Low Voltage Adjustable Precision Shunt Regulator

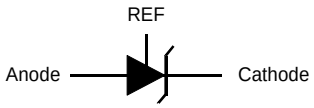
Features

- Precise Reference Voltage to 1.24V
- Guaranteed 0.5%, 1% or 1.5% Reference Voltage Tolerance
- Sink Current Capability, 80uA to 100mA
- Quick Turn-on
- Adjustable Output Voltage, $V_O = V_{REF}$ to 20V
  Low Operational Cathode Current, 80μA Typical
- 0.1Ω Typical Output Impedance
- SOT-23-3, SOT-23-5, TO-92 and SOT-89 Packages
- Lead Free Available (RoHS Compliant)

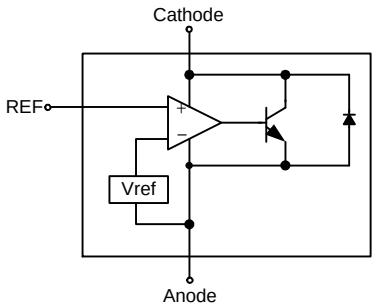
Applications

- Linear Regulators
- Adjustable Power Supply
- Switching Power Supply

Symbol



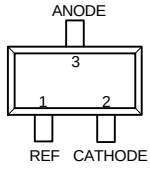
Functional Diagram



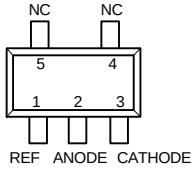
General Description

The APL431L is a 3-terminal low voltage adjustable precision reference with specified thermal stability over applicable commercial temperature ranges. Output voltage may be set to any value between V_{ref} (1.24 V) and 20 V with two external resistors (see Figure 2). When used with an photocoupler, the APL431L is an ideal voltage reference in isolated feedback circuits for 3V to 12V switching-mode power supplies. This device has a typical output impedance of 0.1W. Active output circuitry provides a very sharp turn-on characteristic, making the APL431L excellent replacements for zener diodes in many applications, including on-board regulation and adjustable power supplies.

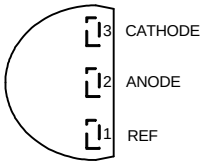
Pinouts



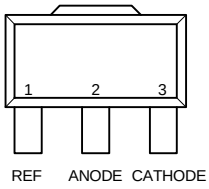
SOT-23-3 (Top View)



SOT-23-5 (Top View)



TO-92 (Top View)



SOT-89 (Top View)

Ordering and Marking Information

<table>
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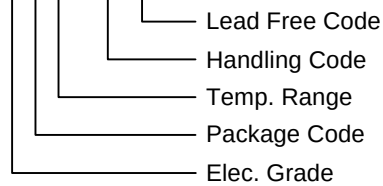
<td>APL431L □□□-□□□
 
</td>
<td>Elec. Grade
A : 0.5% Reference Voltage Tolerance
B : 1% Reference Voltage Tolerance
C : 1.5% Reference Voltage Tolerance
Package Code
A : SOT-23-3 B : SOT-23-5
D : SOT-89 E : TO-92
Y:Chip Form
Temp. Range
C : 0 to 70 °C I : -40 to 85 °C
Handling Code
PB : Plastic Bag TB : Tape & Box
TR : Tape & Reel
Lead Free Code
L : Lead Free Device Blank : Original Device</td>
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<tr>
<td>APL431L A/B : 431L

APL431L D : APL431L
XXXXX
XXXX
X - Date Code</td>
<td>APL431L E : APL
431L
XXXXX
XXXXX - Date Code</td>
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Notes: ANPEC lead-free products contain molding compounds/die attach materials and 100% matte in plate termination finish; which are fully compliant with RoHS and compatible with both SnPb and lead-free soldering operations. ANPEC lead-free products meet or exceed the lead-free requirements of IPC/JEDEC J STD-020C for MSL classification at lead-free peak reflow temperature.

Absolute Maximum Ratings

Symbol	Parameter	Rating	Unit
V_{KA}	Cathode voltage	20	V
I_K	Continuous cathode current range	100	mA
I_{REF}	Reference current range	3	mA
θ_{JA}	Thermal Resistance from Junction to Ambient in Free Air SOT-23-3 SOT-23-5 SOT-89 TO-92	 416 357 250 250	°C/W
T_J	Operating Junction Temperature Range	-40 to 150	°C
T_{STG}	Storage Temperature Range	-65 to 150	°C
T_{SOL}	Lead temperature range, T_s (Soldering, 10sec)	260	°C

Electrical Characteristics T_A= 25°C (unless otherwise noted)

