4- Low 300mA Linear Regulator

Features

- Operating Voltages Range：+2.2V to +7.0V
- Output Voltages Range：+1.2V to +5.0V with 100mV Increment
- Maximum Output Current：300 mA
- Low Dropout: 125mV @ 100mA (V_{OUT}≧2.0 V)
- ±2% Output Voltage Accuracy (special ±1% highly accurate)
- High Ripple Rejection：65 dB
- Output Current Limit Protection (500mA)
- Short Circuit Protection (150mA)
- Thermal Overload Shutdown Protection
- Low ESR Capacitor Compatible
- SOT-23, SOT-89 and TO-92 Packages
- RoHS Compliant and 100% Lead (Pb)-Free

General Description

The AP1722A is a 4-Low (Low-dropout, Low-noise, Low-quiescent current, Low-cost) linear regulator that operations in the input voltage range from +2.2V to +7.0V and delivers 300mA output current.

The high-accuracy output voltage is preset at an internally trimmed voltage 2.5V or 3.3V. Other output voltages can be mask-optioned from 1.2V to 5.0V with 100mV increment, except AP1722A-LL which has 2.85V output voltage.

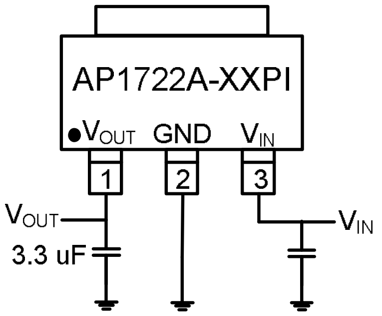
The AP1722A consists of a 1.25V band-gap reference, an error amplifier, and a P-channel pass transistor. Other features include short-circuit protection and thermal shutdown protection. The AP1722A devices are available in SOT-23, SOT-89 And TO-92 packages.

Applications

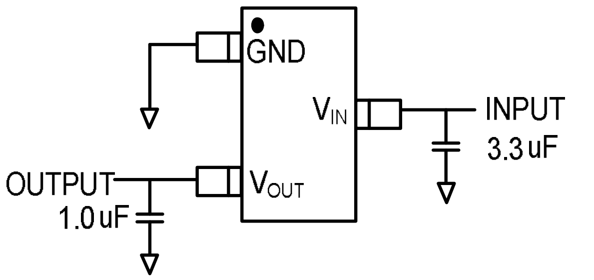
- Battery powered equipments
- Palmtops
- Portable Cameras and video recorders
- Reference voltage sources
- Post Regulator for switching power

Simplified Application Circuit

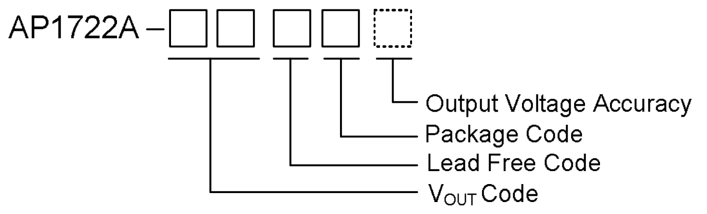
SOT-89



SOT-23



Ordering Information



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

Package Code：

C：SOT-23*　　**G**：SOT-23*

I：SOT-89*　　**L**：SOT-89*

E：TO-92

Output Voltage Accuracy：

1：±1%

Note：

* The difference between “C” & “G” type and “L” & “I” type, please refer ”Pin Description”.

Absolute Maximum Ratings

Parameter		Symbol	Ratings	Units
Input Voltage V_{IN} to GND		V_{IN}	7.0	V
Output Current Limit, $I_{(LIMIT)}$		I_{OUT}	500	mA
Junction Temperature		T_J	+155	°C
Power Dissipation	SOT-23	P_D	350	mW
	SOT-89		550	mW
	TO-92		550	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.

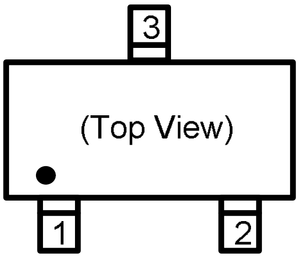
* The power dissipation of UFN-6 would be 500 mW normally with the 0.5X0.5 square inches cooper area connected to the bottom pad. However, it could be up to 1000mW with larger cooper area.

Electrical Characteristics

(T_A=25℃, unless otherwise noted.)

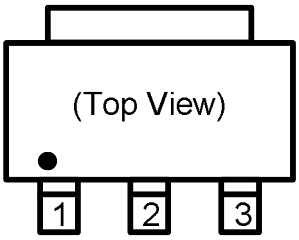
Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{IN}	Input Voltage		2.2		7.0	V
V_{OUT}	Output Voltage	$V_{IN}=V_{OUT}+0.8V$, I_{OUT}=1mA, $V_{IN}\geqq 2.5V$	-2%	V_{OUT}	+2%	V
		$V_{IN}=V_{OUT}+0.8V$, I_{OUT}=1mA, $V_{IN}\geqq 2.5V$	-1%		+1%	
I_{MAX}	Maximum Load Current	$V_{OUT}+0.8V \leqq V_{IN} \leqq 7.0V$	300			mA
I_{LIMIT}	Current Limit				0.5	A
I_{SC}	Short Circuit Current	V_{OUT}=0V, $V_{IN} > V_{OUT}+0.8V$		150		mA
I_Q	Ground Pin Current	I_{LOAD}=0mA to 300mA, $V_{IN}=V_{OUT}+0.8V$		15	30	μA
V_{DROP}	Dropout Voltage	I_{OUT}=100mA, $V_{IN}\geqq 2.5V$		125	140	mV
		I_{OUT}=200mA, $V_{IN}\geqq 2.5V$		250	280	
		I_{OUT}=300mA, $V_{IN}\geqq 2.5V$		550	650	
ΔV_{LINE}	Line Regulation	$V_{OUT}+0.8V<V_{IN}<7.0V$, I_{LOAD}=1mA		0.2	0.3	%/V
ΔV_{LOAD}	Load Regulation	I_{OUT}=0mA to 300mA,		0.01	0.02	%/mA
PSRR	Ripple Rejection	F=1KHz, C_{OUT}=3.3uF, I_{OUT}=30mA		65		dB
T_{SD}	Thermal Shutdown Temperature			150		°C
T_{HYS}	Thermal Shutdown Hysteresis			20		°C

