

## **1.5A High Output Current LDO Regulator**

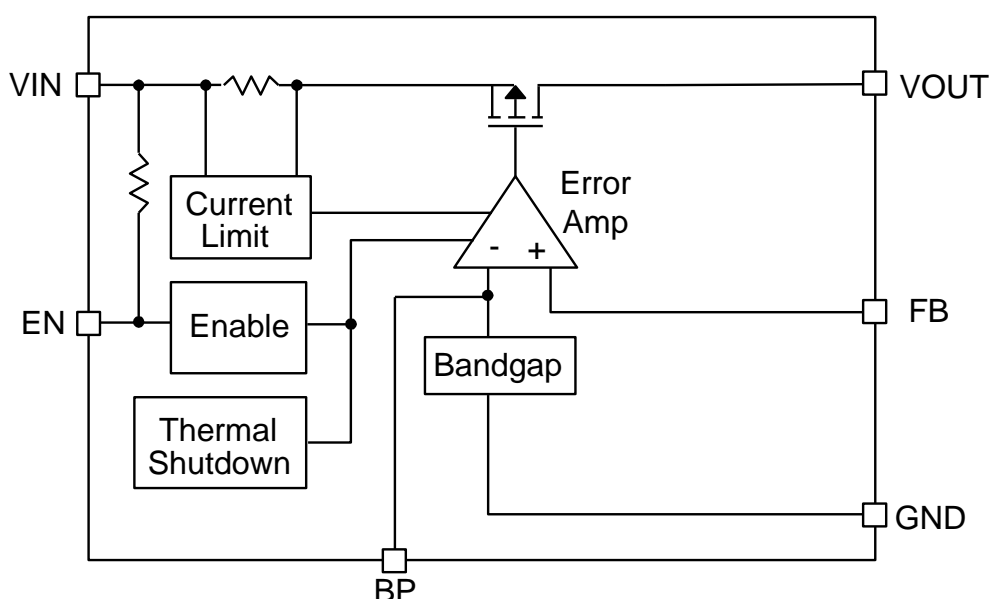
### ❖ GENERAL DESCRIPTION

The AX6643 is a low noise, high output current, low quiescent current and low dropout linear regulator. The Device includes pass element, error amplifier, band-gap, current limit and thermal shutdown circuitry. The output current is up to 1.5A, the characteristics of low dropout voltage and less quiescent current make it good for some critical current application, and for example, some battery powered devices. The typical quiescent current is approximately 50 $\mu$ A. In the shutdown mode, the maximum supply current is less than 2 $\mu$ A. Built-in current-limit, Short current protection and thermal-shutdown functions prevent any fault condition from IC damage.

### ❖ FEATURES

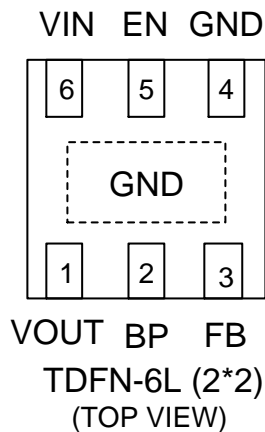
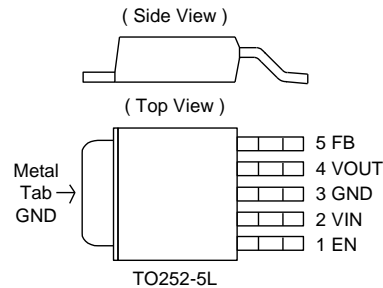
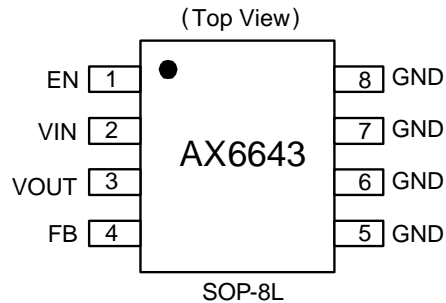
- Input voltage range : 2.6V~5.5V
- Adjustable Output voltage form 0.8V to 5.0V
- Dropout voltage is 450mV at 1.5A output current @  $V_{OUT} = 3.30V$
- Guaranteed 1.5A output current
- Low quiescent current is 50 $\mu$ A (typ.)
- Maximum supply current in shutdown mode < 2 $\mu$ A
- Fast transient response
- Current limit and thermal shutdown protection
- Short circuit current fold-back
- Available in the SOP-8L, TO252-5L and TDFN-6L Pb-Free Packages

### ❖ BLOCK DIAGRAM



## ❖ PIN ASSIGNMENT

The packages of AX6643 are SOP-8L, TO252-5L and TDFN-6L; the pin assignment is given by:



