Buck/Boost 36V1.2A DC-DC LED Driver

GENERAL DESCRIPTION

The UCT4171 is a high-efficiency, DC-to-DC Buck/Boost switching regulator dedicate for LED driver applications. The device operates at an input supply from3.5V to36V and provides an externally adjustable output current of up to 1.2A.The device operates at fixed 500KHz switching frequency, which makes it much ease to choose the external inductor. The UCT4171 is able to dim either by a DC Voltage or by a PWM signal from 100Hz to 20KHz.

The UCT4171 can construct Buck, Boost, or Buck/Boost structure for LED applications.

The UCT4171 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 UCT4171 is available in SOT89-5package.

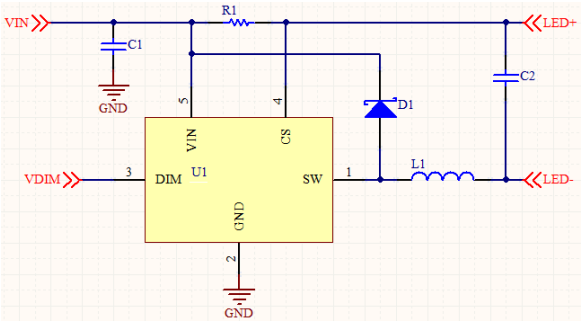
FEATURES

- Wide Operating voltage: 3.5~36V
- High Output Current: Up to 1.2A
- High Efficiency: Up to 97%
- High Accuracy: ±3%
- Excellent Line Regulation: 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
- SOT89-5Package

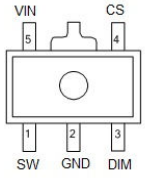
APPLICATIONS

- LED Lighting

TYPICAL APPLICATION CIRCUIT



PIN ASSIGNMENT



PIN DESCRIPTION

PIN NO	SYMBOL	DESCRIPTTION
1	SW	Switch Output
2	GND	Ground
3	DIM	Dimming and Chip Enable Input
4	CS	Current Sense Input
5	VIN	Power Supply Input.

ABSOLUTE MAXIMUM RATINGS(Note 1)

SYMBOL	ITEMS	VALUE	UNIT
V_{IN}	Input Voltage	-0.3 to 40	V
VSW	SW Pin	~0.3 to 44	V
VIN-VCS	CS Pin (to VIN)	-0.3 to 6.0	V
V_{IO}	All Other I/O Pins	-0.3 to 6.0	V
P_{DMAX}	Power Dissipation	1.5	W
P_{TR}	Thermal Resistance SOT89-5, Θ_{JA}	45	℃/W
	Thermal Resistance SOT89-5, Θ_{JC}	25	℃/W
T_J	Junction Temperature	-40 to125	℃
Tstg	Storage Temperature	-55 to 150	℃
Tsolder	Package Lead Soldering Temperature	260℃, 10s	

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Recommended OperatingRange 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 OperatingRange. Specifications are not guaranteed for parameters where no limitis given, however, the typical value is a good indication of device performance.

