300mA High PSRR, Low Noise LDO Regulator

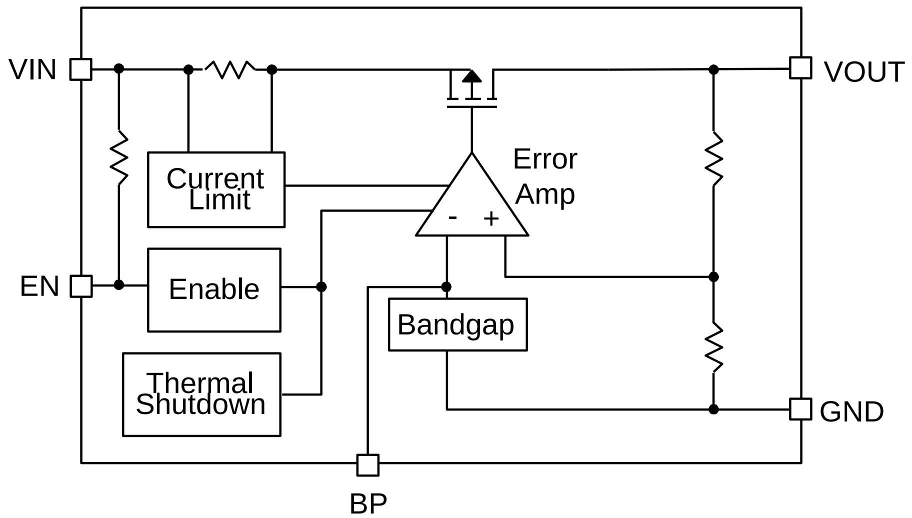
❖ GENERAL DESCRIPTION

The AX6608 is a low dropout, high PSRR, low noise linear regulator with very low quiescent. It can supply 300mA output current with low dropout about 250mV. The Device includes pass element, error amplifier, band-gap, current-limit and thermal shutdown circuitry. 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 30μA. In the shutdown mode, the maximum supply current is less than 1uA. Due to internal flexible design, result in extensively fixed output voltage versions is 1.0V to 3.3V per 0.1V steps. Built-in current-limit and thermal-shutdown functions prevent any fault condition from IC damage.

❖ FEATURES

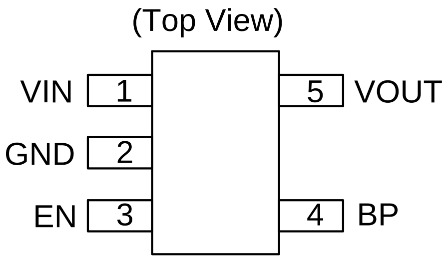
- Input voltage range : 2.8V~5.5V
- Dropout voltage is 250mV at 300mA output current
- Guaranteed 300mA output current
- Low quiescent current is 30μA (typ.)
- Maximum supply current in shutdown mode <1uA
- Fixed Output voltage is 1.0V to 3.3V by 0.1V steps.
- High PSRR=73dB@1KHz
- Fast transient response
- Current limit and thermal shutdown protection
- Available in the 5-Pin Pb-Free SOT-23, TDFN-6L and MSOP-8L Packages

❖ BLOCK DIAGRAM

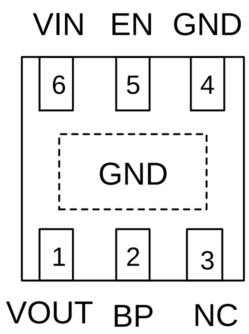


❖ PIN ASSIGNMENT

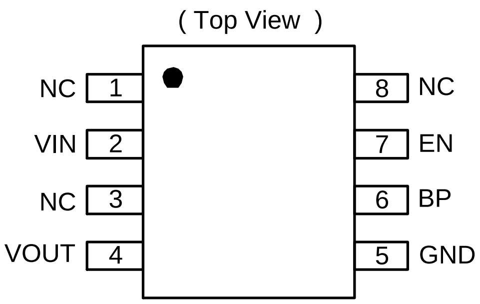
The packages of AX6608 are SOT-23-5L, TDFN-6L and MSOP-8L; the pin assignment is given by:



SOT-23-5L



TDFN-6L (2*2)
(TOP VIEW)



