

3A High Output Current LDO Regulator

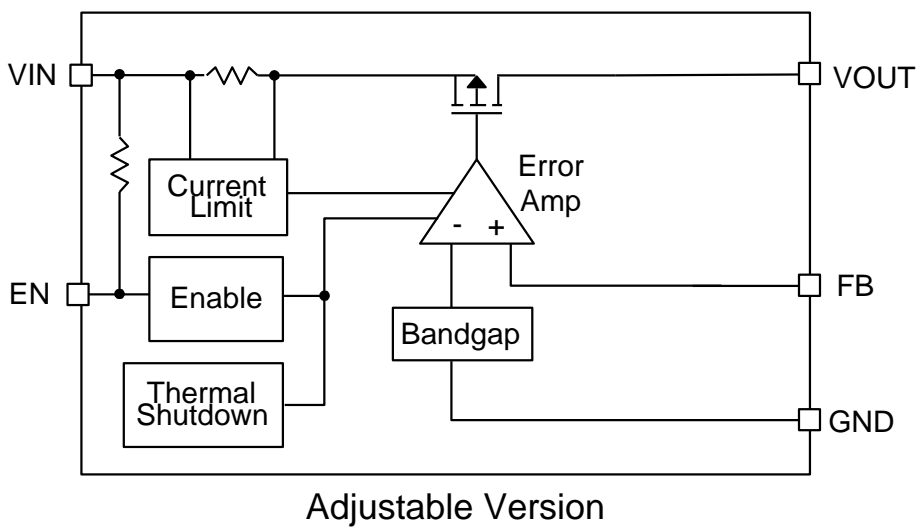
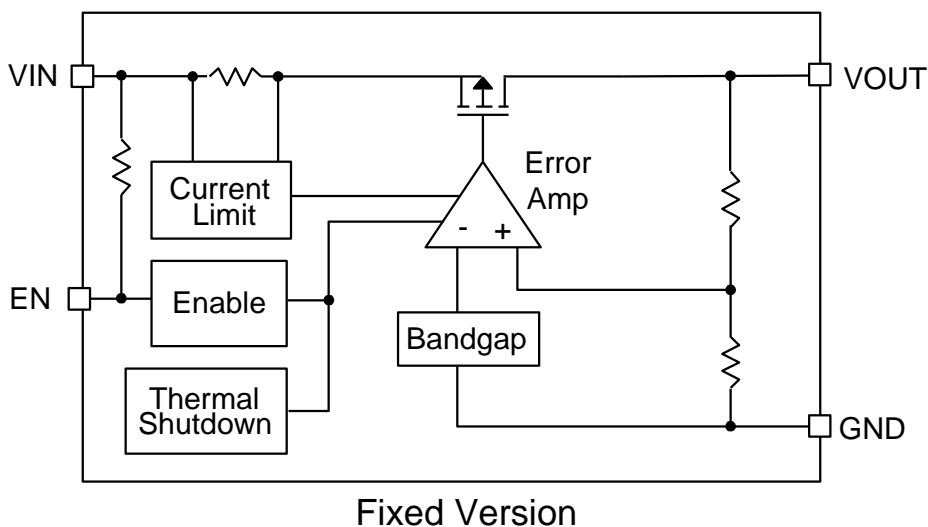
❖ GENERAL DESCRIPTION

The AX6639/A 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 3A. The characteristics of low dropout voltage and less quiescent current make it good for some critical current application, for example, some battery powered devices. The typical quiescent current is approximately 200 μ A. There are 1.5V, 1.8V, 2.5V, 3.3V fixed output voltage and adjustable output versions (SOP-8L-EP and TO263-5L Only). Built-in current-limit, Short current protection and thermal-shutdown functions prevent any fault condition from IC damage.

❖ FEATURES

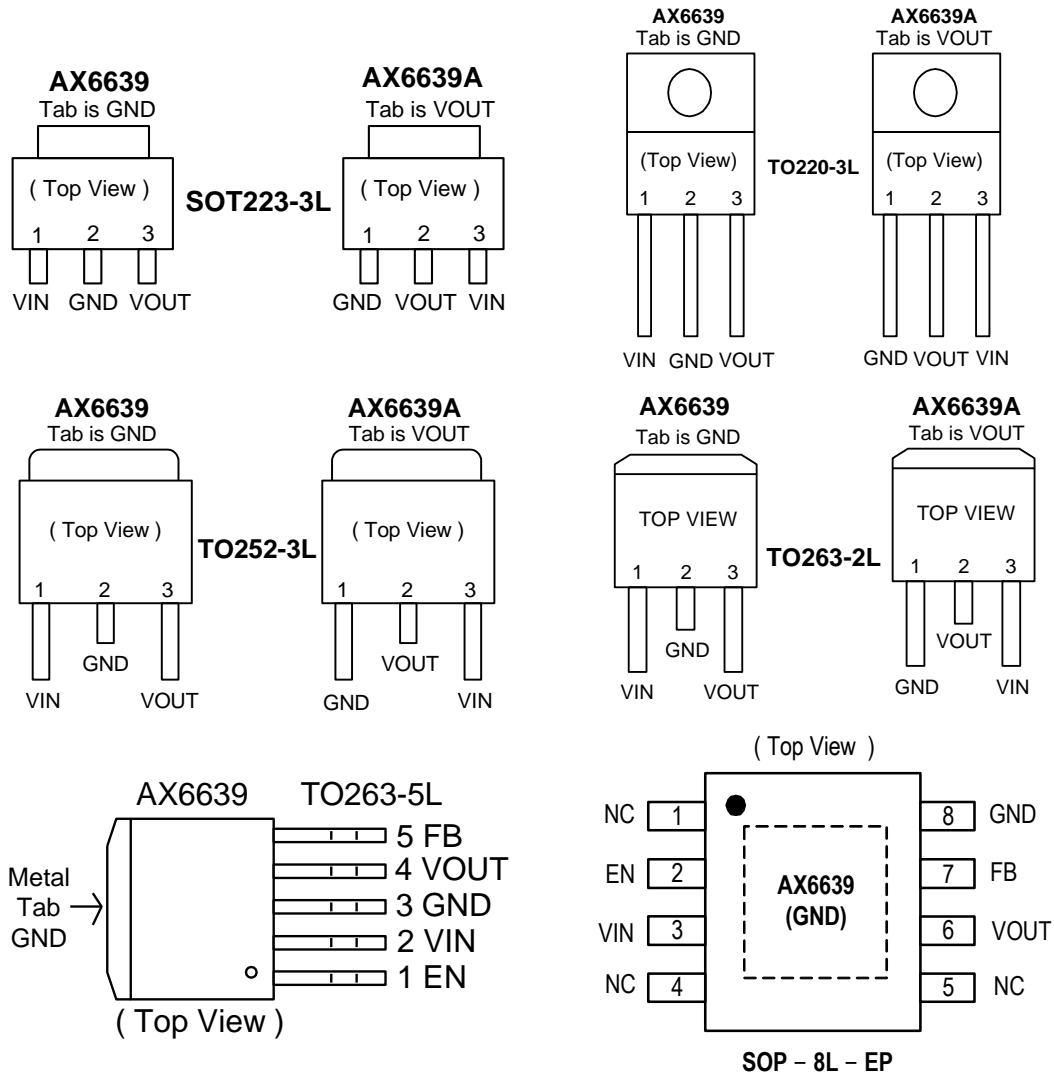
- Input voltage range : 2.6V~5.5V
- Adjustable Output (SOP-8L-EP and TO263-5L Only) and fixed Output voltage for 1.5V, 1.8V, 2.5V and 3.3V
- Dropout voltage is 380mV at 3A output current
- Guaranteed 3A output current
- Low quiescent current is 200 μ A (typ.)
- Fast transient response
- Current limit and thermal shutdown protection
- Short circuit current fold-back
- Available in the 3-Pin TO220, SOT-223, TO252, 2-pin TO263 and 5-Pin TO263 and SOP-8L-EP Pb-Free packages