RECOMMANDED OPERATING RANGE

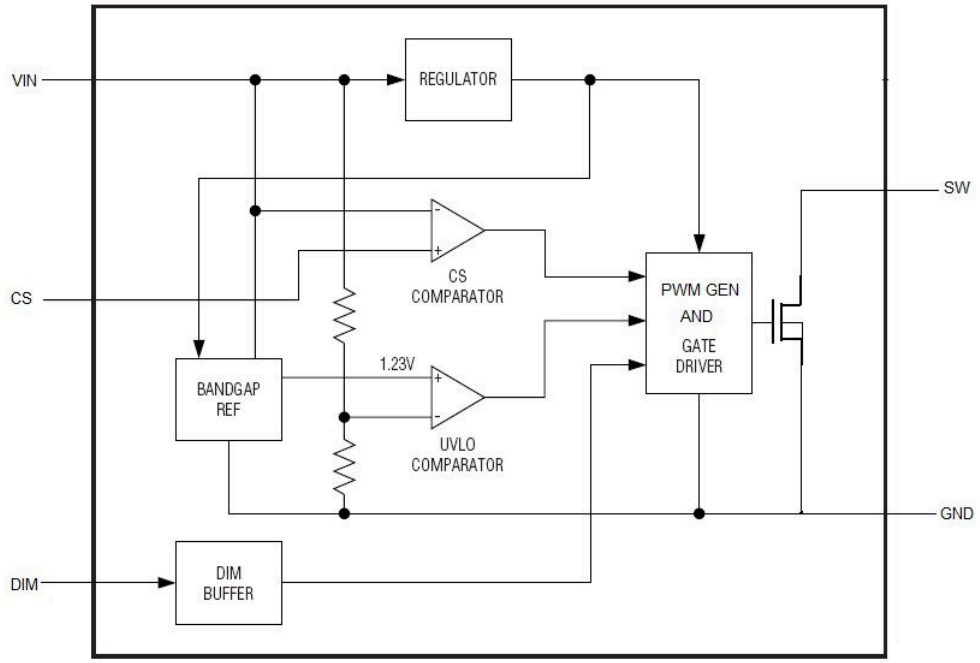
SYMBOL	ITEMS	VALUE	UNIT
V_{IN}	VIN Supply Voltage	3.5to 36	V
T_{OPT}	Operating Temperature	-40 to +85	℃

ELECTRICAL CHARACTERISTICS

The following specifications apply for V_{IN}= 12V, T_A=25°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			3.35		V
V_{UVHYS}	UVLO Hysteresis			250		mV
F_{SW}	Switching Frequency			500		KHz
Current Sense						
V_{CS}	Current Sense Voltage		97	100	103	mV
Operating Current						
I_{OFF}	OFF State Current	VDIM<0.3V		30		μA
DIM Input						
VDIM	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_{DSON}	ON Resistance			0.3		Ω
ISWmean	Continuous SW Current				1.5	A
I_{LEAK}	SW Leakage Current	VSW=40V			1	μA
VOVP	Over-Voltage Protection			44		V
Thermal Shutdown						
T_{SD}	Thermal Shutdown			160		℃
T_{SHYS}	Thermal Shutdown Hysteresis			20		℃

SIMPLIFIED BLOCK DIAGRAM



OPERATION DESCRIPTIONS

The UCT4171 is a 36V 1.2A DC-DC converter specifically designed for LED Driving. It operates from 3.5 to 36V and deliver up to 1.2A output current. The device operates at fixed 500KHz frequency.

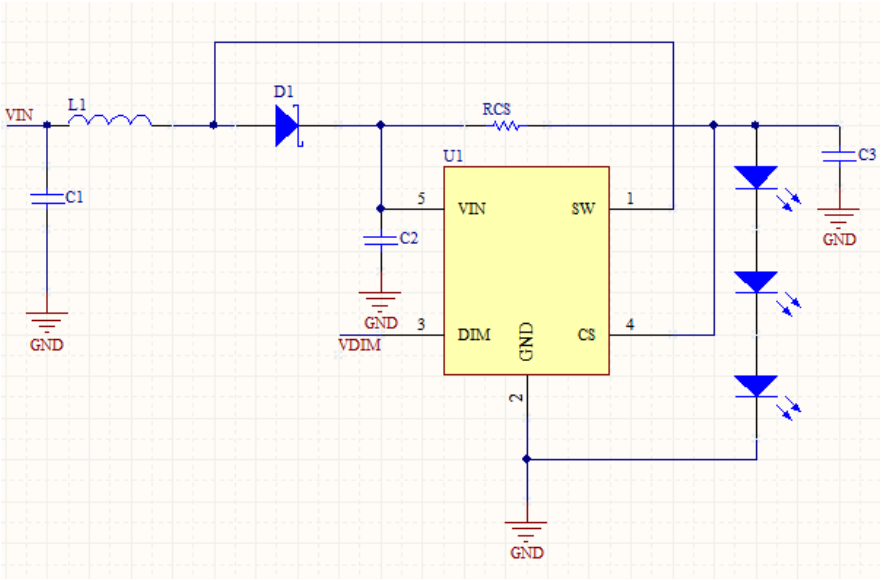
The UCT4171 regulates the inductor current (same as LED current) by sensing via the CS pin the voltage drop on a resistor connected between VIN and inductor, refer to the typical application circuit on the first page.