MSOP - 8L

Name	Description
VIN	Voltage input. The input capacitor in the range of 1uF to 10uF is sufficient.
GND	Ground
EN	Enable pin (Active High)
BP	Reference Noise Bypass (The Bypass capacitor ≧1nF
VOUT	Output Voltage, The AX6608 is stable with an output capacitor 1uF for greate□ .
NC	No Connect

❖ ORDER/MARKING INFORMATION

Order Information

AX6608- XX XX X

Output voltage
10 : 1.0V
11 : 1.1V
⋮
33 : 3.3V

Package
B : SOT-23-5L
Z6 : TDFN-6L (2*2)
U8 : MSOP-8L

Packing
Blank: Bag
A : Taping

Top Marking (TDFN-6L)

L L → Output type, Refer Identification Code

YWX → ID Code: Internal

W → Week: 01~26(A~Z), 27~52(a~z)

Y → Year : 1 = 2011, 2 = 2012, ⋮, 9 = 2019

Top Marking (MSOP-8L)

Logo ← AX

6 6 0 8 → Part number

YYWWX → ID code:internal

WW → WW:01~52

YY → Year: 11=2011, 12=2012, ⋮, 19=2019

Top Marking (SOT-23-5L)

LLYWX → ID code: internal

WW → WW:01~26(A~Z), 27~52(a~z)

Y → Year: 1= 2011, 2= 2012, ⋮, 9=2019

LL → Identification code

Appendix

Part Number	Identification Code SOT-23-5L/TDFN-6L	Part Number	Identification Code SOT-23-5L//TDFN-6L
AX6608-1.0V	U0	AX6608-2.2V	UO
AX6608-1.1V	UA	AX6608-2.3V	Uv
AX6608-1.2V	UB	AX6608-2.4V	UT
AX6608-1.3V	U3	AX6608-2.5V	UF
AX6608-1.4V	U4	AX6608-2.6V	Uf
AX6608-1.5V	UC	AX6608-2.7V	Uw
AX6608-1.6V	US	AX6608-2.8V	UG
AX6608-1.7V	UX	AX6608-2.9V	Uh
AX6608-1.8V	UD	AX6608-3.0V	UH
AX6608-1.9V	Ua	AX6608-3.1V	Ux
AX6608-2.0V	Ue	AX6608-3.2V	UU
AX6608-2.1V	Ub	AX6608-3.3V	Ul

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

Characteristics		Symbol	Rating	Unit
V_{IN} Pin Voltage		V_{IN}	GND - 0.3 to GND + 6	V
Output Voltage		V_{OUT}	GND - 0.3 to V_{IN} + 0.3	V
Enable Voltage		V_{EN}	GND - 0.3 to GND + 6	V
Power Dissipation		PD	Internally limited	mW
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
ESD HBM		HBM	±2	KV
ESD MM		MM	±200	V
Thermal Resistance from Junction to case	SOT-23-5L	θ_{JC}	180	°C/W
	TDFN-6L		25	
	MSOP-8L		45	
Thermal Resistance from Junction to ambient	SOT-23-5L	θ_{JA}	250	°C/W
	TDFN-6L		120	
	MSOP-8 L		200	

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

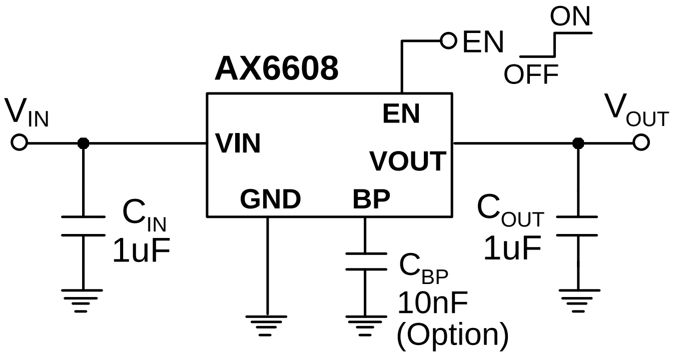
❖ ELECTRICAL CHARACTERISTICS

(V_{IN}=V_{OUT}+1V or V_{IN}=2.8V whichever is greater, C_{IN}=C_{OUT}=1uF, T_A=25°C, unless otherwise noted)

