50mA Ultra-Low Quiescent Current LDO Linear Regulator

Features

- **Operating Voltages Range：+2.5V to +18.0V**
- **Output Voltages Range：+1.5V to +5.0V with 100mV Increment**
- **Low Dropout: 800mV @ 50mA**
- **High Output Voltage Accuracy**
  ±2%：V_{OUT}≧2.7V
  ±2.4%：V_{OUT}≦2.6V
- **Thermal Overload Shutdown Protection**
- **Low ESR Capacitor Compatible**
- **SOT-23, SOT-89 & TO-92 Packages**
- **RoHS Compliant and 100% Lead (Pb)-Free and Green (Halogen Free with Commercial Standard)**

General Description

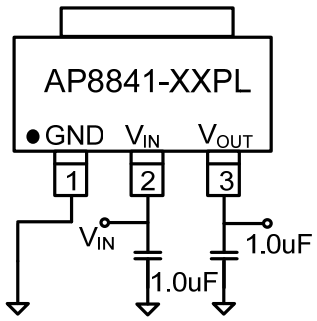
The AP8841 series is a positive voltage regulator with high accuracy output voltage and ultra-low quiescent current which is typically 1.0μA. The device is ideal for battery powered handheld equipments which require low quiescent current. The AP8841 contains a bandgap voltage reference, an error amplifier, a P-channel pass transistor, and a resistor-divider for setting output voltage. The output voltage is fixed with high accuracy by advanced trimming technology.
The AP8841 has been designed to be used with low cost ceramic capacitors and requires a minimum output capacitor of 1.0μF. The devices are available in SOT-23, SOT-89, and TO-92 packages

Applications

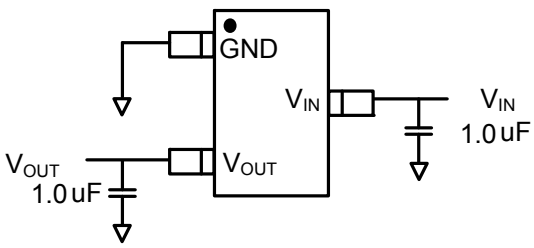
- Battery powered Equipments
- Portable Communication Devices
- Precision Voltage References
- Hand-Held Electronics
- Wireless Communication Systems

Simplified Application Circuit

SOT-89



SOT-23



Ordering Information

AP8841 –□□ □□

Package Code
Lead Free Code
V_{OUT} Code

Vout Code：

Exam. 18=1.8V、**25=**2.5V、**33=**3.3V

Lead Free Code：

P：Commercial Standard, Lead (Pb) Free and Phosphorous (P) Free Package

G：Green (Halogen Free with Commercial Standard)

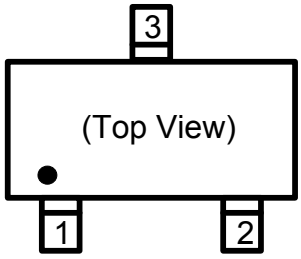
Package Code：

C：SOT-23　　**L**：SOT-89*

E：TO-92　　**Y**：SOT-89*

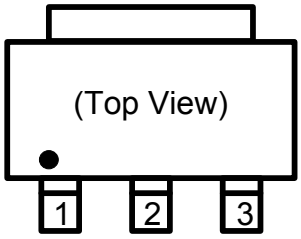
Note： * The difference between “L” & “Y” type, please refer ”Pin Description”.

Pin Assignment & Pin Description



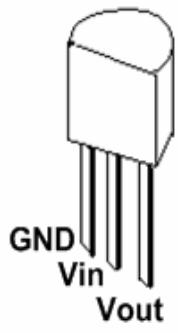
SOT-23

Pin Number	Pin Name	Functions
SOT-23(C)		
1	GND	Ground
2	V_{OUT}	Output
3	V_{IN}	Power Input



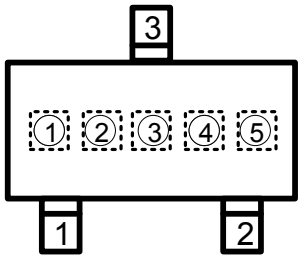
SOT-89

Pin Number		Pin Name	Functions
SOT-89(L)	SOT-89(Y)		
1	1	GND	Ground
2	3	V_{IN}	Power Input
3	2	V_{OUT}	Output



Pin Number	Pin Name	Functions
TO-92(E)		
1	GND	Ground
2	V_{IN}	Power Input
3	V_{OUT}	Output

Package Marking Information



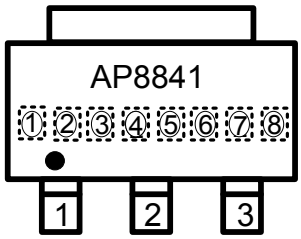
SOT-23-3
(Top View)

