Adjustable Precision Shunt Regulator

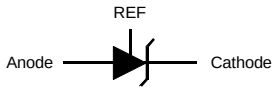
Features

- Precise Reference Voltage to 2.500V
- Guaranteed 0.5% or 1% Reference Voltage Tolerance
- Sink Current Capability , 1mA to 100mA
- Quick Turn-on
- Adjustable Output Voltage , $V_O = V_{REF}$ to 20V
- Low Operational Cathode Current , 250µA Typical
- 0.1Ω Typical Output Impedance
- SOT-23 , SOT-89 and TO-92 Packages
- Lead Free and Green Devices Available (RoHS Compliant)

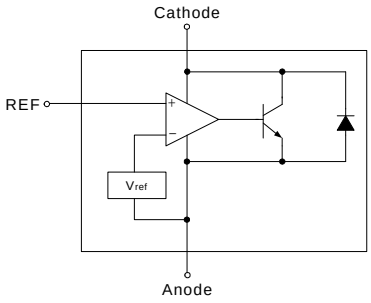
Applications

- Linear Regulators
- Adjustable Power Supply
- Switching Power Supply

Symbol



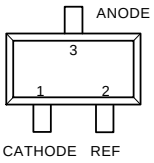
Functional Diagram



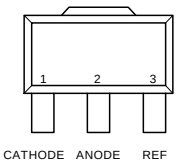
General Description

The APL1431 is a 3-terminal adjustable voltage reference with specified thermal stability over applicable commercial temperature ranges. Output voltage may be set to any value between V_{REF} (2.5 V) and 20 V with two external resistors (see Figure 2). When used with an photocoupler, the APL1431 is an ideal voltage reference in isolated feedback circuits for 2.5V to 12V switching-mode power supplies. This device has a typical output impedance of 0.1Ω. Active output circuitry provides a very sharp turn-on characteristic, making the APL1431 excellent replacements for zener diodes in many applications, including on-board regulation and adjustable power supplies.

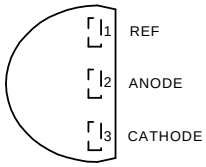
Pin Configuration



SOT-23 (Top View)



SOT-89 (Top View)



TO-92 (Top View)

ANPEC reserves the right to make changes to improve reliability or manufacturability without notice, and advise customers to obtain the latest version of relevant information to verify before placing orders.

Rev. A.4 - Mar., 2008

Ordering and Marking Information

APL1431 □□□-□□□ Assembly Material Handling Code Temp. Range Package Code Elec. Grade	Elec. Grade A : 0.5% Reference Voltage Tolerance B : 1% Reference Voltage Tolerance Package Code A : SOT-23 D : SOT-89 E : TO-92 Y : Chip Form Temp. Range C : 0 to 70 °C I : -40 to 85 °C Handling Code TB : Tape & Box TR : Tape & Reel Assembly Material L : Lead Free Device G : Halogen and Lead Free Device
APL1431 A : 1431	APL1431 E : APL 1431 XXXXX XXXXX - Date Code
APL1431 D : APL1431 XXXXX XXXXX - Date Code	

Note: ANPEC lead-free products contain molding compounds/die attach materials and 100% matte tin plate termination finish; which are fully compliant with RoHS. 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. ANPEC defines "Green" to mean lead-free (RoHS compliant) and halogen free (Br or Cl does not exceed 900ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500ppm by weight).

Absolute Maximum Ratings

Symbol	Parameter		Rating	Unit
V_{KA}	Cathode Voltage		21	V
I_K	Continuous Cathode Current Range		120	mA
I_{REF}	Reference Current Range		3	mA
θ_{JA}	Thermal Resistance from Junction to Ambient in Free Air			°C/W
		SOT-23	416	
		SOT-89	250	
		TO-92	250	
T_A	Ambient Temperature Range	APL1431XXC	0 to 70	°C
		APL1431XXI	-40 to 85	
T_j	Junction Temperature Range	APL1431XXC	0 to 150	°C
		APL1431XXI	-40 to 150	
T_{STG}	Storage Temperature Range		-65 to 150	°C
T_{SDR}	Maximum Lead Soldering Temperature, 10 Seconds		260	°C

