DESCRIPTION

The TP8005 is a buck-mode LED constant-current driver operating in inductive current continuous mode, designed for efficient driving of one or multiple series-connected LEDs. The chip supports an input voltage range of 5V to 36V and features an externally adjustable output current up to 1.2A.

TP8005 integrates a power transistor internally and employs advanced current detection technology. The average LED output current can be set via external resistors, while the DIM pin accepts both analog dimming signals and wide-range PWM dimming signals. When the DIM voltage falls below 0.3V, the internal power transistor turns off, and the chip enters low-power standby mode.

TP8005 integrates an automatic temperature compensation control circuit internally. When the chip's internal temperature exceeds 130°C, the LED output current gradually decreases with rising temperature and eventually stabilizes at a fixed value, thereby eliminating the low-frequency flickering issues associated with traditional overtemperature protection. At 150°C, the LED output current drops to zero.

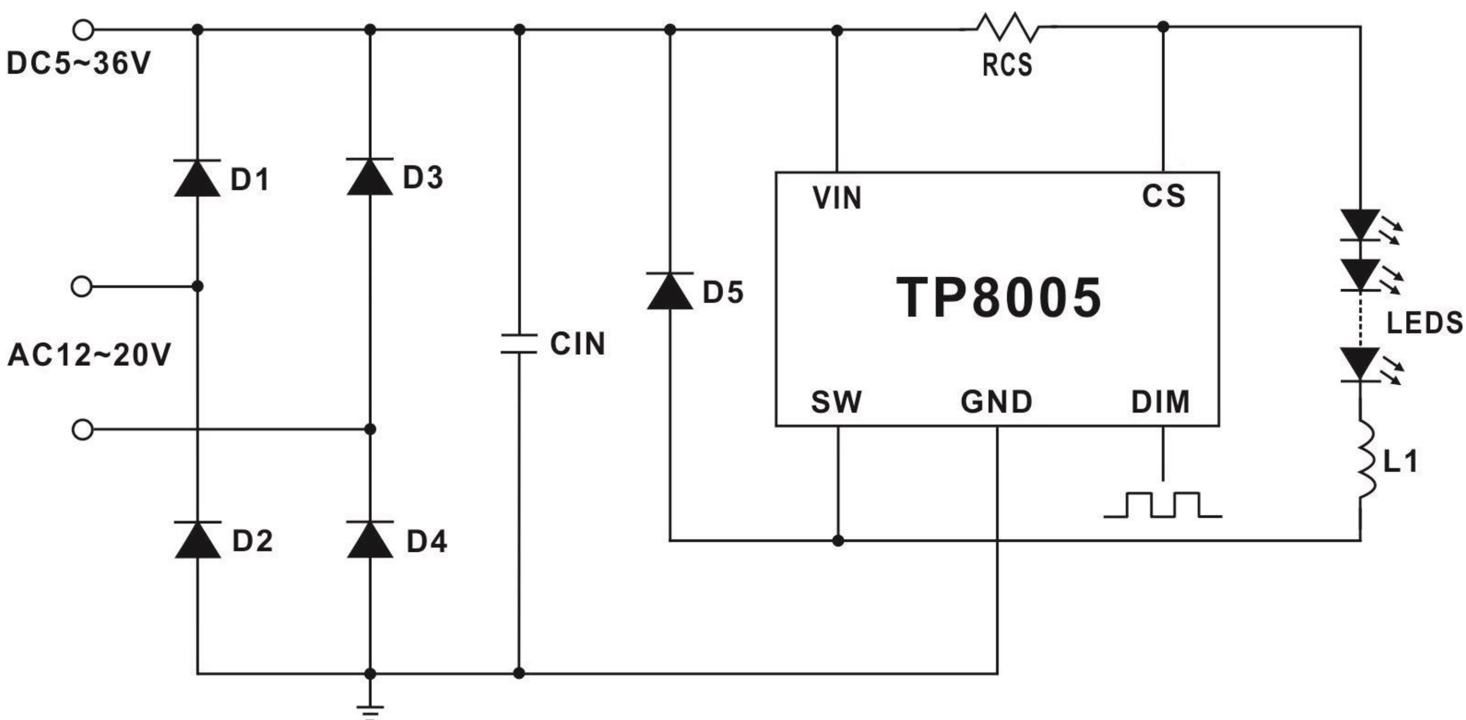
KEY FEATURES

