

## **300mA High PSRR, Low Noise LDO Regulator**

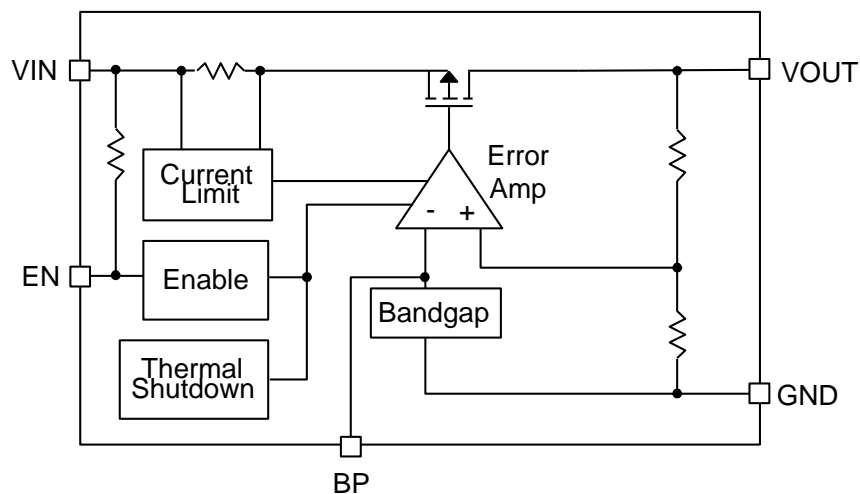
### ❖ GENERAL DESCRIPTION

The AX6603 is a 300mA, low quiescent, high PSRR, low noise and low dropout linear regulator. 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 90 $\mu$ A. In the shutdown mode, the maximum supply current is less than 1 $\mu$ A. Due to internal flexible design, result in extensively fixed output voltage versions form 1.0V to 5V per 0.1V steps. Built-in current-limit, Short current protection and thermal-shutdown functions prevent any fault condition from IC damage.

### ❖ FEATURES

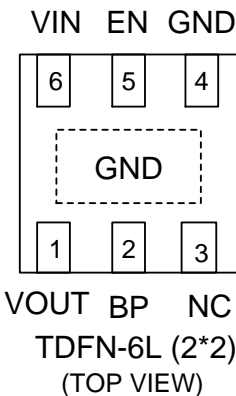
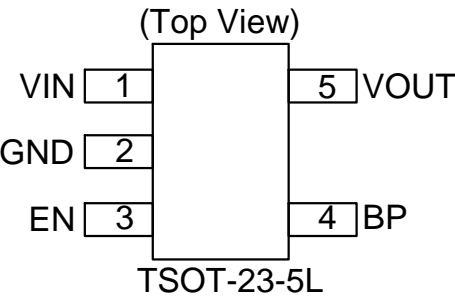
- Input voltage range : 2.6V~6.0V
- Dropout voltage is 200mV at 150mA output current
- Guaranteed 300mA output current
- Low quiescent current is 90 $\mu$ A (typ.)
- Maximum supply current in shutdown mode <1 $\mu$ A
- Fixed Output voltage is form 1.0V to 5V by 0.1V steps.
- High PSRR=70dB@120Hz, 65dB@1KHz
- Fast transient response
- Current limit and thermal shutdown protection
- Short circuit current fold-back
- Available in the TSOT-23-5L and TDFN-6L Packages
- RoHS and Halogen free compliance.

### ❖ BLOCK DIAGRAM



❖ PIN ASSIGNMENT

The packages of AX6603 are TSOT-23-5L and TDFN-6L; the pin assignment is given by:



Name	Description
VIN	Voltage input
GND	Ground
EN	Enable pin
BP	Bandgap
VOUT	Output Voltage
NC	No Connect

