High Voltage LED Driver IC

❖ GENERAL DESCRIPTION

The AX9310 is an adjustable constant current driver for LED applications. A typical application for the AX9310 is to drive LED lamp with TRIAC dimmer.

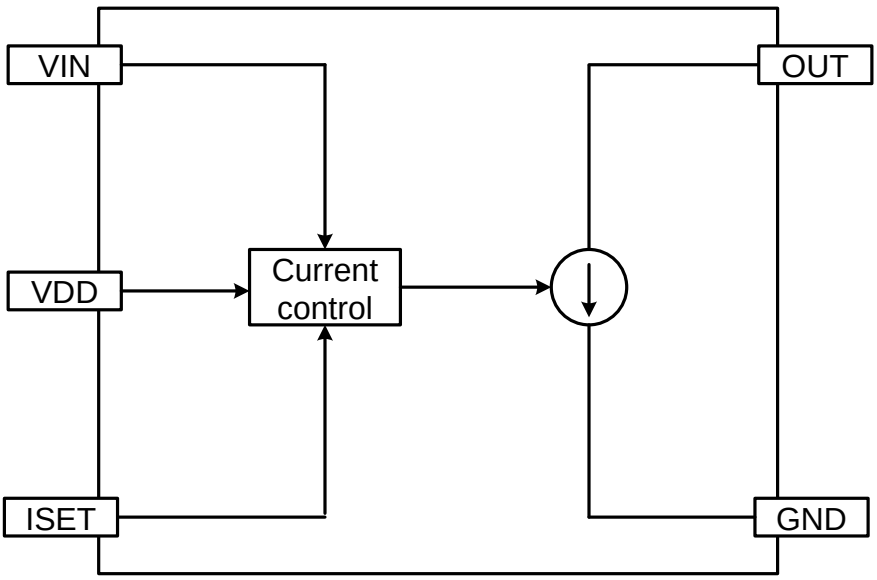
A special circuit is applied to produce a power factor of better than 0.9 with low input current THD. AX9310 is a controller for linear current regulator topology. Therefore, AX9310 minimizes external components, simplifies EMI design and lowers overall bill of materials cost.

Moreover, AX9310 is manufactured by the ultra-high voltage process that can be applied to universal existing power systems. It is available in a PDIP-8L and TO252-4L package.

❖ FEATURES

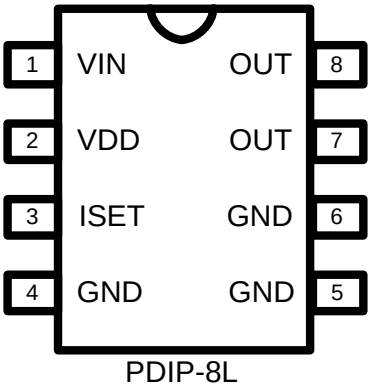
- Single Range Input Voltage (110V or 220V)
- TRIAC Dimmable
- High PFC Application (> 0.90)
- Constant Current LED Driver
- Small Size
- Low Cost
- Patent Pending
- Available in the 8-Pin Pb-Free PDIP and 4-Pin Pb-Free TO252 Package

❖ BLOCK DIAGRAM

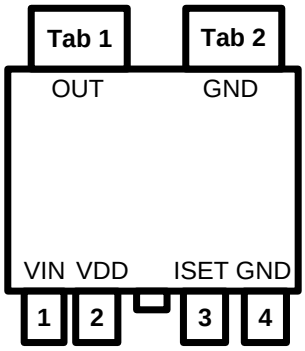


❖ PIN ASSIGNMENT

The packages of AX9310 are PDIP-8L and TO252-4L; the pin assignment is given by:



PDIP-8L



TO252-4L

Name	Description
VIN	Voltage sense
VDD	Supply voltage of drive and control circuits
ISET	Current sense
GND	Current return for driver and control circuits
OUT	Constant current output