Symbol	Parameter	Test Conditions		APL431L Min.	APL431L Typ.	APL431L Max.	Unit
V_{REF}	Reference Voltage	$V_{KA}=V_{REF}$, I_K=10mA T_A =25°C, (Fig. 1)	APL431LA	1.234	1.240	1.246	V
			APL431LB	1.228	1.240	1.252	
			APL431LC	1.223	1.240	1.258	
		T_A=full range (see Note1), (Fig.1)	APL431LA	1.222	1.240	1.258	
			APL431LB	1.215	1.240	1.265	
			APL431LC	1.212	1.240	1.262	
V_{DEF}	V_{DEF} Temp Deviation	T_A=full range (see Note1) $V_{KA}=V_{REF}$, I_K=10mA (Fig. 1)			5	15	mV
ΔV_{REF} / ΔV_{KA}	Ratio of Change in V_{REF} to Change in Cathods Votage	I_K=10mA, V_{KA}=16V to V_{REF} (Fig. 2)			-0.2	-1.0	mV/V
I_{REF}	Reference Input Current	I_K=10mA,R_1=10kΩ,R_2=∞ (Fig. 2)			0.15	0.5	µA
$I_{REF(DEV)}$	I_{REF} Temp Deviation	T_K=full range (see Note 1), R_1=10kΩ, R_2=∞, I_K=10mA, (Fig. 2)			0.05	0.3	µA
$I_{K(off)}$	off-state cathode current	V_{REF}=0V, (Fig. 3)	V_K=6V		0.01	0.1	µA
			V_K=16V		0.01	0.5	
Z_{KA}	Dynamic Output Impedance	$V_{KA}=V_{REF}$, I_K=1mA to 100mA, f ≤1kHz (Fig. 1)			0.1	0.4	Ω
$I_{K(MIN)}$	Minimum Operating Current	$V_{KA}=V_{REF}$ (Fig. 1)			80	100	µA

Notes : 1.Full temperature range is 0°C to 70°C for APL431LXXC,and -40°C to 85°C for APL431LXXI.

Test Figures

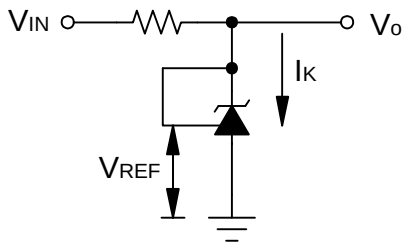


Figure 1. Test Circuit for $V_{KA}=V_{REF}$, $V_O=V_{KA}=V_{REF}$

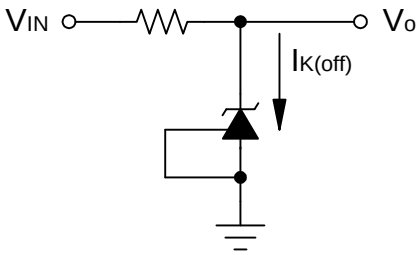


Figure 2. Test Circuit for $I_{K(off)}$

Figure 2. Test Circuit for $V_{KA}>V_{REF}$,

Test Figures (Cont.)

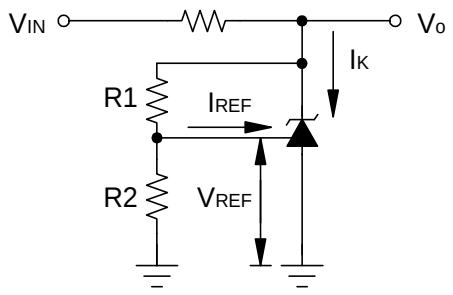
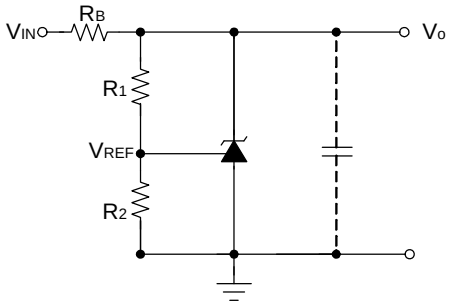
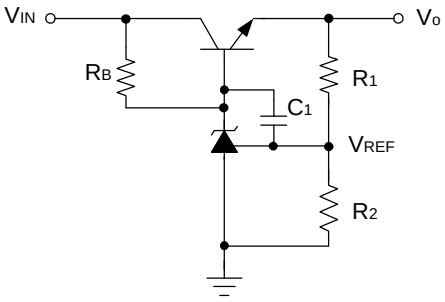


Figure 3. Test Circuit for $V_{KA}>V_{REF}$,
$V_O = V_{KA} = V_{REF} \times (1+R_1/R_2) + I_{REF} \times R_1$

Application Circuits



Precision Voltage Reference



Precision High-Current Series Regulator

Notes for Application Circuits:

1) For the series regulator applications, add a compensation capacitor C1 between CATHODE and REF is strongly recommended to improve the stability of output voltage .

2) Set VOUT according to the following equation: VO = VREF(1+R1/R2)+IREF R1

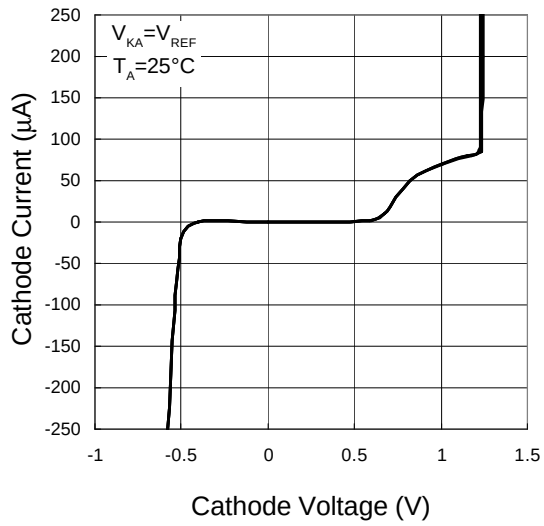
3) Choose the value for RB as follows:

A) The maximum limit for RB should be such that the cathode current(IK) is greater than the minimum operating current (80μA) at VIN(MIN).