❖ ORDER/MARKING INFORMATION

Order Information	
<div> <div>AX6603-XXX XX X</div> <div> <div>Output voltage</div> <div>                     100 : 1.0V                      110 : 1.1V                      :                      285 : 2.85V                      :                      500 : 5.0V                 </div> </div> <div> <div>Package</div> <div>                     BT: TSOT-23-5L                      Z6 : TDFN-6L (2*2)                 </div> </div> <div> <div>Packing</div> <div>                     Blank: Bag                      A : Taping                 </div> </div> </div>	
Top Marking (TSOT-23-5L)	Top Marking (TDFN-6L)
<div> <div> <div>LLYWX</div> <div> <div>→ ID code:internal</div> <div>→ WW:01~26 (A~Z) 27~52 (a~z)</div> <div>→ Year: 8=2018 9=2019 B=2020 C=2021 D=2022 : Z=2044</div> </div> <div> <div>↓</div> <div>Identification code</div> </div> </div> </div>	<div> <div> <div>LL</div> <div>→ Output type Refer Identification Code</div> </div> <div> <div>YWX</div> <div>→ ID Code: Internal</div> <div>→ Week: 01~26(A~Z) 27~52(a~z)</div> <div>→ Year: 8=2018 9=2019 B=2020 C=2021 D=2022 : Z=2044</div> </div> </div>

**Appendix**

Part Number	Identification Code	Part Number	Identification Code	Part Number	Identification Code
AX6603-1.0V	LL	AX6603-2.5V	LQ	AX6603-3.8V	Lg
AX6603-1.1V	LO	AX6603-2.6V	LR	AX6603-3.9V	Lh
AX6603-1.2V	LA	AX6603-2.7V	LS	AX6603-4.0V	Lk
AX6603-1.3V	LB	AX6603-2.8V	LT	AX6603-4.1V	Lm
AX6603-1.4V	LC	AX6603-2.85V	LU	AX6603-4.2V	Ln
AX6603-1.5V	LD	AX6603-2.9V	LV	AX6603-4.3V	Lq
AX6603-1.6V	LE	AX6603-3.0V	LW	AX6603-4.4V	Lr
AX6603-1.7V	LF	AX6603-3.1V	LX	AX6603-4.5V	Ls
AX6603-1.8V	LG	AX6603-3.15V	LY	AX6603-4.6V	Lt
AX6603-1.9V	LH	AX6603-3.2V	LZ	AX6603-4.7V	Lu
AX6603-2.0V	LJ	AX6603-3.3V	La	AX6603-4.75V	Lv
AX6603-2.1V	LK	AX6603-3.4V	Lb	AX6603-4.8V	Lw
AX6603-2.2V	LM	AX6603-3.5V	Ld	AX6603-4.9V	Lx
AX6603-2.3V	LN	AX6603-3.6V	Le	AX6603-5.0V	Ly
AX6603-2.4V	LP	AX6603-3.7V	Lf		

❖ **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
Enable Voltage		$V_{EN}$	GND - 0.3 to GND + 6.5	V
Power Dissipation	TSOT-23-5L	PD	400	mW
	TDFN-6L		830	
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	TSOT-23-5L	$\theta_{JC}$	180	$^{\circ}\text{C/W}$
	TDFN-6L		25	
Thermal Resistance from Junction to ambient	TSOT-23-5L	$\theta_{JA}$	250	$^{\circ}\text{C/W}$
	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 pin.