- Up to 95% efficiency
- Automatic Temperature Compensation Control
- Wide input voltage range: 5V~ 36V
- Max current 1.2A
- The DIM pin supports both PWM and analog dimming.
- ±3% output current accuracy
- Built-in LED open-circuit protection
- Soft start time adjustable
- Package Size:SOT89-5L / SOT23-5L

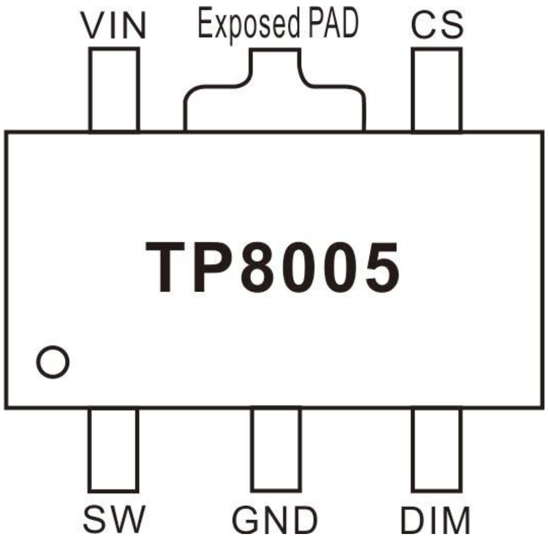
APPLICATION

- Low-voltage LED spotlights replace halogen lamps
- Low-voltage industrial LED lighting
- LED decorative illumination
- Other LED Lighting

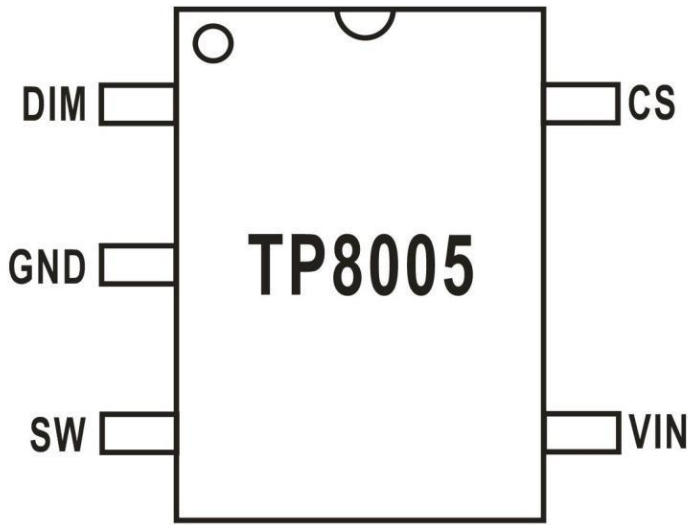
TYPICAL APPLICATION



PIN CONFIGURATION



SOT89-5L



SOT23-5L

ORDER INFORMATION

Order No.	Description
TP8005	Package Size: SOT89-5L
TP8005	Package Size: SOT23-5L

ORDER DESCRIPTION

Pin No.		Pin Name	Description
SOT89-5L	SOT23-5L		
1	1	SW	Internal power transistor drain
2	2	GND	Power Ground
3	3	DIM	Enabled pins, input ports for analog dimming and PWM dimming
4	5	CS	Output current sampling pin; the sampling resistor is connected between VIN and CS
5	4	VIN	The power input pin must be connected to the capacitor grounded directly.
-	-	Exposed PAD	Heat sink, link to power ground

ABSOLUTE MAXIMUM RATINGS (NOTE1)