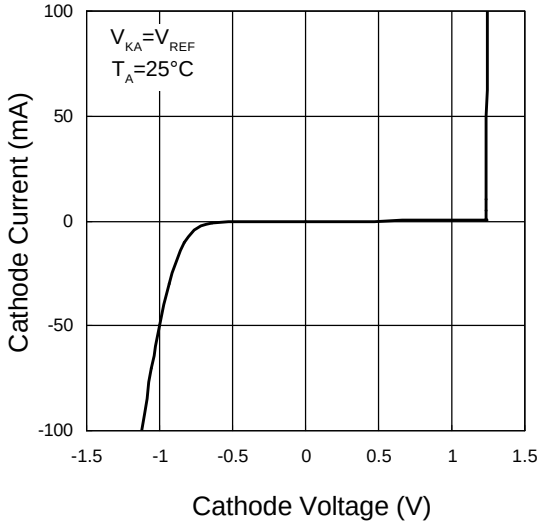
B) The minimum limit for RB should be such that the cathode current (IK) does not exceed 100mA under all load conditions, and the instantaneous turn-on value for IK does not exceed 150mA.

Typical Characteristics

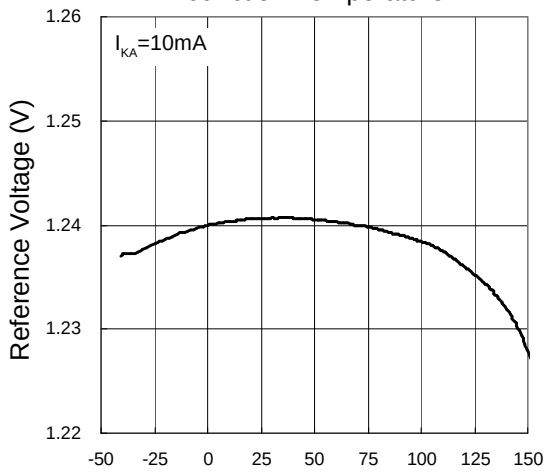
Cathode Current vs. Cathode Voltage



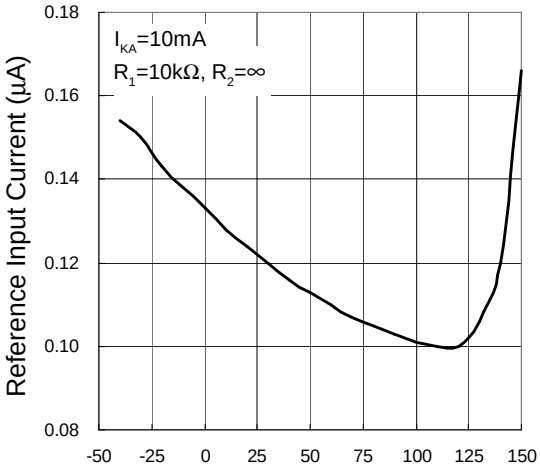
Cathode Current vs. Cathode Voltage



Referemce Voltage vs.
Junction Temperature

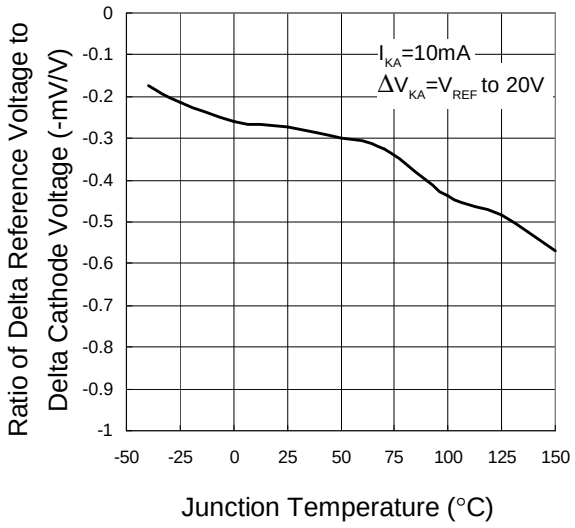


Reference Input Current vs.
Junction Temperature

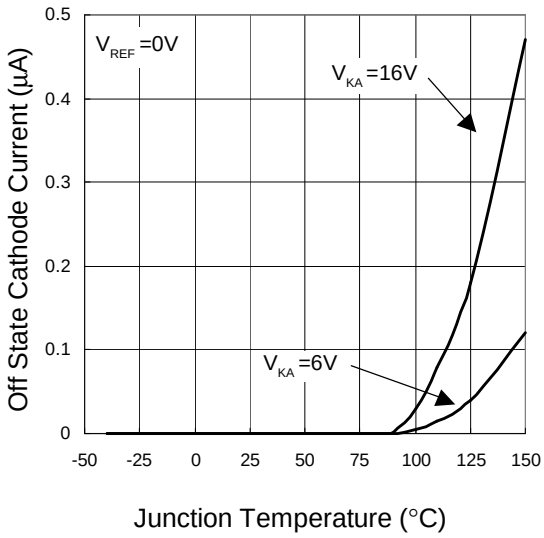


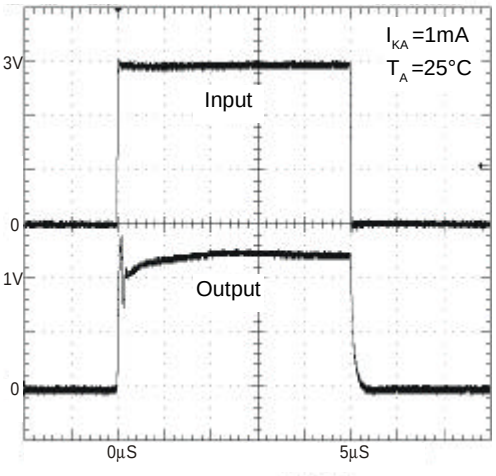
Typical Characteristics

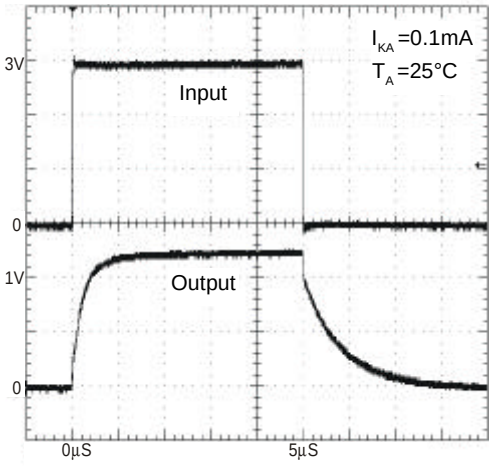
$\Delta V_{REF}/\Delta V_{KA}$ vs. Junction Temperature