❖ BLOCK DIAGRAM



❖ **PIN ASSIGNMENT**

The packages of AX6639/A are TO220-3L, SOT223-3L, SOP-8L-EP, TO252-3L, TO263-2L, TO263-5L; the pin assignment is given by:



Name	Description
VIN	Voltage input
GND	Ground
VOUT	Output Voltage
EN	Enable pin input
FB	Feedback pin
NC	No connect pin

❖ ABOLUTE MAXIMUM RATING (at $T_A=25^{\circ}\text{C}$)

Characteristics		Symbol	Rating	Unit
V _{IN} Pin Voltage		V _{IN}	GND - 0.3 to 6	V
Output Voltage		V _{OUT}	GND - 0.3 to V _{IN} + 0.3	V
EN Pin Voltage		V _{EN}	GND - 0.3 to 6	V
FB Pin Voltage		V _{FB}	GND - 0.3 to 6	V
Power Dissipation		PD	Internally Limited	W
Storage Temperature Range		T _{ST}	-40 to +150	°C
Operating Temperature Range		T _{OP}	-40 to +85	°C
Junction Temperature		T _J	-40 to +125	°C
Thermal Resistance from Junction to case	SOT223	θ _{JC}	15	°C/W
	SOP8L		15	
	TO263		3.5	
	TO252		10	
	TO220		3.5	
Thermal Resistance from Junction to ambient	SOT223	θ _{JA}	75	°C/W
	SOP8L		40	
	TO263		25	
	TO252		45	
	TO220		25	

Note: θ_{JA} is measured with the PCB copper area of approximately 1in² (Multi-layer). That need connect to tap or exposed pad (SOP-8L-EP only) pin.

❖ ELECTRICAL CHARACTERISTICS V_{IN} = 5V, T_A = 25°C (unless otherwise noted)

Characteristics	Symbol	Conditions	Min	Typ	Max	Units	
Input Voltage	V _{IN}	I _{OUT} =30mA (Note1)	2.6	-	5.5	V	
Output Voltage Accuracy	ΔV _{OUT}	I _{OUT} =1mA (Note1)	-2	-	+2	%	
Feedback Voltage (SOP-8L-EP and TO263-5L Only)	V _{FB}	I _{OUT} = 1mA	0.784	0.8	0.816	V	
FB Input Leakage Current (SOP-8L-EP and TO263-5L Only)	I _{FB}	V _{FB} =0.8V	-100	-	100	nA	
Quiescent Current	I _Q	I _{OUT} =0mA, V _{IN} =5V	-	200	300	μA	
Shutdown Current	I _{STB}	For TO263-5L and SOP-8L Only	-	2	5	uA	
Dropout Voltage	V _{DROP}	I _{OUT} =3A	V _{OUT} =1.50V	-	1.20	1.5	V
			V _{OUT} =1.80V	-	0.9	1.2	
			V _{OUT} =2.50V	-	0.57	0.7	
			V _{OUT} =3.30V	-	0.38	0.6	