❖ ORDER/MARKING INFORMATION

Order Information	Top Marking
AX9310 XXX X Package: N: PDIP-8L, D41: TO252-4L Packing: Blank:Tube, A : Taping	Logo ← AX9310 → Part number YYWWX → ID code:internal WW:01~52 Year: 11=2011, 12=2012

❖ ABSOLUTE MAXIMUM RATINGS (at T_A=25°C)

Characteristics		Symbol	Rating	Unit
Supply Voltage		V_{DD}	8	V
Output Voltage		V_{OUT}	650	V
VIN Voltage to GND		V_{IN}	-0.3~6.5	V
ISET Voltage to GND		V_{ISET}	-0.3~6.5	V
Junction Temperature		T_J	150	°C
Lead Temperature (Soldering 5 sec)		T_{LEAD}	260	°C
Storage Temperature Range		T_{ST}	-65 to +150	°C
Power Dissipation		PD	1	W
ESD Rating (Human Body Mode) (Note 3)		V_{ESD}	2	kV
Thermal Resistance from Junction to ambient	PDIP-8L	θ_{JA}	100	°C/W
	TO252-4L		50	°C/W

Note: θ_{JA} is measured with the PCB copper area of approximately 1 in^2 (Multi-layer).That need connect to GND pin.

❖ ELECTRICAL CHARACTERISTICS

(T_A=25°C, unless otherwise noted)

Characteristics	Symbol	Conditions	Min	Typ	Max	Units
VDD SECTION						
Operating Range	V_{DD}	After Turn-on	6	-	8	V
Operating Current	I_{OP}	Normal Operation	0.35	0.85	1.2	mA
Quiescent Current	I_q	During Protection	-	0.5	-	mA
VOLTAGE SENSE SECTION						
Linear Operation Range	V_{IN}		2	-	6	V
LED CURRENT SENSE SECTION						
Current Sense Reference Voltage	V_{ISET}		2.45	2.5	2.55	V
LED OUTPUT SECTION						
MAX. Output Current	$I_{LED(Max)}$		-	60	-	mA