① 、② **Represents Products Series**

Mark	Products Series
41	AP8841

③ **Represents Products Series**	
Mark	**Products Series**
8	AP8841-15
A	AP8841-18
K	AP8841-28
M	AP8841-30
Q	AP8841-33
Z	AP8841-50

④ 、⑤ **Represents Production Date Code**



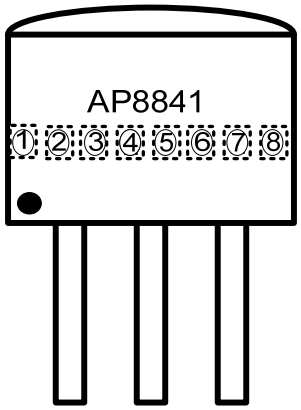
SOT-89-3
(Top View)

Note：

* There is a under-line on 1st digit for C type package.
* There are two under-lines on 4th & 5th digit for Green package.

Top Point Represents Products Series

Mark	Products Series
Top Point	Part No.：AP8841



TO-92
(Top View)

① 、② 、③ 、④ **Represents Products Series**

Mark		Description
① 、②	Voltage	Voltage Code：18、25、33…
③	P, G	Pb-Free Code & Green
④	L, Y, E	Package Code

⑤ 、⑥ 、⑦ 、⑧ **Represents Production Date Code**

Absolute Maximum Ratings

Parameter		Symbol	Ratings	Units
Input Voltage V_{IN} to GND		V_{IN}	20	V
Output Current Limit, $I_{(LIMIT)}$		I_{OUT}	100	mA
Power Dissipation	SOT-23	P_D	310	°C/mW
	SOT-89		550	°C/mW
	TO-92		55	°C/mW
Operating Ambient Temperature Range		T_{OPR}	-40 ~ +125	°C
Storage Temperature Range		T_{STG}	-55 ~ +150	°C
Lead Temperature (soldering, 10sec)			+260	°C

Note:

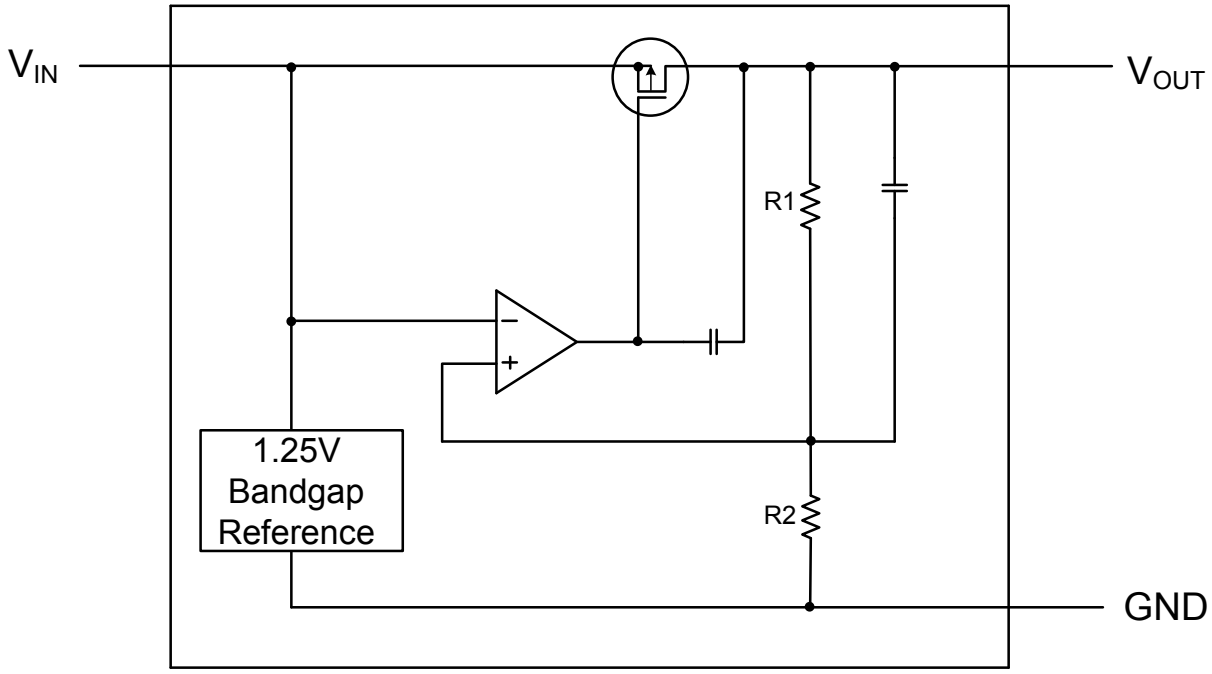
*Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and function operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum -rated conditions for extended periods may affect device reliability.