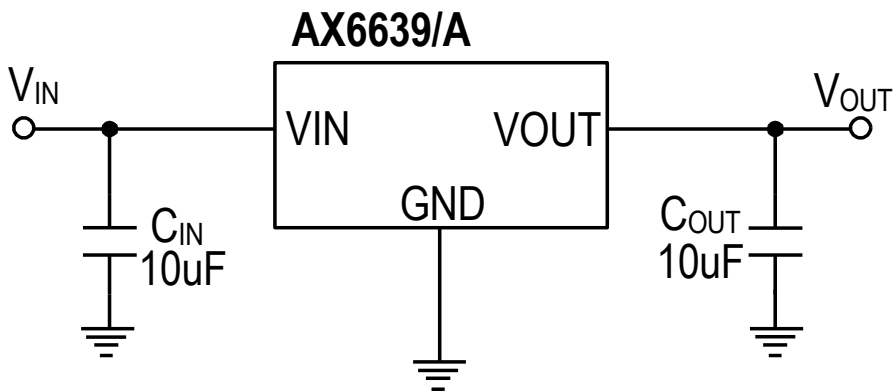
Current Limit (Note 2)	I_{LIMIT}		3.3	4.0	-	A	
Short Circuit Current	I_{short}	Output Voltage < $0.25 \cdot V_{OUT}$	-	1.0	-	A	
Load Regulation (Note 3)	ΔV_{LOAD}	$I_{OUT} = 10m \sim 3A$	-	15	30	mV	
Enable Input Threshold	V_{ENH}	Regulator Enable	2.0	-	-	V	
	V_{ENL}	Regulator Shutdown	-	-	0.6		
Enable Pin Current	I_{ENH}	$V_{EN} = V_{IN}$	-	0.003	0.1	μA	
	I_{ENL}	$V_{EN} = 0V$	-	2	4		
Ripple Rejection	PSRR	$C_{IN} = 10\mu F,$ $C_O = 10\mu F,$ $I_{OUT} = 10mA$	$F = 120Hz$	-	65	-	dB
			$F = 1KHz$	-	55	-	
Temperature Shutdown	TS		-	140	-	$^{\circ}C$	
Temperature Shutdown Hysteresis	TSH		-	30	-	$^{\circ}C$	

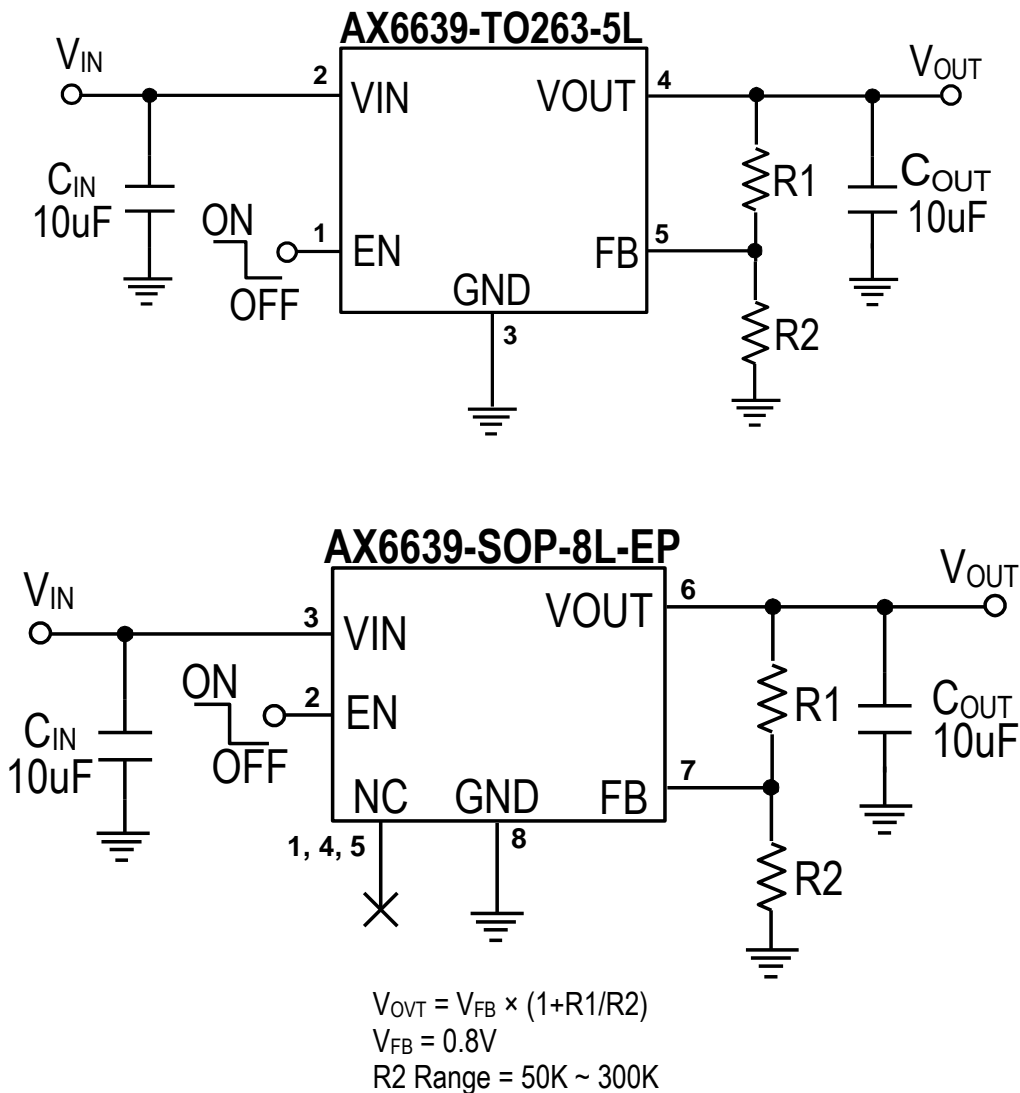
Note1. Minimum V_{IN} voltage is defined by output adds a dropout voltage.

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

Note3. Regulation is measured at constant junction temperature by using pulsed testing with a low ON time.

❖ APPLICATION CIRCUIT





❖ FUNCTION DESCRIPTIONS

A minimum of 10 μ F capacitor must be connected from V_{OUT} to ground to insure stability. Typically a large storage capacitor is connected from V_{IN} 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_{OUT} in order for the device to regulate properly.

Enable Function

The AX6639/A (TO263-5L and SOP-8L-EP only) 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. If the enable function is not needed in a specific application, it can be floating.