Parameter	Value	Unit
VIN to GND voltage	-0.3~+40	V
SW to GND voltage	-0.3~+40	V
CS to VIN voltage	-1.0~+1.0	V
DIM to GND voltage	-0.3~+6	V
Power transistor output current	1.2	A
power consumption (SOT89-5L, Note2)	1.5	W
power consumption (SOT23-5L, Note2)	0.5	W
Working Temperature Range	-40~150	℃
Storage Temperature Range	-50~150	℃
ESD level (HBM)	2000	V
ESD level (mm)	200	V

RECOMMENDED OPERATING RANGE

Parameter	Symbol	Operating Condition	Recommended Value	Unit
Supply Voltage	VIN	Normal operation	0~36	V
Operating Temperature	T_{OP}	Normal operation	-40~85	℃

Note 1: Absolute maximum ratings define limits beyond which the IC may be permanently damaged. The recommended operating range ensures normal IC operation within this span, though not all performance specifications are fully guaranteed. Electrical characteristics specify DC and AC parameters under designated test conditions within the operating range that warrant targeted performance metrics. For parameters without specified upper/lower limits, accuracy is not guaranteed by this datasheet; typical values reasonably reflect device performance.

Note 2: The maximum power consumption decreases as the ambient temperature rises, determined by TJMAX, θJA, and the ambient temperature TA. The maximum allowable power consumption PDMAX is equal to (TJMAX-TA)/ϴJA, or the smaller value among the figures specified in the absolute maximum ratings.

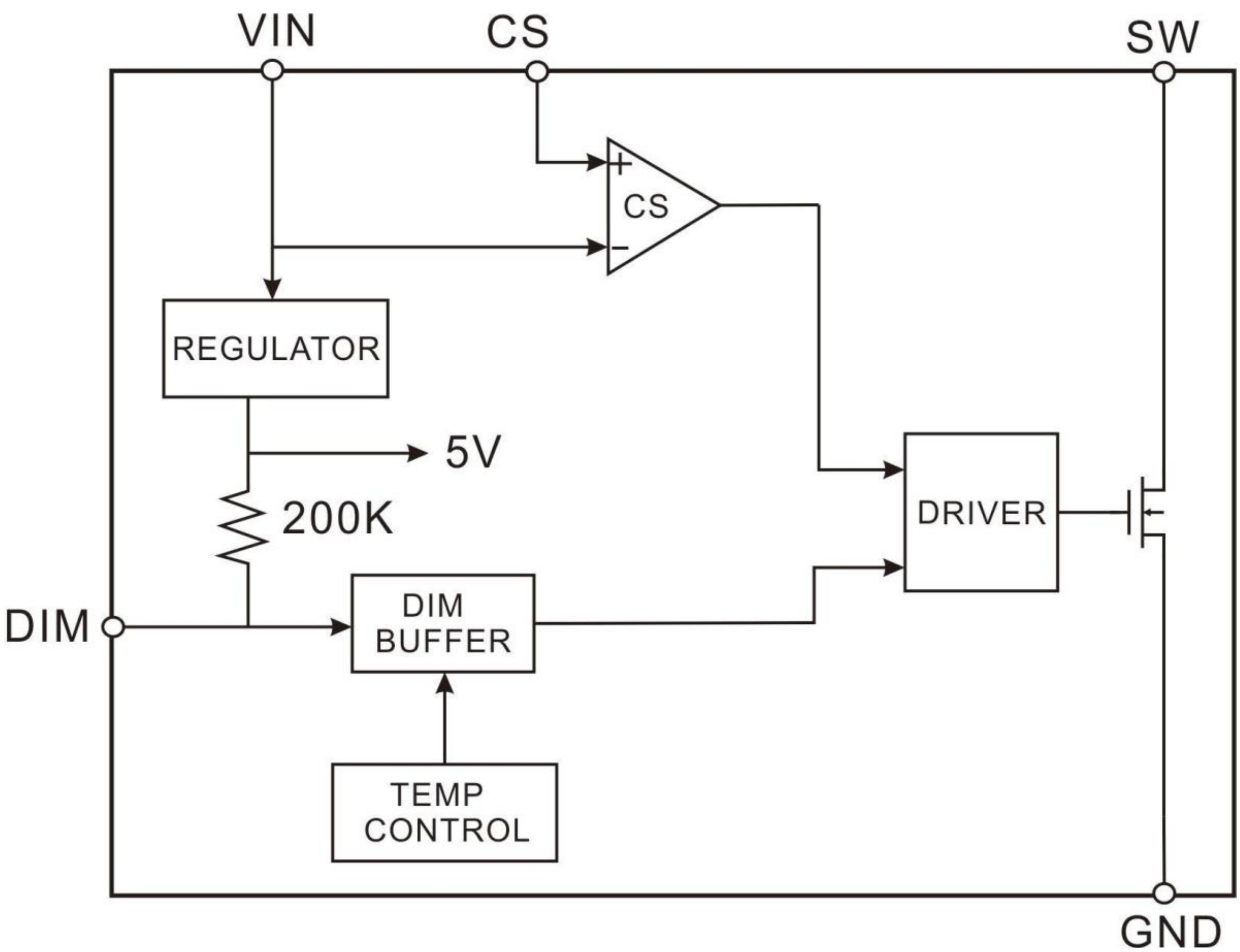
ELECTRICAL CHARACTERISTICS (NOTE 3)