Pin Assignment & Pin Description



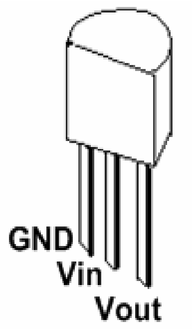
SOT-23

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



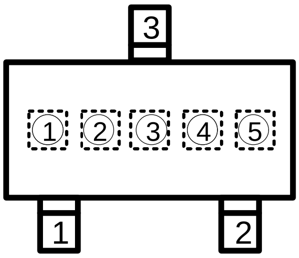
SOT-89

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

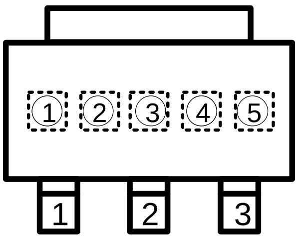


Pin Number	Pin Name	Functions
SOT-92		
1	GND	Ground
2	V_{IN}	Power Input
3	V_{OUT}	Output

Package Marking Information



SOT-23
(Top View)



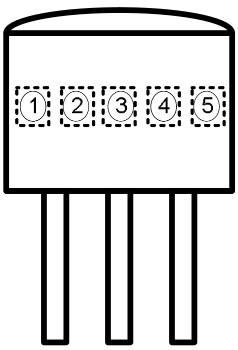
SOT-89
(Top View)

①、② Represents Products Series

Mark	Products Series
2A	AP1722A-XXPC/G/L/I/E

③ Represents Type of Regulator

Mark	Products Series
5	AP1722A-12PC/G/L/I/E
8	AP1722A-15PC/G/L/I/E
A	AP1722A-18PC/G/L/I/E
D	AP1722A-20PC/G/L/I/E
G	AP1722A-25PC/G/L/I/E
J	AP1722A-27PC/G/L/I/E
K	AP1722A-28PC/G/L/I/E
L	AP1722A-LLPC/G/L/I/E (V_{OUT}=2.85V)
M	AP1722A-30PC/G/L/I/E
Q	AP1722A-33PC/G/L/I/E
V	AP1722A-36PC/G/L/I/E



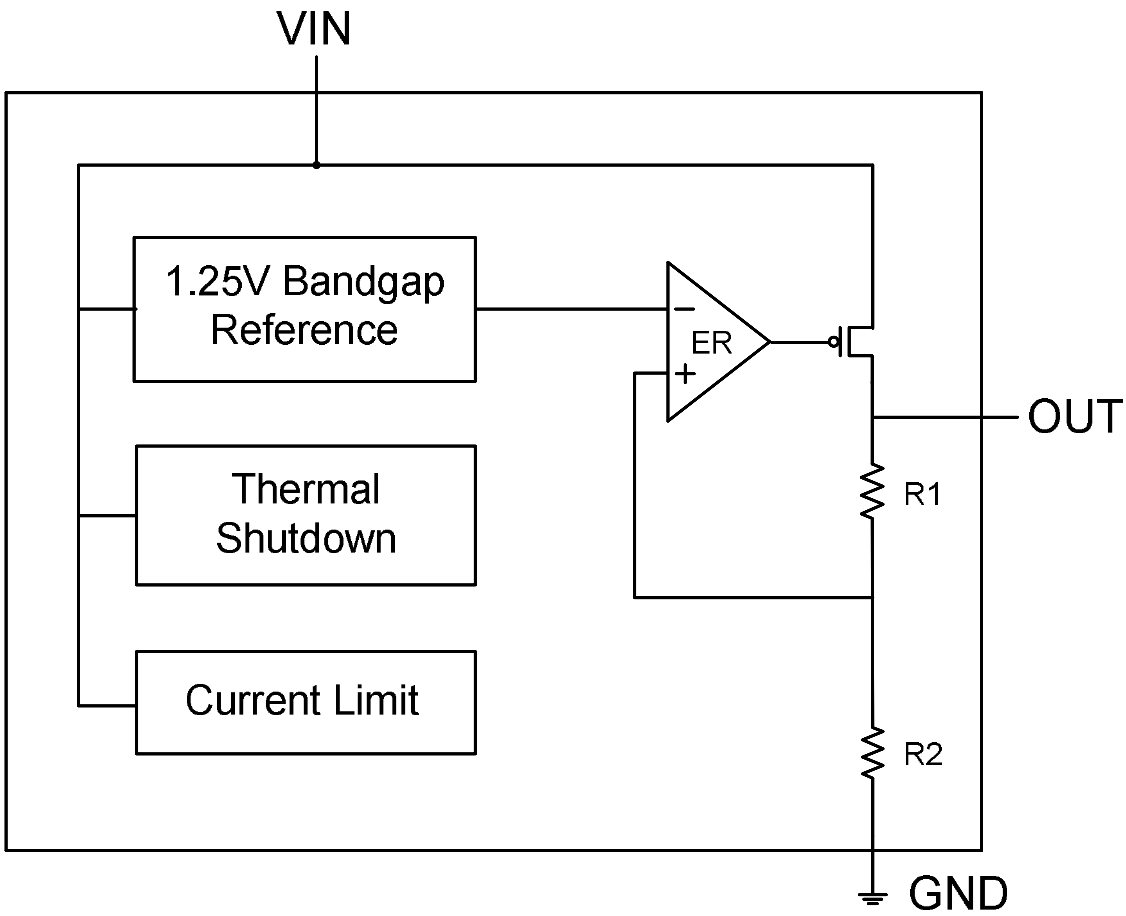
TO-92
(Top View)

④、⑤ Represents Production Date Code

Note：

* There is a under-line on 1st digit for C type, I type and E type package.
* There is a under-line on 2nd digit for G type and L type package.
* There is a top-line on 2nd digit for ±1% output voltage accuracy.