Characteristics	Symbol	Conditions		Min	Typ	Max	Units
Input Voltage	V_{IN}	**(Note1)**		2.8	-	5.5	V
Output Voltage Accuracy	ΔV_{OUT}	I_{OUT}=1mA		-2	-	+2	%
Quiescent Current	I_Q	I_{OUT} =0mA		-	30	60	μA
Dropout Voltage **(Note2)**	V_{DROP}	I_{OUT}=300mA	1.0V≦V_{OUT}≦2.0V	-	1500	-	mV
			1.5V＜V_{OUT}≦2.0V	-	1000	-	
			2.0V＜V_{OUT}≦2.8V	-	350	-	
			2.8V＜V_{OUT}≦3.3V	-	250	-	
Current Limit	I_{LIMIT}	R_{LOAD}=1Ω		300	-	-	mA
Line Regulation	ΔV_{LINE}	I_{OUT} =1mA, V_{IN}=V_{OUT}+1V to 5V		-	1	5	mV
Load Regulation **(Note3)**	ΔV_{LOAD}	I_{OUT} =0m~150mA		-	6	20	mV
Ripple Rejection	PSRR	C_{OUT}=1uF, I_{OUT} =1mA	F=1KHz	-	-73	-	dB
			F=10K	-	-60	-	
Enable Input Threshold	V_{ENH}			1.4	-	-	V
	V_{ENL}			-	-	0.4	
Enable Pin Current	I_{EH}	V_{EN}=V_{IN}		-	-	0.1	μA
Shutdown Current	I_{SD}	V_{IN}=3.6V, V_{EN}=0V		-	-	1	μA
Temperature Coefficient	T_C	I_{OUT}=1mA, V_{IN}=5V		-	50	-	ppm/°C
Temperature Shutdown	T_S			-	160	-	ºC
Temperature Shutdown Hysterisis	T_{SH}			-	25	-	ºC

Note1. Minimum V_{IN} voltage is defined by output adds a dropout voltage.
Note2. The dropout voltage is defined as V_{IN}-V_{OUT}, which is measured when V_{OUT} drop about 100mV.
Note3. Regulation is measured at constant junction temperature by using pulsed testing with a low ON time.

❖ APPLICATION CIRCUIT



❖ FUNCTION DESCRIPTIONS

A minimum of 1uF 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.

❖ APPLICATION INFORMATION

Like any low-dropout regulator, the AX6608 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 1μF capacitor on the input and a 1μF capacitor on the output of the AX6608. Larger input capacitor values and lower ESR provide better supply-noise rejection and transient response. A large value output capacitor may be necessary if large, fast transients are anticipated and the device is located several inches from the power source. The capacitors is recommended to use 1uF X5R or X7R dielectric ceramic capacitors with 30mΩ to 50mΩ ESR range between device outputs to ground for transient stability.

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 Thermal Shutdown Protection

In order to prevent overloading or thermal condition from damaging the device, AX6608 regulator has internal thermal and current limiting functions designed to protect the device. It will rapidly shut off PMOS pass element during overloading or over temperature condition.

Thermal Considerations

The AX6608 series can deliver a current of up to 300mA 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:

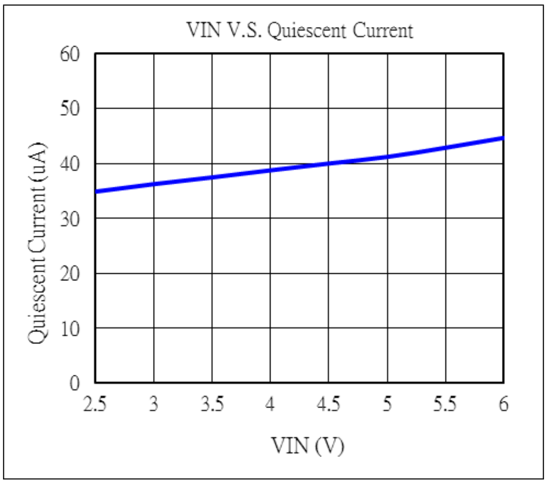
$$PD\ (MAX) = (T_{J\ (MAX)} - T_A) / \theta_{JA}$$