Electrical Characteristics

(T_A=25℃, unless otherwise noted.)

Symbol	Parameter	Test Conditions		Min	Typ	Max	Unit
V_{IN}	Input Voltage			2.5		18.0	V
V_{OUT}	Output Voltage	$V_{IN}=V_{OUT}+1.0V$, I_{OUT}=1mA, $V_{OUT}\leqq 2.6V$		V_{OUT}* 0.976	V_{OUT}	V_{OUT}* 1.024	V
		$V_{IN}=V_{OUT}+1.0V$, I_{OUT}=1mA, $V_{OUT}\geqq 2.7V$		V_{OUT}* 0.98		V_{OUT}* 1.02	
I_{MAX}	Maximum Load Current			50			mA
I_Q	Ground Pin Current	I_{LOAD}=0mA, $V_{IN}=V_{OUT}+1.0V$			1.0	2.5	μA
V_{DROP}	Dropout Voltage	V_{OUT}=5.0V	I_{OUT}=1mA		16	20	mV
			I_{OUT}=10mA		160	200	
			I_{OUT}=50mA		800	1000	
ΔV_{LINE}	Line Regulation	$V_{OUT}+1.0V < V_{IN} < 12V$, I_{OUT}=1mA			0.2	0.3	%/V
ΔV_{LOAD}	Load Regulation	I_{OUT}=0mA to 50mA,			0.01	0.02	%/mA
ΔV_{OUT} /ΔT_A	Temperature Characteristic of ΔV_{OUT}	V_{IN}=5.0V, I_{OUT}=10mA, T_A=-40°C ~ +125°C			0.6		mV/°C

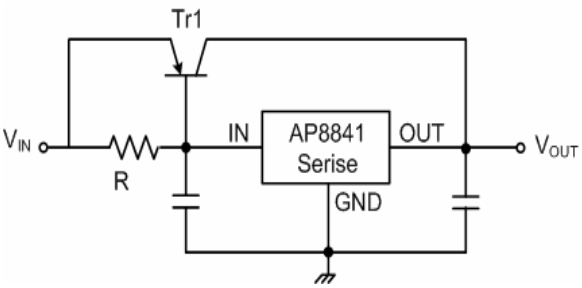
Function Block Diagram



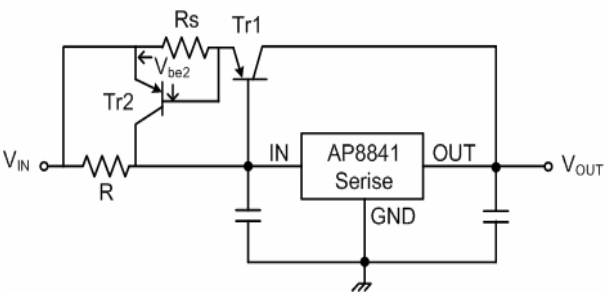
APPLICATION CIRCUITS

Current Boost Circuit

The figure below shows a boost circuit for increasing the output current. Output current 60mA or more can be obtained by this circuit.



Short-Circuit protection of Tr1 can be implemented by adding the sense resistor RS and the PNP transistor Tr2 as shown below.

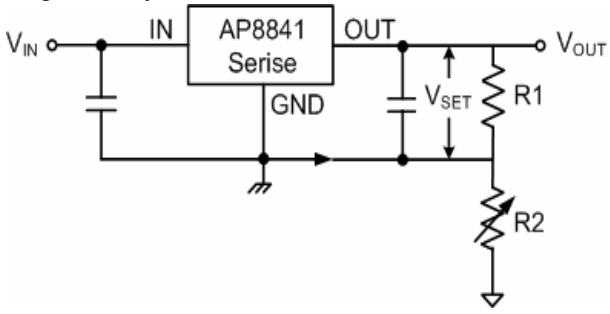


The current limit of the protection circuit is:

$$I_{LIMIT} = \frac{V_{be2}}{Rs}$$

Voltage Boost Circuit

If the output voltage you need is greater than 5.0V, the circuit in the figure below will increase output voltages easily



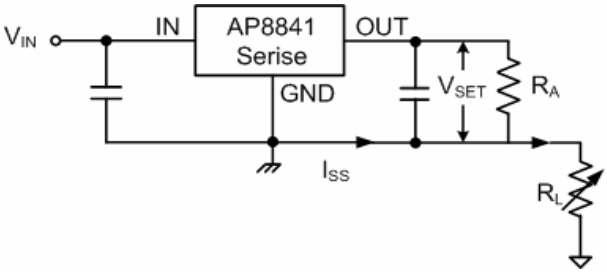
The output voltage is obtained by:

$$V_{OUT} = V_{SET} \times \left(1 + \frac{R2}{R1}\right) + I_{SS} \times R2$$

Where V_{SET} is the preset output voltage of AP8841 and I_{SS} is the quiescent current. Because of the low quiescent current, the resistor values, R1 and R2, can be set as large as several hundreds kΩ to lower the power consumption of the whole system.