Function Block Diagram



Detail Description

The AP1722A is a low-dropout linear regulator. The device provides preset 2.5V and 3.3V output voltages for output current up to 300mA. Other mask options for special output voltages from 1.2V to 5.0V with 100mV increment are also available (but only 1.28V in stead of 1.3V). As illustrated in function block diagram, it consists of a 1.25V reference, error amplifier, a P-channel pass transistor, and an internal feedback voltage divider.

The 1.25V bandgap 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 resistive divider connected to V_{OUT} pin. Additional blocks include with output current limiter and shutdown logic.

Internal P-channel Pass Transistor

The AP1722A features a P-channel MOSFET pass transistor. Unlike similar designs using PNP pass transistors, P-channel MOSFETs require no base drive, which reduces quiescent 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 AP1722A does not suffer from these problems and consumes only 15μA (Typical) of current consumption under light loads.

Output Voltage Selection

The AP1722A output voltage is preset at an internally trimmed voltage 1.8V, 2.5V or 3.3V. The output voltage also can be mask-optioned from 1.2V to 5.0V with 100mV increment The first two digits of part number suffix identify the output voltage (see ***Ordering Information***). For example, AP1722A-33 has a preset 3.3V output voltage.

Current Limit

The AP1722A also includes a fold back current limiter. It monitors and controls the pass-transistor's gate voltage, estimates the output current, and limits the output current within 500mA.

Thermal Overload Protection

Thermal overload protection limits total power dissipation in the AP1722A. When the junction temperature exceeds T_J = +150°C, a thermal sensor turns off the pass transistor, allowing the IC to cool down. The thermal sensor turns the pass transistor active again after the junction temperature cools down by 20°C resulting in a pulsed output during continuous thermal overload conditions.

Thermal overload protection is designed to protect the AP1722A in the event of fault conditions. For continuous operation, the maximum operating junction temperature rating of T_J=+125°C should not be exceeded.

Operating Region and Power Dissipation

Maximum power dissipation of the AP1722A depends on the thermal resistance of the case and circuit board, the temperature difference between the die junction and ambient air, and the rate of airflow. The power dissipation across the devices is P = I_{OUT} x (V_{IN}-V_{OUT}). The resulting maximum power dissipation is:

$$P_{MAX} = \frac{(T_J - T_A)}{q_{JC} + q_{CA}} = \frac{(T_J - T_A)}{q_{JA}}$$

Where (T_J-T_A) is the temperature difference between the AP1722A die junction and the surrounding air, θ_{JC} is the thermal resistance of the package chosen, and θ_{CA} is the thermal resistance through the printed circuit board, copper traces and other materials to the surrounding air. For better heat-sinking, the copper area should be equally shared between the V_{IN}, V_{OUT}, and GND pins.

If the AP1722A uses a SOT-89 package and this package is mounted on a double sided printed circuit board with two square inches of copper allocated for "heat spreading", the resulting θ_{JA} is 180 °C/W.

Based on a maximum operating junction temperature 125 °C with an ambient of 25°C, the maximum power dissipation will be:

$$P_{MAX} = \frac{(T_J - T_A)}{q_{JC} + q_{CA}} = \frac{(125 - 25)}{180} = 0.555W$$

Thermal characteristics were measured using a double-side board with 1" x 2" square inches of copper area connected to the GND pin for "heat spreading".

Inout-Output Voltage

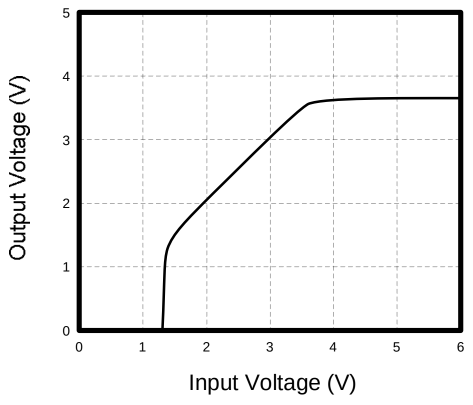
A regulator's minimum input-output voltage differential, or dropout voltage, determines the lowest us- able supply voltage. In battery-powered systems, this will determine the useful end-of-life battery voltage. The AP1722A uses a P-channel MOSFET pass transistor, its dropout voltage is a function of drain-to-source on-resistance ($R_{DS(ON)}$) multiplied by the load current.

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

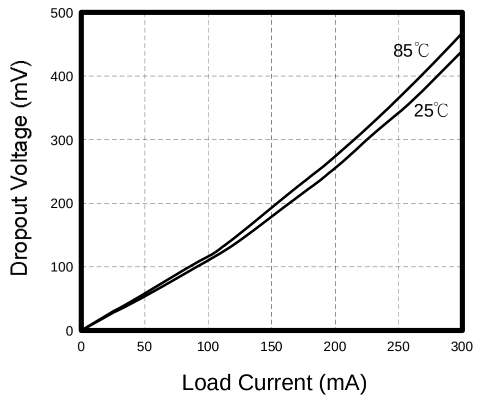
Typical Operating Characteristics

(C_{IN}=1μF , C_{OUT}=3.3μF, T_A=+25℃, unless otherwise noted.)

