

# AX431 Series

Adjustable Shunt Regulator

## Description

The AX431 series are three-terminal adjustable regulators with guaranteed thermal stability over applicable temperature ranges. The output voltage may be set to any value between  $V_{REF}$  (approximately 2.495 volts) and 36 volts with two external resistors. These devices have a typical dynamic output impedance of  $0.2\Omega$ . Active output circuitry provides a very sharp turn-on characteristic, making these devices excellent replacement for zener diodes in many applications.

## Features

- Programmable output voltage
- Temperature coefficient is 50ppm/°C typical
- Temperature compensated for operation over full temperature range
- Low output noise voltage
- Fast turn on response

## Ordering Information

Package	$V_{REF}: 2.495\pm 2\%$	$V_{REF}: 2.495\pm 1\%$	$V_{REF}: 2.495\pm 0.5\%$
SOT-23	AX431AN	AX431BN	AX431CN
SOT-89	AX431AM	AX431BM	AX431CM
TO-92	AX431AA	AX431BA	AX431CA
SO-8	AX431AS	AX431BS	AX431CS

## Absolute Maximum Ratings

(Operating temperature range applies unless otherwise specified)

Characteristics	Symbol	Value	Unit
Cathode Voltage	$V_{KA}$	36	V
Cathode Current Range (Continuous)	$I_k$	-100~+150	mA
Reference Input Current Range	$I_{REF}$	0.05~+10	mA
Power Dissipation	$P_D$	SOT-23	280
		SOT-89	770
		TO-92	770
		SO-8	770
Operating Temperature Range	$T_{opr}$	0~+70	°C
Storage Temperature Range	$T_{stg}$	-65~+150	°C

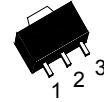
## Operating Conditions

Characteristics	Symbol	Min.	Max.	Unit
Cathode Voltage	$V_{KA}$	$V_{REF}$	36	V
Cathode Current Range (Continuous)	$I_k$	1	100	mA

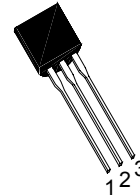
### AX431 Series Pin Assignment



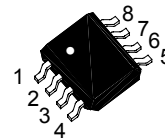
3-Lead Plastic **SOT-23**  
 Package Code: N  
 Pin 1: Reference  
 Pin 2: Cathode  
 Pin 3: Anode



3-Lead Plastic **SOT-89**  
 Package Code: M  
 Pin 1: Reference  
 Pin 2: Anode  
 Pin 3: Cathode

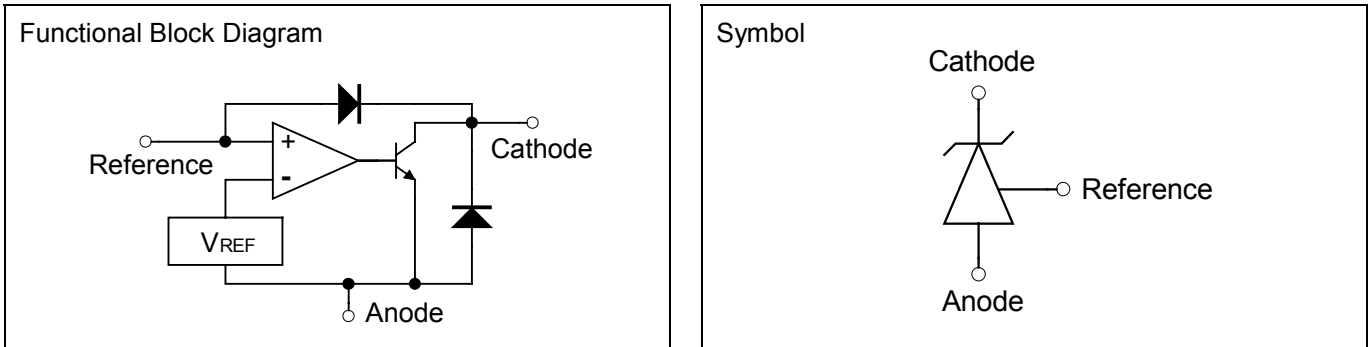


3-Lead Plastic **TO-92**  
 Package Code: A  
 Pin 1: Reference  
 Pin 2: Anode  
 Pin 3: Cathode