Unless otherwise specified, Ta = 25℃, VIN = 12V

Symbol	Parameter	Test Condition		Min.	Typ.	Max	Unit
Input Voltage							
V_{IN}	Input voltage			5		36	V
I_{OP}	Operating current	VIN = VCS = 12V		100	150	250	uA
VUVLO	Under voltage protection	V_{IN} Raising			4.2		V
VUVLO, HYS	Under voltage protection hysteresis	V_{IN} Falling			4		V
Current Senior							
V_{CS}	Average current sensor	VIN–VCS	BinA	96	98	100.2	mV
			BinB				
VCS, HYS	Sampling voltage hysteresis				±15		%
I_{CS}	CS pin input current	V_{IN}–V_{CS}=50mV			8		μA
Operating Frequency							
F_{SW}	Maximum operation frequency					1	MHz
DIM Input							
V_{DIM}	DIM floated voltage	DIM floating			5		V
R_{DIM}	DIM pull-up resistor				200		KΩ
IDIM_L	DIM ground leakage current	VDIM=0			25		μA
VDIM_H	DIM input high signal			2.5			V
VDIM_L	DIM input low signal					0.3	V
DIM Dimming							
VDIM_DC	Analog dimming voltage range			0.5		2.5	V
f_{DIM}	Max PWM dimming frequency	f_{osc}=500KHz				50	KHz
DPWM_LF	Low-frequency PWM dimming duty cycle	f_{DIM}=100Hz		0.05%		100%	
DPWM_HF	High-frequency PWM dimming duty cycle	fDIM=20 kHz		10%		100%	
Power Tube							
RS_{W}	SW on resistance				0.35		Ω
ISW_MEAN	SW continuous current					1.2	A
ILEAK	SW leakage current				0.5	5	μA
Temperature Control							
T_{ST}	Starting temperature for temperature compensation				130		℃

Note 3: The minimum and maximum specification ranges of the datasheet are guaranteed by testing, while the typical values are guaranteed by design, testing, or statistical analysis.

BLOCK DIAGRAM



APPLICATION DESCRIPTION

Application Description

TP8005, inductor L1, and current sampling resistor RCS together form a self-oscillating, inductor-based continuous-current mode buck LED constant-current driver.