FB Function (SOP-8L-EP and TO263-5L only)

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 AX6639/A 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 (see Capacitor Characteristics Section). 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 10μF capacitor on the input and a 10μF capacitor on the output of the AX6639/A. Larger input capacitor values and lower ESR (X5R, X7R) provide better supply-noise rejection and transient response. A higher-value output capacitor 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 AX6639/A 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, AX6639/A 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 AX6639/A series can deliver a current of up to 3A 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:

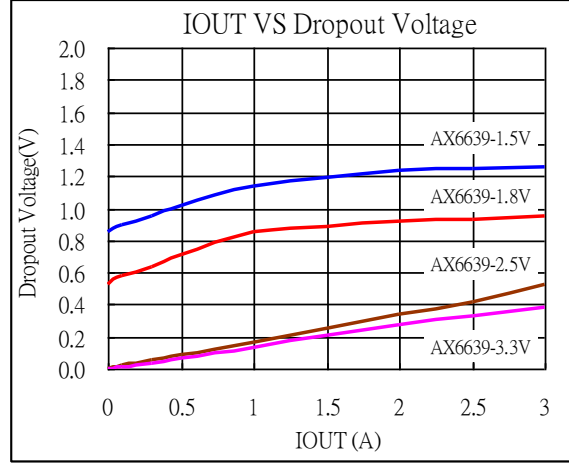
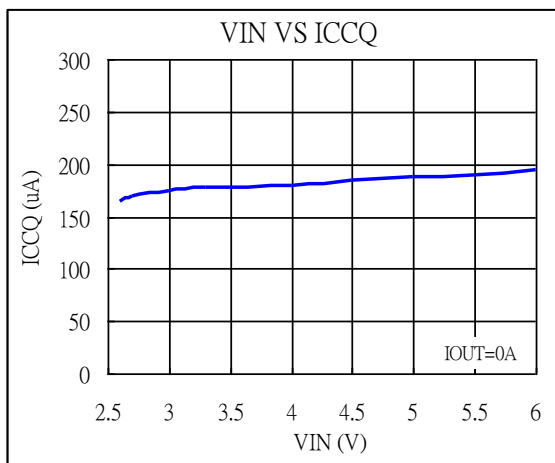
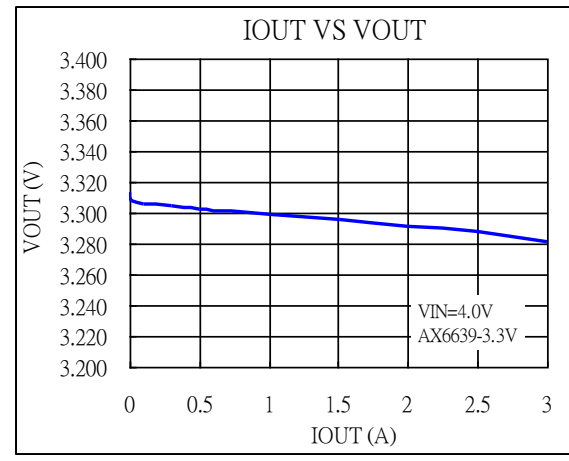
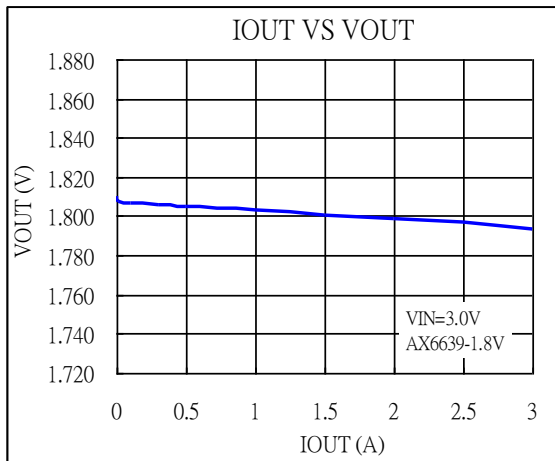
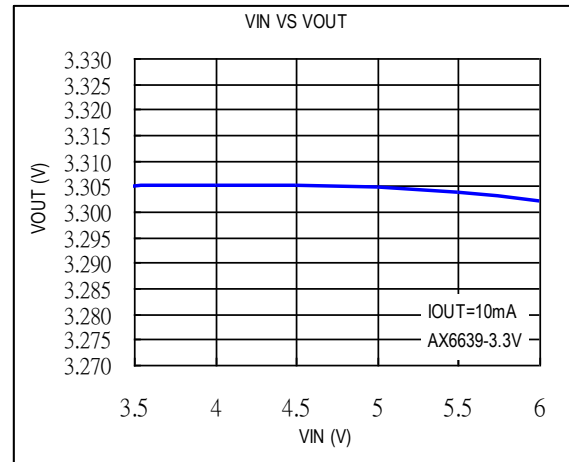
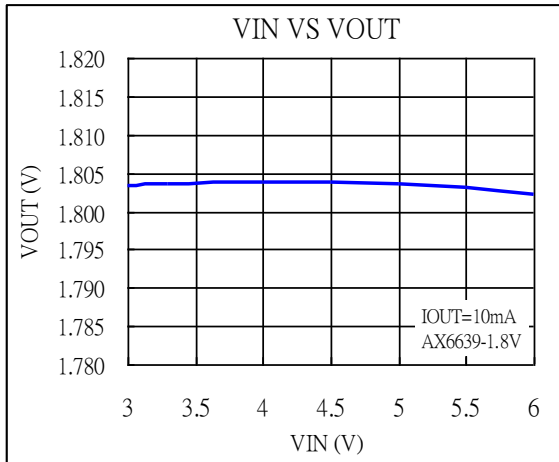
$$PD (MAX) = (T_{J(MAX)} - T_A) / \theta_{JA}$$

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 (θ_{JA}) for SOT223-3L package at recommended minimum footprint is 75°C/W that is connect 1 in² PCB copper area to tap pin.