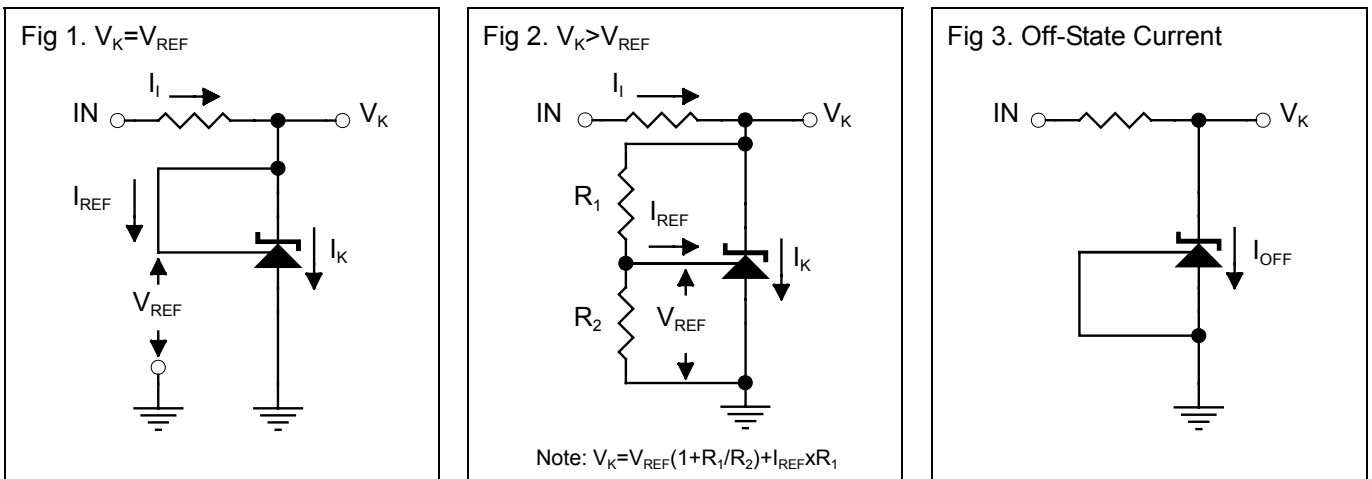


3-Lead Plastic **SO-8**  
 Package Code: S  
 Pin 1: Cathode  
 Pin 2/3/6/7: Anode  
 Pin 4/5: NC  
 Pin 8: Reference