Operating Principle

When VIN powers up, the initial currents through inductor L1 and sense resistor RCS are zero, resulting in no voltage difference between VIN and CS. The CS comparator outputs a high level, which feeds the negative input of the PWM comparator, causing the PWM comparator to output high and turn on the internal power MOSFET of the IC. The SW pin is pulled low. Current flows from VIN through the current-sense resistor RCS, LEDs, inductor L1, and the internal power device to GND. The rising slope of the current is jointly determined by VIN, L1, and the LED forward voltage drop, generating a voltage drop VRCS across RCS. When VRCS exceeds 115% of the Vcs threshold, the CS comparator switches its output low, turning off the internal power MOSFET. The inductor freewheeling current circulates through L1, Schottky diode D5, RCS, and the LED string back to L1, forming a falling voltage ramp across RCS.
Once VRCS drops below 85% of the Vcs threshold, the CS comparator output reverts to high, and the internal power MOSFET turns on again. TP8005 repeats this cycle periodically. Therefore, the average current flowing through the LEDs is

$$I_{OUT}=\frac{1.15*Vcs+0.85*Vcs}{2*Rcs}=\frac{Vcs}{Rcs}$$

The high-side current-sensing architecture minimizes the number of external components. With a current-sense resistor of 1% tolerance, the LED output current accuracy can be controlled within ±3%.
TP8005 supports PWM dimming via the DIM pin. The LED current is disabled when the DIM pin voltage is lower than 0.3V, and fully enabled when the voltage exceeds 2.5V. The supported PWM dimming frequency ranges from 100 Hz up to over 20 kHz. The PWM dimming function is available when the high-level voltage of the PWM signal falls between 0.5V and 2.5V. Refer to the subsequent sections for detailed application information.
Analog dimming can also be realized by applying an external DC voltage to the DIM pin. The maximum LED current is determined by the current-sense resistor RCS. The valid analog dimming range of DC voltage (VDIM) is 0.5V to 2.5V. When the DC voltage (VDIM) is higher than 2.5V, the output LED current remains constant and is set by RCS.
The LED current can also be adjusted by connecting a resistor between the DIM pin and GND. An internal pull-up resistor (typical value: 200kΩ) is connected to the internal 5V regulated supply. The voltage at the DIM pin is determined by the voltage divider formed by the internal pull-up resistor and the external resistor.
The DIM pin can be left floating during normal operation. When the voltage applied to the DIM pin is lower than 0.3V, the internal power MOSFET of the IC turns off, and the LED current drops to zero.

LED Average Current Setting

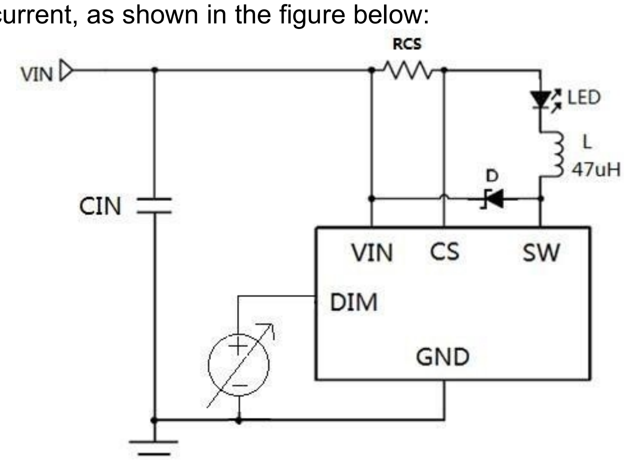
The average LED current is determined by the resistor RCS connected between VIN and CS.

$$I_{OUT}=\frac{Vcs}{Rcs}(R_{CS}\geq 0.082\Omega)$$

Where Vcs is the average current-sense reference voltage for the CS pin, with a typical value of 100 mV. The above formula is valid only when the DIM pin is left floating, or an external DC voltage between 2.5V and 5V is applied to the DIM pin. In practice, the RCS sets the maximum LED output current, and the actual LED output current can be dimmed down to any value by adjusting the DIM pin voltage.