❖ APPLICATION CIRCUIT

(1) PDIP-8L

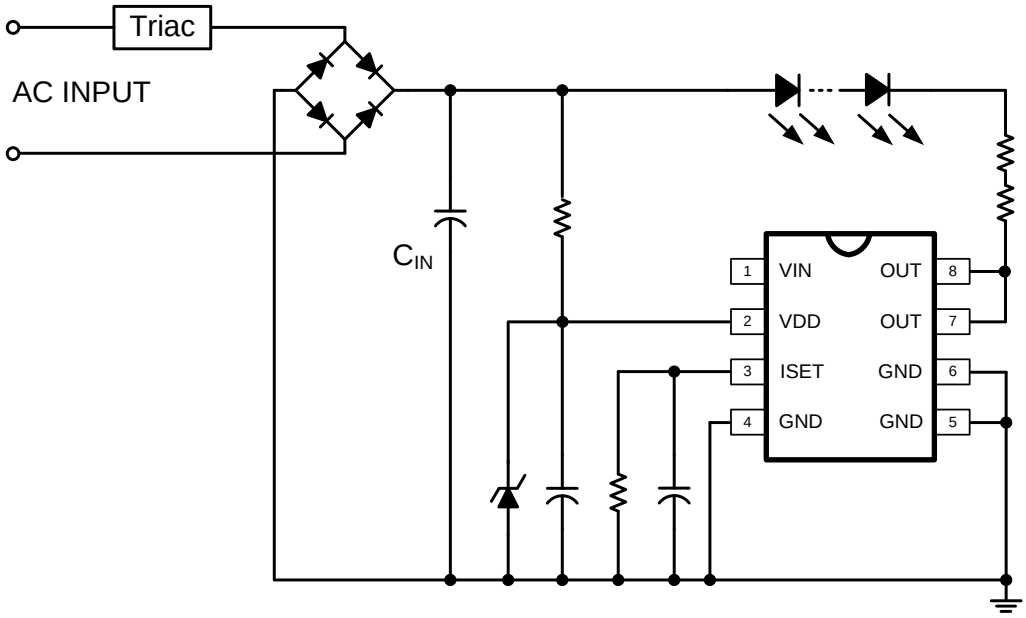


Figure 1-1

(2)PDIP-8L

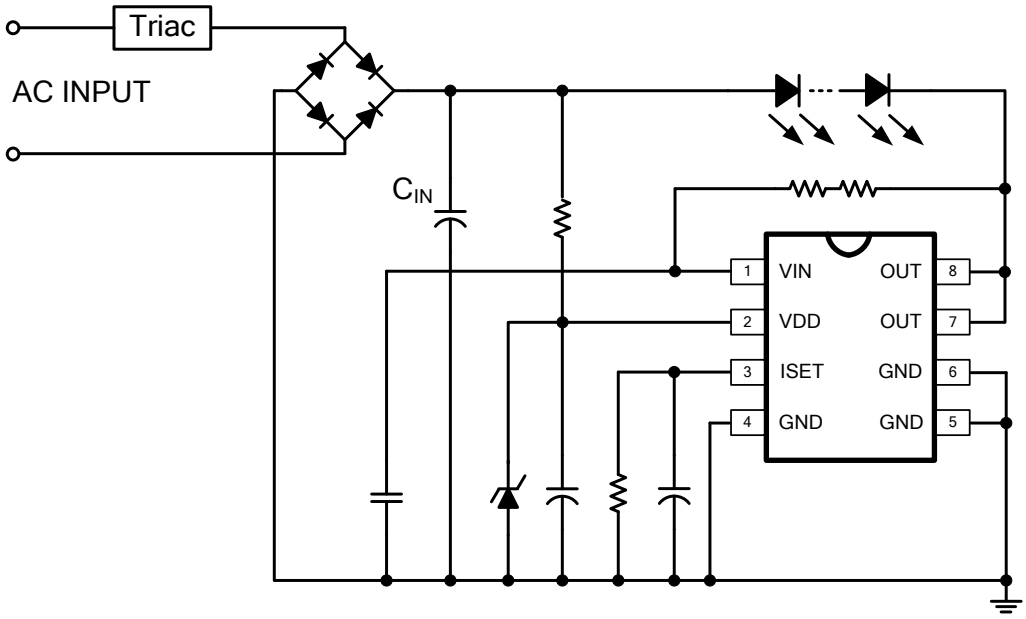


Figure 1-2

❖ APPLICATION CIRCUIT (CONTINUED)

