS

The following specifications apply for $V_{IN}=12V$, $T_A=25^{\circ}C$, unless specified otherwise.

SYMBOL	ITEMS	CONDITIONS	MIN	TYP	MAX	UNIT
VIN Operating Range						
V_{IN}	Input Voltage		3.5		36	V
V_{UVLO}	UVLO Voltage			3.4		V
V_{UVHYS}	UVLO Hysteresis			0.3		V
F_{SW}	Switching Frequency			500		KHz
Current Sense						
V_{CS}	Current Sense Voltage		97	100	103	mV
Operating Current						
I_{OFF}	OFF State Current	$V_{DIM}<0.3V$		30		μA
DIM Input						
V_{DIM}	DIM Voltage			4		V
V_{DIM_H}	DIM Minimum High Level		2.5			V
V_{DIM_L}	DIM Maximum Low Level				0.3	V
V_{DIM_DC}	DIM DC Dimming Range		0.5		2.5	V
f_{DIM}	Dimming frequency		0.1		20	KHz
D_{DIM_L}	Duty Cycle Range of DIM	$f=100Hz$	0.02		100	%
	Brightness Control Range			5000:1		
D_{DIM_H}	Duty Cycle Range of DIM	$f=20KHz$	4		100	%
	Brightness Control Range			25:1		
I_{DIM}	DIM Pull-up Current			2		μA
Output Switch						
$R_{DS(on)}$	ON Resistance			0.3		Ω
$I_{SW\text{mean}}$	Continuous SW Current				2.2	A
I_{LEAK}	SW Leakage Current	$V_{SW}=40V$			1	μA
VOVP	Over-Voltage Protection			44		V
Thermal Shutdown						
T_{SD}	Thermal Shutdown			160		$^{\circ}C$
T_{SHYS}	Thermal Shutdown Hysteresis			20		$^{\circ}C$

SIMPLIFIED BLOCK DIAGRAM



OPERATION DESCRIPTIONS

The UCT4172 is a 36V 2A DC-DC converter specifically designed for LED Driving. It operates from 3.5 to 36V and deliver up to 2A output current. The device operates at fixed 500KHz frequency.

The UCT4172 regulates the inductor current (same as LED current) by sensing via the CS pin the voltage drop on a resistor connected between VIN and inductor, refer to the typical application circuit on the first page.

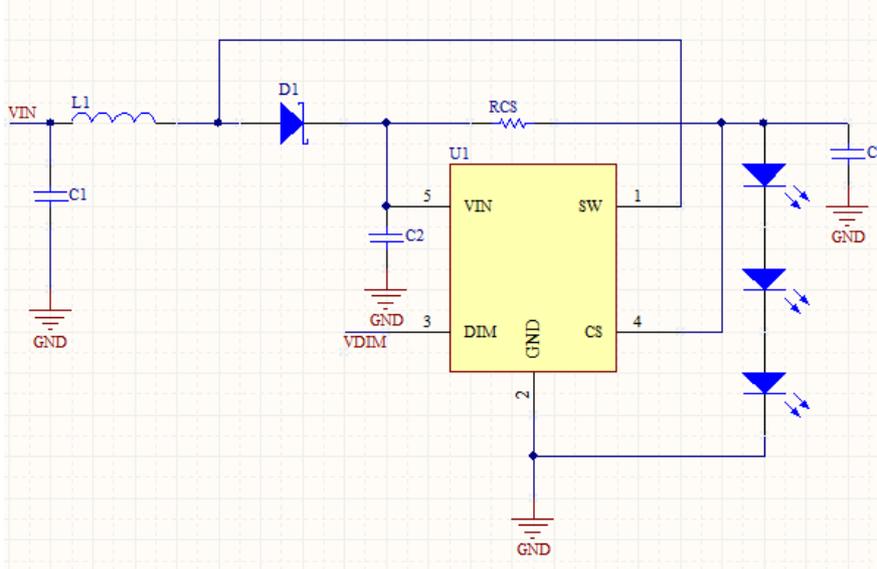
The DIM pin operates as Chip Enable, DC Dimming

or PWM Dimming input. It is internally pulled up so that left floating is the same as set to LOGIC HIGH which enables the device. The UCT4172 supports high frequency PWM Dimming, The dimming frequency can be as high as 200KHz.