Name	Description
VIN	Input voltage
GND	Ground
VOUT	Regulator Output Voltage. Adjustable from 0.8V to 5.5V.
EN	Active-Low Shutdown Input. A logic low reduces the supply current to less than 2μA. Connect to VIN or Floating for normal operation.
FB	Feedback Input for Setting the Output Voltage. Connect to an external resistor divider for adjustable output operation.
BP	Band-gap (TDFN-6L only)

## ❖ ORDER/MARKING INFORMATION

Order Information	
<p>AX6643 XX X</p> <p>Package      Packing</p> <p>S : SOP-8L      Blank: Bulk</p> <p>D5 : TO252-5L      A : Taping</p> <p>Z6 : TDFN-6L (2*2)</p>	
Top Marking (SOP-8L/TO252-5L)	Top Marking (TDFN-6L)
<p>Logo ← <b>AX</b> 6 6 4 3 → Part number</p> <p>YY WW X → ID code: internal</p> <p>WW: 01~52</p> <p>Year: 10=2010</p> <p>11=2011</p>	<p><b>M</b> 1 → AX6643</p> <p><b>Y</b> <b>W</b> <b>X</b> → ID Code: Internal</p> <p>Week: 01~26(A~Z)</p> <p>27~52(a~z)</p> <p>Year : A = 2010</p> <p>1 = 2011</p>

### ❖ ABSOLUTE MAXIMUM RATINGS (at $T_A=25^{\circ}\text{C}$ )

Characteristics		Symbol	Rating	Unit
$V_{IN}$ Pin Voltage		$V_{IN}$	GND- 0.3 to GND + 6.5	V
Output Voltage		$V_{OUT}$	GND- 0.3 to $V_{IN} + 0.3$	V
EN Pin Voltage		$V_{EN}$	GND- 0.3 to $V_{IN} + 0.3$	V
FB/BP Pin Voltage		$V_{FB/BP}$	GND- 0.3 to $V_{IN} + 0.3$	V
Power Dissipation	SOP-8L	PD	1.65	W
	TO252-5L		2.22	
	TDFN-6L		0.83	
Storage Temperature Range		$T_{ST}$	-40 to +150	$^{\circ}\text{C}$
Operating Temperature Range		$T_{OP}$	-40 to +85	$^{\circ}\text{C}$
Junction Temperature		$T_J$	-40 to +125	$^{\circ}\text{C}$
Thermal Resistance from Junction to case	SOP-8L	$\theta_{JC}$	20	$^{\circ}\text{C/W}$
	TO252-5L		10	
	TDFN-6L		25	
Thermal Resistance from Junction to ambient	SOP-8L	$\theta_{JA}$	60	$^{\circ}\text{C/W}$
	TO252-5L		45	
	TDFN-6L		120	

Note:  $\theta_{JA}$  is measured with the PCB copper area of approximately 1 in<sup>2</sup>(Multi-layer). That need connect to GND/Tap pin.

### ❖ ELECTRICAL CHARACTERISTICS $T_A=25^{\circ}\text{C}$ (unless otherwise noted)

Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Input Voltage	$V_{IN}$	$I_{OUT}=30\text{mA}$	2.6	-	5.5	V
FB Voltage	$V_{FB}$	$V_{IN}=2.6\text{V to }5.5\text{V}$ , $I_{OUT}=1\text{mA}$	0.784	0.8	0.816	V
FB Input Leakage Current	$I_{FB}$	$V_{FB}=0.8\text{V}$	-100	-	100	nA
Adjustable Output Voltage Range	$V_{OUT}$		$V_{FB}$	-	5.0	V
Quiescent Current	$I_Q$	$I_{OUT}=0\text{mA}$ , $V_{IN}=5\text{V}$	-	50	80	$\mu\text{A}$
Shutdown Current	$I_{SD}$	$I_{OUT}=0\text{mA}$ , $V_{EN}=0\text{V}$	-	-	2	$\mu\text{A}$
Dropout Voltage	$V_{DROP}$	$I_{OUT}=1.5\text{A}$	$V_{OUT}=1.20\text{V}$	-	1.3	V
			$V_{OUT}=1.50\text{V}$	-	1.0	
			$V_{OUT}=1.80\text{V}$	-	0.70	
			$V_{OUT}=2.50\text{V}$	-	0.55	
			$V_{OUT}=3.30\text{V}$	-	0.45	
Current Limit (Note 1)	$I_{LIMIT}$		1.6	2.0	-	A
Short Circuit Current	$I_{short}$	$V_{FB}<0.2\text{V}$	-	600	-	mA
Load Regulation (Note 2)	$\Delta V_{LOAD}$	$I_{OUT}=10\text{m}\sim 1.5\text{A}$	-	0.5	1	%
Ripple Rejection	PSRR	$C_{IN}=2.2\mu\text{F}$ , $F=120\text{Hz}$	-	65	-	dB
		$C_O=2.2\mu\text{F}$ , $I_{OUT}=10\text{mA}$ , $F=1\text{KHz}$	-	60	-	
Enable Input Threshold	$V_{ENH}$	Regulator Enable	2.0	-	-	V
	$V_{ENL}$	Regulator Shutdown	-	-	0.6	
Enable Pin Current	$I_{ENH}$	$V_{EN}=V_{IN}$	-	0.003	0.1	$\mu\text{A}$
	$I_{ENL}$	$V_{EN}=0\text{V}$	-	1.0	1.5	