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 UCT4171 supports high frequency PWM Dimming, The dimming frequency can be as high as 20KHz.

The UCT4171 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 UCT4171 include cycle-by-cycle current limit, under-voltage lockout, thermal regulation and thermal shutdown.

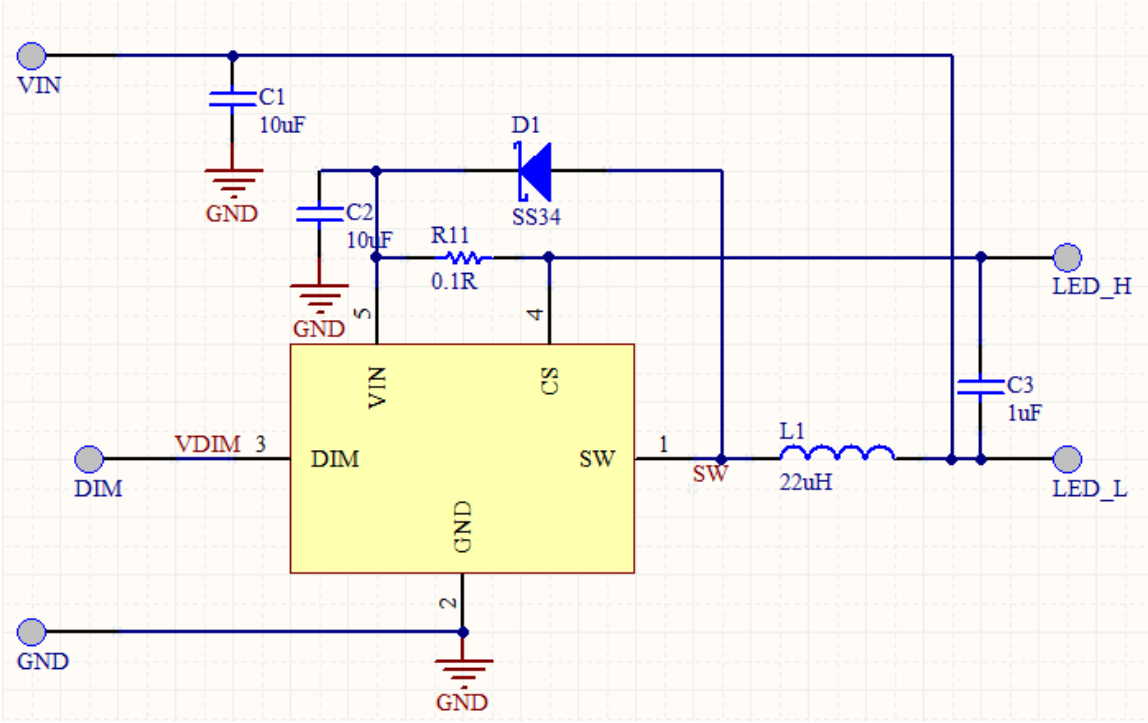
ADDITIONAL APPLICATION CIRCUIT

1. Boost Driver(VIN<VLED)



In this case the VIN Voltage is lower than the total LED string Voltage. The minimum VIN Voltage is 4V.

2. Buck-Boost Driver

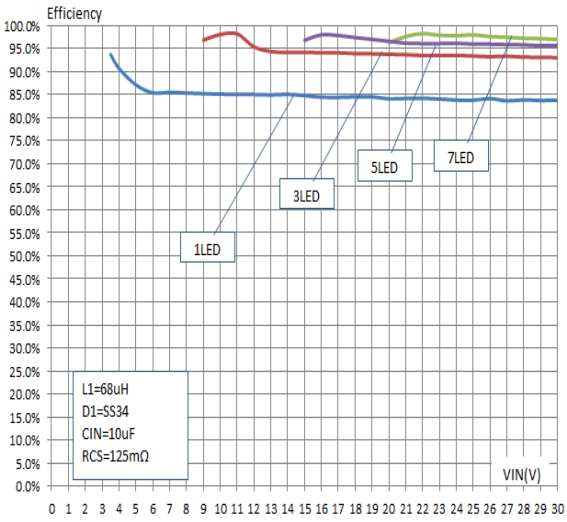


With this circuit the VIN Voltage can be either higher or lower than the LED string Voltage. Note that the Maximum VIN+VLED shall be lower than the device OVP voltage, which is 40V typically.