The UCT4172 has built-in soft-start to limit the inrush current during startup and to limit the amount of overshoot on the output. Other protection features in the UCT4172 include cycle-by-cycle current limit, under-voltage lockout, thermal regulation and thermal shutdown.

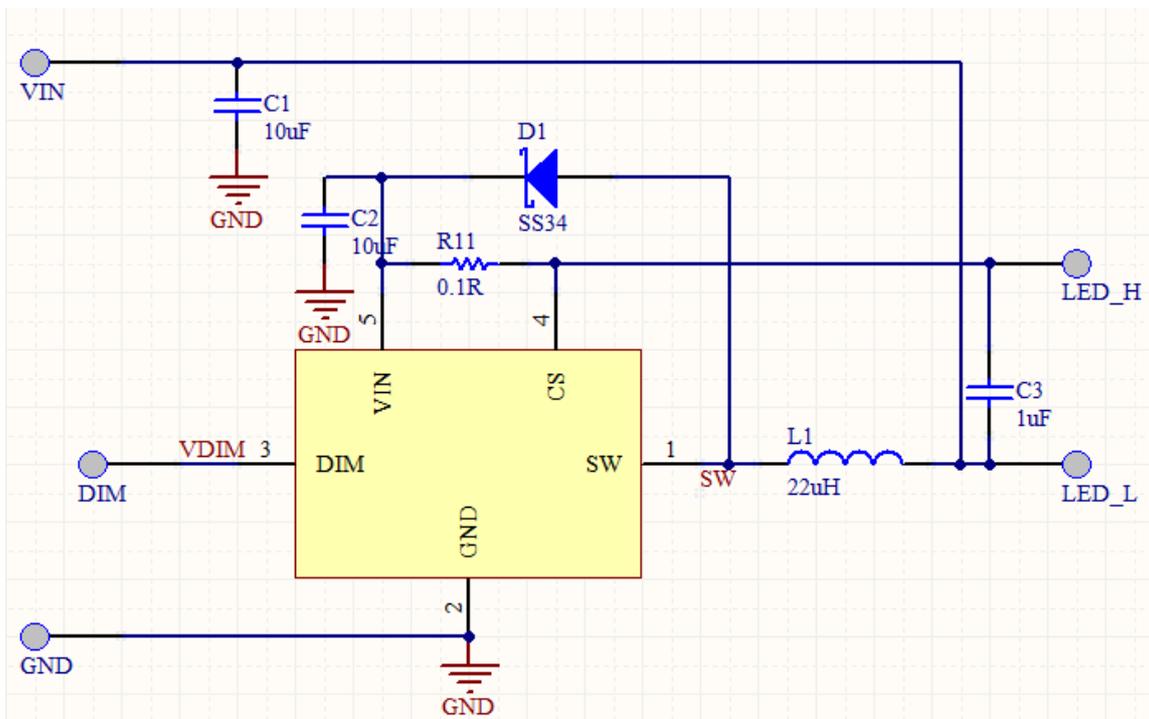
ADDITIONAL APPLICATION CIRCUIT

1. Boost Driver(VIN<VLED)



In this case the VIN Voltage is lower than the total LED string Voltage. The minimum VIN Voltage is 3.5V.