## ❖ ELECTRICAL CHARACTERISTICS (CONTINUOUS)

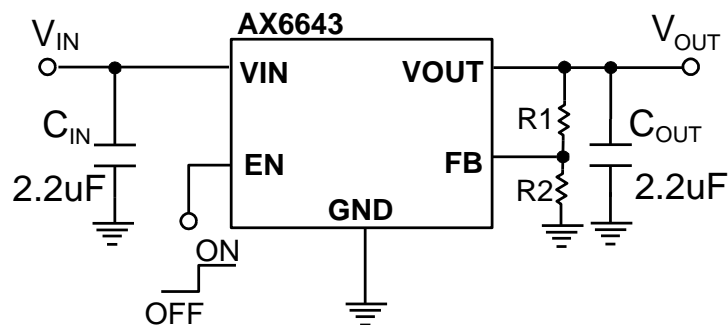
Temperature Shutdown	T <sub>S</sub>	-	150	-	°C
Temperature Shutdown Hysteresis	T <sub>SH</sub>	-	30	-	°C

Note1: Current limit is measured at constant junction temperature by using pulsed testing with a low ON time.

Note2: Regulation is measured at constant junction temperature by using pulsed testing with a low ON time.

## ❖ APPLICATION CIRCUIT

### 1. SOP-8L/TO252-5L

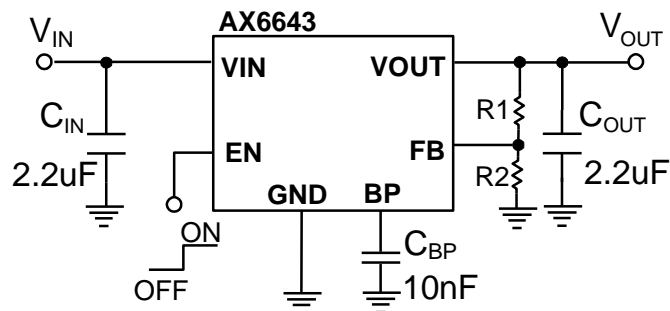


$$V_{OUT} = V_{FB} * (1 + R1/R2)$$

$$V_{FB} = 0.8V$$

$$R2 \text{ Range} = 50K \sim 300K$$

### 2. TDFN-6L



## ❖ FUNCTION DESCRIPTION

A minimum of 2.2μF capacitor must be connected from V<sub>OUT</sub> to ground to insure stability. Typically a large storage capacitor is connected from V<sub>IN</sub> to ground to ensure that the input voltage does not sag below the minimum dropout voltage during the load transient response. This pin must always be dropout voltage higher than V<sub>OUT</sub> in order for the device to regulate properly.

## Enable Function

The AX6643 features an LDO regulator enable/disable function. To assure the LDO regulator will switch on; the EN turn on control level must be greater than 2.0 volts. The LDO regulator will go into the shutdown mode when the voltage on the EN pin falls below 0.6 volts. For protecting the system, the AX6643 have a quick-discharge function. If the enable function is not needed in a specific application, it may be tied to VIN to keep the LDO regulator in a continuously on state.

## FB Function

The output is an adjustable version, the FB voltage is 0.8V. The output voltage can be set by outside resistances. The output voltage,  $V_{OUT}$ , is then given by the following equation:

$$V_{OUT} = 0.8 * (1 + R1/R2)$$

For the reasons of reducing power dissipation and loop stability, R2 is recommending to choose 50K~300KΩ.

## ❖ APPLICATION INFORMATION

Like any low-dropout regulator, the AX6643 requires input and output decoupling capacitors. The device is specifically designed for portable applications requiring minimum board space and smallest components. These capacitors must be correctly selected for good performance. Please note that linear regulators with a low dropout voltage have high internal loop gains which require care in guarding against oscillation caused by insufficient decoupling capacitance.