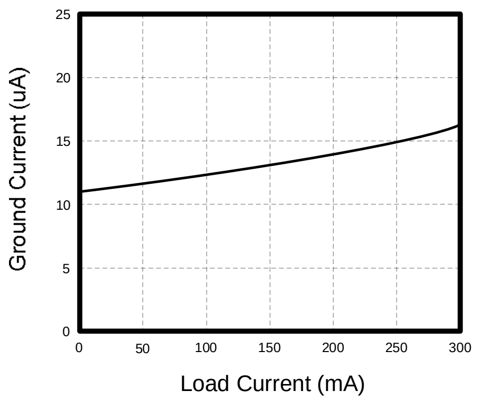
Input Voltage vs. Output Voltage



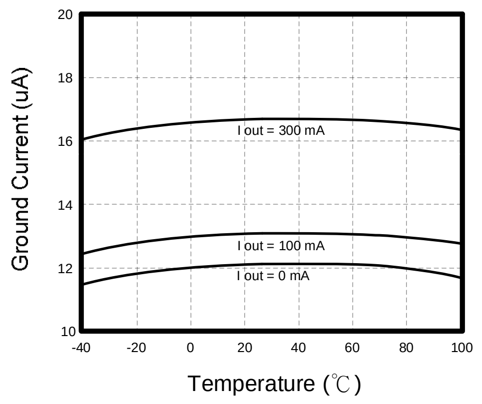
Dropout Voltage vs. Load Current



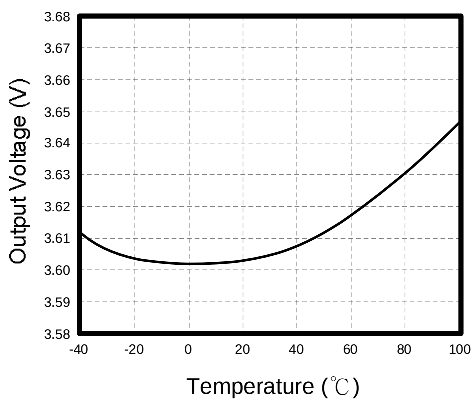
Ground Current vs. Load Current



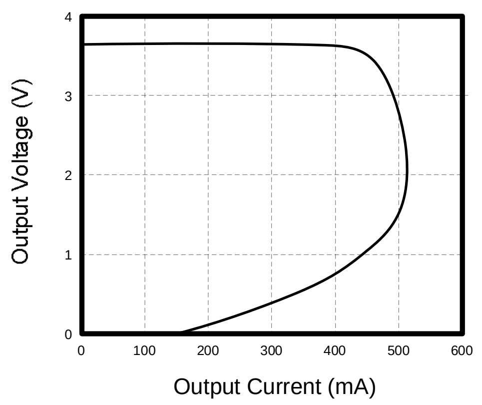
Ground Current vs. Temperature

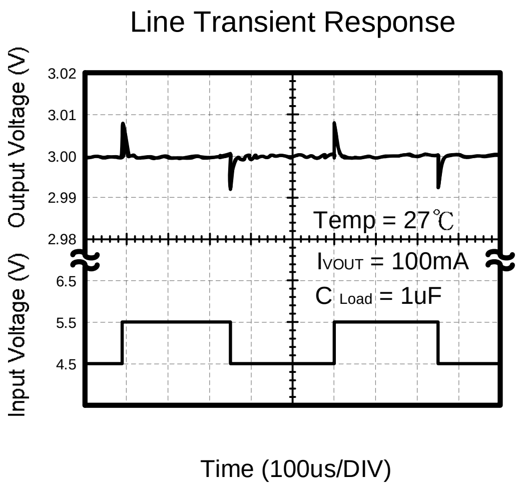


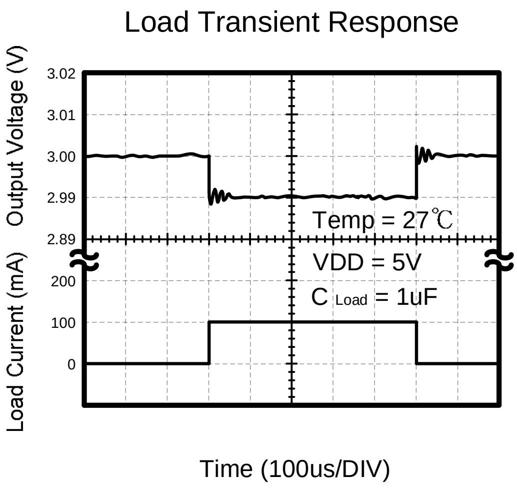
Output Voltage vs. Temperature

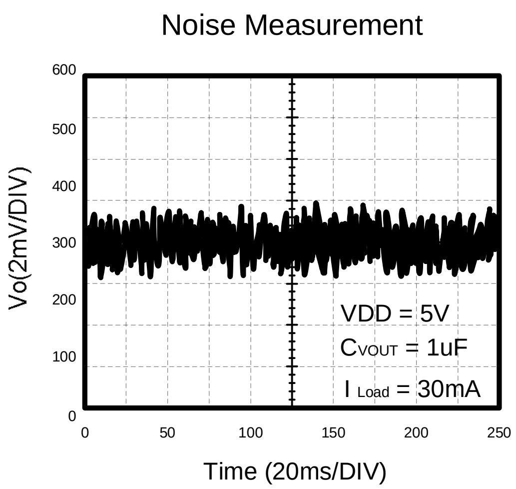


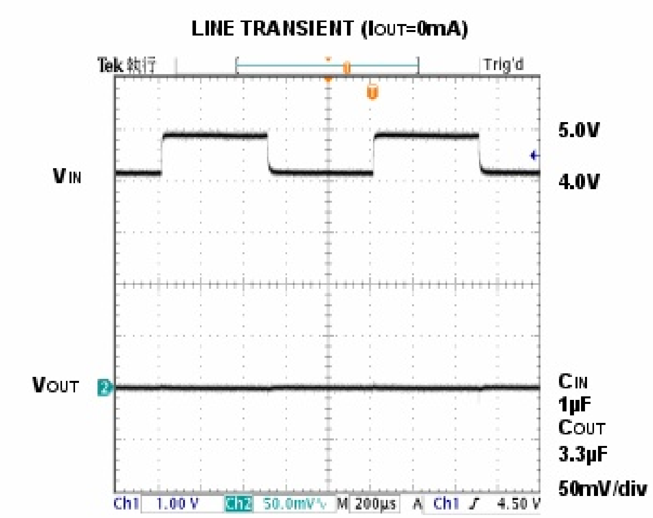
Output Voltage vs. Current Limit

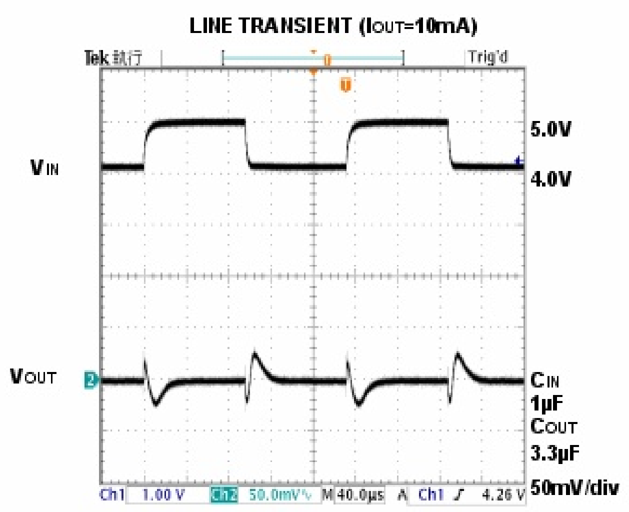



Line Transient Response
Output Voltage (V)
Input Voltage (V)
3.02
3.01
3.00
2.99