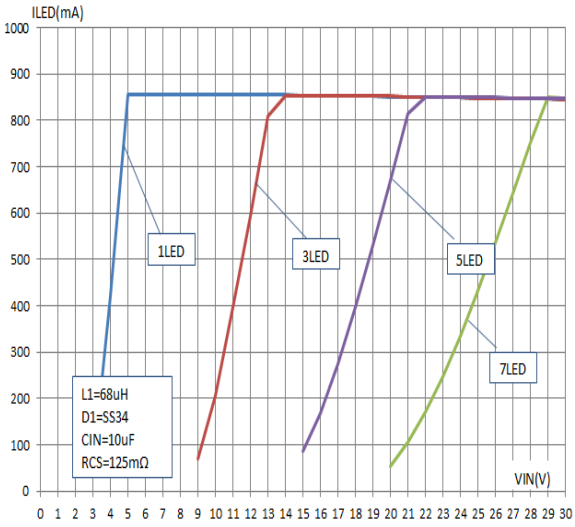
TYPICAL OPERATING CHARACTERISTICS

Tested under TA=25°C, unless otherwise specified

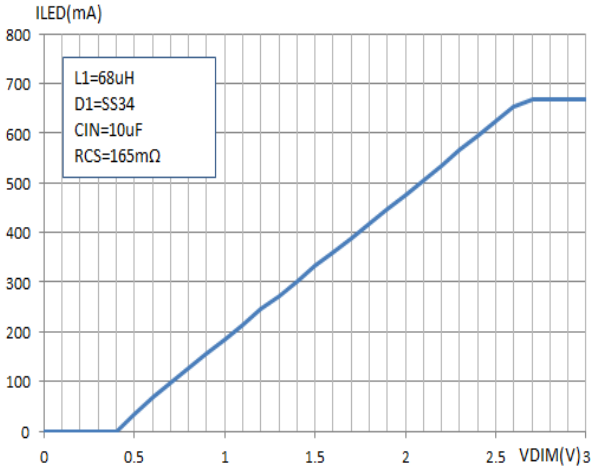
1. Efficiency for 1x3W, 3x3W, 5x3W and 7x3W