Constant Current Source

The AP8841 Series can be used as a constant current source within allowable current limit.

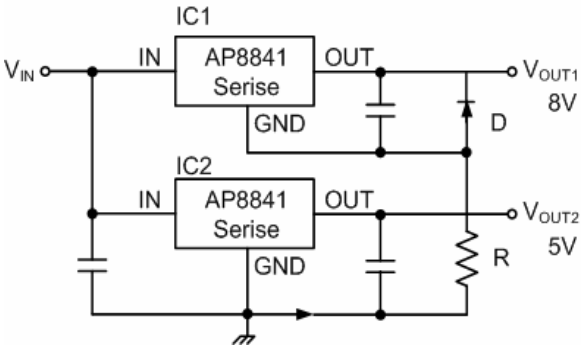


The output current is obtained by:

$$I_{OUT} = \frac{V_{SET}}{R_A} + I_{SS}$$

Dual Supply

A dual supply can be constructed with two AP8841 series as show in the figure below. This circuit provides two outputs (5V and 8V) with the AP8841 -30Px and the AP8841-50Px. As the resistance R lets the quiescent current of IC1 pass. R is unnecessary if the minimum output current of IC2 is more than the IC1 quiescent current. D is a protection diode in case V_{OUT2} becomes larger than V_{OUT1}.



Detail Description

The AP8841 is a low quiescent current LDO linear regulator. It supplies a preset 3.3V, 3.6V and 5.0V output voltages for output current up to 50mA. Other mask options for special output voltages from 1.5V to 5.0V with 100mV increment are also available. As illustrated in function block diagram, it consists of a 1.23V band gap reference, error amplifier, P-channel pass transistor and an internal feedback voltage divider.

The 1.23V band gap reference is connected to the error amplifier, which compares this reference with the feedback voltage and amplifies the voltage difference. If the feedback voltage is lower than the reference voltage, the pass-transistor gate is pulled lower, which allows more current to pass to the output pin and increases the output voltage. If the feedback voltage is too high, the pass-transistor gate is pulled up to decrease the output voltage.

The output voltage is feedback through an internal resistor-divider connected to OUT. Additional blocks include an output current limiter, thermal sensor, and shutdown logic.

Internal P-channel Pass Transistor

The AP8841 features a P-channel MOSFET pass transistor. Unlike similar designs using PNP pass transistors, P-channel MOSFETs require no base drive, which reduces ground pin current. PNP-based regulators also waste considerable current in dropout conditions when the pass transistor saturates, and use high base-drive currents under large loads. The AP8841 does not suffer from these problems and consumes only 1.0μA (Typ.) of ground pin current under heavy loads as well as in dropout conditions.

Output Voltage Selection

The first two digits of part number suffix identify the output voltage (see Ordering Information). For example, the AP8841-50PE has a preset 5.0V output voltage.

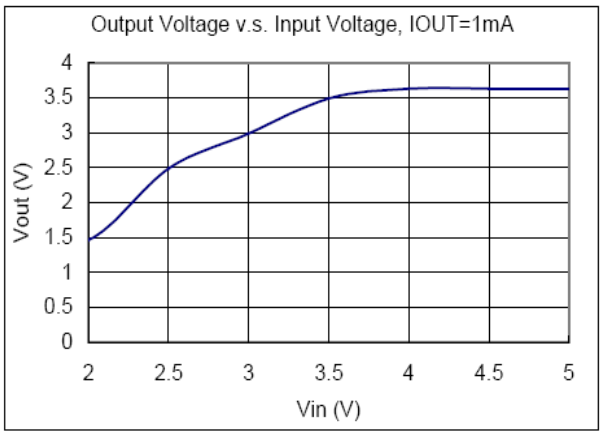
Input-Output Voltage

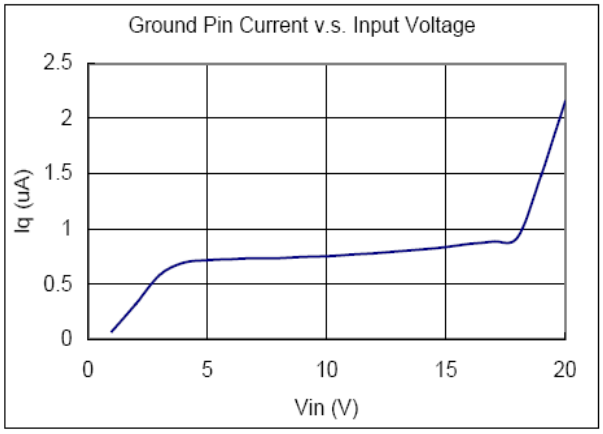
A regulator's minimum input-output voltage differential, or dropout voltage, determines the lowest usable supply voltage. In battery-powered systems, this will determine the useful end-of-life battery voltage. The AP8841 uses a P-channel MOSFET pass transistor, its dropout voltage is a function of drain-to-source on-resistance ($R_{DS(ON)}$) multiplied by the load current.