Off State Cathode Current vs. Junction Temperature

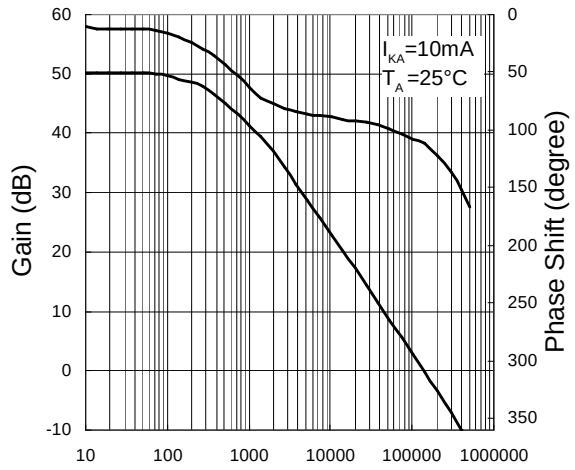


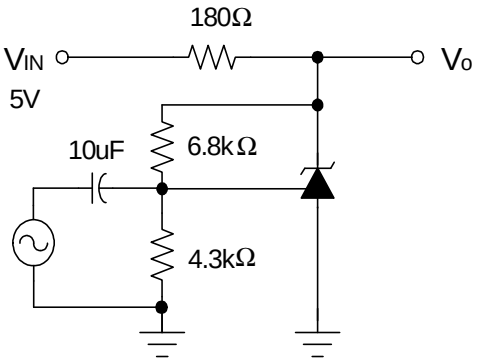




Typical Characteristics

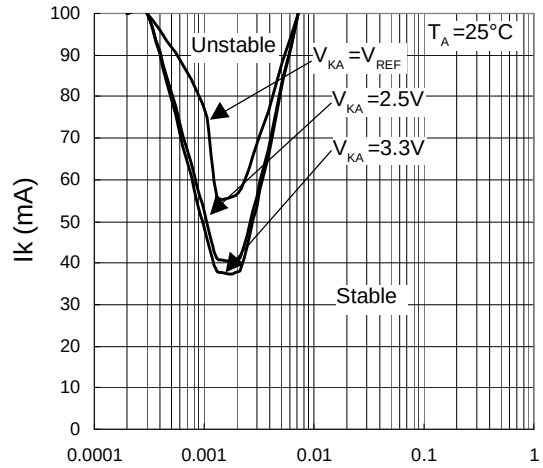
Gain vs. Phase Shift vs. Frequency

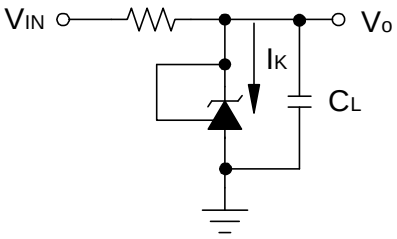




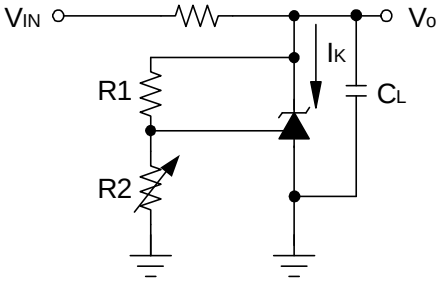
Gain & Phase Test Circuit

Stability Boundary Conditions



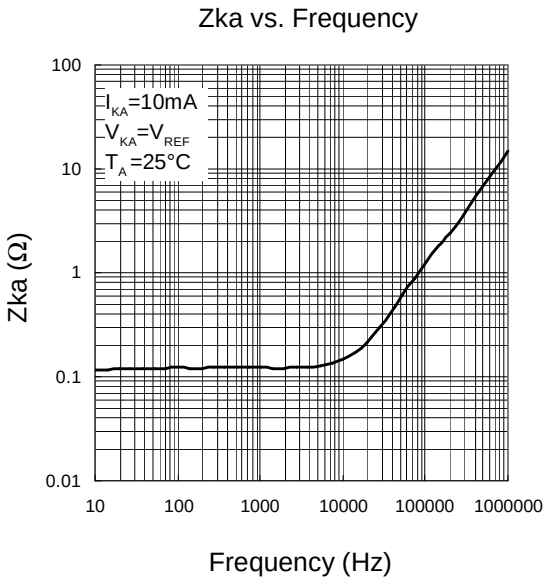


Stability Test Circuit for V_{KA}=V_{REF}



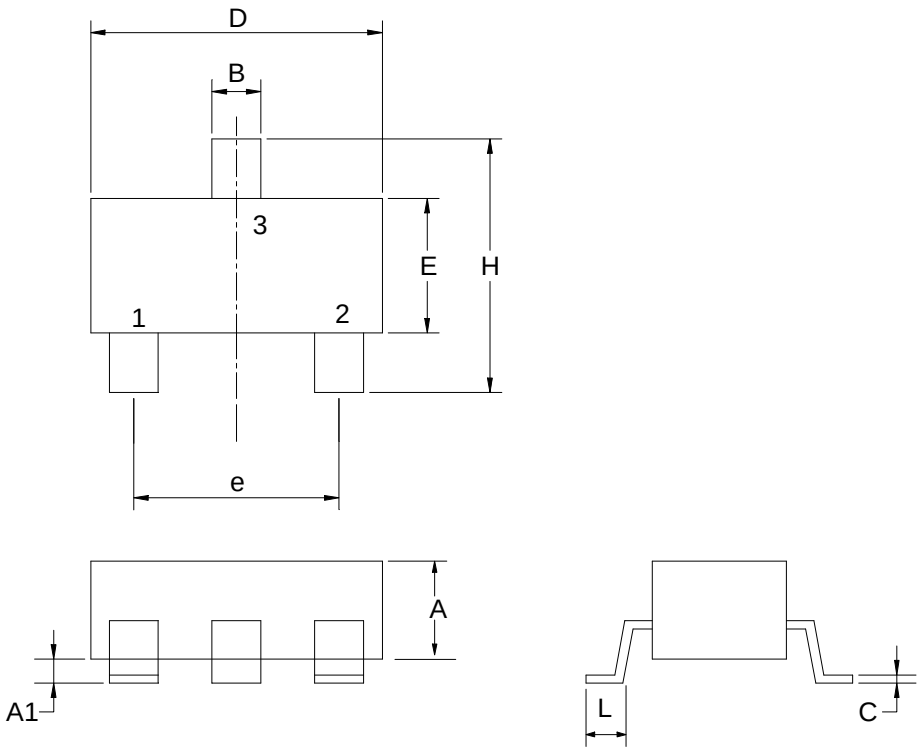