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

Symbol	Parameter	Test Conditions	APL1431			Unit
			Min.	Typ.	Max.	
V_{REF}	Reference Voltage	$V_{KA}=V_{REF}$, I_K=10mA[*1] APL431A	2.487	2.500	2.513	V
		$V_{KA}=V_{REF}$, I_K=10mA[*1] APL431B	2.475	2.500	2.525	
$\Delta V_{REF}/T$	Reference Voltage Drift Over Temp. Range	$V_{KA}=V_{REF}$, I_K=10mA				mV
		T_A= 0 to 70°C[*1]			20	
		T_A= -40 to 85°C[*1]			30	
$\Delta V_{REF} / \Delta V_{KA}$	Voltage Ratio (open loop gain)	I_K=10mA, $V_{KA}=V_{REF}$ to 10V[*2]		-1.5	-3	mV/V
		I_K=10mA, $V_{KA}=V_{REF}$ to 20V[*2]		-1.2	-2.5	

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

Symbol	Parameter	Test Conditions	APL1431			Unit
			Min.	Typ.	Max.	
I_{REF}	Reference Current	I_K=10mA, R_1=10kΩ, R_2=open*2		1.0	3	μA
$\Delta I_{REF}/T$	Reference Current Drift	I_K=10mA, R_1=10kΩ, R_2=open, T_A= -40 to 85°C*2		0.3	1	μA
$I_{K(min)}$	Min. Cathode Current	$V_{KA}=V_{REF}$*1		0.25	0.5	mA
$I_{K(off)}$	Off-state Cathode Current	V_{KA}= 20V, V_{REF}= 0V*3		0.1	1	μA
$\|Z_{KA}\|$	Dynamic Impedance	$V_{KA}=V_{REF}$, I_K=1mA to 100mA, f ≤1kHz*1		0.1	0.4	Ω
I_K	Cathode Current				100	mA

Notes : *1 : use Figure 1
*2 : use Figure 2
*3 : use Figure 3

Test figures

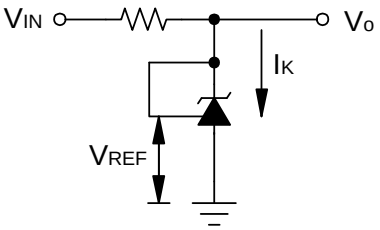


Figure 1. Test Circuit for $V_{KA}=V_{REF}$, $V_O=V_{KA}=V_{REF}$

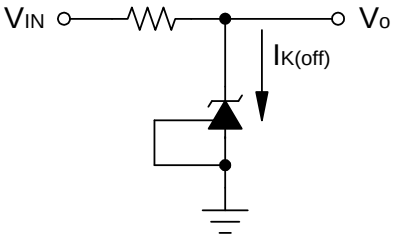


Figure 3. Test Circuit for $I_{K(off)}$

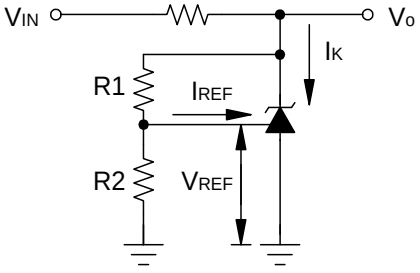
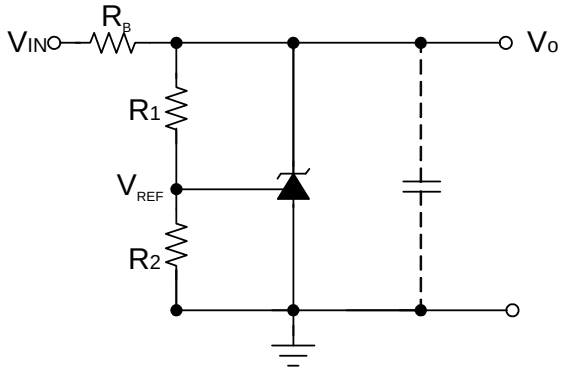
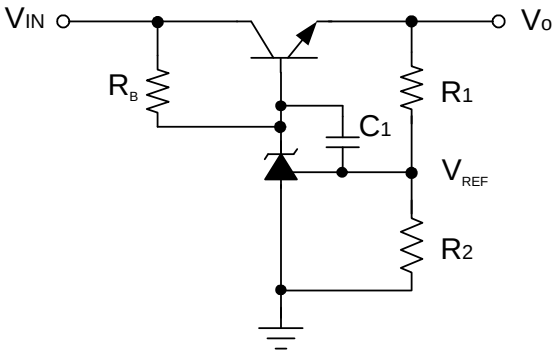


Figure 2. Test Circuit for $V_{KA}>V_{REF}$,
$V_O= V_{KA}= V_{REF}\times (1+R_1/R_2) + I_{REF}\times R_1$