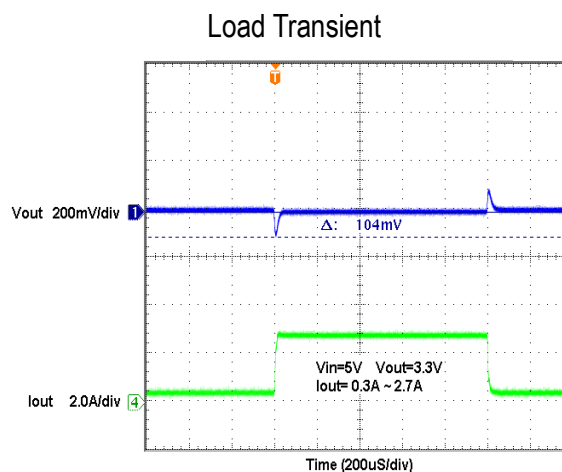
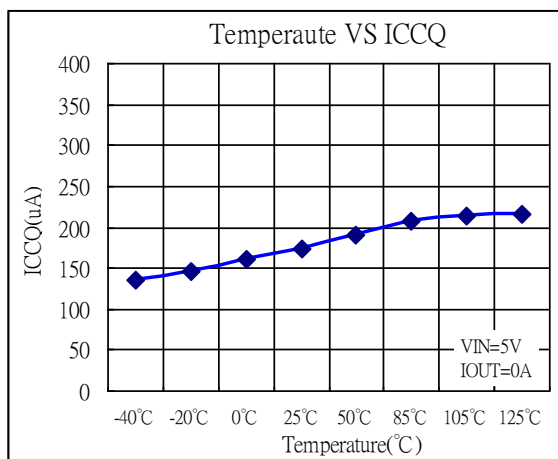
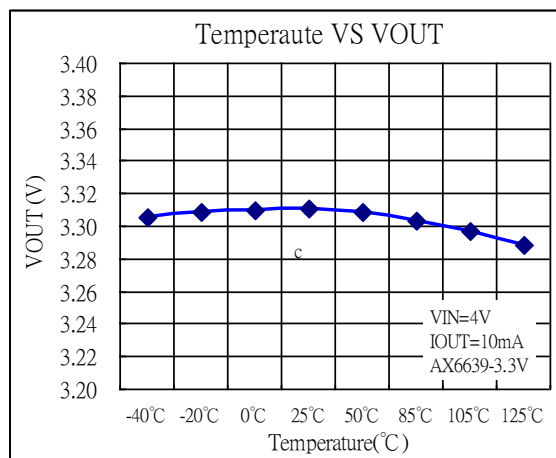
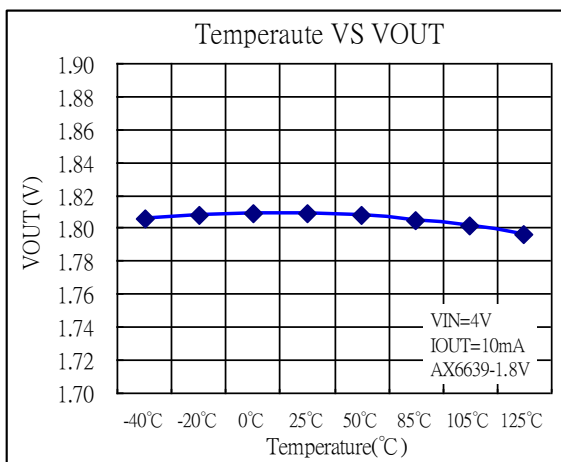
PCB Layout

An input capacitance of $\cong 10\mu F$ is required between the AX6639/A 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 VIN 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.

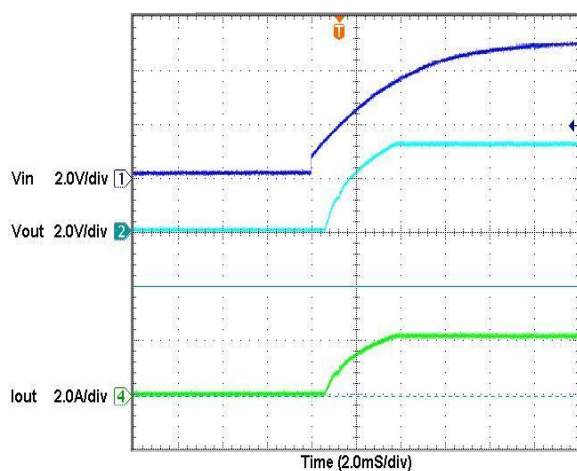
❖ TYPICAL CHARACTERISTICS



❖ TYPICAL CHARACTERISTICS (CONTINUOUS)

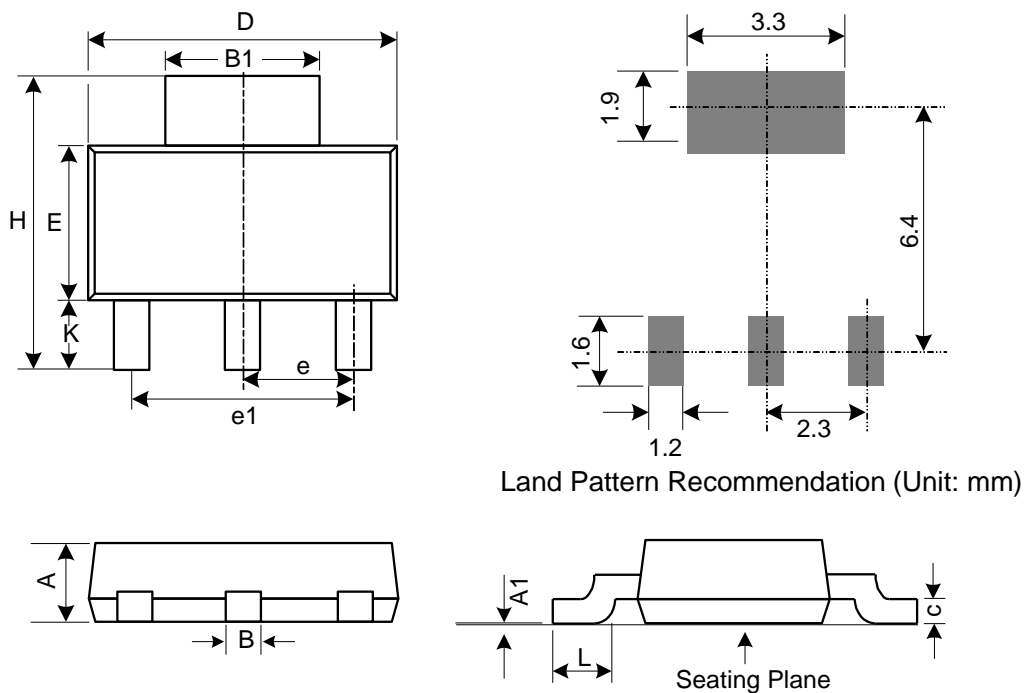


Power-ON (VIN=5V, VOUT=3.3V, IOUT=2A)