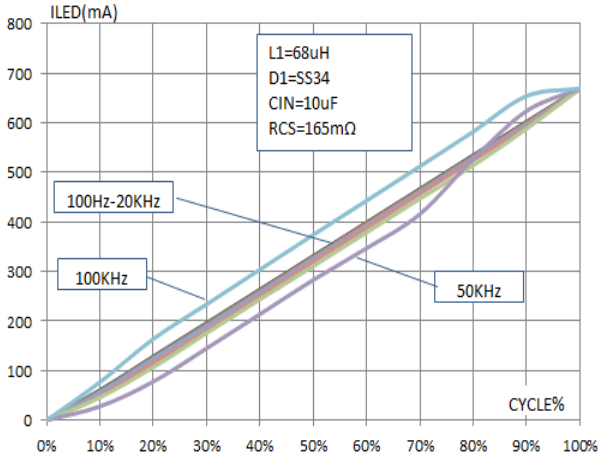
2. ILED for 1X3W, 3X3W, 5x3W and 7x3W



3. DC Dimming Effect

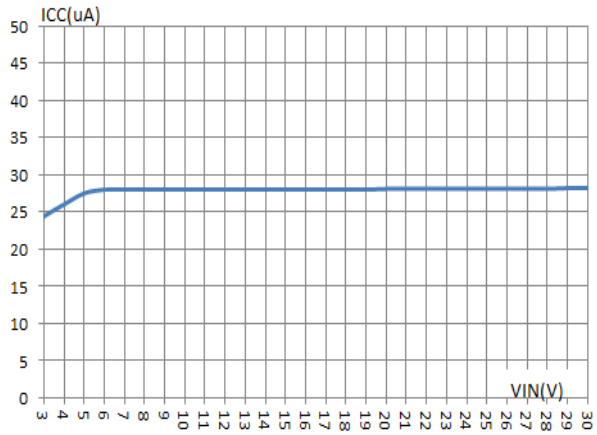


4. PWM Dimming Effect

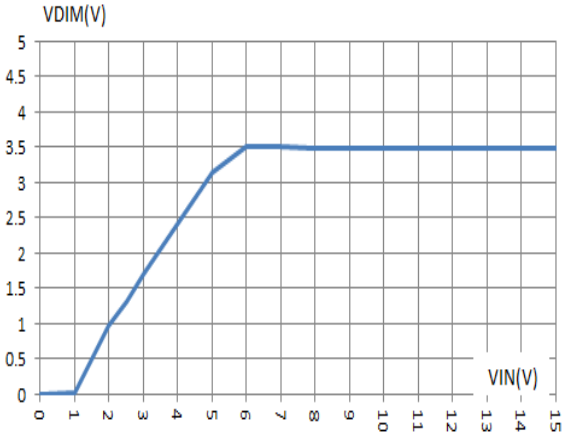


5. IOFF vs VIN

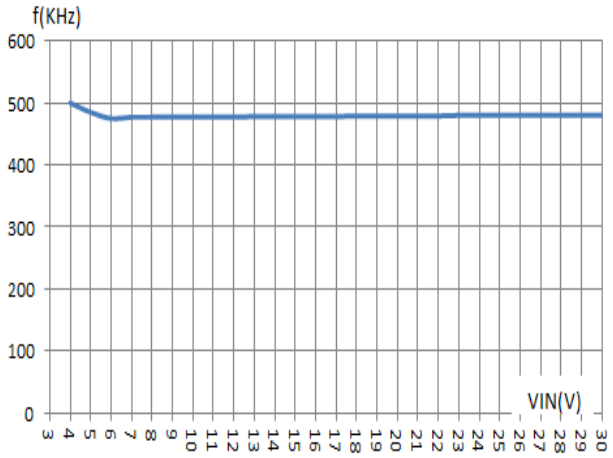
6. VDIM vs VIN

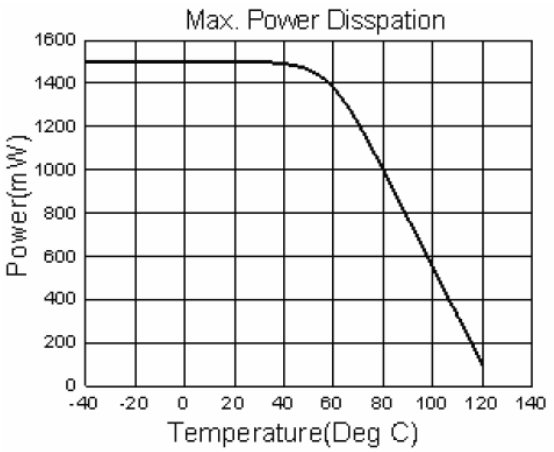


7. Frequency vs VIN



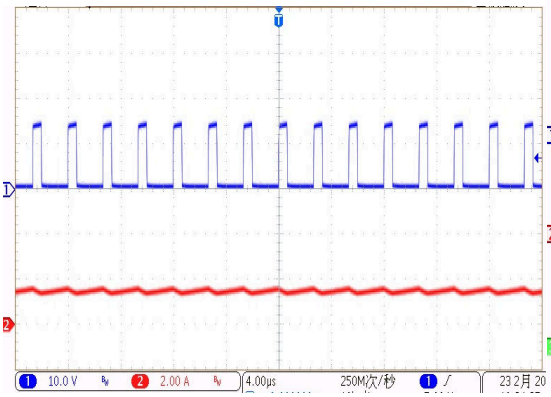
8. Maximum Power Dissipation vs Temperature