## Functional Block Diagram & Symbol



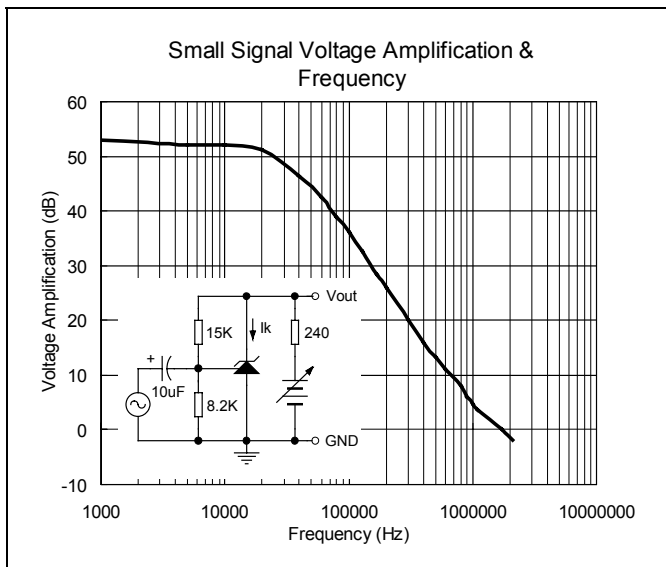
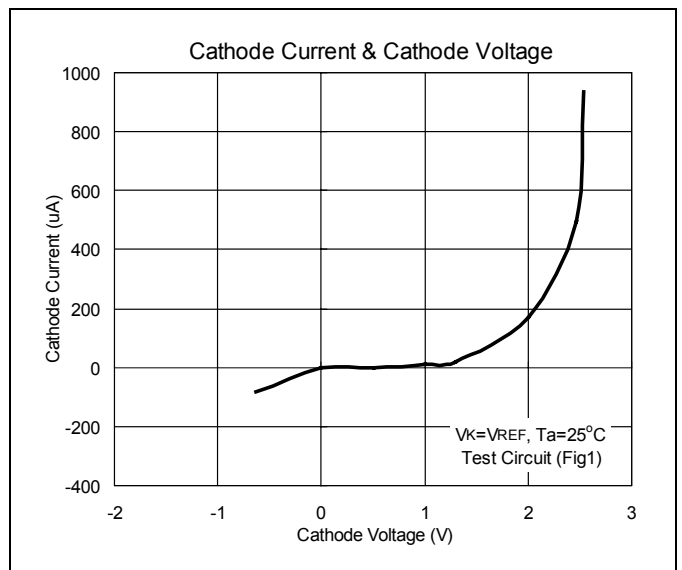
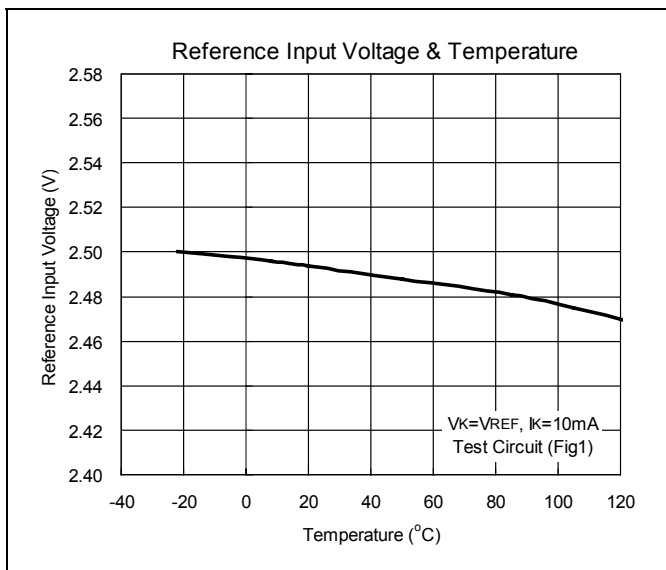
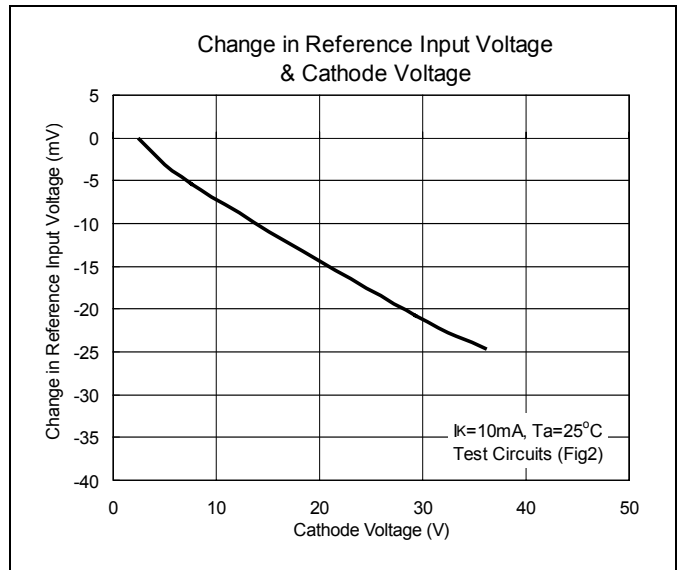
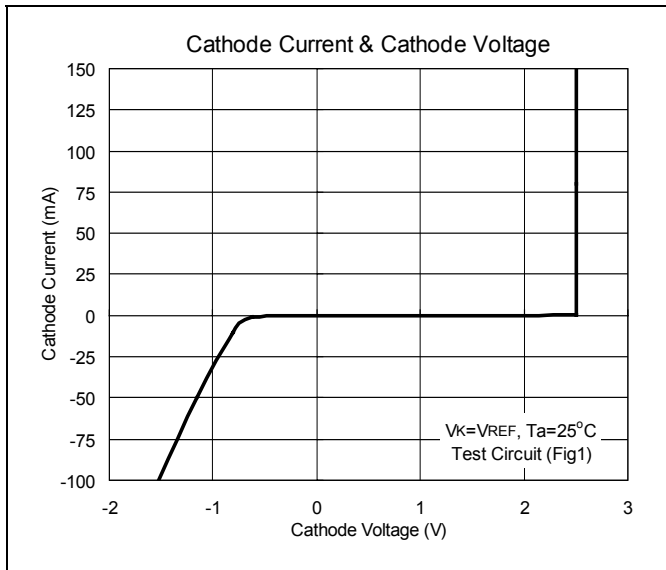
## Test Circuits