### Capacitor Selection

Normally, use a 2.2μF capacitor on the input and a 2.2μF capacitor on the output of the AX6643. Larger input capacitor values and lower ESR (X5R, X7R) provide better supply-noise rejection and transient response. A higher- value output capacitor (4.7μF) may be necessary if large, fast transients are anticipated and the device is located several inches from the power source.

### Input-Output (Dropout) Voltage

A regulator's minimum input-to-output voltage differential (dropout voltage) determines the lowest usable supply voltage. In battery-powered systems, this determines the useful end-of-life battery voltage. Because the device uses a PMOS, its dropout voltage is a function of drain-to source on-resistance,  $R_{DS(ON)}$ , multiplied by the load current:

$$V_{DROPOUT} = V_{IN} - V_{OUT} = R_{DS(ON)} \times I_{OUT}$$

## Current Limit and Short-Circuit Protection

The AX6643 used a current sense-resistor to monitor the output current. A portion of the PMOS output transistor's current is mirrored to a resistor such that the voltage across this resistor is proportional to the output current. Once the output current exceeds limit threshold, AX6643 would be protected with a limited output current. Further more, when the output is short to ground, the output current would be folded-back to a less limit.

## Thermal Considerations

The AX6643 series can deliver a current of up to 1.5A over the full operating junction temperature range. However, the maximum output current must be dated at higher ambient temperature to ensure the junction temperature does not exceed 125°C. With all possible conditions, the junction temperature must be within the range specified under operating conditions. Power dissipation can be calculated based on the output current and the voltage drop across regulator.

$$PD = (V_{IN} - V_{OUT}) I_{OUT}$$

The final operating junction temperature for any set of conditions can be estimated by the following thermal equation:

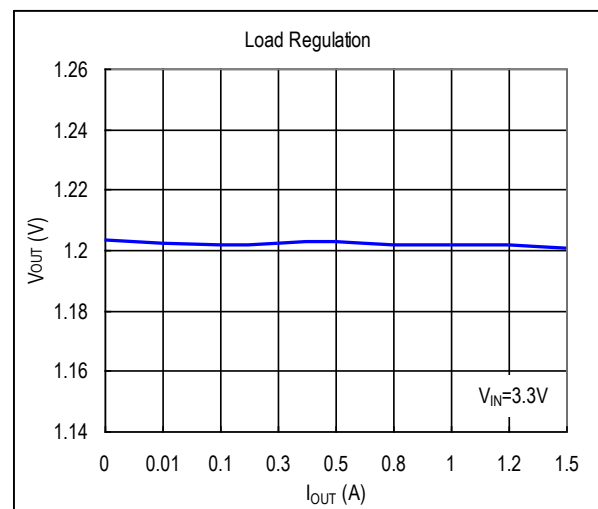
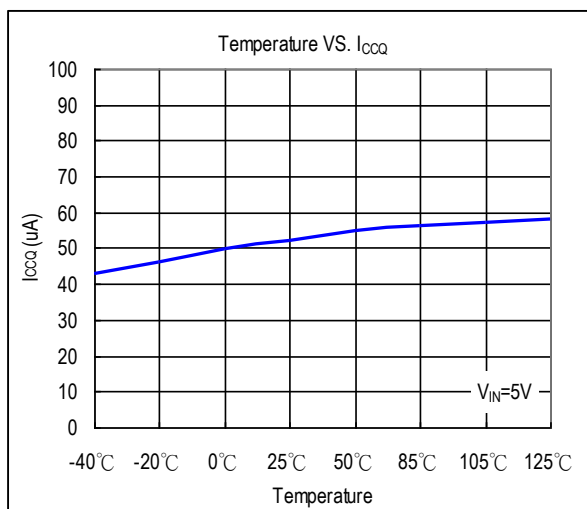
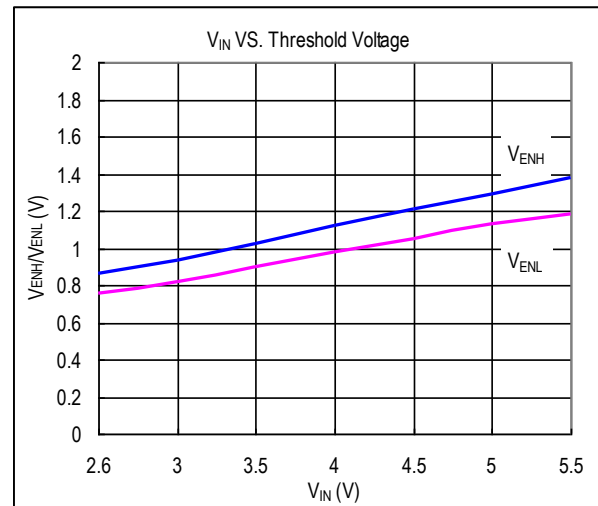
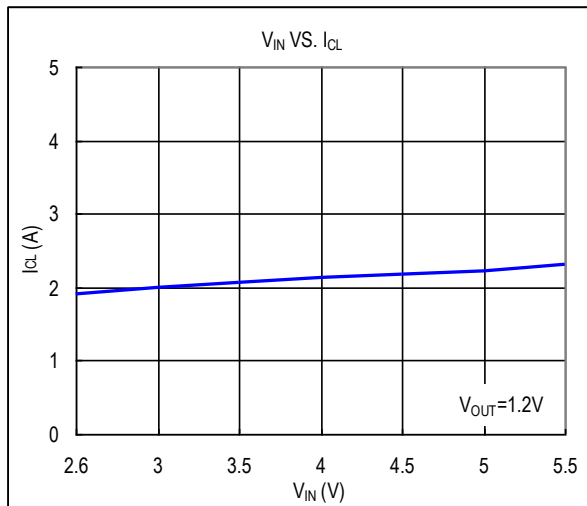
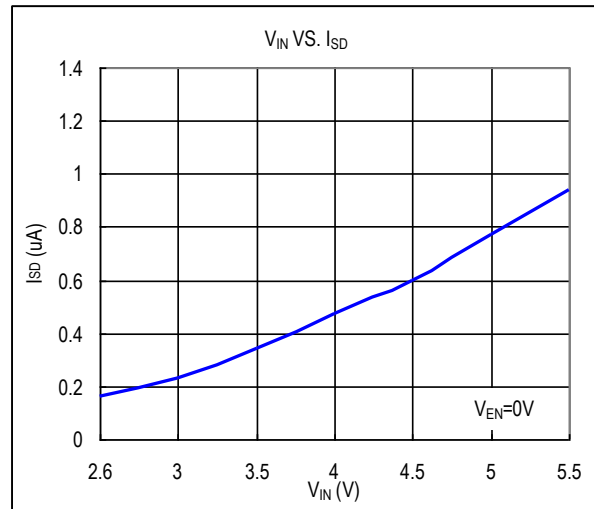
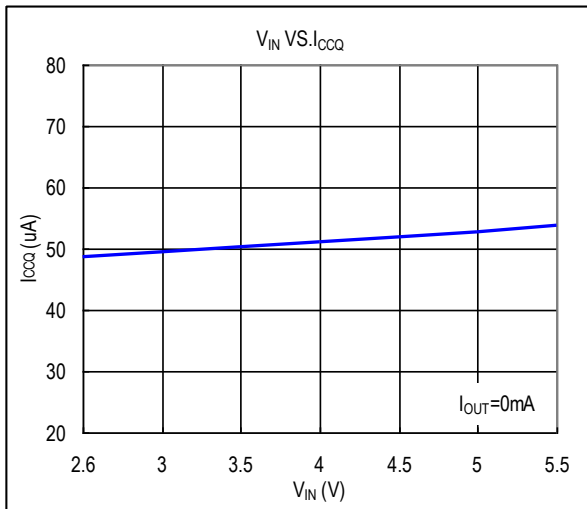
$$PD (MAX) = (T_{J(MAX)} - T_A) / \theta_{JA}$$

Where  $T_{J(MAX)}$  is the maximum junction temperature of the die (125°C) and  $T_A$  is the maximum ambient temperature. The junction to ambient thermal resistance ( $\theta_{JA}$ ) for SOP-8L package at recommended minimum footprint is 60°C/W that is connected 1 in<sup>2</sup> PCB copper area to GND Pin.

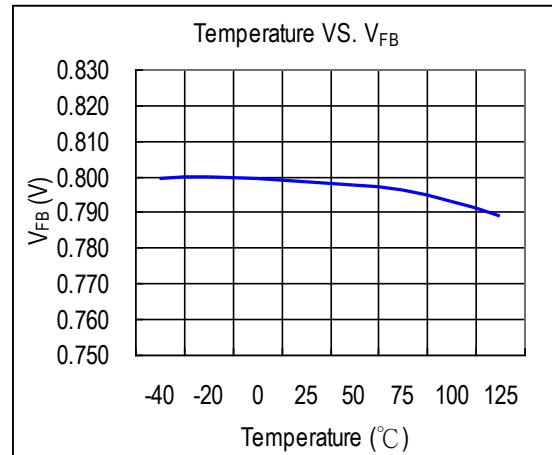
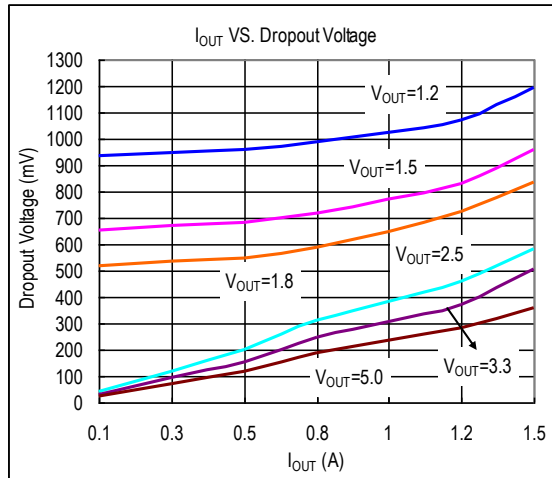
## PCB Layout