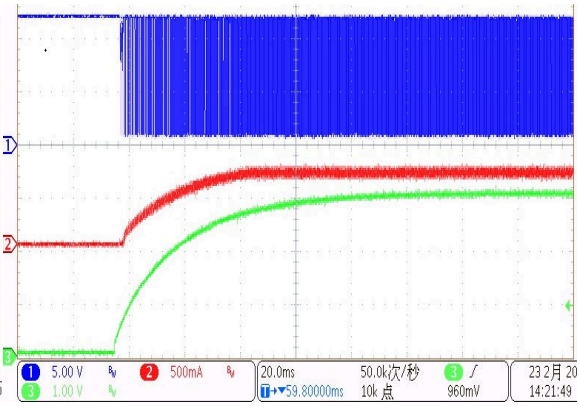


9. Operating Waveform

10. Start-up



CHAN1: VSW, CHAN2:ILED



CHAN1: VSW, CHAN2: ILED, CHAN3: VDIM

APPLICATION INFORMATION

- **Inductor Selection**

A 10~68 μ H inductor is operable depending slightly on the application itself. Please keep the device out of DCM area for high efficiency. If 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 47~100uF Input capacitors necessary for theUCT4171 applications for decoupling.

- **Diode Selection**

Using a Schottky diode is recommended in UCT4171 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:

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

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 PWM Signal to DIM Pin

With a PWM signal(<=20KHz) applied to the DIM pin, the UCT4171 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 UCT4171 and corresponds to zero LED current. A 100% duty cycle PWM signal turns on the LEDs continuously at full current.

2. 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 UCT4171 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 a internal current sensing circuit and limited to the maximum current, typically 1.5A..

- **Thermal Regulation and Shutdown**

The UCT4171 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 UCT4171 from malfunctioning when the power supply is too low(<3.1V), and recovers when the power supply goes high.

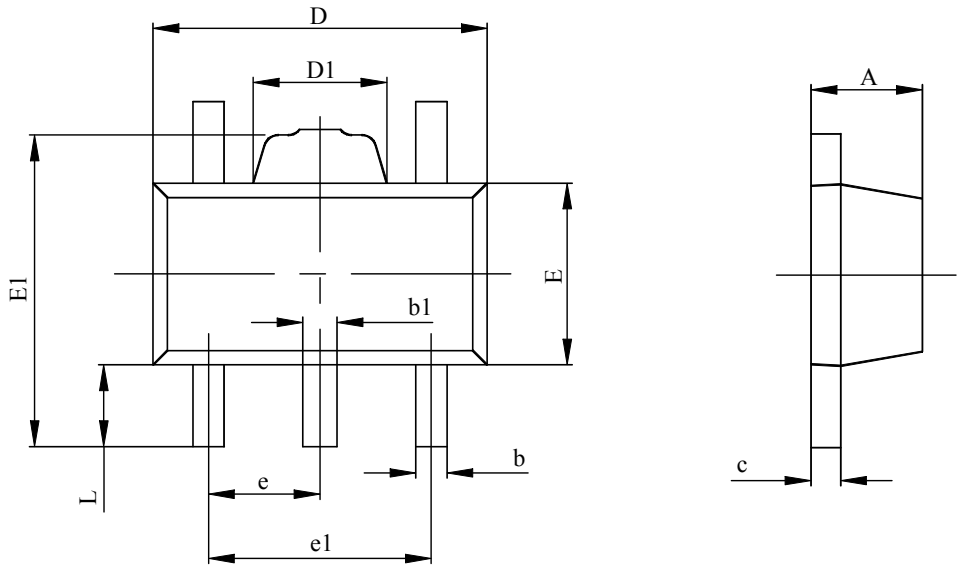
- **Layout Considerations**

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 UCT4171, 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

SOT89-5



SYMBOL	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	1.400	1.600	0.055	0.063
b	0.320	0.520	0.013	0.020
b1	0.360	0.560	0.014	0.022
c	0.350	0.440	0.014	0.017
D	4.400	4.600	0.173	0.181
D1	1.400.	1.800	0.055	0.071
E	2.300	2.600	0.091	0.102
E1	3.940	4.250	0.155	0.167
e	1.500 TYP.		0.060 TYP.	
e1	2.900	3.100	0.114	0.122
L	0.900	1.100	0.035	0.043