Stability Test Circuit for V_{KA}>V_{REF},
V_O= V_{KA}= V_{REF}× (1+R_1/R_2) + I_{REF}× R_1
Use the MLCC for CL

Typical Characteristics



Package Information

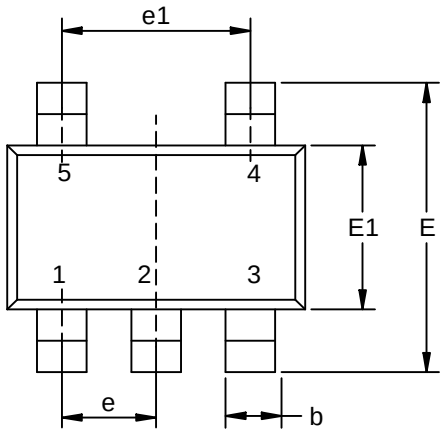
SOT-23

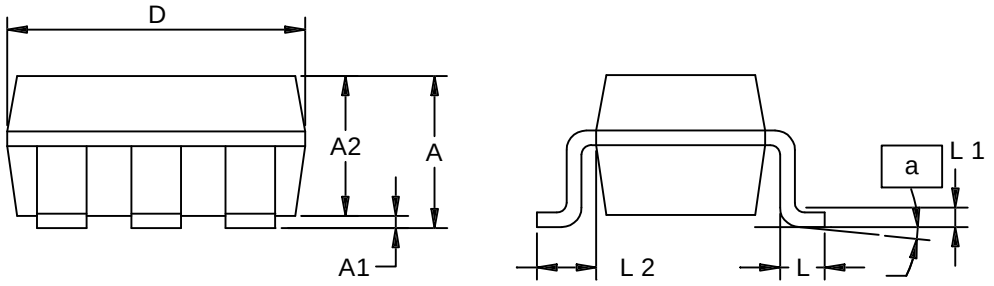


Dim	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	1.00	1.30	0.039	0.051
A1	0.00	0.10	0.000	0.004
B	0.35	0.51	0.014	0.020
C	0.10	0.25	0.004	0.010
D	2.70	3.10	0.106	0.122
E	1.40	1.80	0.055	0.071
e	1.90/2.1 BSC.		0.075/0.083 BSC.	
H	2.40	3.00	0.094	0.118
L	0.37		0.015	