(3) TO252-4L

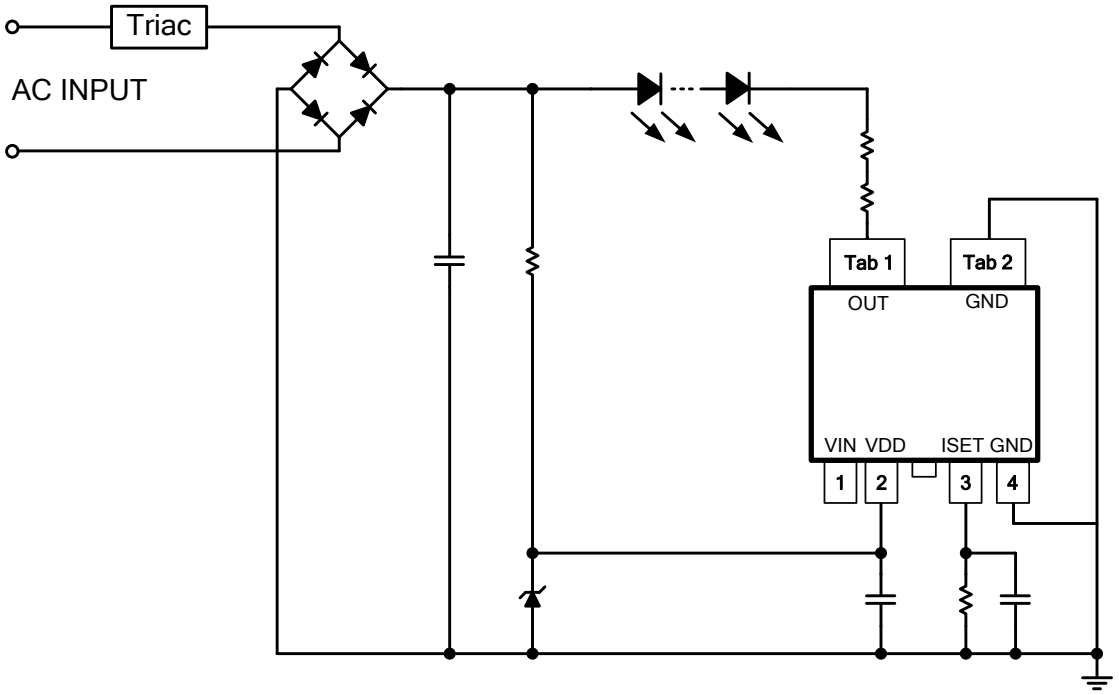


Figure 2-1

(4) TO252-4L

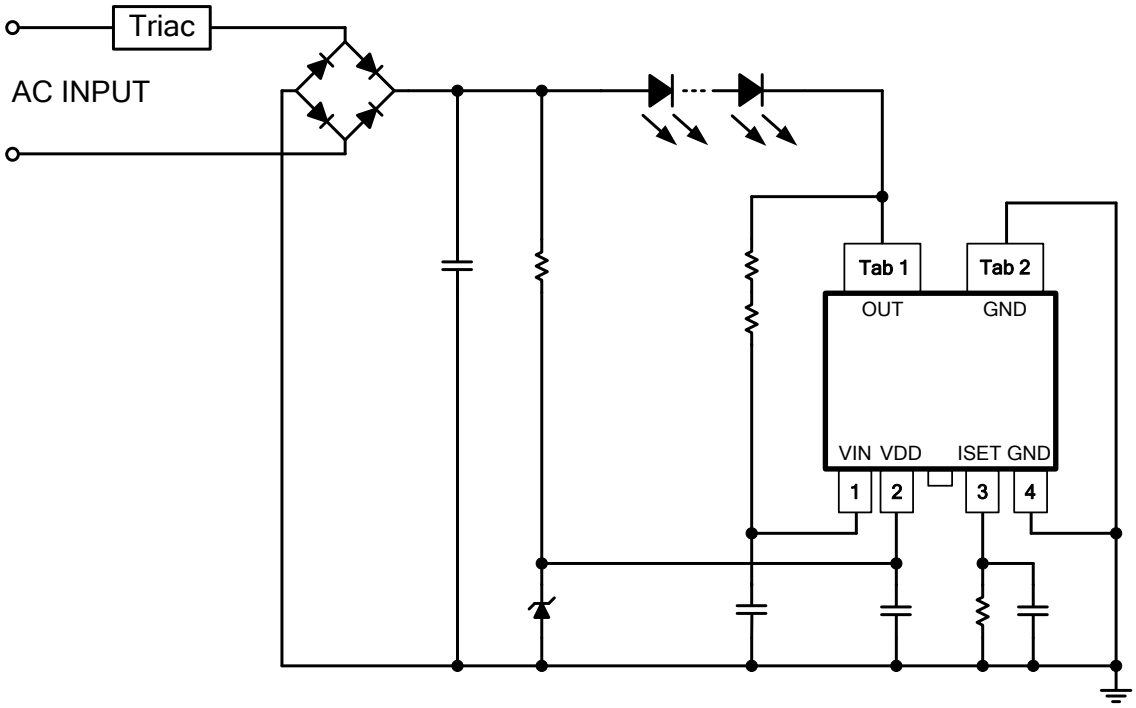


Figure 2-2

❖ APPLICATION INFORMATION

OPERATION

AX9310 can be applied to linear constant current high voltage LED driver. AX9310 is an adjustable constant current driver IC targeted for LED applications with PF > 0.9 and adapts to all types of TRIAC dimmer. With special control circuitry, AX9310 is able to reduce AC input current distortion with an extremely high PF.