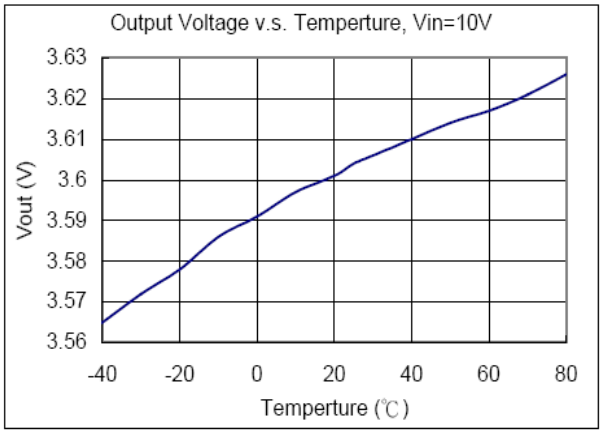
$$V_{DROPOUT} = V_{IN} - V_{OUT} = R_{DS(ON)} \times I_{OUT}$$

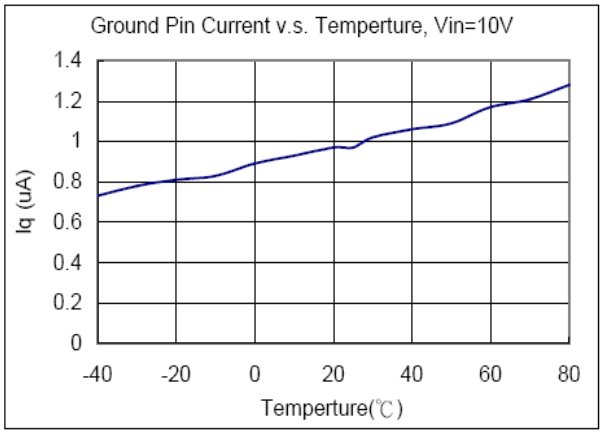
Typical Operating Characteristics

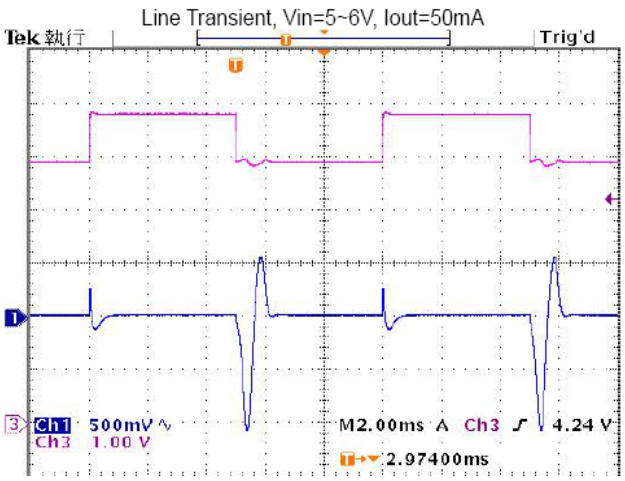
(AP8841-36PE tested, C_{IN}=1.0μF, C_{OUT}=1.0μF, T_A=+25℃, unless otherwise noted.)