2.98
6.5
5.5
4.5
Temp = 27℃
IVOUT = 100mA
C Load = 1uF
Time (100us/DIV)

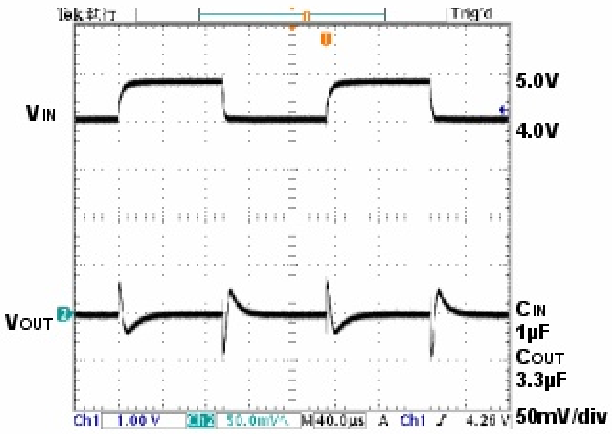

Load Transient Response
Output Voltage (V)
Load Current (mA)
3.02
3.01
3.00
2.99
2.89
200
100
0
Temp = 27℃
VDD = 5V
C Load = 1uF
Time (100us/DIV)


Noise Measurement
Vo(2mV/DIV)
600
500
400
300
200
100
0
0
50
100
150
200
250
VDD = 5V
CVOUT = 1uF
I Load = 30mA
Time (20ms/DIV)

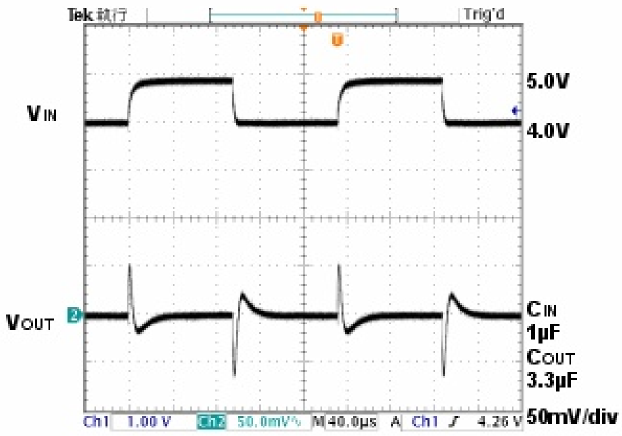

LINE TRANSIENT (IOUT=0mA)
VIN
VOUT
5.0V
4.0V
CIN
1μF
COUT
3.3μF
50mV/div


LINE TRANSIENT (IOUT=10mA)
VIN
VOUT
5.0V
4.0V
CIN
1μF
COUT
3.3μF
50mV/div

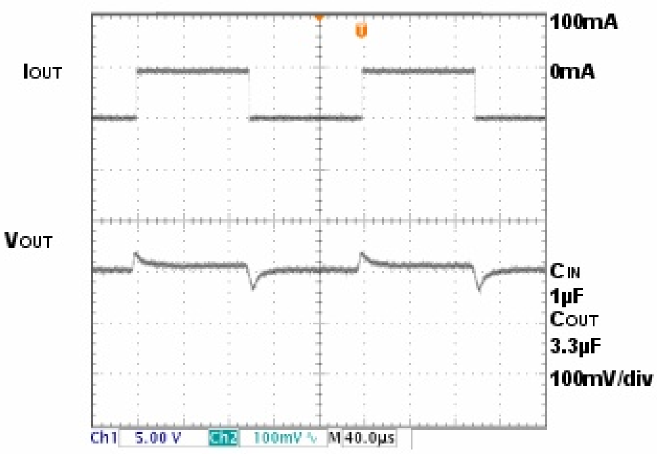
LINE TRANSIENT (I_{OUT}=100mA)