Package Information

SOT-23-5

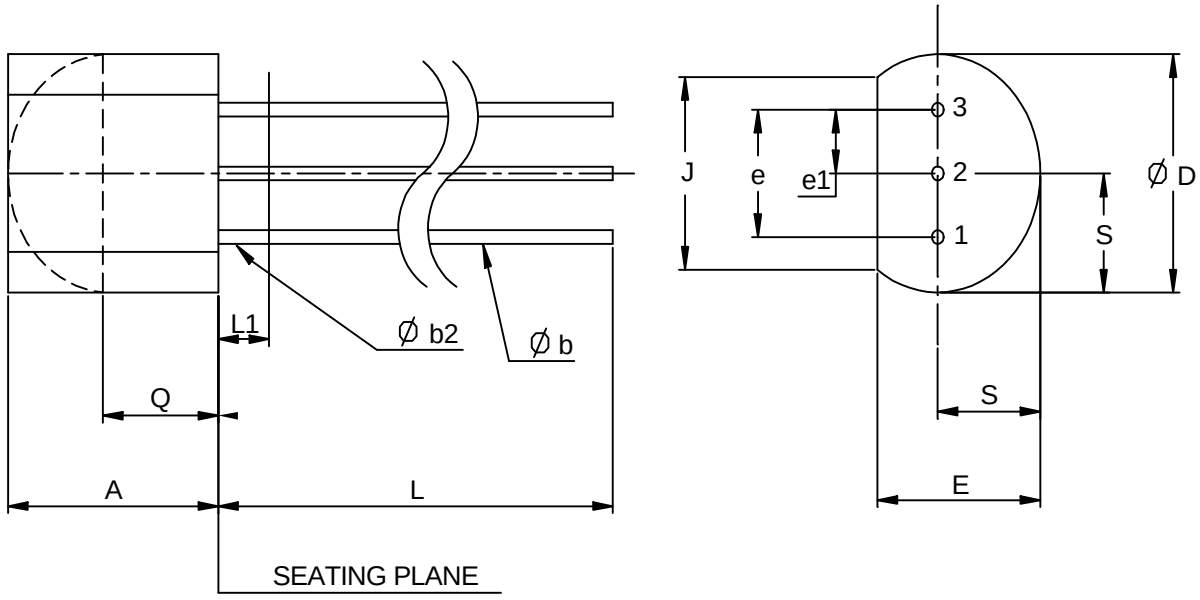




Dim	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	0.95	1.45	0.037	0.057
A1	0.05	0.15	0.002	0.006
A2	0.90	1.30	0.035	0.051
b	0.35	0.55	0.0138	0.0217
D	2.8	3.00	0.110	0.118
E	2.6	3.00	0.102	0.118
E1	1.5	1.70	0.059	0.067
e	0.95		0.037	
e1	1.90		0.075	
L	0.35	0.55	0.014	0.022
L1	0.20 BSC		0.008 BSC	
L2	0.5	0.7	0.020	0.028
a	0°	10°	0°	10°

Package Information

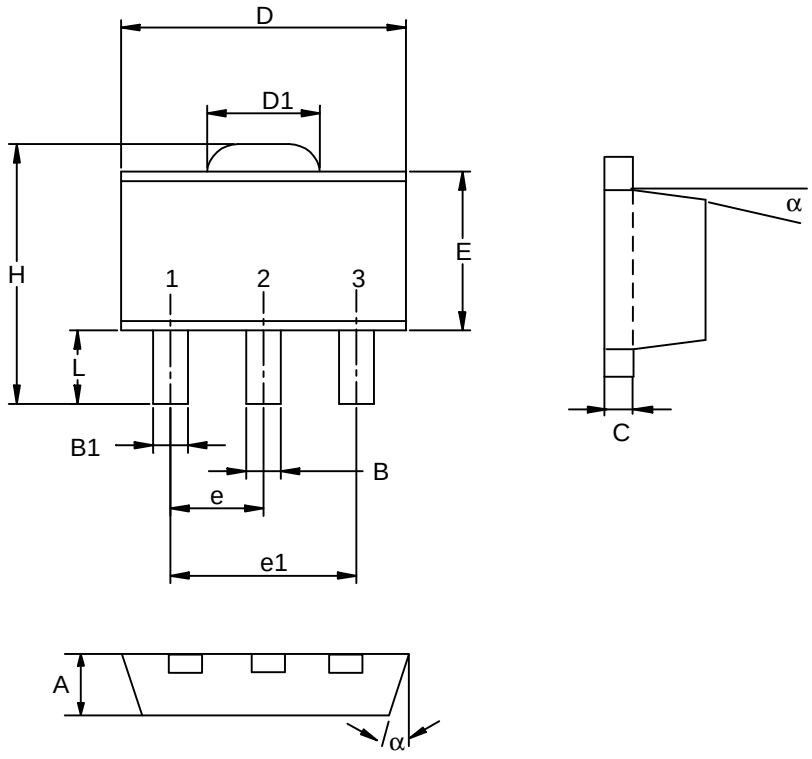
TO-92



Dim	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	4.318	5.334	0.170	0.210
ϕ b	0.406	0.559	0.016	0.022
ϕ b2	0.406	0.559	0.016	0.022
ϕ D	4.445	5.207	0.175	0.205
E	3.175	4.191	0.125	0.165
e	2.413	2.667	0.095	0.105
e1	1.143	1.397	0.045	0.055
J	3.429		0.135	
L	12.70		0.500	
L1		1.27		0.050
Q	2.921		0.115	
S	2.032	2.667	0.080	0.105