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 V_O according to the following equation: $V_O = V_{REF}(1+R1/R2)+I_{REF}$ xR1

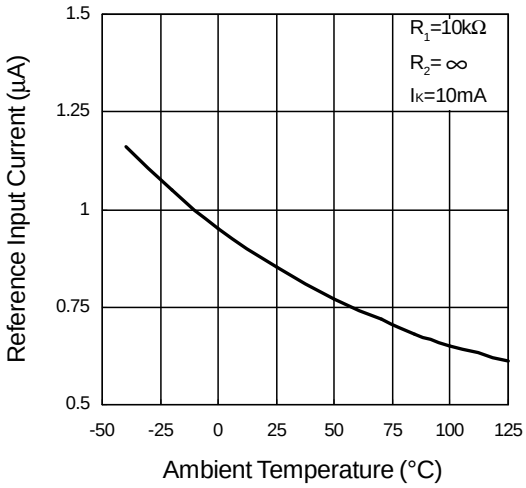
3) Choose the value for R_B as follows:

A) The maximum limit for R_B should be such that the cathode current (I_K) is greater than the minimum operating current (0.5mA) at $V_{IN(MIN)}$.

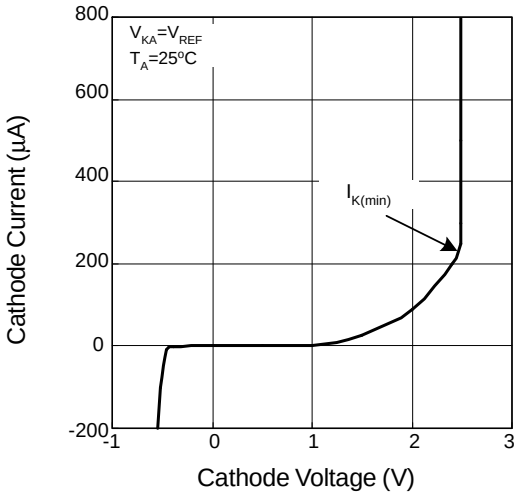
B) The minimum limit for R_B should be such that the cathode current (I_K) does not exceed 100mA under all load conditions, and the instantaneous turn-on value for I_K does not exceed 120mA.

Typical Characteristics

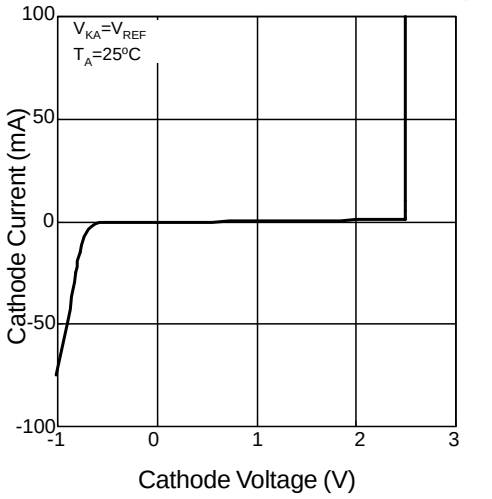
Reference Input Current vs. Ambient Temperature