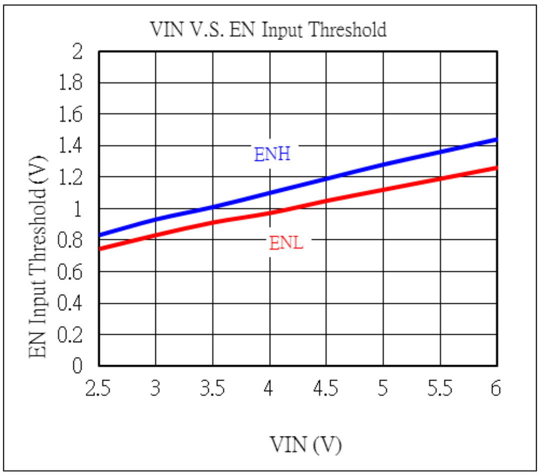
Where $T_{J\ (MAX)}$ is the maximum junction temperature of the die (125°C) and T_A is the maximum ambient temperature. The junction to ambient thermal resistance (θ_{JA}) for SOT-23-5L package at recommended minimum footprint is 250°C/W.

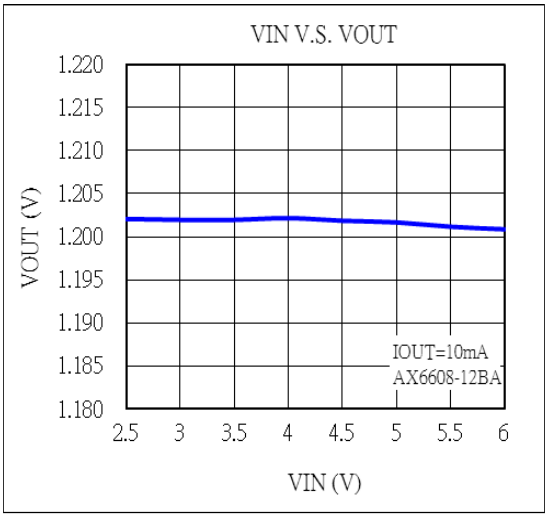
PCB Layout

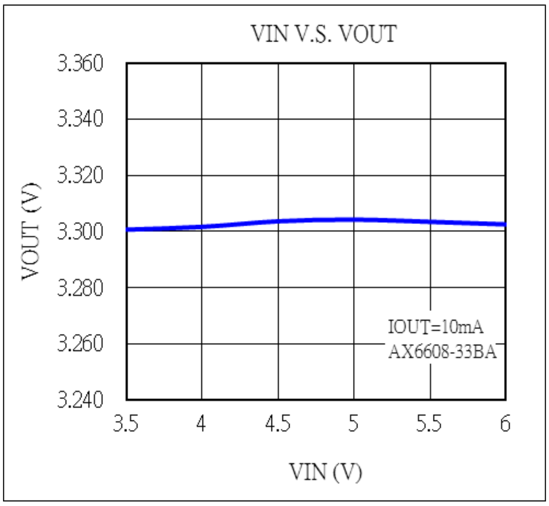
An input capacitance of ≅ 1μF is required between the AX6608 input pin and ground (the amount of the capacitance may be increased without limit), this capacitor must be located a distance of not more than 1cm from the input and return to a clean analog ground. Input capacitor can filter out the input 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.