## ❖ ELECTRICAL CHARACTERISTICS

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

Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Input Voltage	$V_{IN}$	$I_{OUT}=10\text{mA}$ (Note1)	2.6	-	6	V
Output Voltage Accuracy (Note2)	$\Delta V_{OUT}$	$V_{IN}=V_{OUT}+0.1\text{V}$ to 6V $V_{OUT}\geq 1.80\text{V}$ , $I_{OUT}=1\text{mA}$	-3	-	+3	%
		$V_{IN}=2.6\text{V}$ to 6V $1.80 > V_{OUT}\geq 1.20\text{V}$ , $I_{OUT}=1\text{mA}$	-4	-	+4	
Quiescent Current	$I_Q$	$I_{OUT}=0\text{mA}$ , $V_{IN}=5\text{V}$	-	90	-	$\mu\text{A}$
Dropout Voltage	$V_{DROP}$	$I_{OUT}=300\text{mA}$	$V_{OUT}=1.20\text{V}$	-	1.40	V
			$V_{OUT}=1.50\text{V}$	-	1.10	
			$V_{OUT}=1.80\text{V}$	-	0.8	
			$V_{OUT}=2.50\text{V}$	-	0.4	
			$V_{OUT}=3.00\text{V}$	-	0.37	
			$V_{OUT}=3.30\text{V}$	-	0.36	
			$V_{OUT}=4.75\text{V}$	-	0.25	
			$V_{OUT}=5.00\text{V}$	-	0.24	
Current Limit (Note 3)	$I_{LIMIT}$		400	600	-	mA
Short Circuit Current	$I_{short}$	$V_{OUT}<1.0\text{V}$	-	170	-	mA
Load Regulation (Note 4)	$\Delta V_{LOAD}$	$I_{OUT}=10\text{m}\sim 300\text{mA}$	-	-	0.02	%/mA
Ripple Rejection	PSRR	$C_{IN}=1\mu\text{F}$ , $C_O=2.2\mu\text{F}$ , $I_{OUT}=10\text{mA}$	$F=120\text{Hz}$	-	70	dB
			$F=1\text{KHz}$	-	65	
Enable Input Threshold	$V_{ENH}$		2.0	-	-	V
	$V_{ENL}$		-	-	0.8	
Enable Pin Current	$I_{ENH}$	$V_{EN}=V_{IN}$	-	0.003	0.1	$\mu\text{A}$
	$I_{ENL}$	$V_{IN}=3.6\text{V}$ , $V_{EN}=0\text{V}$	-	0.35	1	$\mu\text{A}$
Shutdown Current	$I_{SD}$	$V_{IN}=3.6\text{V}$ , $V_{EN}=0\text{V}$	-	-	1	$\mu\text{A}$
Temperature Shutdown	$T_S$		-	150	-	$^{\circ}\text{C}$
Temperature Shutdown Hysteresis	$T_{SH}$		-	30	-	$^{\circ}\text{C}$

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

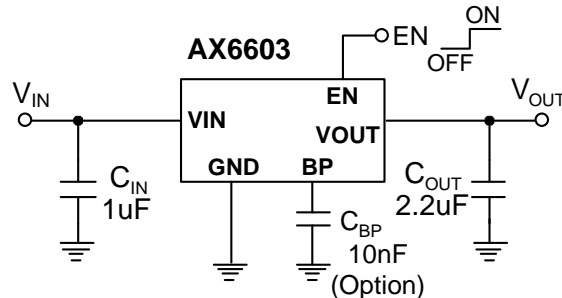
Note2:  $V_{IN}$  minimum must larger than 2.6V.

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

Note4: Regulation is measured at constant junction temperature by using pulsed testing with a low ON time.

## ❖ APPLICATION CIRCUIT

TSOT-23-5L/TDFN-6L:



## ❖ FUNCTION DESCRIPTIONS

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.

## ❖ APPLICATION INFORMATION

Like any low-dropout regulator, the AX6603 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 1µF capacitor on the input and a 2.2µF capacitor on the output of the AX6603. Larger input capacitor values and lower ESR (X5R, X7R) provide better supply-noise rejection and transient response. A higher- value output capacitor (10µF) 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<sub>DS (ON)</sub>, multiplied by the load current:

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

## Current Limit and Short-Circuit Protection

The AX6603 uses 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, AX6603 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 AX6603 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:

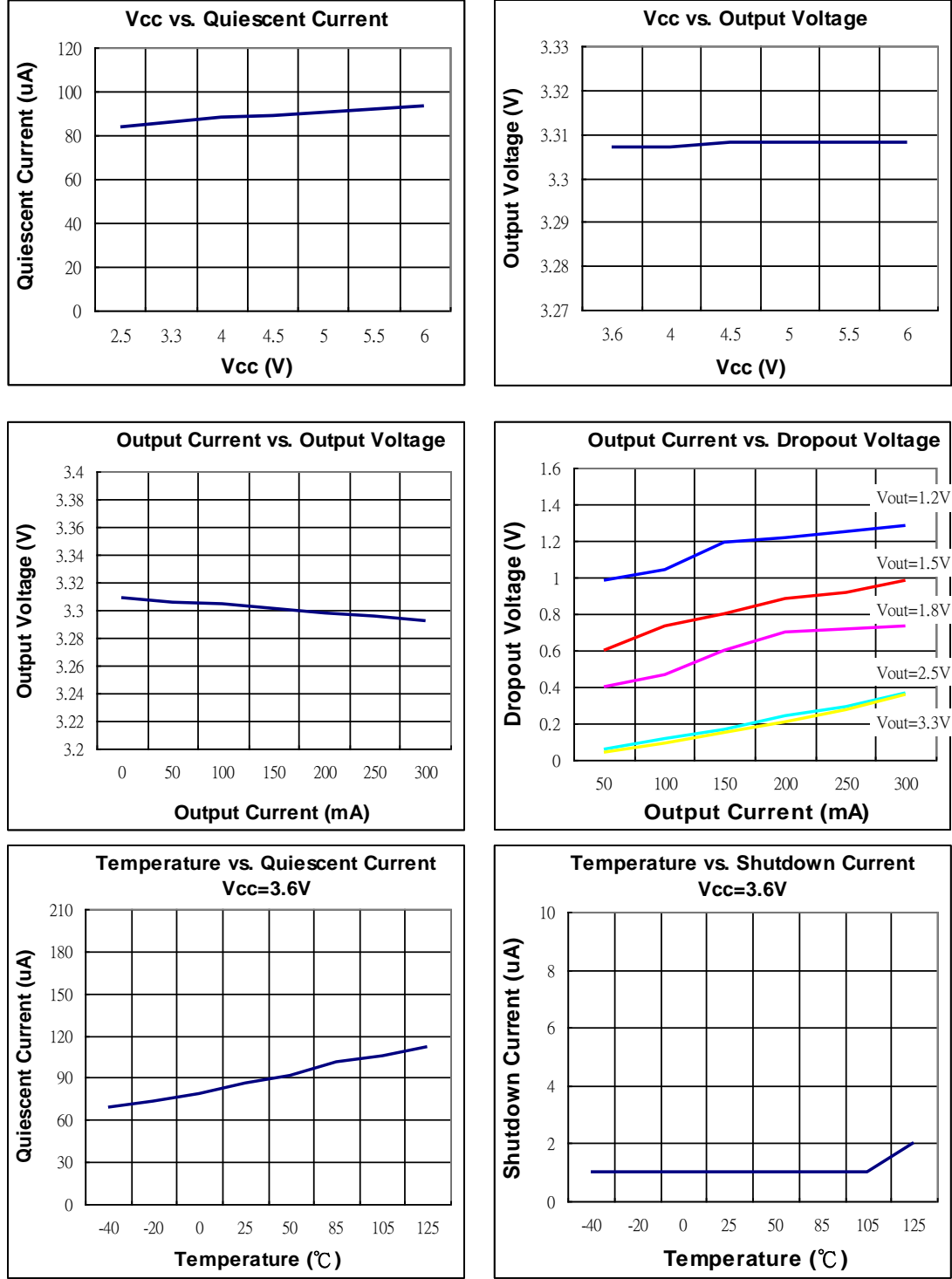
$$PD (MAX) = (T_{J (MAX)} - T_A) / \theta_{JA}$$

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 ( $\theta_{JA}$ ) for TSOT-23-5L package at recommended minimum footprint is 250°C/W.