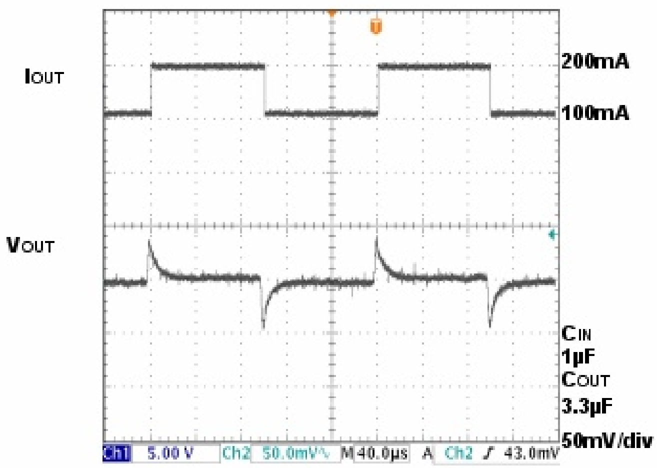
LINE TRANSIENT (I_{OUT}=200mA)



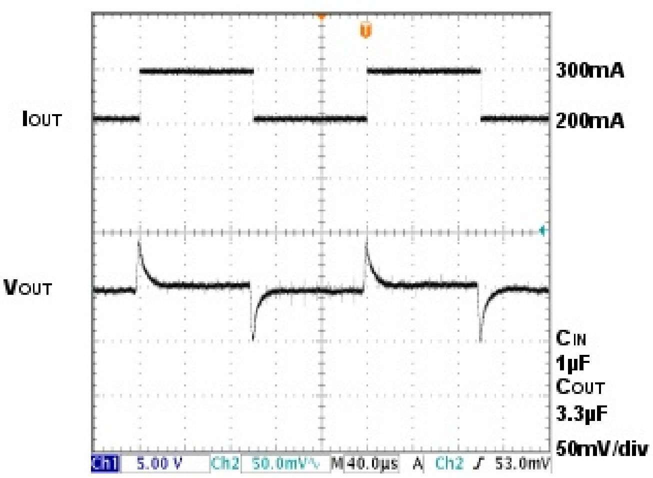
LOAD TRANSIENT



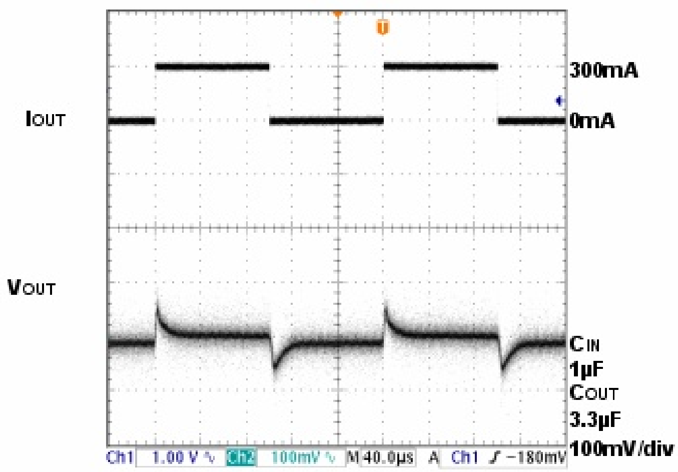
LOAD TRANSIENT



LOAD TRANSIENT

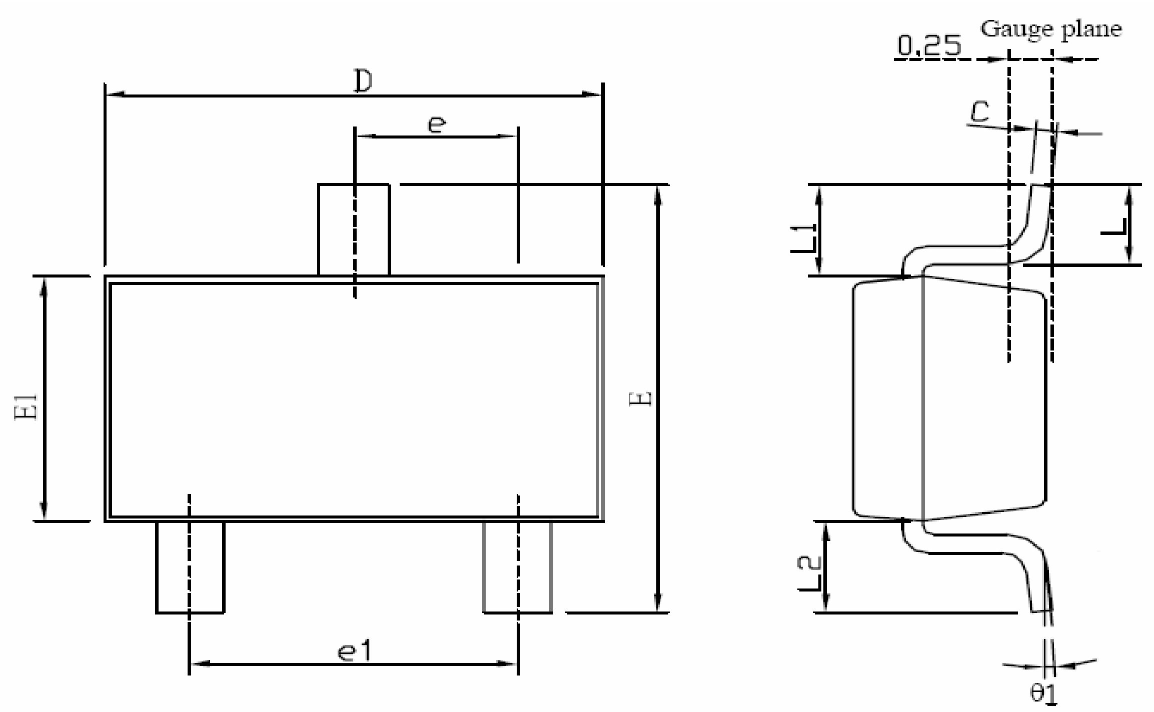


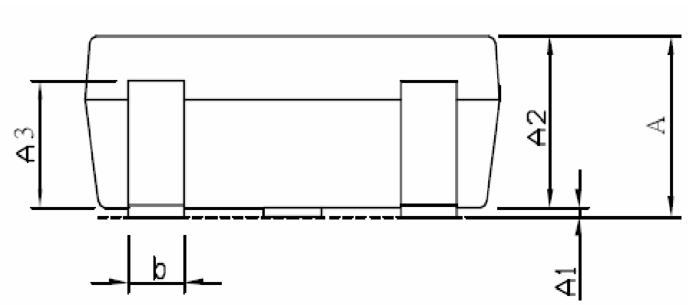
LOAD TRANSIENT



Package Outline

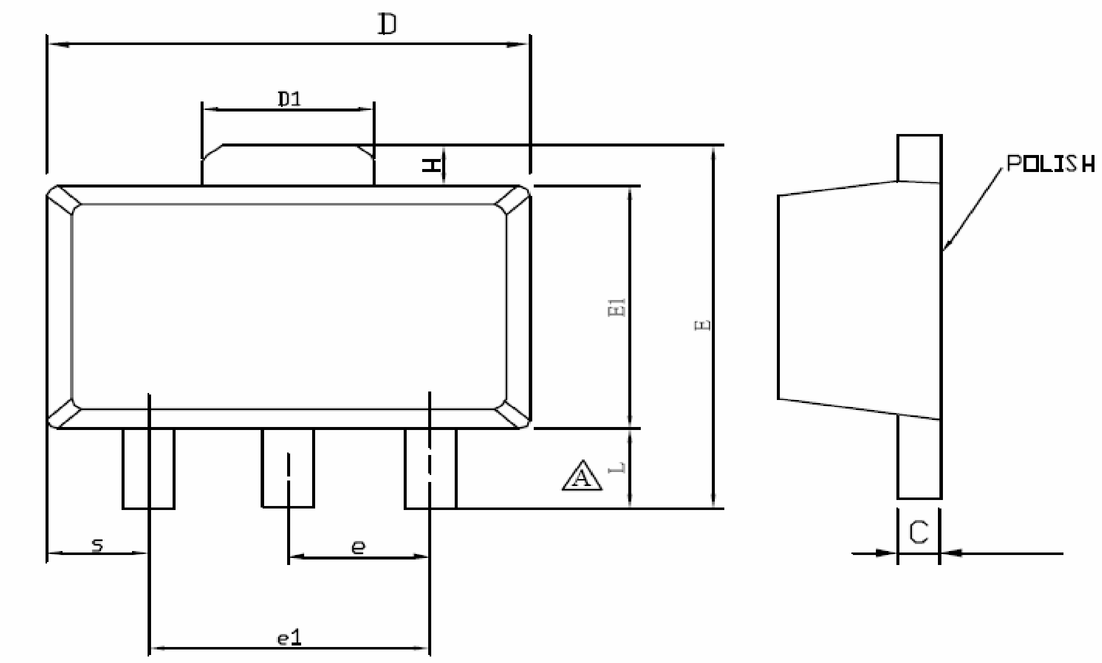
A) SOT-23