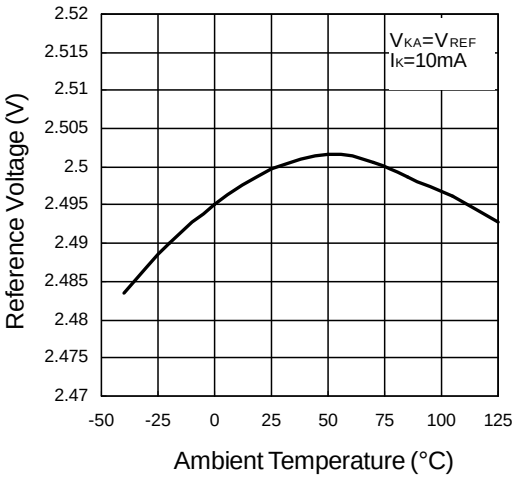
Cathode Current vs. Cathode Voltage



Cathode Current vs. Cathode Voltage

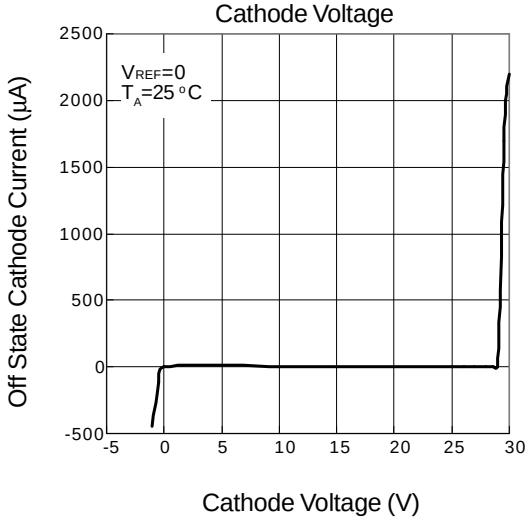


Reference Voltage vs. Ambient Temperature

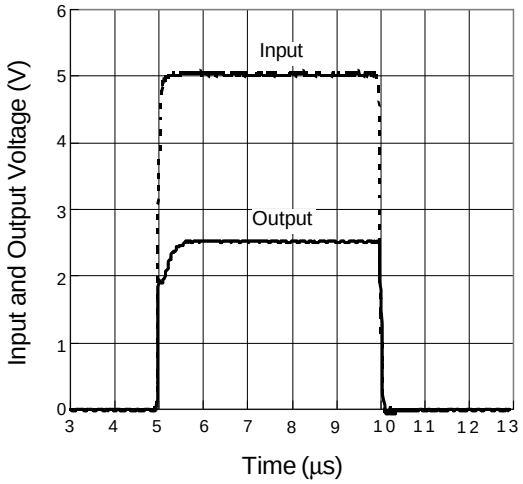


Typical Characteristics (Cont.)

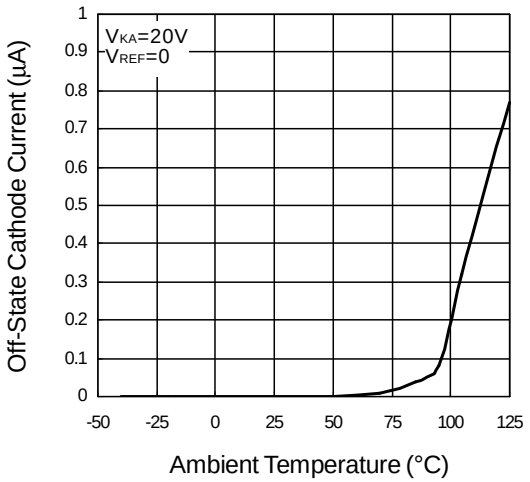
Off State Cathode Current vs. Cathode Voltage



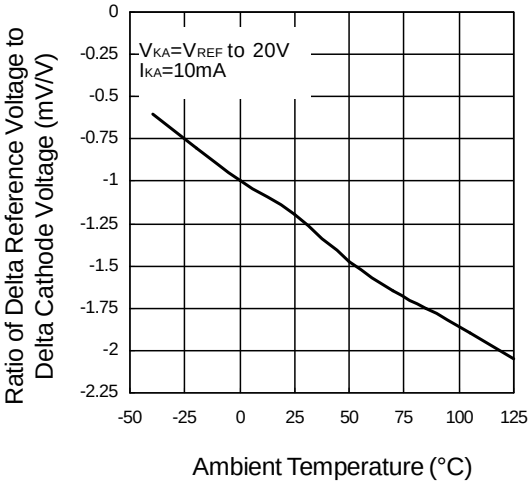
Pulse Response



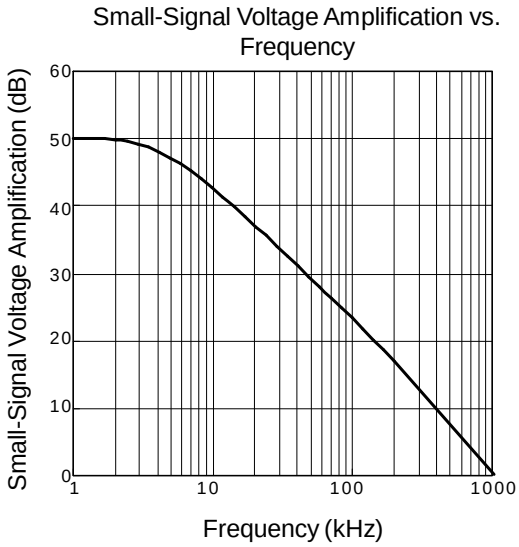
Off-State Cathode Current vs. Ambient Temperature