An input capacitance of  $\cong 2.2\mu F$  is required between the AX6643 input pin and ground (the amount of the capacitance may be increased without limit), this capacitor must be located a distance of not more than 1cm from the input and return to a clean analog ground. Input capacitor can filter out the input voltage spike caused by the surge current due to the inductive effect of the package pin and the printed circuit board's routing wire. Otherwise, the actual voltage at the  $V_{IN}$  pin may exceed the absolute maximum rating. The output capacitor also must be located a distance of not more than 1cm from output to a clean analog ground. Because it can filter out the output spike caused by the surge current due to the inductive effect of the package pin and the printed circuit board's routing wire.

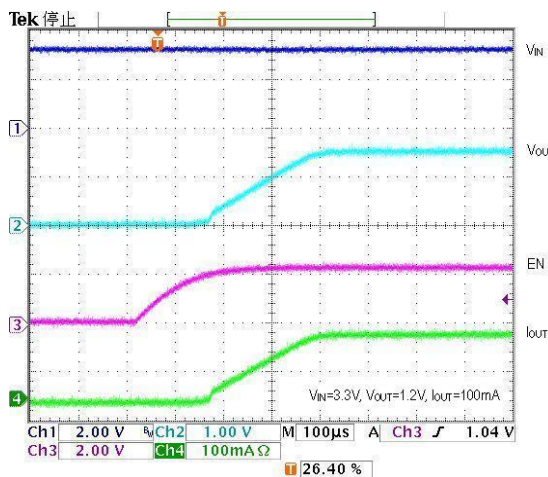
❖ TYPICAL CHARACTERISTICS



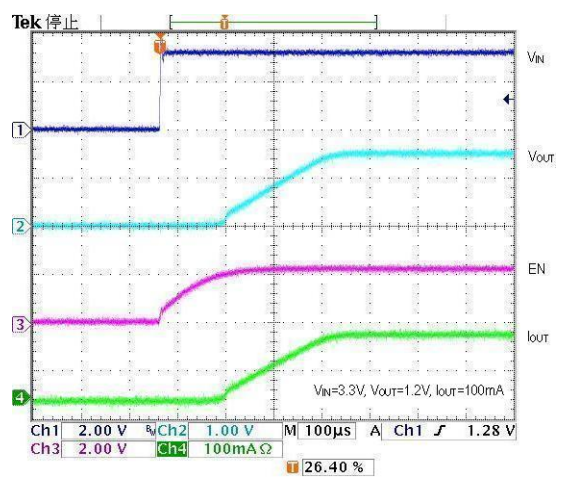
❖ TYPICAL CHARACTERISTICS (CONTINUOUS)



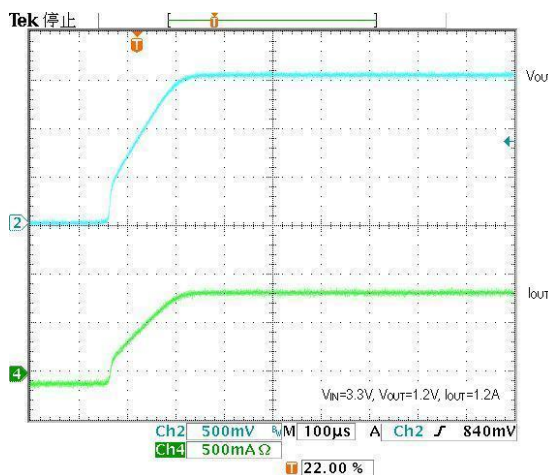
EN-ON (SOP-8L Only)