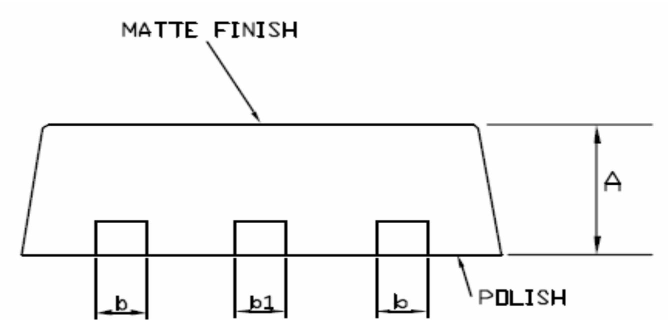




Symbols	Dimensions in Millmeters		
	Min	Nom	Max
A	1.00	1.10	1.40
A1	0.00	0.05	0.10
A2	1.00	1.10	1.30
A3	0.70	0.80	0.90
b	0.35	0.40	0.50
C	0.12	0.125	0.225
D	2.70	2.90	3.10
E	2.60	2.80	3.00
E1	1.40	1.60	1.80
e	---	0.95(Typ)	---
e1	---	1.90(Typ)	---
θ1	1°	5°	9°
L	0.37	---	---
L1	---	0.6REF	---
L1-L2	---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