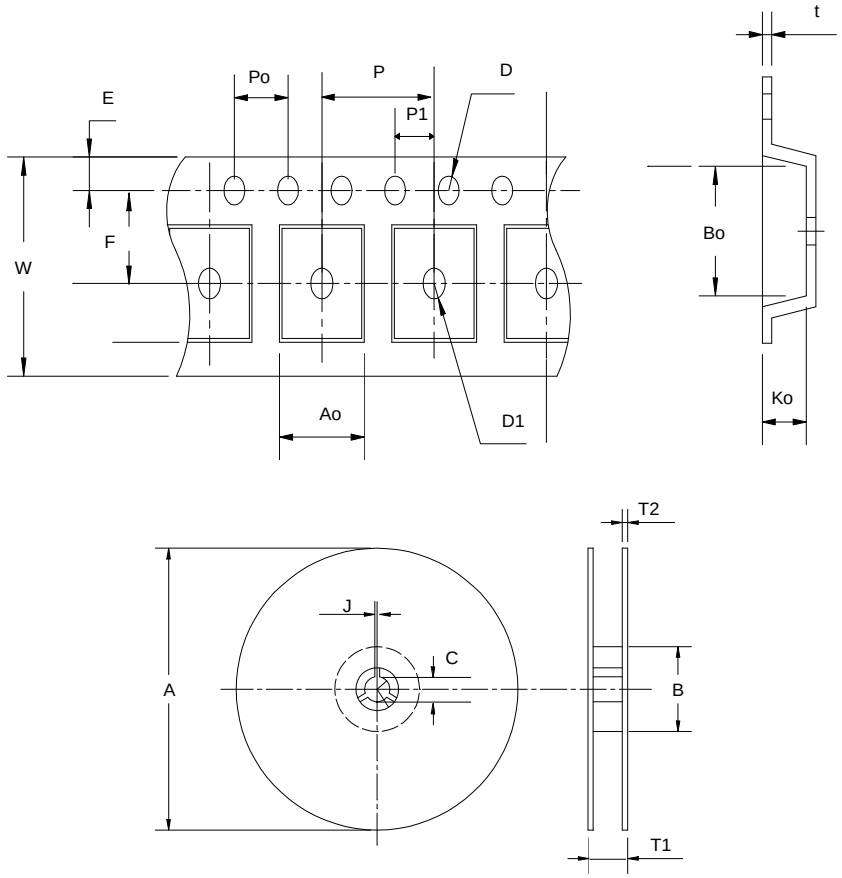
Package Information

SOT-89 (Reference EIAJ ED-7500A Reg stration SC-62)



Dim	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	1.40	1.60	0.055	0.063
B	0.40	0.56	0.016	0.022
B1	0.35	0.48	0.014	0.019
C	0.35	0.44	0.014	0.017
D	4.40	4.60	0.173	0.181
D1	1.35	1.83	0.053	0.072
e	1.50 BSC		0.059 BSC	
e1	3.00 BSC		0.118 BSC	
E	2.29	2.60	0.090	0.102
H	3.75	4.25	0.148	0.167
L	0.80	1.20	0.031	0.047
α		10°		10°

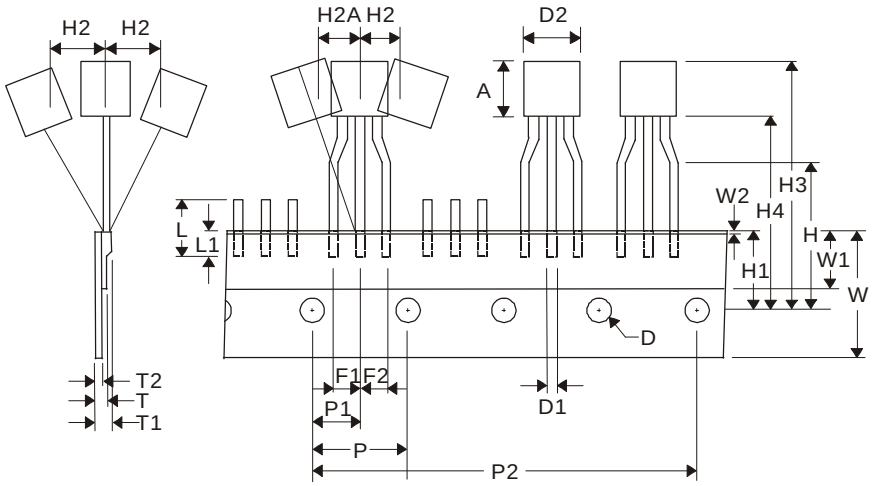
Carrier Tape & Reel Dimensions



Carrier Tape & Reel Dimensions

Application	A	B	C	J	T1	T2	W	P	E
SOT-89	178 ±1	70 ± 2	13.5 ± 0.15	3 ± 0.15	14 ± 2	1.3 ± 0.3	12 + 0.3 12 - 0.1	8 ± 0.1	1.75± 0.1
	F	D	D1	Po	P1	Ao	Bo	Ko	t
	5.5 ± 0.05	1.5± 0.1	1.5± 0.1	4.0 ± 0.1	2.0 ± 0.1	4.8 ± 0.1	4.5± 0.1	1.80± 0.1	0.3±0.013
Application	A	B	C	J	T1	T2	W	P	E
SOT-23	178±1	60 ± 1.0	12.0	2.5 ± 0.15	9.0 ± 0.5	1.4	8.0+ 0.3 - 0.3	4.0	1.75
	F	D	D1	Po	P1	Ao	Bo	Ko	t
	3.5 ± 0.05	1.5 +0.1	ϕ0.1MIN	4.0	2.0 ± 0.05	3.1	3.0	1.3	0.2±0.03
Application	A	B	C	J	T1	T2	W	P	E
SOT-23-5	178 ±1	72 ± 1.0	13.0 + 0.2	2.5 ± 0.15	8.4 ± 2	1.5 ± 0.3	8.0 ± 0.3	4 ± 0.1	1.75± 0.1
	F	D	D1	Po	P1	Ao	Bo	Ko	t
	3.5 ± 0.05	1.5± 0.1	1.5± 0.1	4.0 ± 0.1	2.0 ± 0.1	3.15 ± 0.1	3.2± 0.1	1.4± 0.1	0.2±0.033