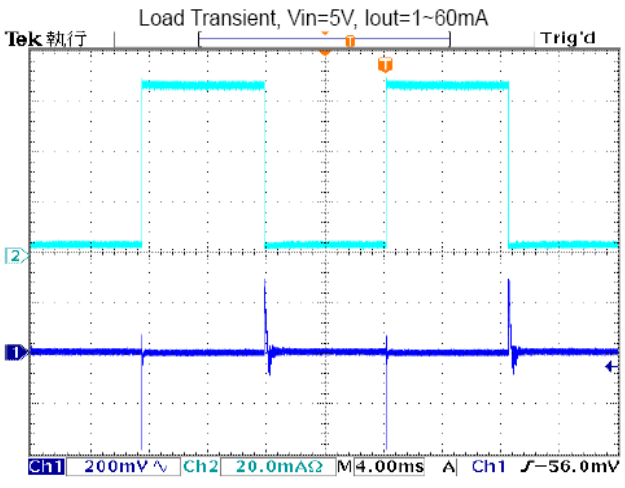






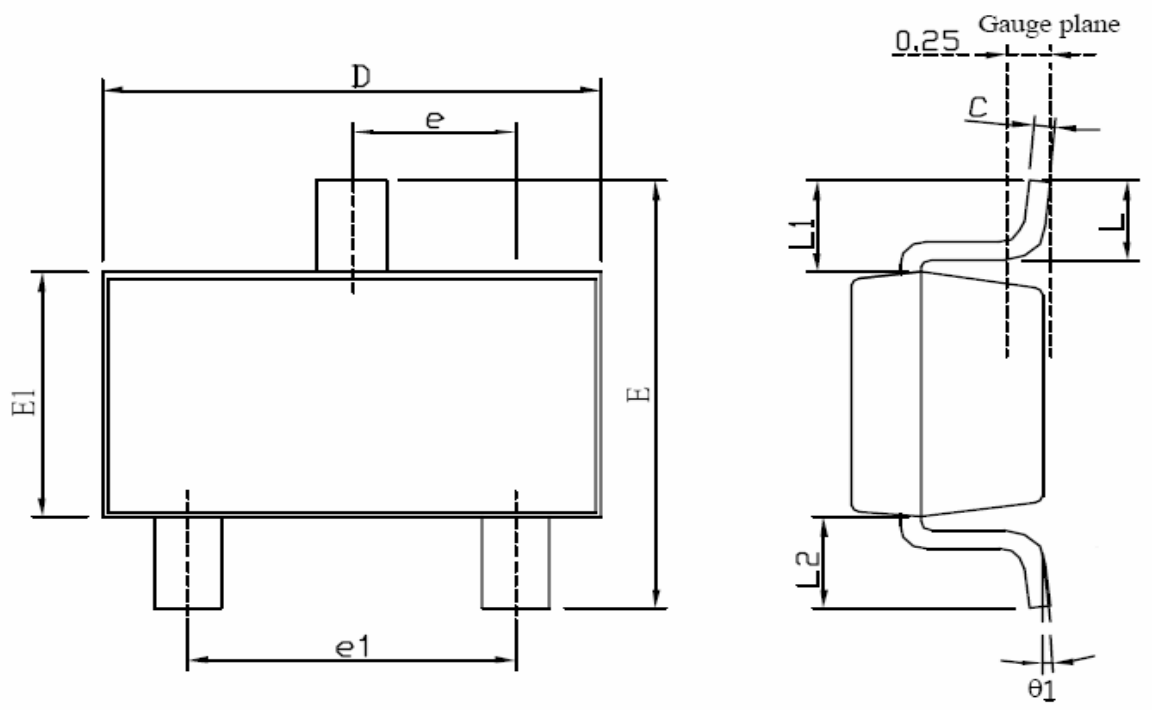


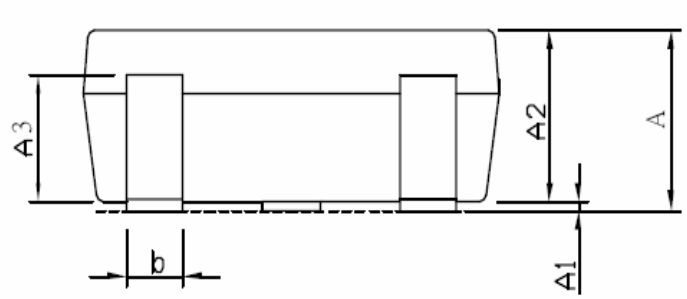




Package Outline

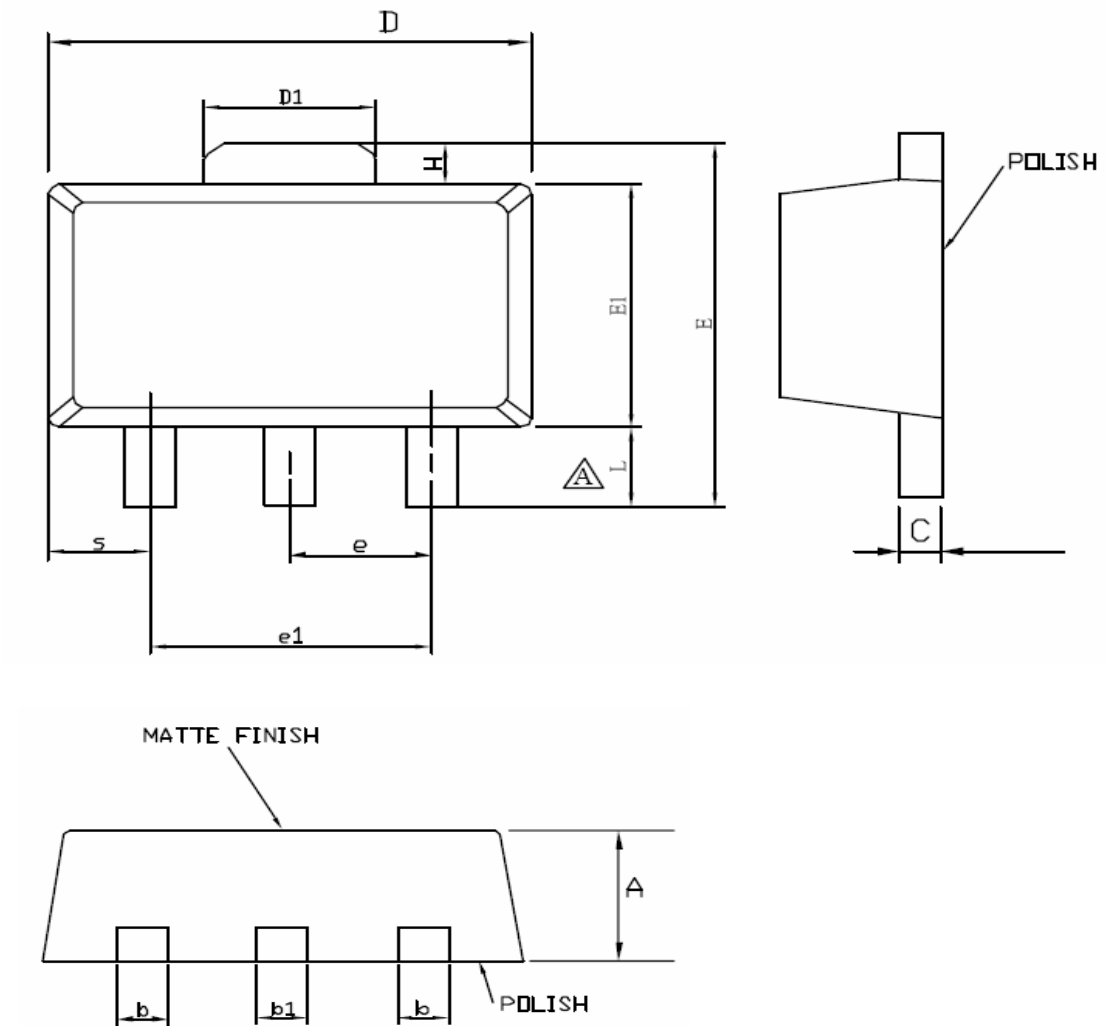
A) SOT-23





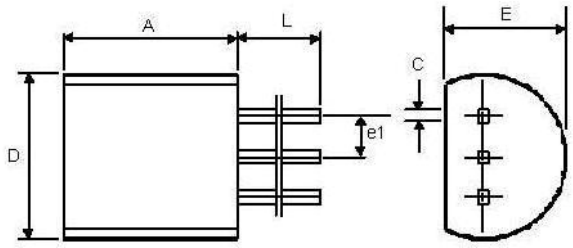
Symbols	Dimensions in Millmeters		
	Min	Nom	Max
A	1.00	1.10	1.40
A1	0.00	0.05	0.10
A2	1.00	1.10	1.30
A3	0.70	0.80	0.90
b	0.35	0.40	0.50
C	0.12	0.125	0.225
D	2.70	2.90	3.10
E	2.60	2.80	3.00
E1	1.40	1.60	1.80
e	---	0.95(Typ)	---
e1	---	1.90(Typ)	---
θ1	1°	5°	9°
L	0.37	---	---
L1	---	0.6REF	---
L1-L2	---	---	0.12