❖ PACKAGE OUTLINES

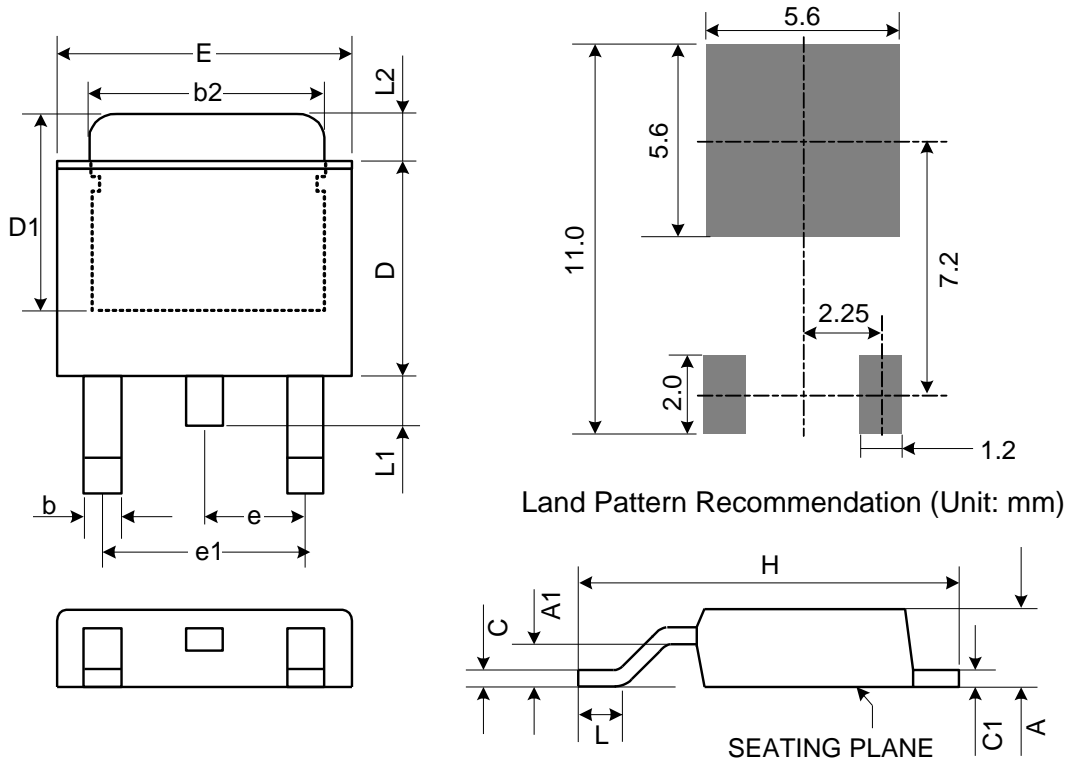
(1) SOT223-3L



Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	1.8	-	-	0.071
A1	0.02	0.06	0.1	0.001	0.002	0.004
B	0.66	0.75	0.84	0.026	0.03	0.033
B1	2.9	3	3.1	0.114	0.118	0.122
C	0.23	0.315	0.35	0.009	0.012	0.014
D	6.3	6.5	6.7	0.248	0.256	0.264
E	3.3	3.5	3.7	0.13	0.138	0.146
H	6.7	7	7.3	0.264	0.278	0.287
L	0.75	-	-	0.03	-	-
K	1.5	1.75	2	0.059	0.069	0.079
e	2.3 Basic			0.091 Basic		
e1	4.6 Basic			0.181 Basic		