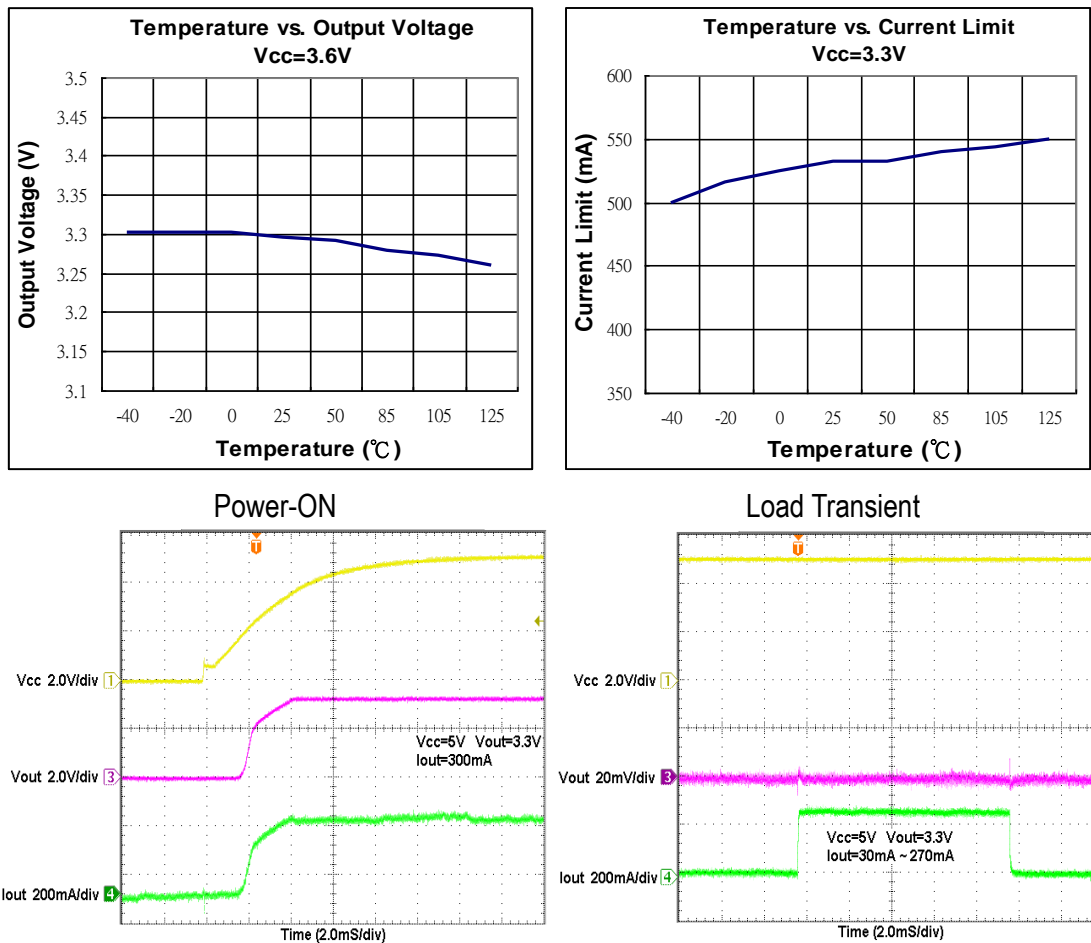
## PCB Layout

An input capacitance of  $\cong 1\mu F$  is required between the AX6603 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 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



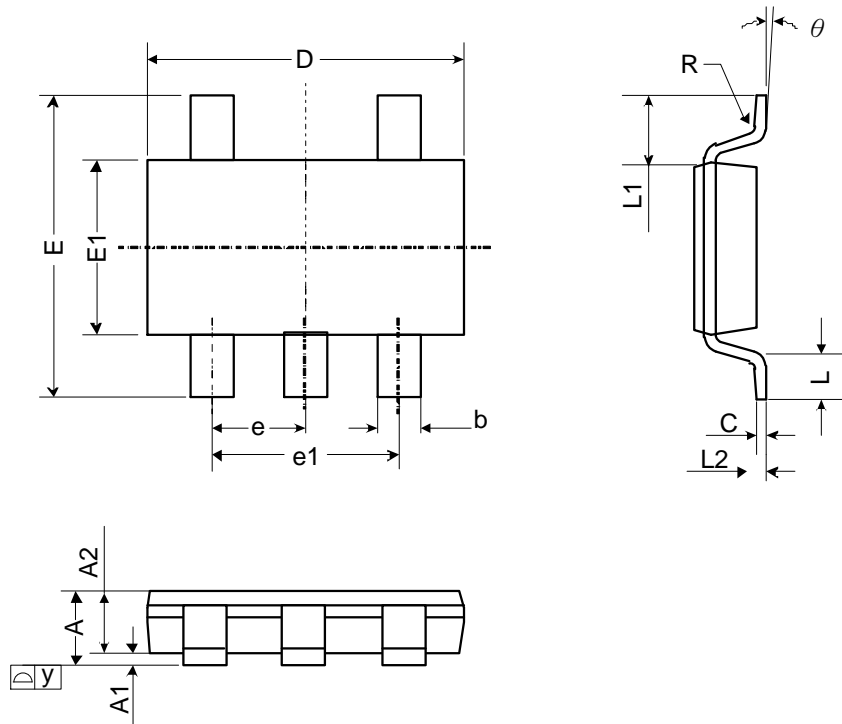
❖ TYPICAL CHARACTERISTICS (CONTINUES)