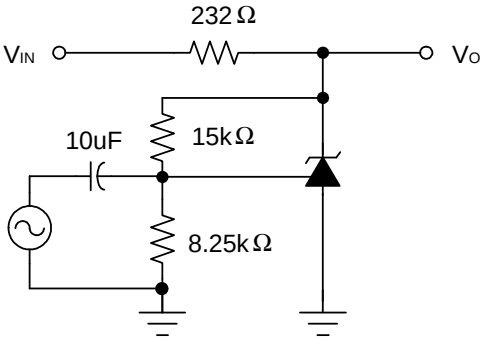


Ratio of Delta Reference Voltage to Delta Cathode Voltage vs. Ambient Tmperature

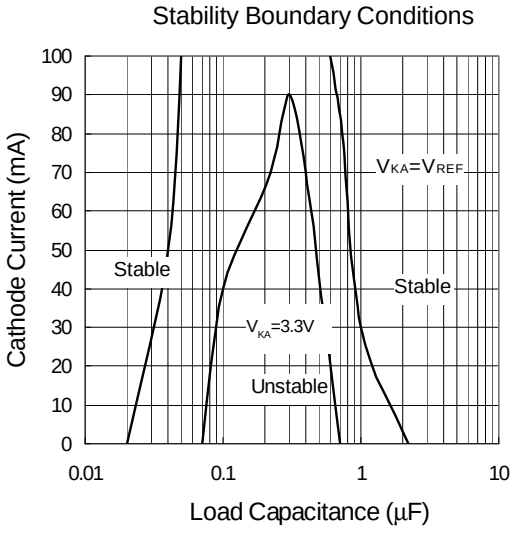


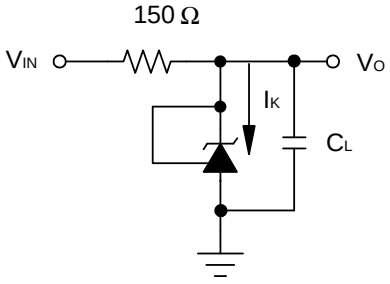
Typical Characteristics (Cont.)