AX9310 is a controller for linear current regulator topology. Therefore, the AX9310 minimizes external components, simplifies EMI design and lowers overall bill of materials cost. Furthermore, AX9310 is manufactured by the ultra high voltage process that can be applied to universal power systems.

Application circuit shown in Figure 3, the zener diode produces a stabilized voltage output to VDD of AX9310 as the power supply for internal control circuit (7.5V zener is recommend).

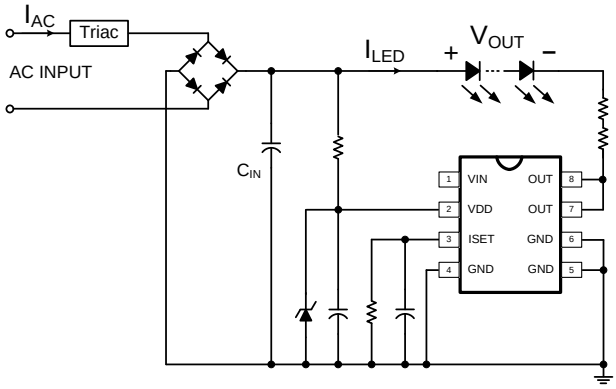


Figure 3

As shown in Figure 4, ISET pin sets the LED turn on current with a resistor. When the input voltage is lower than LED forward voltage, LED has a very small forward current. When the input voltage is higher than forward voltage, LED would current increase rapidly. Hence, AX9310 bases on the setting of ISET pin to adjust the current.

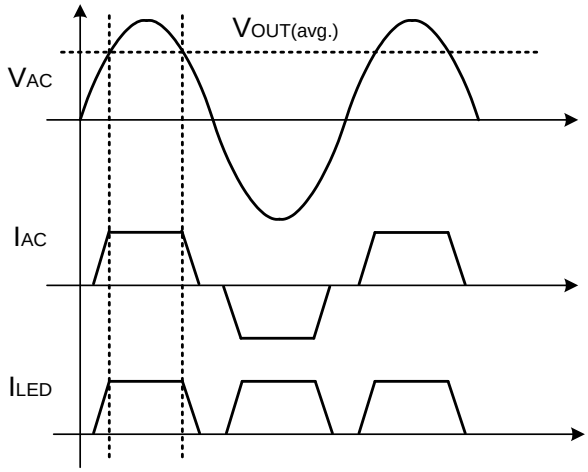


Figure 4

CURRENT LIMITATION SETTINGS

When apply to AC power input, as shown in Figure 4, the input voltage is a sine wave. Therefore, the input voltage is higher than the LED forward voltage, which would drive LED current. The current is a trapezoidal wave. The current height is set by ISET pin. The average LED current equation is as below:

$$I_{LED} = I_{SET} \approx \frac{V_{ref}}{R_{SET}} \times [1 - \frac{2 \times \sin^{-1}(\frac{V_{OUT(avg.)}}{V_{AC(peak)}})}{\pi}]$$

OUTPUT VOLTAGE SETTINGS

AX9310 is a controller for linear current regulator topology. Unlike switching controller, linear regulator doesn't need inductor for energy storage. In addition, linear regulator has very low electromagnetic radiation and is benefit for EMI solution. The efficiency of linear regulator depends on the input and output voltage ratio. Equation is as below:

$$\eta \leq \frac{V_{OUT}}{V_{IN}}$$

According to the equation, AX9310 can get high efficiency with high VOUT, which means that the load is properly applied with High VF LED or more strings of low-power LEDs. However, the LED turn-on angle will be smaller. When mounting with a TRIAC dimmer, the adjustable light angle will be limited.
The recommended loads for different AC inputs are as follows:

LED Pattern / VAC	High VF LED	Low Power LED (VF = 2.8V ~ 3.4V)
110 V_{AC}	85V ~115V	30S ~ 33S / 2P
220 V_{AC}	170V ~ 220V	60S ~ 66S / 1P

HIGH POWER FACTOR APPLICATIONS

The AX9310 is an adjustable constant current driver for LED application. A typical application for the AX9310 is to drive LED lamp with TRIAC dimmer. The AX9310 includes a special circuit which can produce a power factor of better than 0.9 with low input current THD. Therefore, over 10nF capacitor Cin is not recommended, otherwise it would result in the decrease of PFC.