2. Buck-Boost Driver

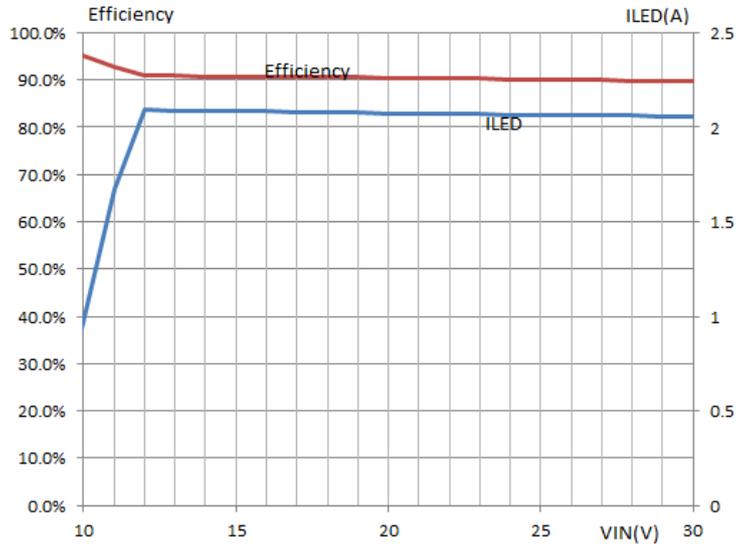


With this circuit the VIN Voltage can be either higher or lower than the LED string Voltage. Note that the Maximum VIN+VLED shall be lower than the device OVP voltage, which is 44V typically.

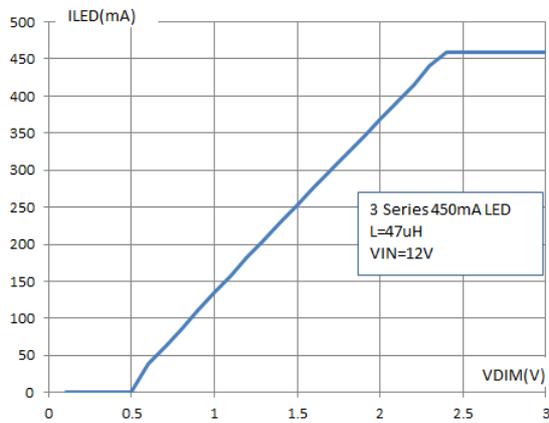
TYPICAL OPERATING CHARACTERISTICS

Tested under $T_A=25^{\circ}\text{C}$, unless otherwise specified

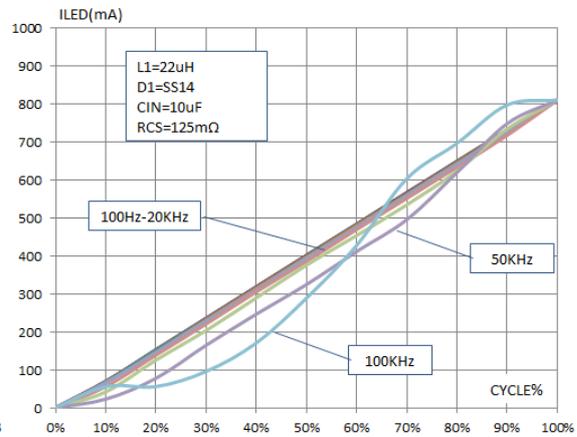
1. Efficiency and Line Regulation for 3x2A



2. DC Dimming Effect

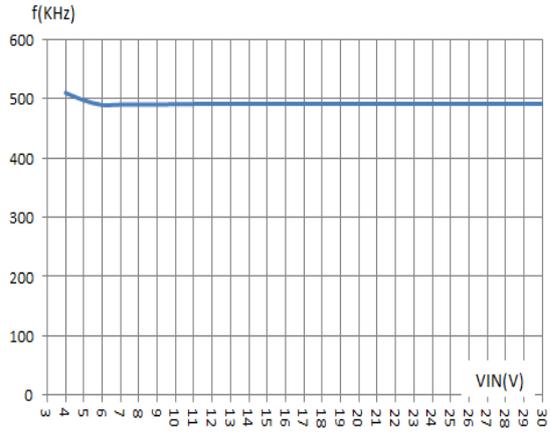
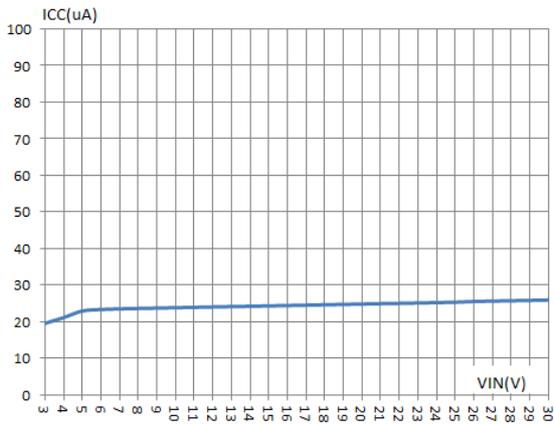