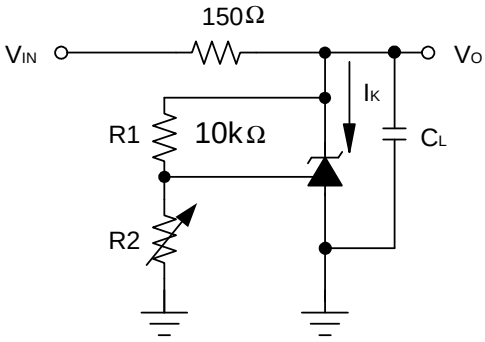


Voltage Amplification
Test Circuit



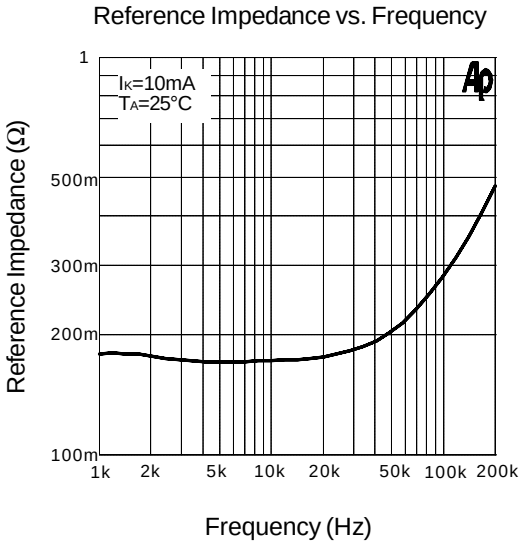


Stability Test Circuit for $V_{KA}=V_{REF}$



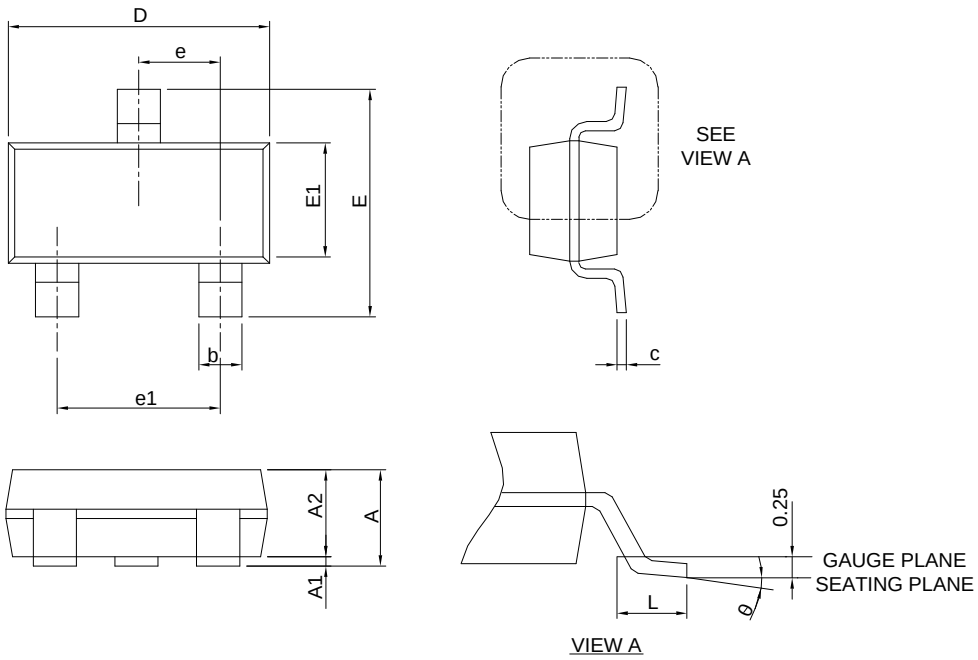
Stability Test Circuit for $V_{KA}>V_{REF}$,
$V_O = V_{KA} = V_{REF} \times (1+R1/R2) + I_{REF} \times R1$
Use the MLCC for C_L

Typical Characteristics (Cont.)



Package Information

SOT-23-3

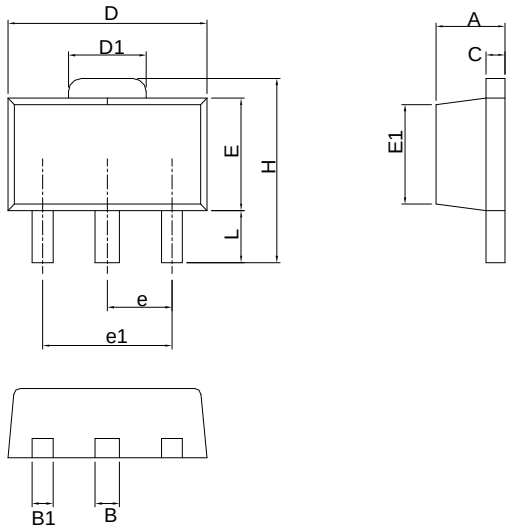


SYMBOL	SOT-23			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A		1.45		0.057
A1	0.00	0.15	0.000	0.006
A2	0.90	1.30	0.035	0.051
b	0.30	0.50	0.012	0.020
c	0.08	0.22	0.003	0.009
D	2.70	3.10	0.106	0.122
E	2.60	3.00	0.102	0.118
E1	1.40	1.80	0.055	0.071
e	0.95 BSC		0.037 BSC	
e1	1.90 BSC		0.075 BSC	
L	0.30	0.60	0.012	0.024
θ	0°	8°	0°	8°

Note : Dimension D and E1 do not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 10 mil per side.

Package Information

SOT-89

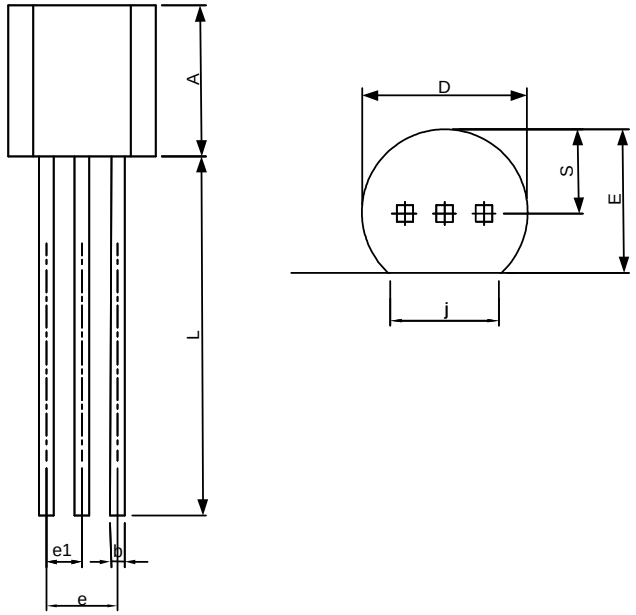


SYMBOL	SOT-89			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	1.40	1.60	0.055	0.063
B	0.44	0.56	0.017	0.022
B1	0.36	0.48	0.014	0.019
C	0.35	0.44	0.014	0.017
D	4.40	4.60	0.173	0.181
D1	1.62	1.83	0.064	0.072
E	2.29	2.60	0.090	0.102
E1	2.13	2.29	0.084	0.090
e	1.50 BSC		0.059 BSC	
e1	3.00 BSC		0.118 BSC	
H	3.94	4.25	0.155	0.167
L	0.89	1.20	0.035	0.047

Note : Follow JEDEC TO-243 AA.