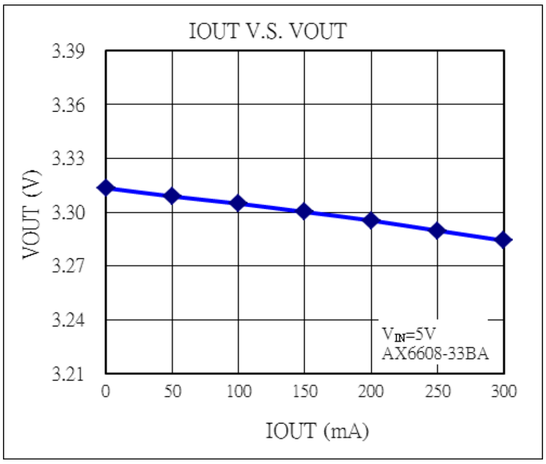
❖ TYPICAL CHARACTERISTICS

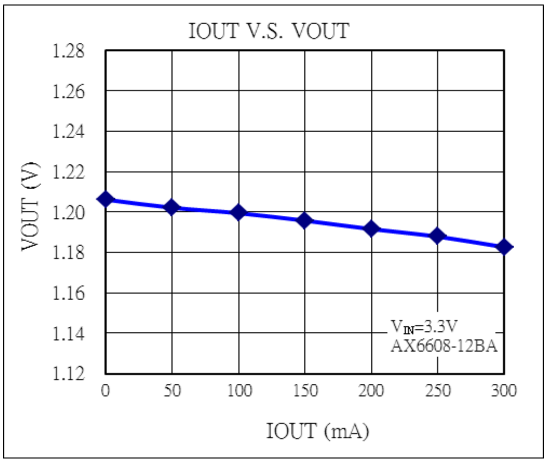




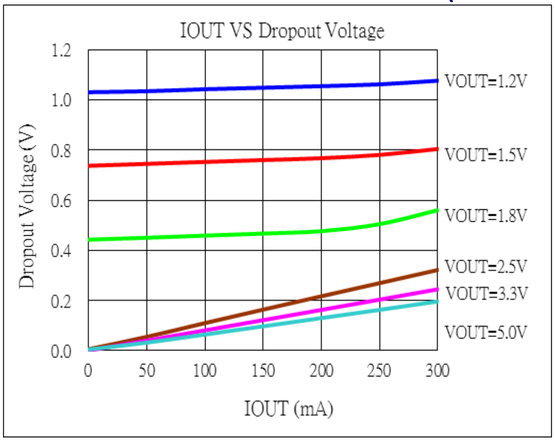


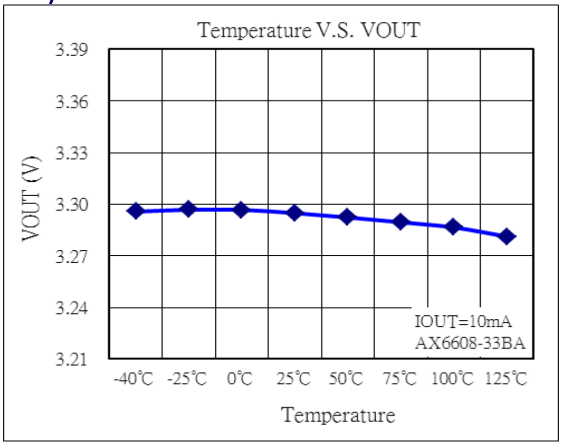


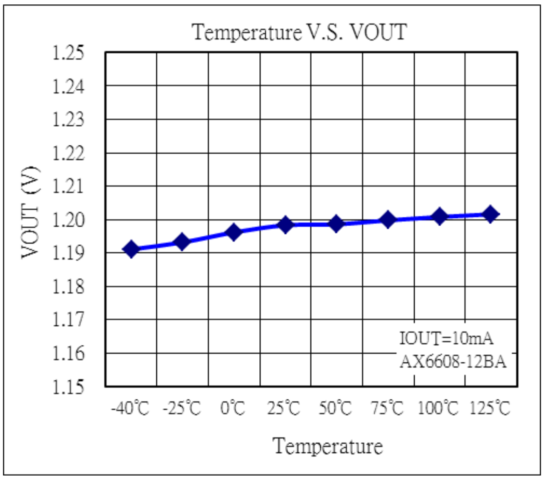




❖ TYPICAL CHARACTERISTICS (CONTINUES)

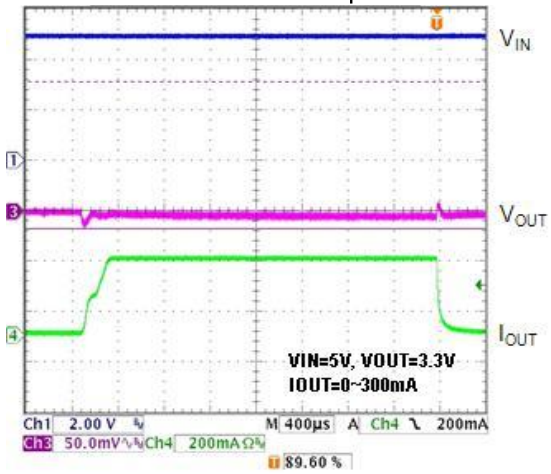




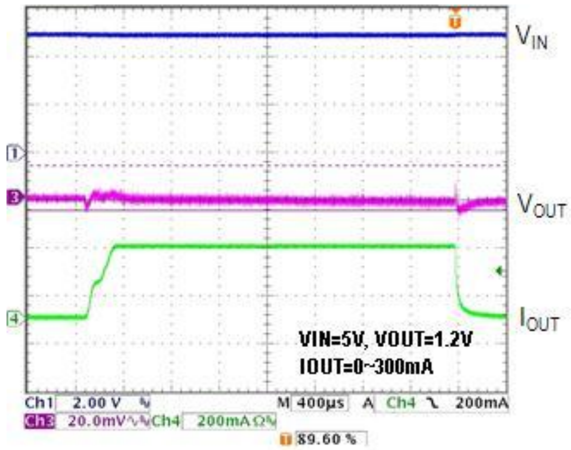


❖ TYPICAL CHARACTERISTICS (CONTINUES)