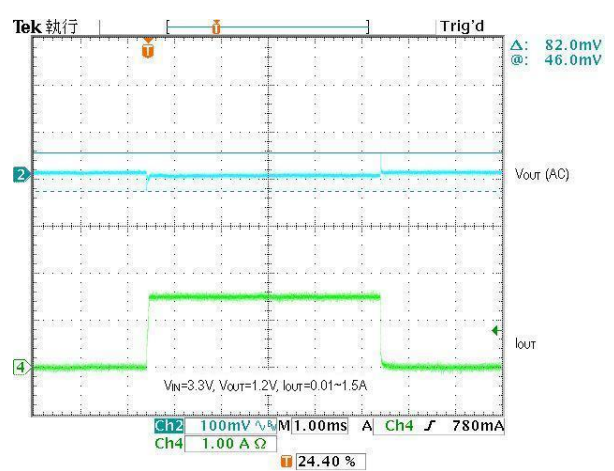
Power-ON



Thermal Shutdown Release



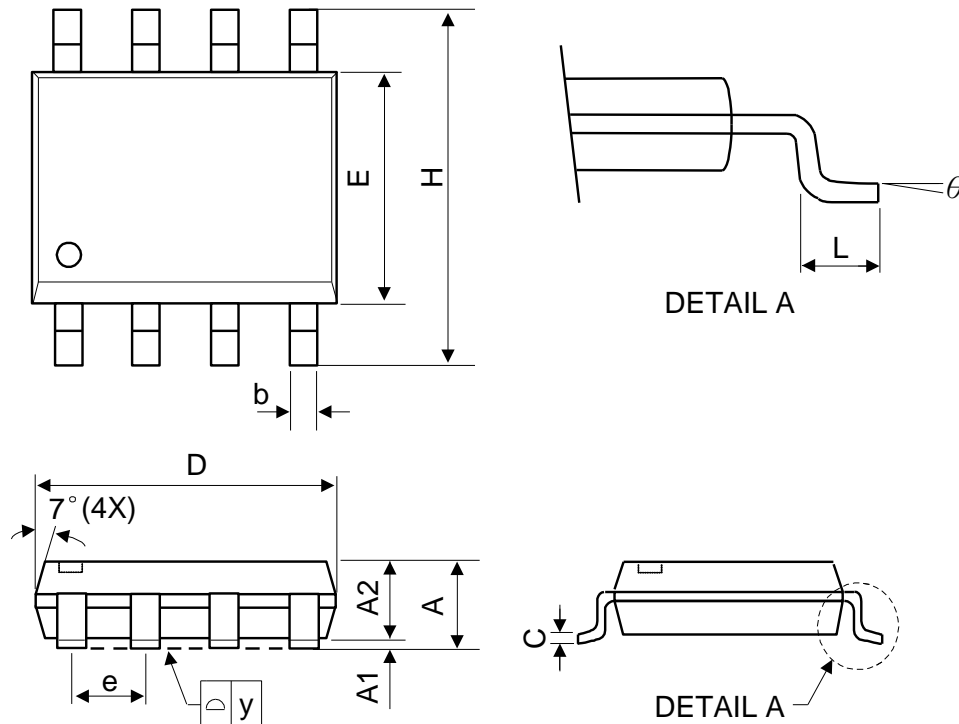
Load Transient





❖ **PACKAGE OUTLINES**

**(1) SOP-8L**

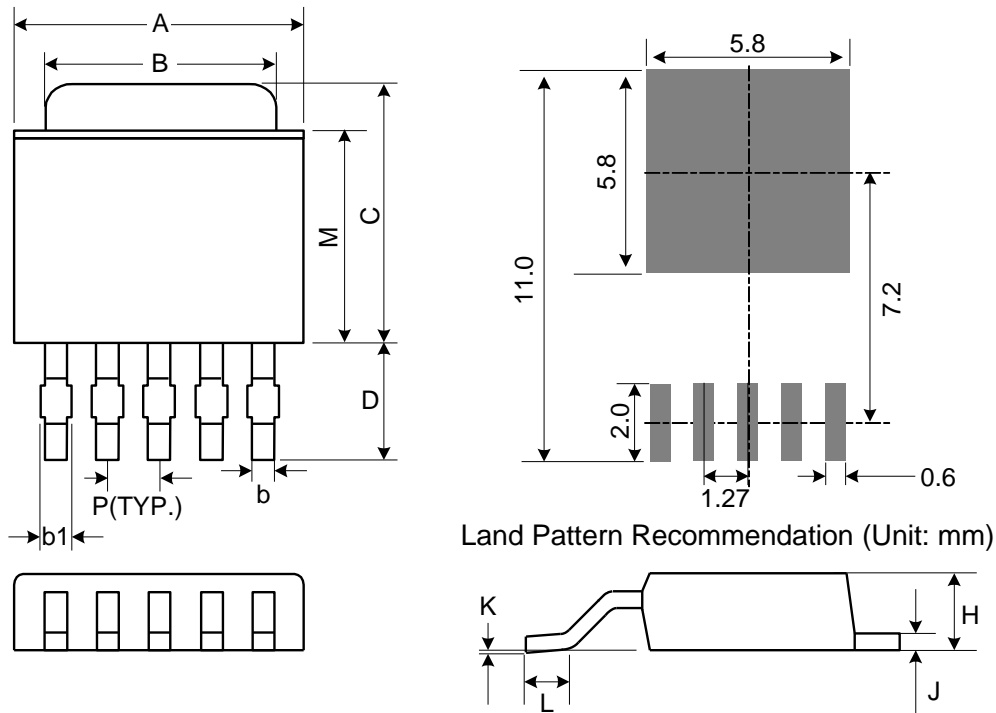


Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	1.75	-	-	0.069
A1	0.1	-	0.25	0.04	-	0.1
A2	1.25	-	-	0.049	-	-
C	0.1	0.2	0.25	0.0075	0.008	0.01
D	4.7	4.9	5.1	0.185	0.193	0.2
E	3.7	3.9	4.1	0.146	0.154	0.161
H	5.8	6	6.2	0.228	0.236	0.244
L	0.4	-	1.27	0.015	-	0.05
b	0.31	0.41	0.51	0.012	0.016	0.02
e	1.27 BSC			0.050 BSC		
y	-	-	0.1	-	-	0.004
θ	0°	-	8°	0°	-	8°

Mold flash shall not exceed 0.25mm per side

JEDEC outline: MS-012 AA

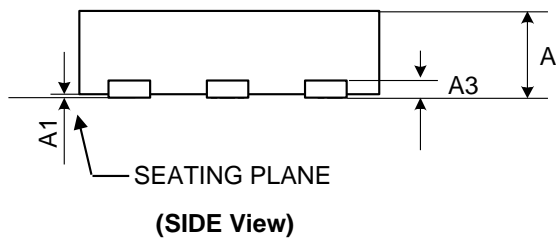
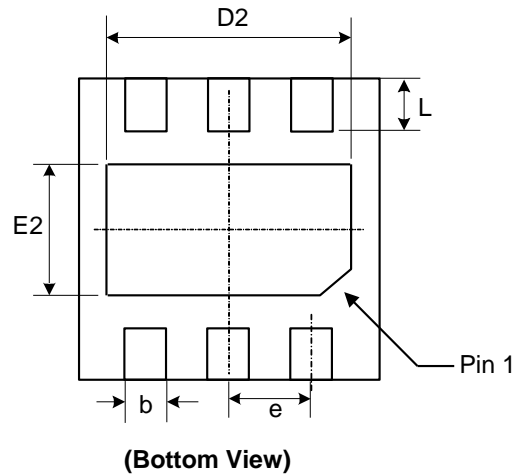
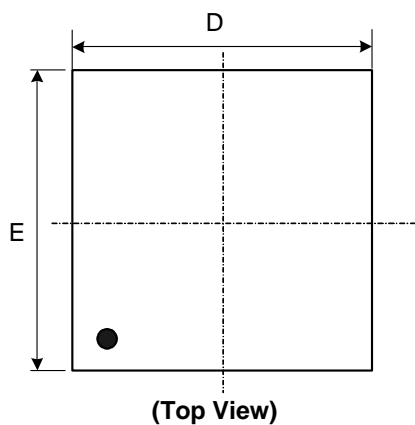
(2) TO252-5L



Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	6.35	6.6	6.73	0.250	0.260	0.265