❖ PACKAGE OUTLINES

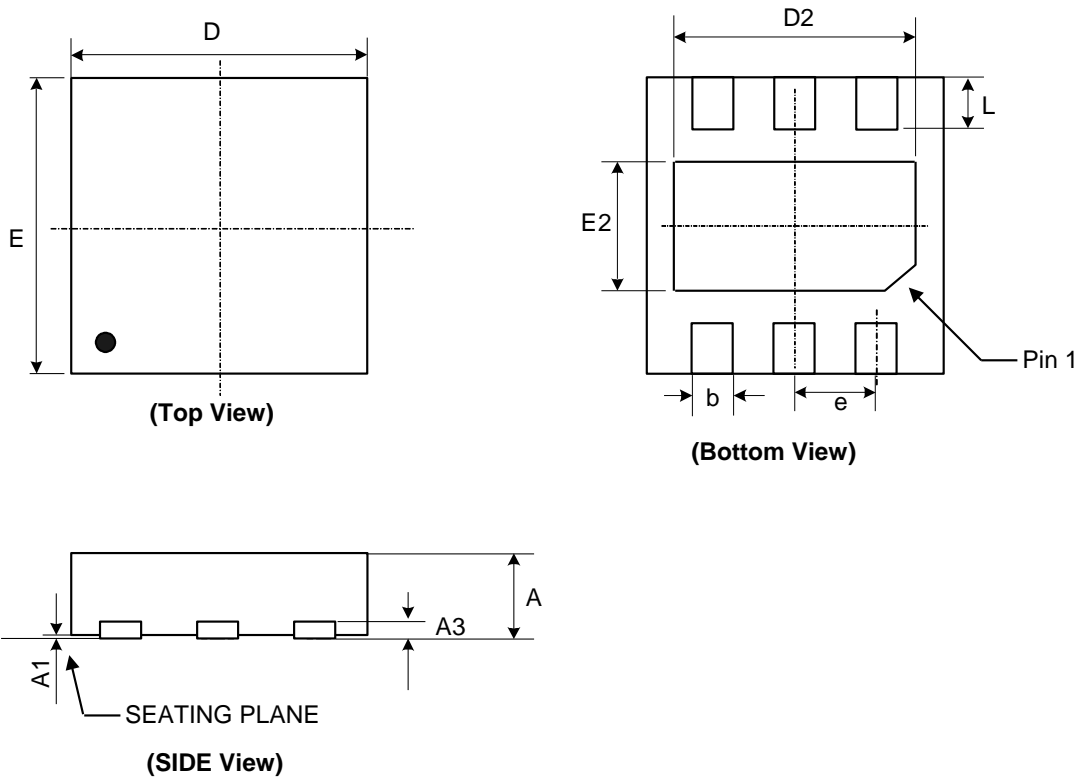
(1) TSOT-23-5L



Symbol	Dimensions in Millimeters			Dimensions in Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	-	-	1.1	-	-	0.043
A1	0	-	0.1	0	-	0.004
A2	0.70	0.90	1.0	0.028	0.035	0.039
b	0.30	0.40	0.5	0.012	0.016	0.02
C	0.08	0.14	0.2	0.003	0.006	0.008
D	2.80	2.90	3.0	0.110	0.114	0.118
E	2.60	2.80	3.0	0.102	0.110	0.118
E1	1.50	1.60	1.7	0.059	0.063	0.067
e	0.95 BSC.			0.037 BSC.		
e1	1.90 BSC.			0.075 BSC.		
L	0.30	0.45	0.6	0.012	0.018	0.024
L1	0.60 REF.			0.024 REF.		
L2	0.25 BSC.			0.010 BSC.		
y	-	-	0.1	-	-	0.004
R	0.10	-	-	0.004	-	-
θ	0°	-	8°	0°	-	8°