Package Information

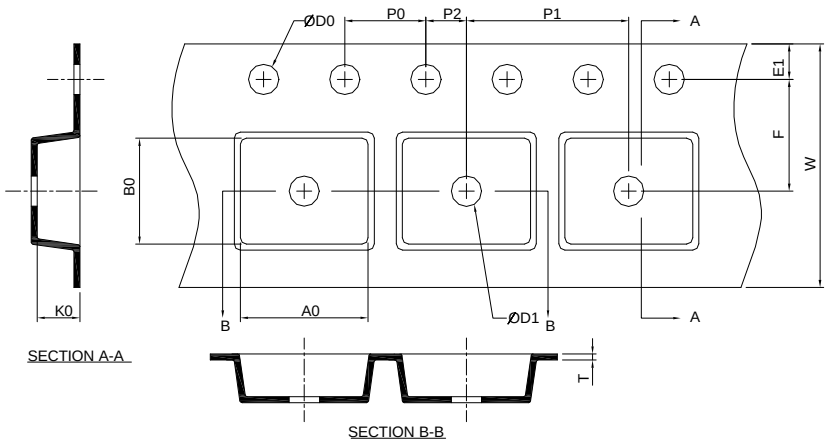
TO-92

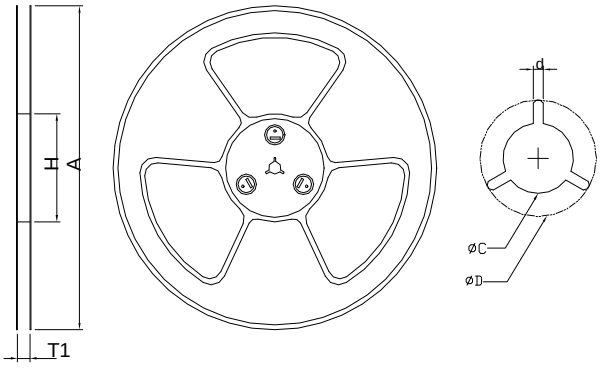


SYMBOL	TO-92			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	4.32	5.33	0.170	0.210
b	0.41	0.53	0.016	0.021
D	4.45	5.20	0.175	0.205
E	3.18	4.19	0.125	0.165
e	2.42	2.66	0.095	0.105
e1	1.15	1.39	0.045	0.055
j	3.43	4.00	0.135	0.157
L	12.70	15.00	0.500	0.591
S	2.03	2.66	0.080	0.105

Note : FollowJEDEC TO-92.