B) SOT-89



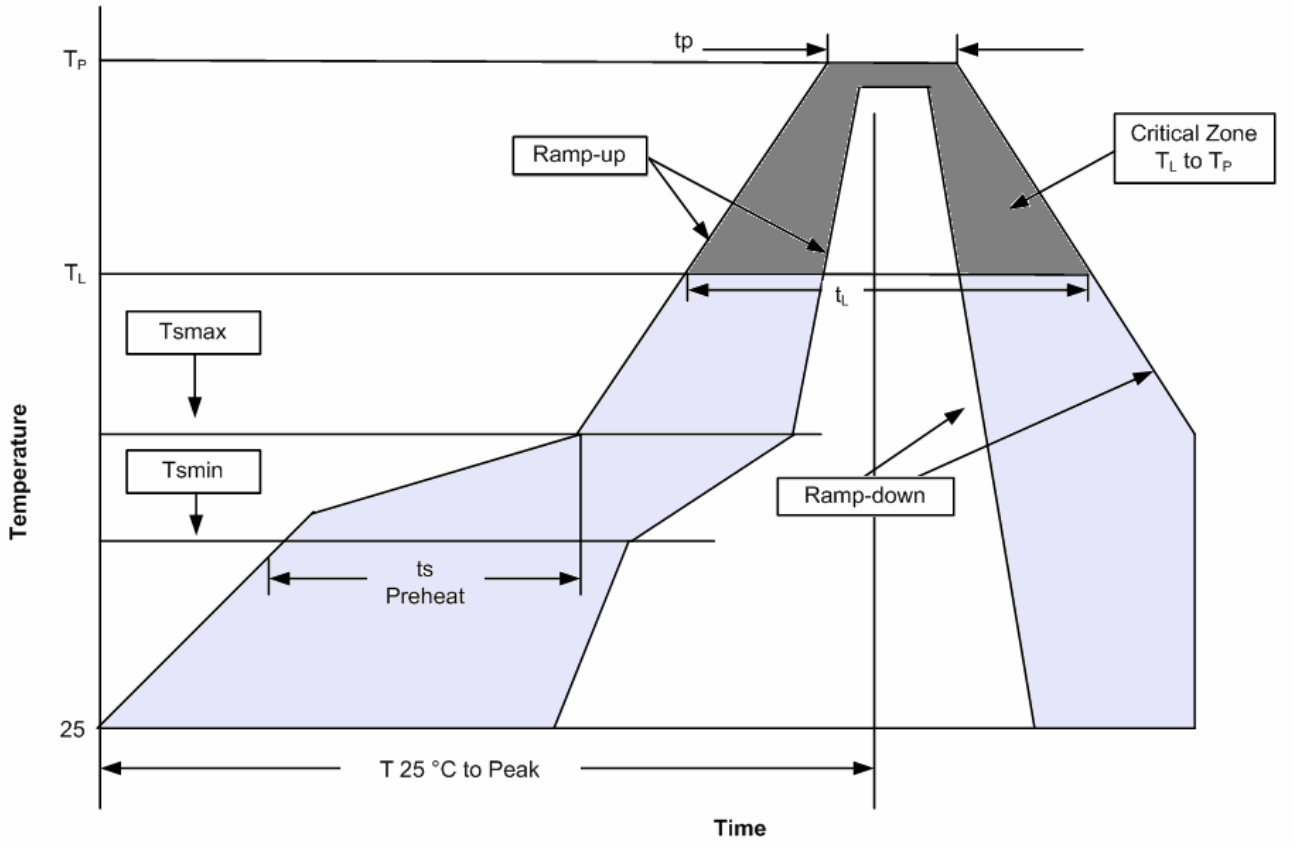
Symbol	Dimensions in millimeters			Dimensions in inches		
	Min	Nom	Max	Min	Nom	Max
A	1.40	1.50	1.60	0.055	0.059	0.063
L	0.89	1.04	1.20	0.0350	0.041	0.047
b	0.36	0.42	0.48	0.014	0.016	0.018
b1	0.41	0.47	0.53	0.016	0.018	0.020
C	0.38	0.40	0.43	0.014	0.015	0.017
D	4.40	4.50	4.60	0.173	0.177	0.181
D1	1.40	1.60	1.75	0.055	0.062	0.069
E	3.64	---	4.25	0.143	---	0.167
E1	2.40	2.50	2.60	0.094	0.098	0.102
e1	2.90	3.00	3.10	0.114	0.118	0.122
H	0.35	0.40	0.45	0.014	0.0169	0.018
S	0.65	0.75	0.85	0.026	0.030	0.034
e	1.40	1.50	1.60	0.054	0.059	0.063

C) TO-92



SYMBOL	MIN	MAX
A	4.32	5.33
C	0.38 (TYP.)	
D	4.40	5.20
E	3.17	4.20
e1	1.27 (TYP.)	
L	12.7	-

Reflow Condition (IR/Convection or VPR Reflow)



Classification Reflow Profiles

Profile Feature	Pb-Free / Green Assembly
Average ramp-up rate (T_L to T_P)	3°C/second max
Preheat - Temperature Min (Tsmin) - Temperature Max (Tsmax) - Time (min to max) (ts)	150°C 200°C 60-180 seconds
Time maintained above: - Temperature (T_L) - Time (t_L)	217°C 60-150 seconds
Peak/Classification Temperature (Tp)	See table 1
Time within 5°C of actual Peak Temperature (tp)	20-40 seconds
Ramp-down Rate	6°C/second max
Time 25°C to Peak Temperature	8 minutes max

Notes：
1) All temperatures refer to topside of the package.
2) Measured on the body surface.

Table 2. Pb-free / Green Process – Package Classification Reflow Temperatures

Package Thickness	Volume mm³ <350	Volume mm³ 350~2000	Volume mm³ ≧2000
<2.5 mm	260 +0°C*	260 +0°C*	260 +0°C*
1.6-2.5 mm	260 +0°C*	250 +0°C*	245 +0°C*
≧2.5 mm	250 +0°C*	245 +0°C*	245 +0°C*

Notes：
* Tolerance: The device manufacturer/supplier shall assure process compatibility up to and including the stated classification temperature (this means Peak reflow temperature +0°C. For example 260°C+0°C) at the rated MSL level.