B	5.21	5.33	5.46	0.205	0.210	0.215
C	6.86	7.24	7.62	0.270	0.285	0.300
D	2.67 REF			0.105 REF		
P	1.27 REF			0.050 REF		
H	2.18	2.29	2.39	0.086	0.090	0.094
J	0.46	0.51	0.58	0.018	0.020	0.023
K	0.00	0.08	0.13	0.000	0.003	0.005
L	1.40	1.60	1.78	0.055	0.063	0.070
M	5.33	5.46	5.59	0.210	0.215	0.220
b	0.38	0.56	0.71	0.015	0.022	0.028
b1	0.38	0.53	0.66	0.015	0.021	0.026

Mold flash shall not exceed 0.005inch per side

**(3) TDFN-6L (2\*2 0.75mm)**



Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	0.70	0.75	0.80	0.028	0.030	0.031
A1	0.00	0.02	0.05	0.000	0.001	0.002
A3	0.203 REF.			0.008 REF.		
b	0.20	0.28	0.35	0.009	0.011	0.013
D	1.95	2.00	2.05	0.077	0.079	0.081
D2	1.35	1.50	1.65	0.055	0.059	0.063
E	1.95	2.00	2.05	0.077	0.079	0.081
E2	0.75	0.90	1.05	0.031	0.035	0.039
e	0.65 BSC.			0.026 BSC.		
L	0.20	0.30	0.40	0.008	0.012	0.016