HIGH OUTPUT POWER APPLICATIONS

AX9310 is available in PDIP-8L and TO252-4L package that can withstand up to 1 watt power consumption.

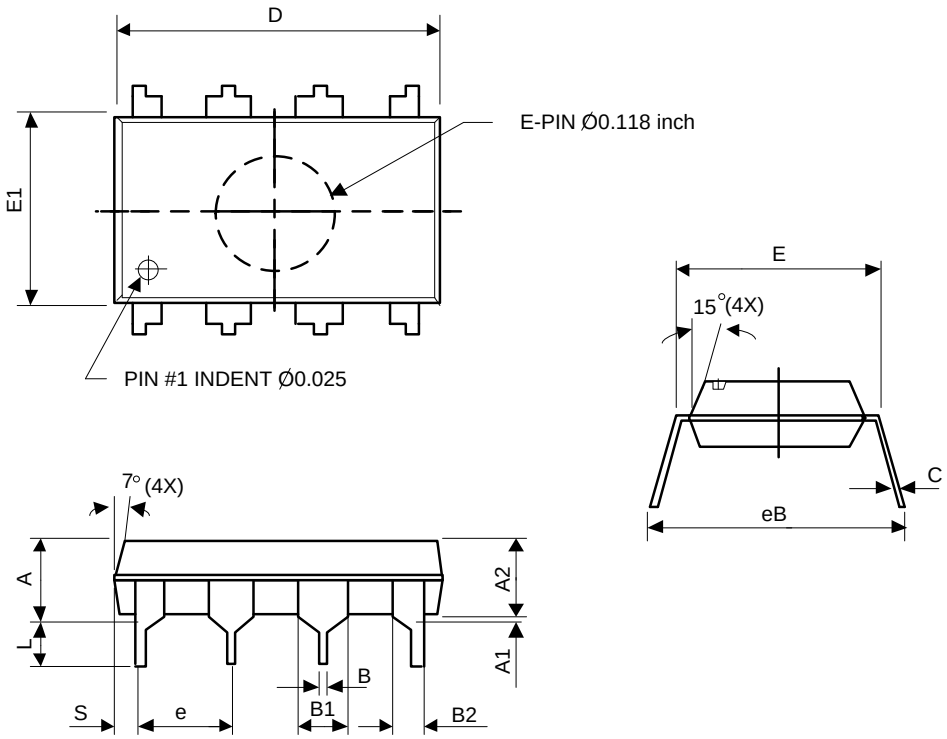
As shown in Figure 1-1 (or Figure 1-2), in high output power applications, If increases the Cin capacitance, rectified voltage would be close to DC. It can increase the output current and improve the output power. However, the high output power applications will reduce power factor.

In AC applications, the current limiting resistor of zener diode is about 1 MΩ. In high AC input voltage applications, this current limiting resistor should be noted that whether the voltage stress is sufficient. For example, the voltage stress on the R0805 resistor should not exceed 200V.

If input voltage peak is higher than 200V, this current limiting resistor should be divided into two 500KΩ/R0805 resistors in series to increase its stress capability.