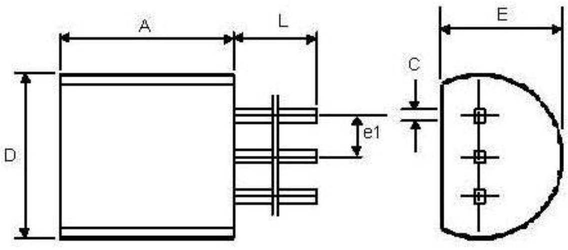
B) SOT-89-3





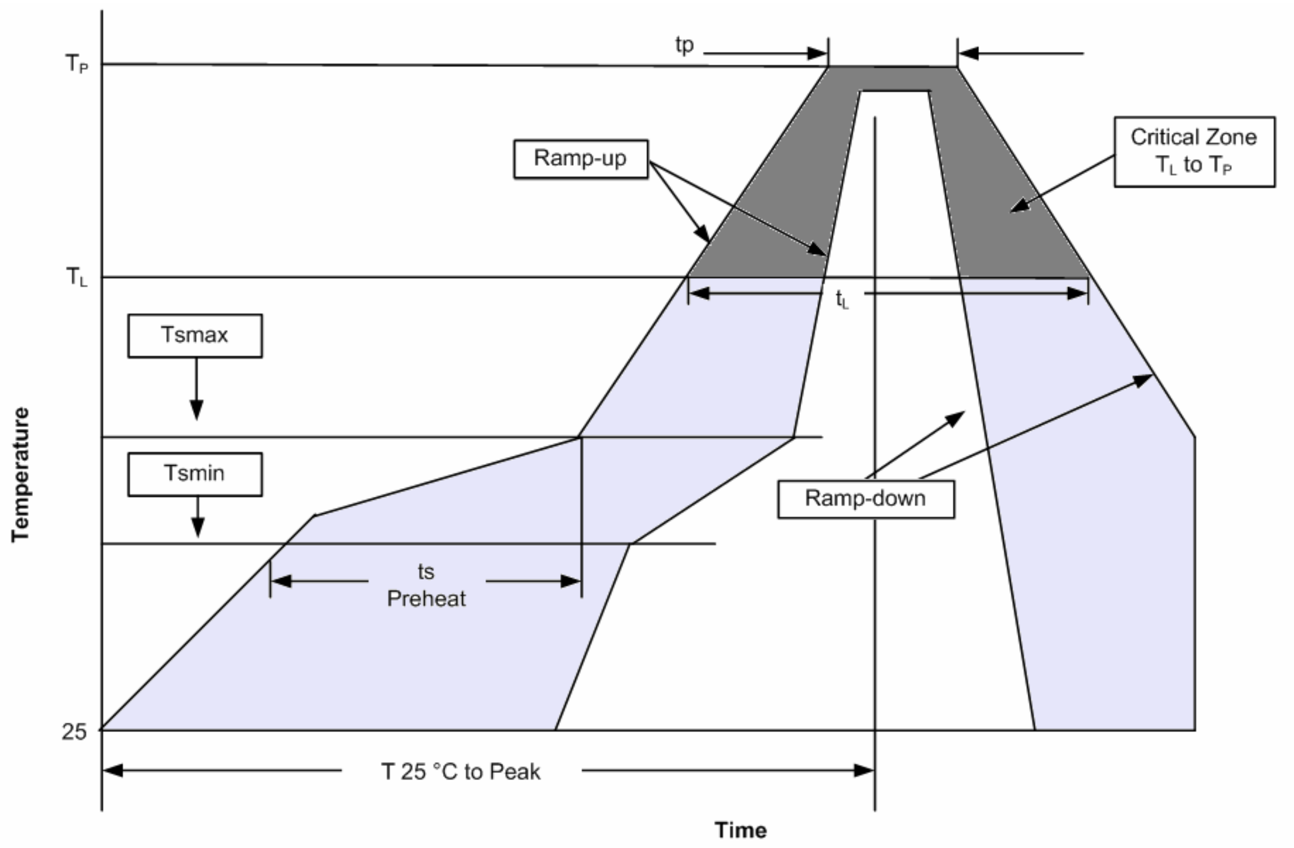
Symbol	Dimensions in millimeters			Dimensions in inches		
	Min	Nom	Max	Min	Nom	Max
A	1.40	1.50	1.60	0.055	0.059	0.063
L	0.89	1.04	1.20	0.0350	0.041	0.047
b	0.36	0.42	0.48	0.014	0.016	0.018
b1	0.41	0.47	0.53	0.016	0.018	0.020
C	0.38	0.40	0.43	0.014	0.015	0.017
D	4.40	4.50	4.60	0.173	0.177	0.181
D1	1.40	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	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average ramp-up rate (T_L to T_P)	3°C/second max	3°C/second max
Preheat - Temperature Min (Tsmin) - Temperature Max (Tsmax) - Time (min to max) (ts)	100°C 150°C 60-120 seconds	150°C 200°C 60-180 seconds
Time maintained above: - Temperature (T_L) - Time (t_L)	183°C 60-150 seconds	217°C 60-150 seconds
Peak/Classification Temperature (Tp)	See table 1	See table 2
Time within 5°C of actual Peak Temperature (tp)	10-30 seconds	20-40 seconds
Ramp-down Rate	6°C/second max	6°C/second max
Time 25°C to Peak Temperature	6 minutes max	8 minutes max

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

Table 1. Sn-Pb Eutectic Process – Package Peak Reflow Temperatures

Package Thickness	Volume mm³ <350	Volume mm³ ≧350
<2.5 mm	240 +0/-5°C	225 +0/-5°C
≧2.5 mm	225 +0/-5°C	225 +0/-5°C

Table 2. Pb-free 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.