Analog Dimming

An external DC voltage (VDIM) can be applied to the DIM pin for analog dimming to adjust the LED output current, as shown in the figure below:



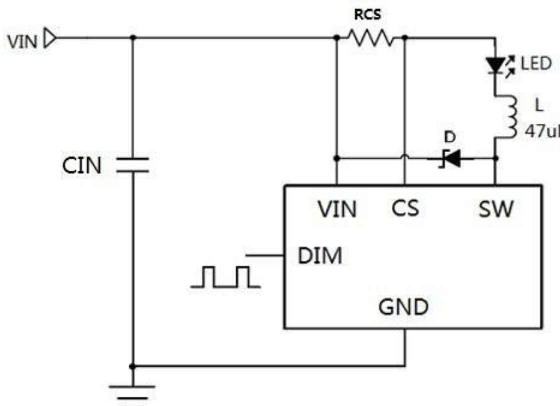
The output current can be expressed by the following two formulas in this case:

$$I_{OUT}=\frac{Vcs}{Rcs}X\frac{V_{DIM}}{2.5V}(0.5V\leq V_{DIM}\leq 2.5V)$$

$$I_{OUT}=\frac{Vcs}{Rcs}(2.5V\leq V_{DIM}\leq 5.0V)$$

PWM Dimming

TP8005 supports PWM dimming by inputting a PWM signal to the DIM pin to adjust the LED output current, as shown in the figure below:



The output current is proportional to the duty cycle of the PWM signal, and the average output current can be expressed by the following two formulas:

$$IOUT = \frac{Vcs}{Rcs} * D(0 \le D \le 100\%, 2.5V \le V_{PLUSE} \le 5V)$$

$$IOUT = \frac{Vcs}{Rcs} * D * \frac{V_{PULSE}}{2.5V}(0 \le D \le 100\%, 0.5V \le V_{PULSE} \le 2.5V)$$

Where VPULSE refers to the high-level amplitude of the PWM signal. With PWM dimming, the LED output current can be adjusted from 0% to 100%. The brightness of the LED is determined by the duty cycle of the PWM signal. For example, if the PWM signal has a duty cycle of 25%, the average output current of the LED will be 25% of the preset current. It is recommended to set the PWM dimming frequency above 100 Hz to prevent visible LED flicker to the human eye. Compared with analog dimming, PWM dimming has the advantage of maintaining constant LED color temperature. The maximum dimming frequency of TP8005 can exceed 20 kHz.

Automatic Temperature Compensation Control

TP8005 integrates an internal automatic temperature compensation control circuit. When the internal IC temperature exceeds 130°C, the LED output current will gradually decrease as the temperature rises and finally settle at a certain current level. This eliminates the low-frequency LED flicker issue caused by conventional over-temperature protection. When the internal IC temperature rises to 150°C, the LED output current drops to zero.

Shutdown Mode

System shutdown can be achieved by applying a voltage below 0.3V to the DIM pin, putting the IC into standby mode. Typically, the typical standby current of the IC is around 80μA.

Soft Start Mode

An external capacitor connected to the DIM pin enables soft start. It allows the DIM pin voltage to rise slowly during system power-up, which in turn makes the LED output current ramp up gradually. The soft-start time is approximately 150us per nF of external capacitance.

LED Open-Circuit Protection

TP8005 features output open-circuit protection. If the load becomes open, the IC will enter a safe low-power mode. Normal operation resumes once the load is reconnected.

Inductor Selection

For TP8005 with LED output current ranging from 0 to 1.2A, the recommended inductance value is 47μH ~100 μH. The saturation current of the inductor must be 30% to 50% higher than the LED output current.

Diode Selection

To maximize efficiency and performance, Diode D5 shall be a Schottky diode with fast recovery, low forward voltage drop, low parasitic capacitance, and low leakage current. The current rating and voltage rating are determined by specific applications, and a 30% derating margin is required for stable and reliable operation. It is critical to take the reverse leakage current of Schottky diodes under temperatures above 85°C into consideration. Excessive leakage current will increase system power consumption.
For rectifier diodes D1~D4 under 12VAC input, low forward drop Schottky diodes are mandatory to reduce self power loss.