JEDEC outline: TO-261 AB

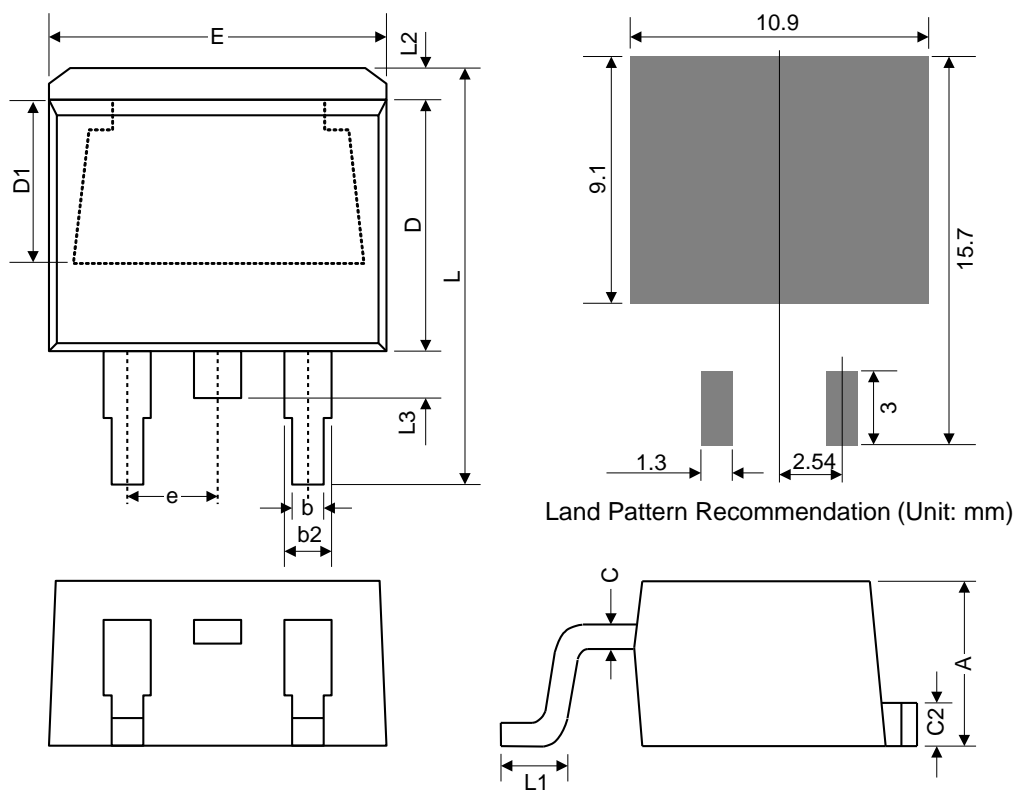
(2) TO252-3L



Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	2.18	2.29	2.39	0.086	0.09	0.094
A1	-	-	0.13	-	-	0.005
b	0.51	0.71	0.89	0.02	0.028	0.035
b2	4.95	5.21	5.46	0.195	0.205	0.215
C	0.46	0.53	0.61	0.018	0.021	0.024
C1	0.46	0.53	0.58	0.018	0.021	0.023
D	5.33	5.46	5.59	0.21	0.215	0.22
D1	4.57	-	-	0.18	-	-
E	6.35	6.55	6.73	0.25	0.258	0.265
e	2.29 BSC			0.090 BSC.		
e1	4.58 BSC			0.180 BSC.		
H	9.4	9.7	10.4	0.37	0.382	0.41
L	1.4	1.6	1.78	0.055	0.063	0.07
L1	-	-	1.02	-	-	0.04
L2	1.52	1.78	2.03	0.06	0.07	0.08

Mold flash shall not exceed 0.005inch per side
JEDEC outline: TO-252 AB

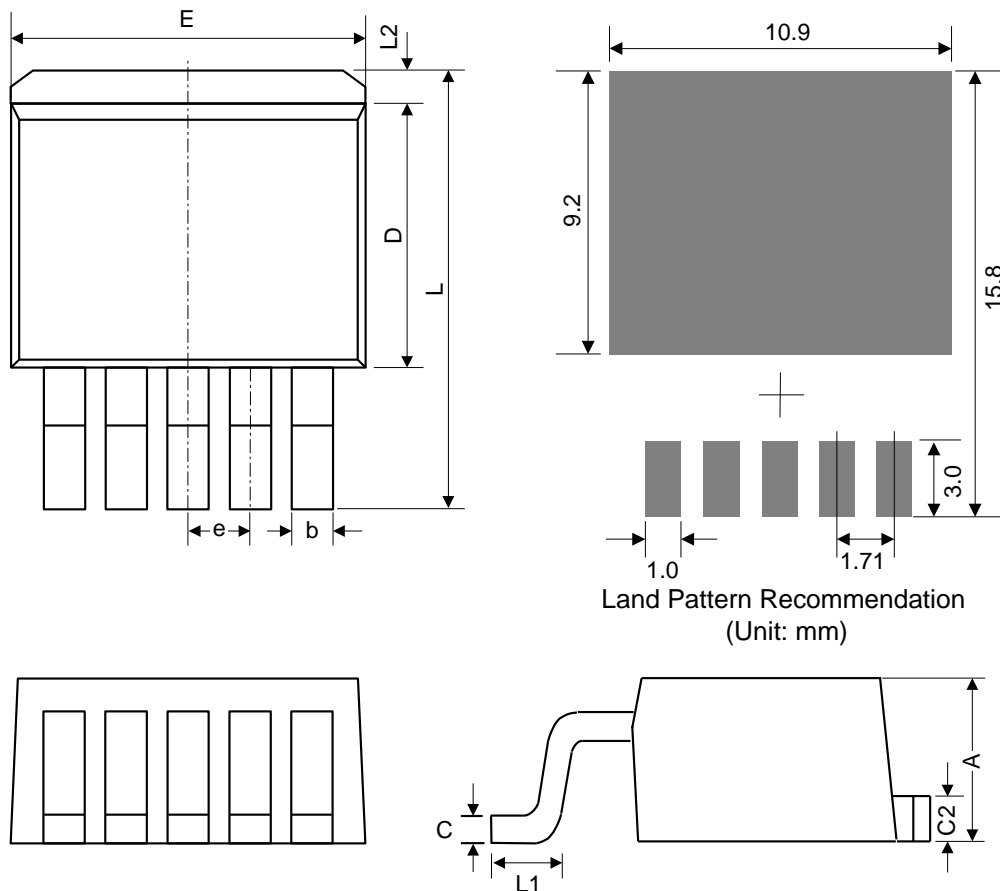
(3) TO263-2L



Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	4.06	4.45	4.83	0.16	0.175	0.19
b	0.51	0.76	0.99	0.02	0.03	0.039
b2	1.14	1.47	1.78	0.045	0.058	0.07
C	0.38	0.56	0.74	0.015	0.022	0.029
C2	1.14	1.4	1.65	0.045	0.055	0.065
D	8.38	9.02	9.65	0.33	0.355	0.38
D1	5.08	-	-	0.2	-	-
E	9.65	10.2	10.7	0.38	0.4	0.42
e	2.54 BSC			0.1 BSC		
L	14.6	15.2	15.9	0.575	0.6	0.625
L1	1.78	2.29	2.79	0.07	0.09	0.11
L2	-	-	1.68	-	-	0.066
L3	-	-	1.78	-	-	0.07