3. PWM Dimming Effect

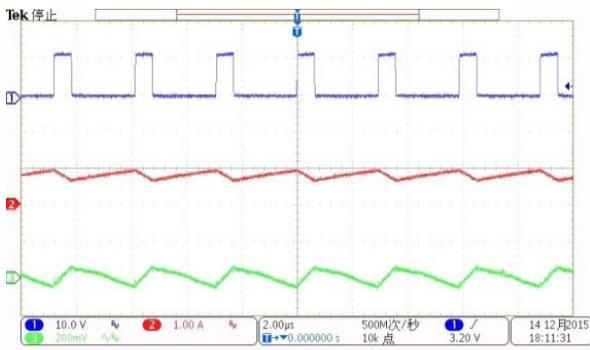


4. IOFF vs VIN

5. Frequency vs VIN

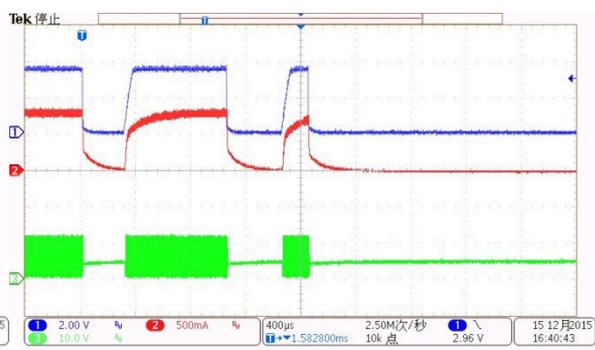


6. Operating Waveform



CHAN1: VSW, CHAN2:ILED, CHAN3: VCS(AC)

7. Start-up and Disable



CHAN1: VDIM, CHAN2: ILED, CHAN3: VSW

APPLICATION INFORMATION

● Inductor Selection

A 10~68 μ H inductor is operable depending slightly on the application itself. If high efficiency is a critical requirement, a low DCR inductor should be selected. The inductor's saturation current rating should also exceed the peak input current, especially for high load current application.

● Input Capacitor Selection

A low ESR 47~100 μ F Input capacitors necessary for the UCT4172 applications for decoupling.

● Diode Selection

Using a Schottky diode is recommended in UCT4172 applications because of its low forward voltage drop and fast reverse recovery time. The current rating of the Schottky diode should exceed the peak current of the boost converter. The voltage rating should also exceed the target output voltage.

● LED Current Setting

LED current is determined by the sensing resistor RCS. The sensing voltage is internally set at 100mV. For accurate LED current settings, precision 1% resistors are recommended. The formula is shown below:

$$RCS = 100\text{mV}/I_{LED}$$

For a 1A LED current, RCS shall be 0.1 Ω .

● LED Dimming Control

Below there are five different LED dimming control methods described:

1. Using a Low Frequency PWM Signal to DIM Pin
 With a low frequency(≤ 1 KHz) PWM signal applied to the DIM pin, the UCT4172 is correspondingly turned ON or OFF by the PWM signal. The LEDs alternate between zero and full programmed current. The average LED current increases proportionally with the duty cycle of the PWM signal. A 0% duty cycle PWM signal will turn off the UCT4172 and

corresponds to zero LED current. A 100% duty cycle PWM signal turns on the LEDs continuously at full current.

2. Using a High Frequency PWM Signal to DIM Pin

If the PWM signal applied to DIM pin is high frequency(≥ 5 KHz), the UCT4172 can directly adjust the LED current without periodically turning ON/OFF. This is the most recommending dimming mode because perfect linearity can be achieved.

3. Using a DC Voltage to DIM pin

If a proper DC Voltage is available in the system, then using the DC voltage for dimming is another solution. Just apply the DC voltage to DIM pin. The effective DC voltage range is 0.5 to 2.5V.

● Power Sequence

In order to assure the normal soft start function for suppressing the inrush current the input voltage should be ready before DIM pulls high.

● Soft-Start

The function of soft-start is made for suppressing the inrush current to an acceptable value at the beginning of power on. The UCT4172 provides a built-in soft-start function by clamping the output voltage of error amplifier so that the duty cycle of the PWM will be increased gradually in the soft-start period.