Reduce Output Ripple

To reduce the LED output current ripple, a capacitor can be connected in parallel across the LED load. An output capacitor of 1μF can reduce the LED output current ripple by approximately one-third. Further increasing the output capacitance will suppress more ripple.
Note that the output capacitor does not affect the system switching frequency or efficiency, but it will impact the system startup delay and the available PWM dimming frequency.

Thermal Considerations

When the system operates under high ambient temperature or drives high-current loads, care must be taken to prevent the system from reaching its power limit. Enlarging the COPPER PAD **AREA** under the IC pins improves heat dissipation.
For practical applications, a copper weight of 1 oz per 25 mm² of PCB area is recommended for proper thermal performance.
Note that improper inductor selection and excessive parasitic capacitance at switching nodes will degrade system efficiency.

Thermal Compensation for Load Current

High-brightness LEDs sometimes require output current thermal compensation to ensure stable and reliable operation. The TP8005 supports thermal monitoring by connecting an external NTC thermistor or negative temperature coefficient diode near the LEDs to the DIM pin; the IC adjusts the LED load output current based on the detected LED temperature.

PCB Layout

A well-designed PCB layout is critical to maximize system stability and minimize noise. Multi-layer PCBs are an effective solution to suppress noise interference. To effectively reduce noise on current loops, the input bypass capacitor shall have an independent ground connection.

SW Pin

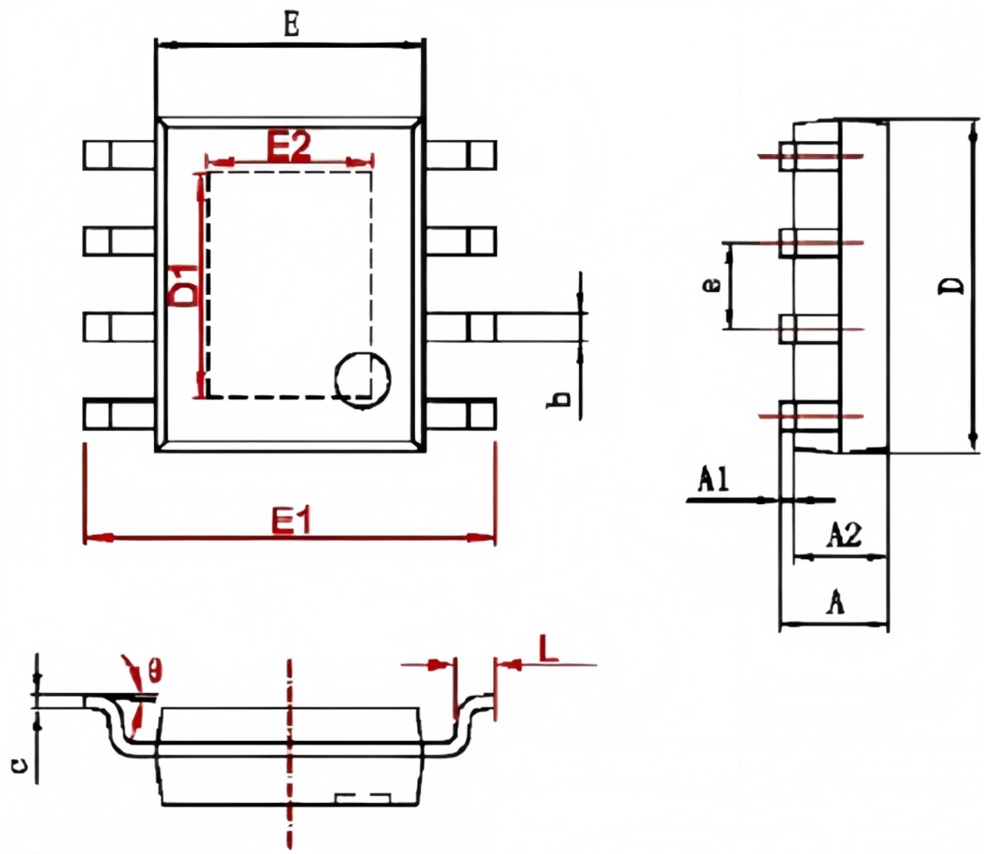
The SW pin is a fast-switching node, so its PCB trace should be kept as short as possible. Meanwhile, the IC’s GND pin requires a high-quality ground connection.