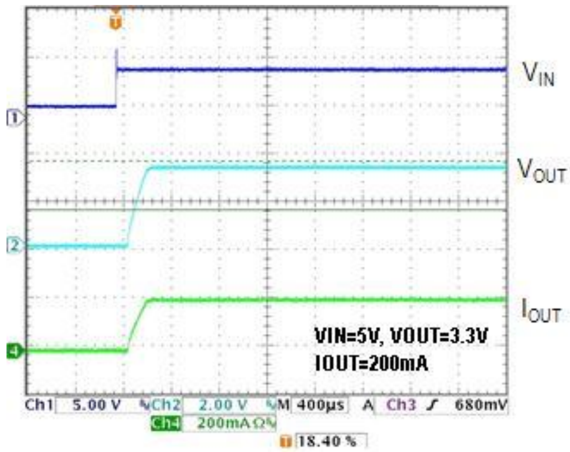
Load transient response



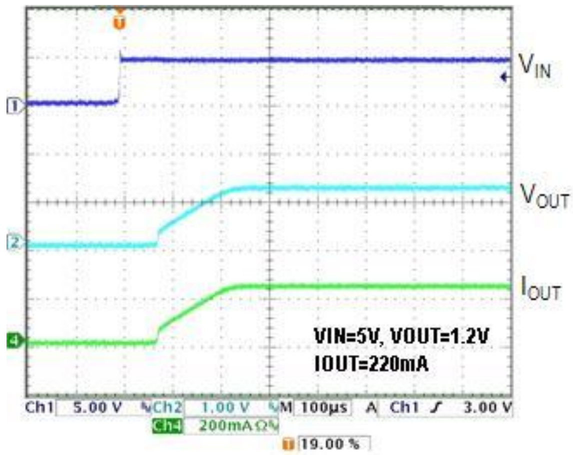
Load transient response



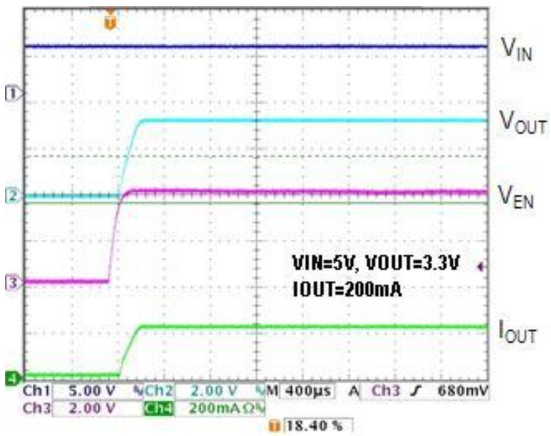
Power ON



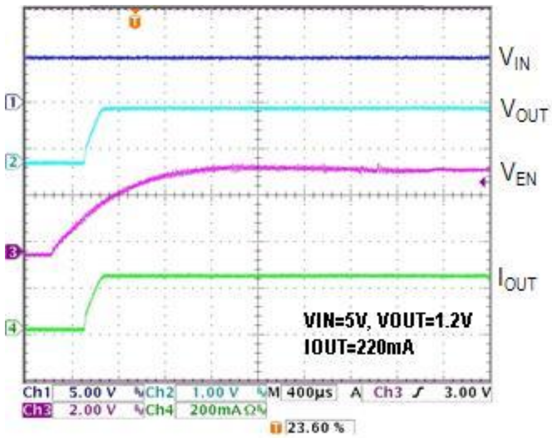
Power ON



EN ON

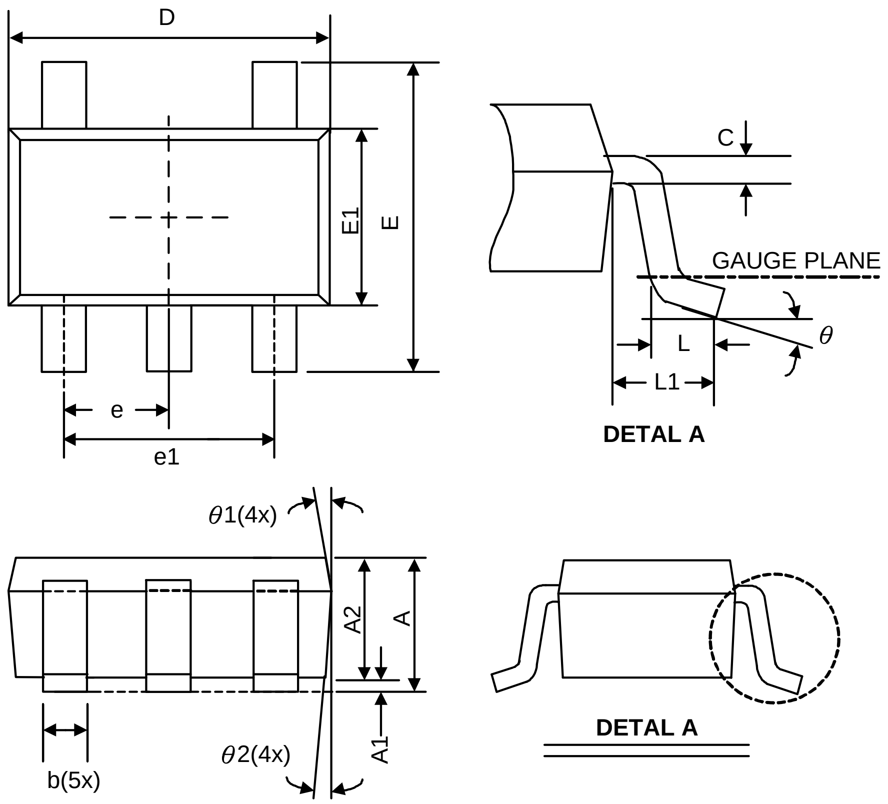


EN ON



❖ PACKAGE OUTLINES

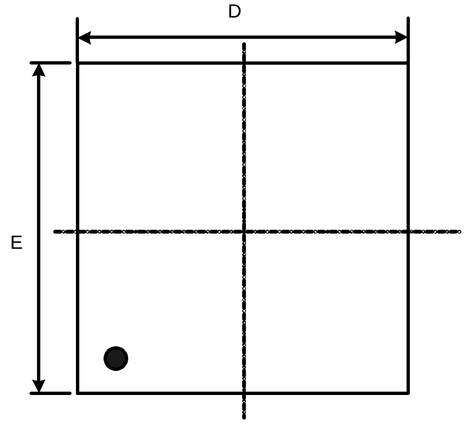
(1) SOT-23-5L



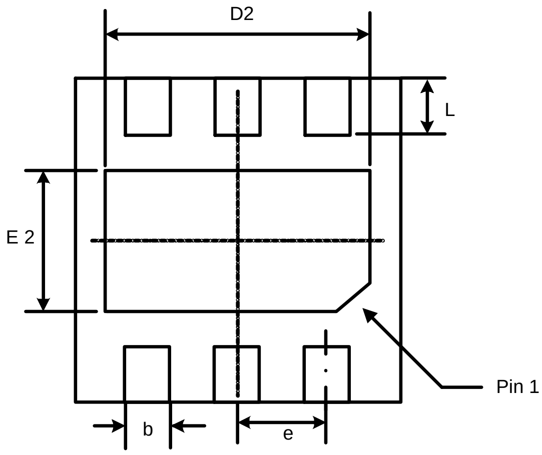
Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	1.45	-	-	0.057
A1	0	0.08	0.15	0	0.003	0.006
A2	0.9	1.1	1.3	0.035	0.043	0.051
b	0.3	0.4	0.5	0.012	0.016	0.02
C	0.08	0.15	0.22	0.003	0.006	0.009
D	2.7	2.9	3.1	0.106	0.114	0.122
E1	1.4	1.6	1.8	0.055	0.063	0.071
E	2.6	2.8	3	0.102	0.11	0.118
L	0.3	0.45	0.6	0.012	0.018	0.024
L1	0.5	0.6	0.7	0.02	0.024	0.028
e1	1.9 BSC			0.075 BSC		
e	0.95 BSC			0.037 BSC		
θ	0^o	4^o	8^o	0^o	4^o	8^o
θ 1	5^o	10^o	15^o	5^o	10^o	15^o
θ 2	5^o	10^o	15^o	5^o	10^o	15^o