● Current Limiting

The current flow through inductor as charging period is detected by an internal current sensing circuit and limited to the maximum current, typically 2.5A..

● Thermal Regulation

The UCT4172 has the thermal regulation scheme. It adaptively regulates the current when the device works at very heavy load condition and/or high temperature environment.

- **UVLO**

The Under-Voltage Lock Out function disables the UCT4172 from malfunctioning when the power supply is too low(<3.9V), and recovers when the power supply goes high.

- **Thermal Shutdown**

The UCT4172 has thermal shutdown function in case thermal regulation fails in some extreme cases.

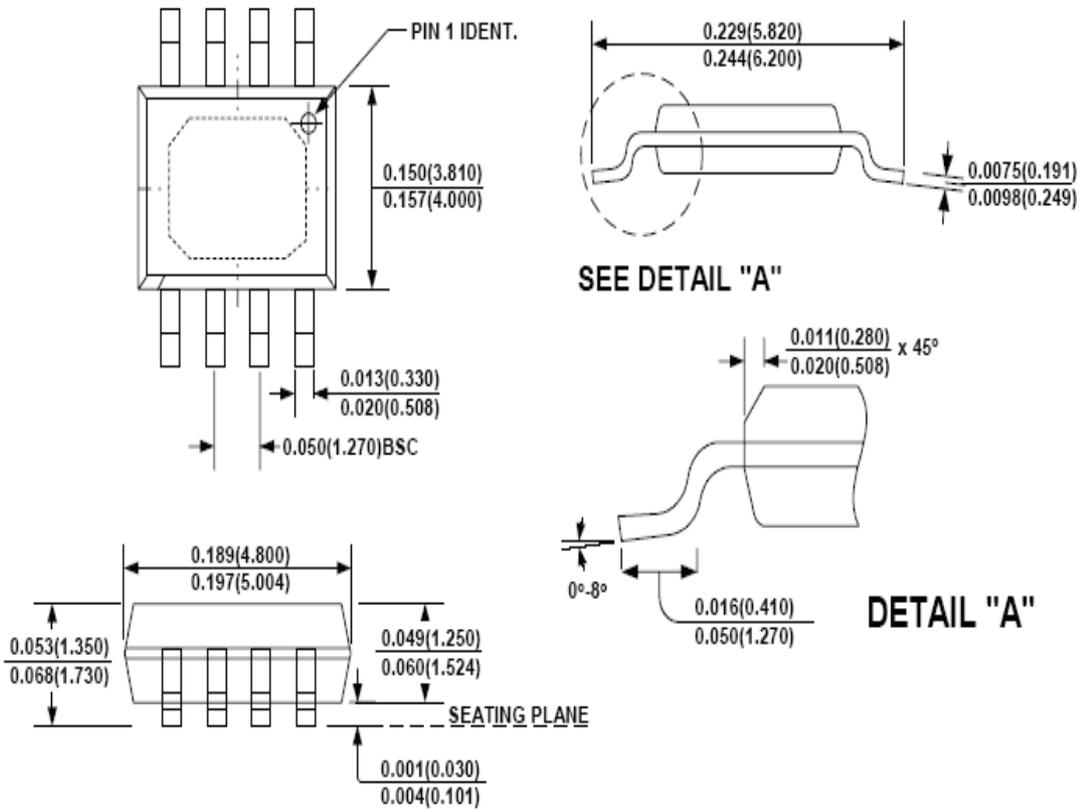
- **Layout Considerations**

PCB layout is very important for high frequency switching regulators in order to keep the loop stable and minimize noise. For best performance of the UCT4172, the following guidelines must be strictly followed.

- Input and Output capacitors should be placed close to the IC and connected to ground plane to reduce noise coupling.
- The GND pin should be connected to a strong ground plane for heat sinking and noise protection.
- Keep the main current traces as possible as short and wide.
- The SW node is with high frequency voltage swing. It should be kept in a smallest area.
- Keep the CS pin connection short and away from the noisy devices.

PACKAGE OUTLINE

ESOP8



NOTE:

1) Control dimension is in inches. Dimension in bracket is millimeters.