Bypass Capacitor, Inductor, and Current-Sense Resistor

For PCB layout design, place the inductor as far away from the IC as possible to minimize electromagnetic interference to the chip. If PCB space permits, lay out extensive copper pours connected to the power GND or VIN pin to absorb interference generated by the inductor. The traces on both sides of the current-sense resistor RCS shall be minimized in length to reduce trace parasitic inductance and guarantee accurate current sensing. Mount the bypass capacitor as close to the IC’s VIN pin as possible with short, wide traces.

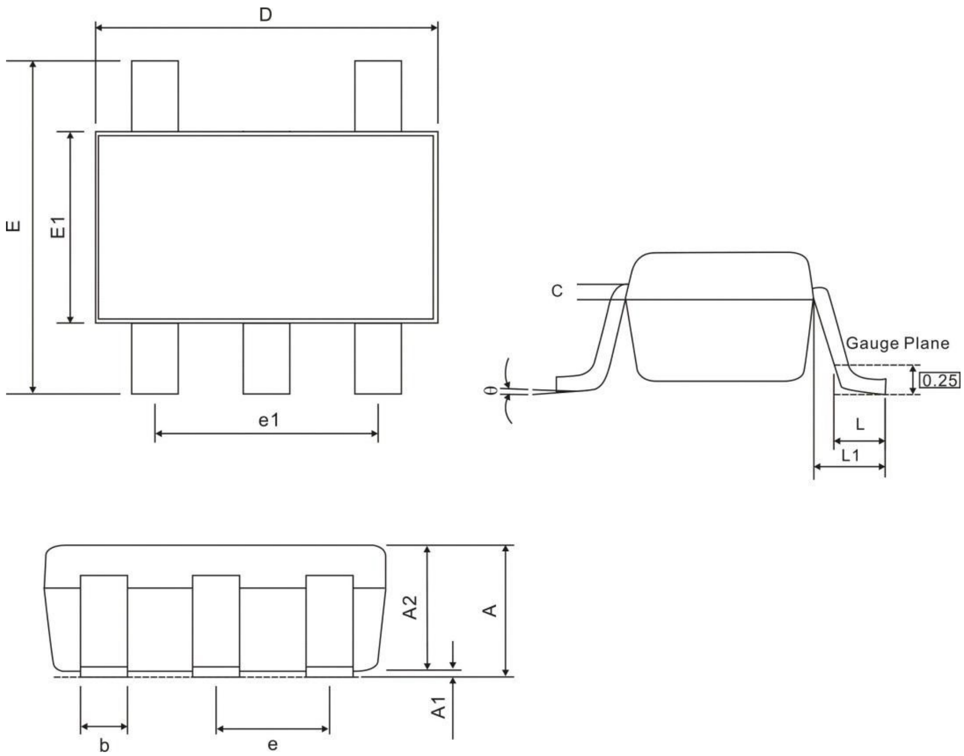
PACKAGE SIZE:

SOT89-5L



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.050	0.150	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
D1	3.202	3.402	0.126	0.134
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
E2	2.313	2.513	0.091	0.099
e	1.270 (BSC)		0.050 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

SOT23-5L



Symbol	mm		
	Min.	Typ.	Max
A	1.00	-	1.45
A1	0.00	-	0.15
A2	0.90	-	1.30
b	0.31	-	0.50
c	0.08	-	0.22
D	2.90 BSC		
E	2.80BSC		
E1	1.60BSC		
e	0.95BSC		
e1	1.90BSC		
L	0.30	0.45	0.60
	0°	-	8°

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