Mold flash shall not exceed 0.005inch per side
JEDEC outline: TO-263 AB

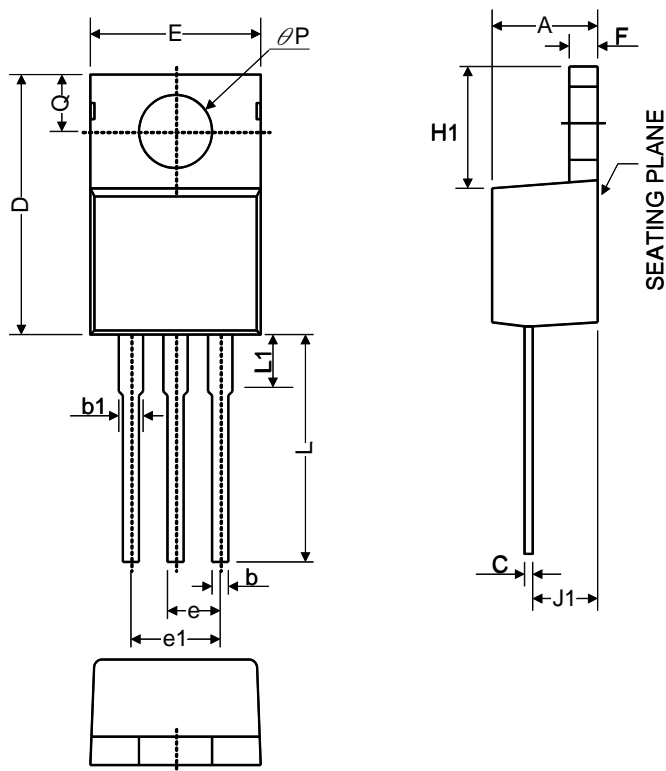
(4) TO263-5L



Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	4.06	4.45	4.83	0.16	0.175	0.19
b	0.51	0.76	0.99	0.02	0.03	0.039
C	0.38	0.56	0.74	0.015	0.022	0.029
C2	1.14	1.4	1.65	0.045	0.055	0.065
D	8.38	9.02	9.65	0.33	0.355	0.38
E	9.65	10.2	10.7	0.38	0.4	0.42
e	1.70 BSC			0.067 BSC		
L	14.6	15.2	15.9	0.575	0.6	0.625
L1	1.78	2.29	2.79	0.07	0.09	0.11
L2	-	-	1.68	-	-	0.066

Mold flash shall not exceed 0.005inch per side
JEDEC outline: TO-263 BA

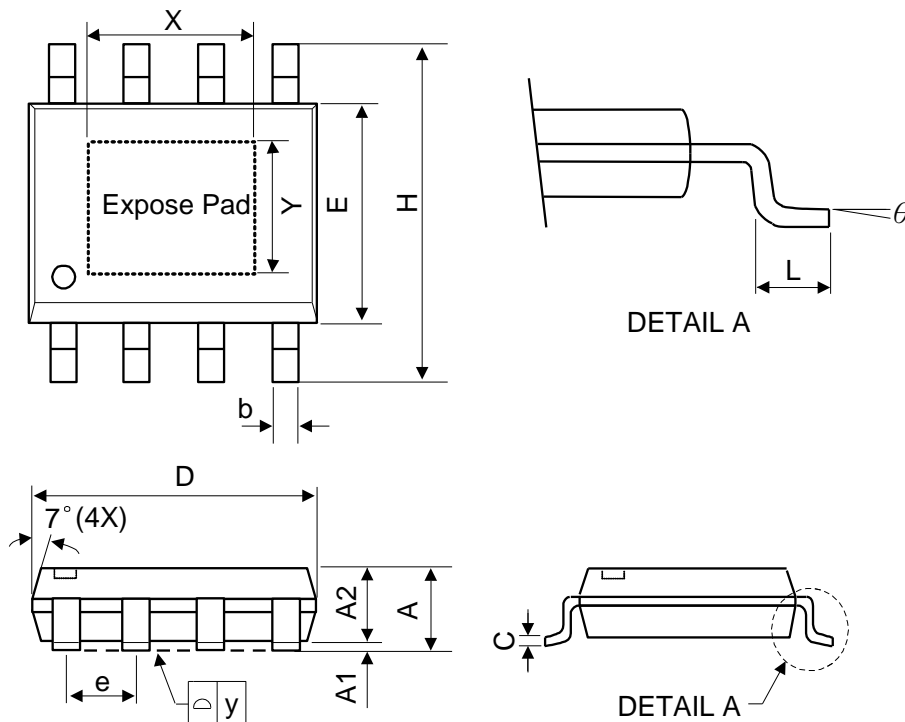
(5) TO220-3L



Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	3.55	4.19	4.83	0.14	0.165	0.19
b1	1.14	1.45	1.78	0.045	0.057	0.07
b	0.38	0.69	1.02	0.015	0.027	0.04
C	0.36	0.48	0.61	0.014	0.019	0.024
D	14.2	15.4	16.5	0.56	0.605	0.65
E	9.7	10.2	10.7	0.38	0.4	0.42
e	2.54BSC			0.1BSC		
e1	5.08BSC			0.2BSC		
F	0.51	0.95	1.397	0.02	0.038	0.055
H1	5.84	6.35	6.86	0.23	0.25	0.27
J1	2.03	2.48	2.92	0.08	0.098	0.115
L	12.7	13.7	14.73	0.5	0.54	0.58
L1			6.35			0.25
theta P	3.53	3.81	4.09	0.139	0.15	0.161
Q	2.54	2.98	3.43	0.1	0.118	0.135

Mold flash shall not exceed 0.005inch per side
JEDEC outline: TO-220 AB

(6) SOP-8L-EP



Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	1.75	-	-	0.069
A1	0	-	0.15	0	-	0.06
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
X	-	2.34	-	-	0.092	-
Y	-	2.34	-	-	0.092	-
θ	0°	-	8°	0°	-	8°

Mold flash shall not exceed 0.25mm per side
JEDEC outline: MS-012 BA