Carrier Tape & Reel Dimensions

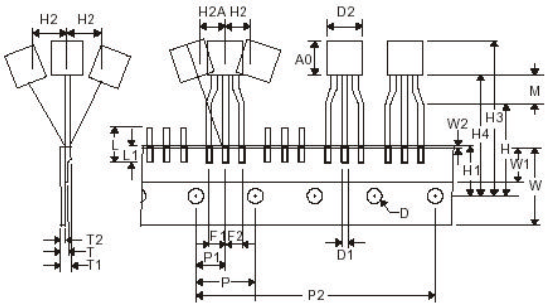


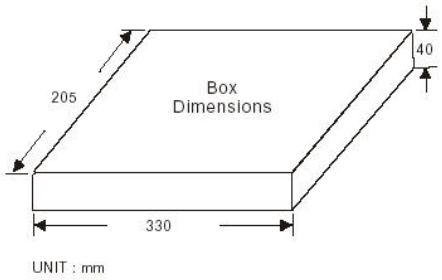


Application	A	H	T1	C	d	D	W	E1	F
SOT-23-3	178.0±2.00	50 MIN.	8.4+2.00 -0.00	13.0+0.50 -0.20	1.5 MIN.	20.2 MIN.	8.0±0.30	1.75±0.10	3.5±0.05
	P0	**P1**	**P2**	**D0**	**D1**	**T**	**A0**	**B0**	**K0**
	4.0±0.10	4.0±0.10	2.0±0.10	1.5+0.10 -0.00	1.5 MIN.	0.6+0.00 -0.40	3.20±0.20	3.10±0.20	1.50±0.20
Application	**A**	**H**	**T1**	**C**	**d**	**D**	**W**	**E1**	**F**
SOT-89	178.0±2.00	50 MIN.	8.4+2.00 -0.00	13.0+0.50 -0.20	1.5 MIN.	20.2 MIN.	12.0±0.30	1.75±0.10	5.50±0.05
	P0	**P1**	**P2**	**D0**	**D1**	**T**	**A0**	**B0**	**K0**
	4.0±0.10	8.0±0.10	2.0±0.10	1.5+0.10 -0.00	1.5 MIN.	0.6+0.00 -0.40	4.80±0.20	4.50±0.20	1.80±0.20

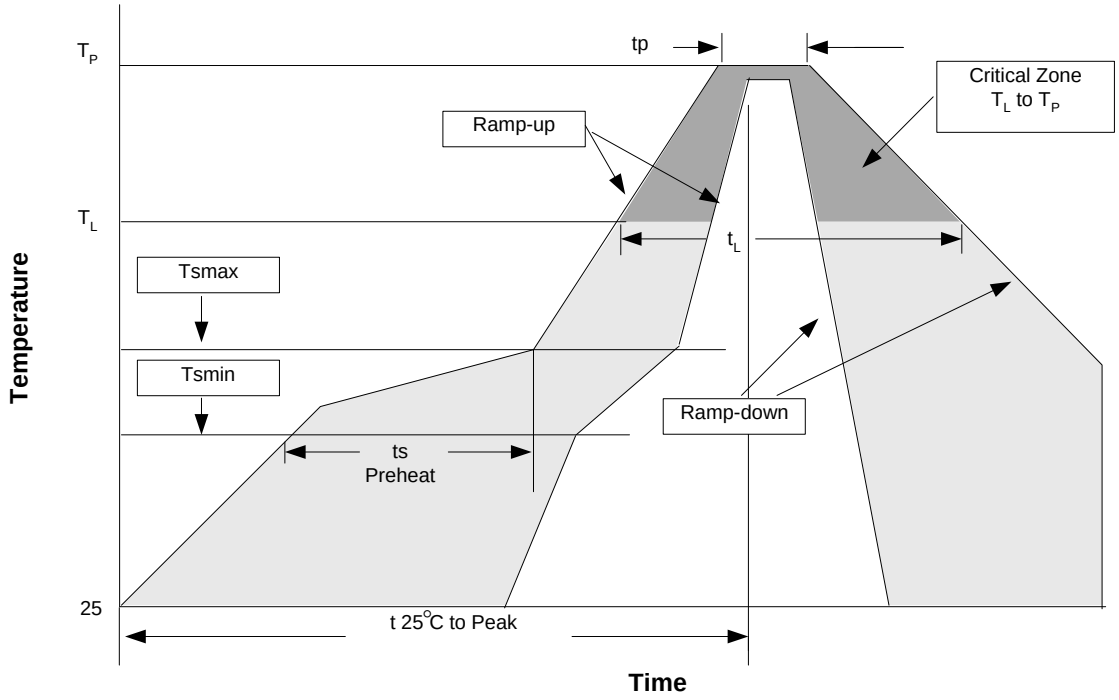
(mm)

Carrier Tape & Box Dimensions





Reflow Condition (IR/Convection or VPR Reflow)



Devices Per Unit

Package Type	Unit	Quantity
SOT-23-3	Tape & Reel	3000
SOT-89	Tape & Reel	1000
TO-92	Tape & Box	2000

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

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.

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

Classification Reflow Profiles (Cont.)

Table 1. SnPb Eutectic Process – Package Peak Reflow Temperatures

Package Thickness	Volume mm^3 <350	Volume mm^3 350
<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 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.			

Customer Service

Anpec Electronics Corp.
Head Office :
No.6, Dusing 1st Road, SBIP,
Hsin-Chu, Taiwan, R.O.C.
Tel : 886-3-5642000
Fax : 886-3-5642050

Taipei Branch :
2F, No. 11, Lane 218, Sec 2 Jhongsing Rd.,
Sindian City City, Taipei County 23146, Taiwan
Tel : 886-2-2910-3838
Fax : 886-2-2917-3838