❖ PACKAGE OUTLINES

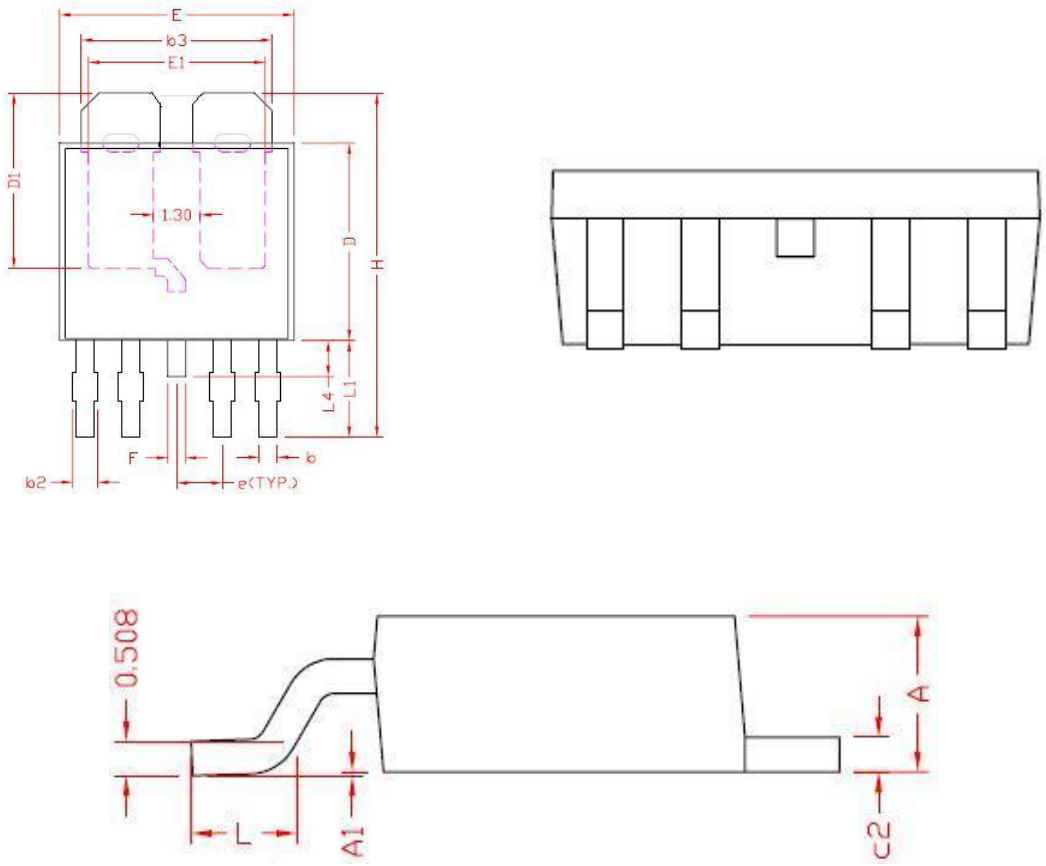
(1) PDIP-8L



Symbol	Dimensions in millimeters			Dimensions in inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	5.33	-	-	0.21
A1	0.38			0.015	-	-
A2	2.92	3.3	4.95	0.115	0.13	0.195
B	0.36	0.46	0.51	0.014	0.018	0.02
B1	1.14	1.52	1.78	0.045	0.06	0.07
B2	0.76	0.99	1.14	0.03	0.039	0.045
C	0.2	0.25	0.36	0.008	0.01	0.014
D	9.02	9.27	10.16	0.355	0.365	0.4
E	7.62	7.87	8.26	0.3	0.31	0.325
E1	6.1	6.35	7.11	0.24	0.25	0.28
e	2.54 BSC			0.100 BSC		
L	2.92	3	3.81	0.115	0.13	0.15
eB	-	-	10.92	-	-	0.43
S	0.13	-	-	0.005	-	-

JEDEC outline: MO-100 BA

(2) TO252-4L



Symbol	Millimeter		Symbol	Millimeter	
	Min.	Max.		Min.	Max.
A	2.20	2.40	E	6.40	6.80
A1	0	0.15	E1	3.81	---
b	0.40	0.60	e	1.27REF	
b2	0.50	0.80	F	0.40	0.60
b3	5.20	5.50	H	9.40	10.20
c2	0.45	0.55	L	1.40	1.77
D	5.40	5.80	L1	2.40	3.00
D1	4.27	---	L4	0.80	1.20