Carrier Tape & Reel Dimensions



Application	A	D	D1	D2	F1,F2	H	H1	H2	H2A
	3.18~12	4.0±0.2	0.36~0.53	9.0 MAX	2.5+0.2 -0.1	16±0.5	9±0.5	0.5 MAX	0.5 MAX
	H3	H4	L	L1	P	P1	P2	T	T1
TO-92	27.0 MAX	20.0 MAX	11.0 MAX	2.5 MIN	12.7±0.2	6.35±0.4	50.8±0.5	0.55 MAX	1.42 MAX
	T2	W	W1	W2					
	0.36~0.68	17.5~19	5.0~7.0	0.5 MAX					

(mm)

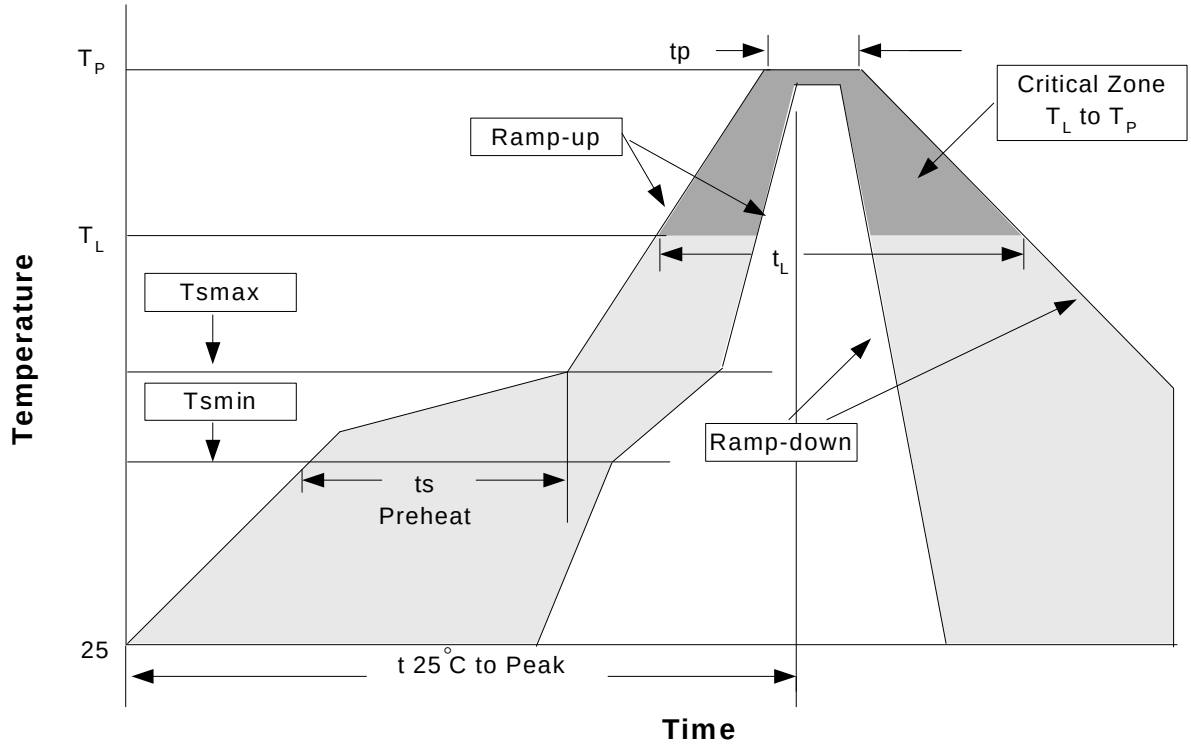
Cover Tape Dimensions

Application	Carrier Width	Cover Tape Width	Devices Per Reel
SOT- 23	8	5.3	3000
SOT-23-5	8	5.3	3000
SOT- 89	12	9.3	1000
TO-92	17.5~19	5.0~7.0	2000

Physical Specifications

Terminal Material	Solder-Plated Copper (Solder Material : 90/10 or 63/37 SnPb), 100%Sn
Lead Solderability	Meets EIA Specification RSI86-91, ANSI/J-STD-002 Category 3.

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: All temperatures refer to topside of the package .Measured on the body surface.

Classification Reflow Profiles (Cont.)

Table 1. SnPb Entectic Process – Package Peak Reflow Temperatures

Package Thickness	Volume mm^3 <350	Volume mm^3 ³350
<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 mm^3 <350	Volume mm^3 350-2000	Volume mm^3 >2000
<1.6 mm	260 +0°C*	260 +0°C*	260 +0°C*
1.6 mm – 2.5 mm	260 +0°C*	250 +0°C*	245 +0°C*
≥2.5 mm	250 +0°C*	245 +0°C*	245 +0°C*
*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.			

Reliability Test Program

Test item	Method	Description
SOLDERABILITY	MIL-STD-883D-2003	245°C, 5 SEC
HOLT	MIL-STD-883D-1005.7	1000 Hrs Bias @125°C
PCT	JESD-22-B,A102	168 Hrs, 100%RH, 121°C
TST	MIL-STD-883D-1011.9	-65°C~150°C, 200 Cycles
ESD	MIL-STD-883D-3015.7	VHBM > 2KV, VMM > 200V
Latch-Up	JESD 78	10ms, 1_{tr} > 100mA

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