JEDEC outline: MO-178 AA

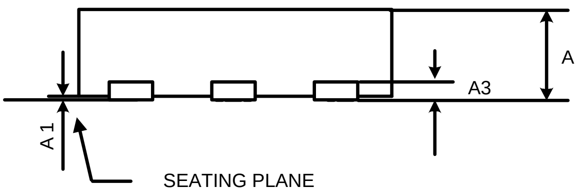
(2) TDFN-6L (2*2 0.75mm)



(Top View)



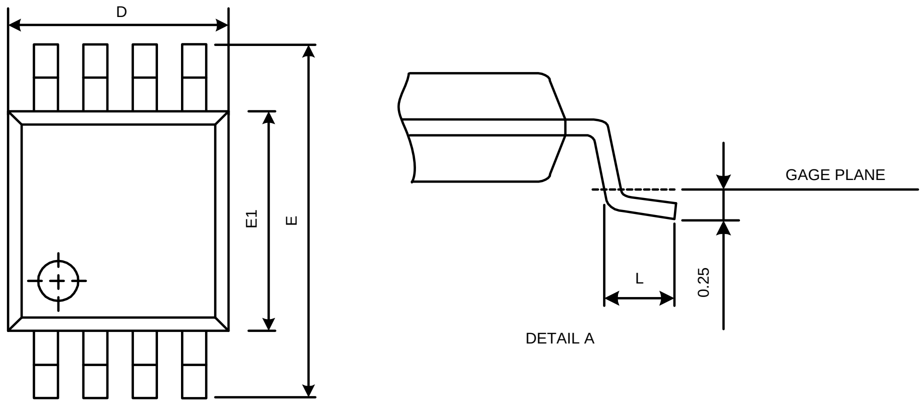
(Bottom View)

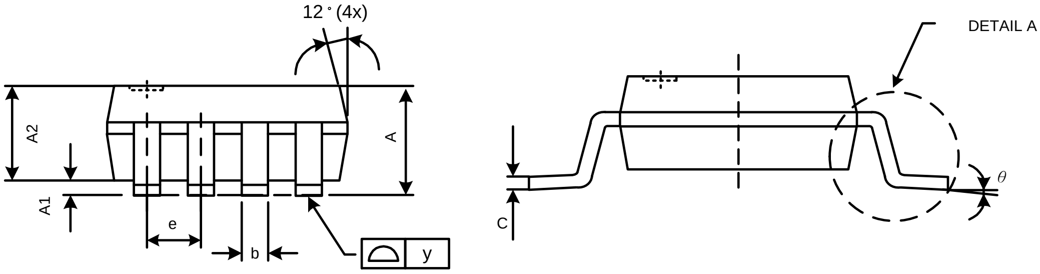


(SIDE View)

Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	0.7	0.75	0.8	0.028	0.03	0.031
A1	0	0.02	0.05	0	0.001	0.002
A3	0.203 REF.			0.008 REF.		
b	0.2	0.28	0.35	0.009	0.011	0.013
D	1.95	2	2.05	0.077	0.079	0.081
D2	1.0	1.5	1.7	0.039	0.059	0.067
E	1.95	2	2.05	0.077	0.079	0.081
E2	0.5	0.9	1.1	0.02	0.035	0.043
e	0.65 BSC.			0.026 BSC.		
L	0.2	0.3	0.4	0.008	0.012	0.016

(3) MSOP-8L





Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	1.1	-	-	0.043
A1	0	0.08	0.15	0	0.003	0.006
A2	0.75	0.85	0.95	0.03	0.033	0.037
b	0.22	0.3	0.38	0.009	0.012	0.015
C	0.08	0.15	0.23	0.003	0.006	0.009
D	2.9	3	3.1	0.114	0.118	0.122
E	4.8	4.9	5	0.189	0.193	0.197
E1	2.9	3	3.1	0.114	0.118	0.122
e	0.65 BSC			0.026 BSC		
L	0.4	0.6	0.8	0.016	0.024	0.031
y	-	-	0.1	-	-	0.004
θ	0º	4º	8º	0º	4º	8º

JEDEC outline: MO-187 AA