JECED outline: MO-193 AB

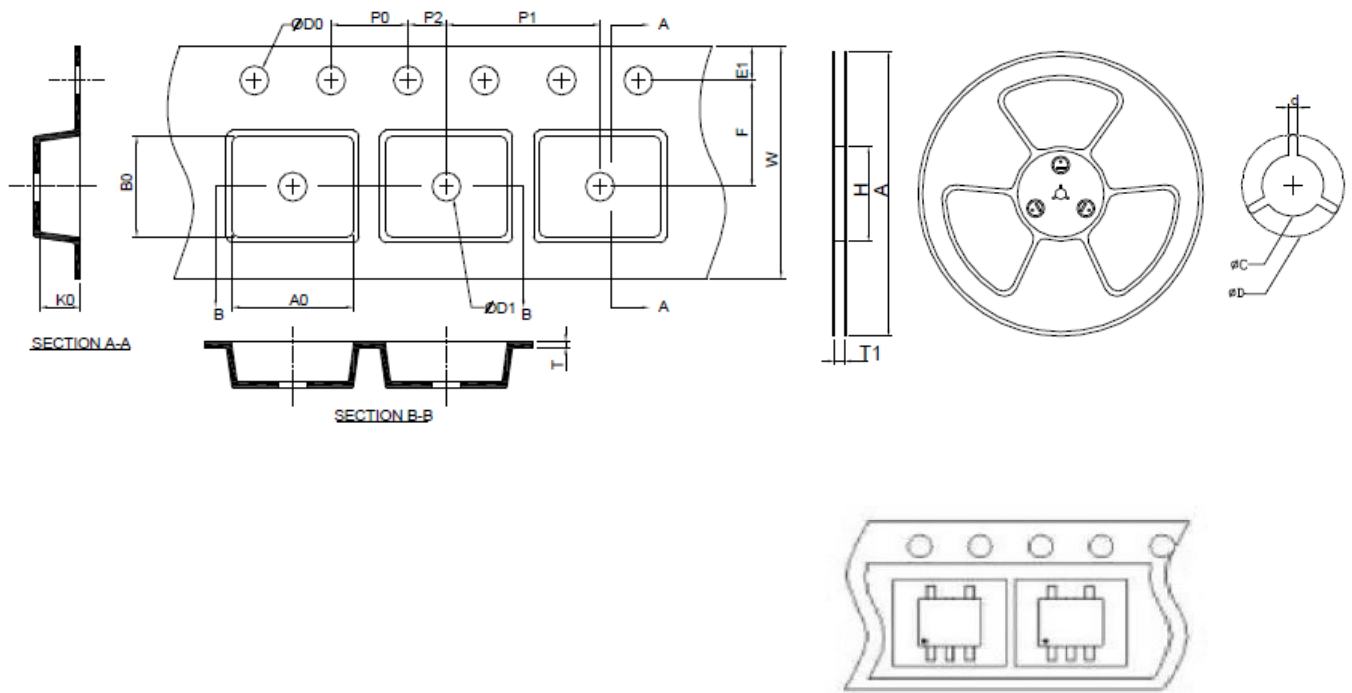
(2) TDFN-6L (2\*2 0.75mm)



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	0.02	0.05	0	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	1.20	1.35	1.45	0.047	0.053	0.057
E	1.95	2.00	2.05	0.077	0.079	0.081
E2	0.50	0.70	0.90	0.020	0.028	0.035
e	0.65 BSC.			0.026 BSC.		
L	0.20	0.30	0.40	0.008	0.012	0.016

❖ Carrier tape dimension

**TSOT-23-5L**



A	H	T1	C	d	D	W	E1	F
178.0±2.00	50 MIN.	8.4+2.00 -0.00	13.0+0.50 -0.20	1.5 MIN.	20.2 MIN.	8.0±0.30	1.75±0.10	3.5±0.05
P0	P1	P2	D0	D1	T	A0	B0	K0
4.0±0.10	4.0±0.10	2.0±0.05	1.5+0.10 -0.00	1.0 MIN.	0.6+0.00 -0.40	3.20±0.20	3.10±0.20	1.50±0.20

(mm)

**TDFN-6L ( 2x2mm)**