## Electrical Characteristics (T<sub>A</sub> = 25°C unless otherwise specified)

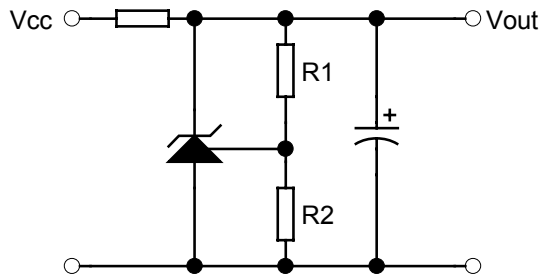
Characteristics		Symbol	Test Conditions	Min	Typ	Max	Unit
Reference Input Voltage <sup>(Fig1)</sup>	AX431AN/AM/AA/AS	V <sub>REF</sub>	V <sub>K</sub> = V <sub>REF</sub> , I <sub>k</sub> = 10mA	2.445	2.495	2.545	V
	AX431BN/BM/BA/BS			2.470	2.495	2.520	
	AX431CN/CM/CA/CS			2.483	2.495	2.507	
Deviation of Reference Input Voltage Over-Temperature <sup>(Fig1)</sup>	V <sub>REF(dev)</sub>	V <sub>K</sub> = V <sub>REF</sub> , I <sub>k</sub> = 10mA T <sub>min</sub> ≤ T <sub>a</sub> ≤ T <sub>max</sub>	-	4	17	mV	
Ratio of Change in Reference Input Voltage to the Change in Cathode Voltage <sup>(Fig2)</sup>	ΔV <sub>REF</sub> / ΔV <sub>K</sub>	I <sub>k</sub> = 10mA, ΔV <sub>K</sub> = 10V to V <sub>REF</sub>	-	-1.4	-2.7	mV/V	
		I <sub>k</sub> = 10mA, ΔV <sub>K</sub> = 36V to 10V	-	-1.0	-2.0	mV/V	
Reference Input Current <sup>(Fig2)</sup>	I <sub>REF</sub>	I <sub>k</sub> = 10mA, R <sub>1</sub> = 10kΩ, R <sub>2</sub> = ∞	-	2	4	μA	
Deviation of Reference Input Current Over Full Temperature Range <sup>(Fig2)</sup>	I <sub>REF(dev)</sub>	I <sub>k</sub> = 10mA, R <sub>1</sub> = 10kΩ, R <sub>2</sub> = ∞, T <sub>a</sub> = Full Range	-	0.4	1.2	μA	
Minimum Cathode Current for Regulation <sup>(Fig1)</sup>	I <sub>K(min)</sub>	V <sub>K</sub> = V <sub>REF</sub>	-	0.4	1.0	mA	
Off-State Cathode Current <sup>(Fig3)</sup>	I <sub>K(off)</sub>	V <sub>K</sub> = 36V, V <sub>REF</sub> = 0	-	0.1	1.0	μA	
Dynamic Output Impedance <sup>(Fig1)</sup>	Z <sub>K</sub>	V <sub>K</sub> = V <sub>REF</sub> , f ≤ 1kHz I <sub>k</sub> = 1 to 100mA	-	0.2	0.5	Ω	

## Characteristics Curve



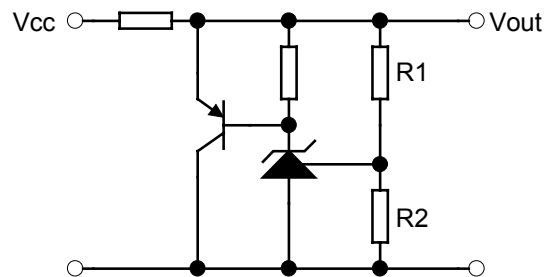
## Typical Application

Fig 4. Shunt Regulator



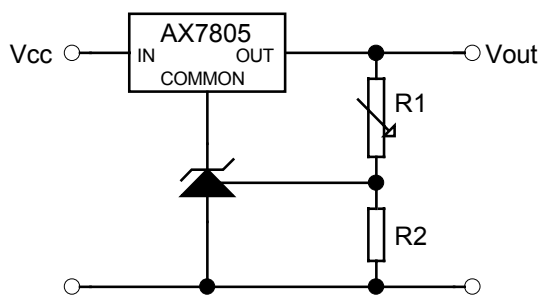
$$V_{out} = (1 + R_1/R_2)V_{REF}$$

Fig 5. High Current Shunt Regulator



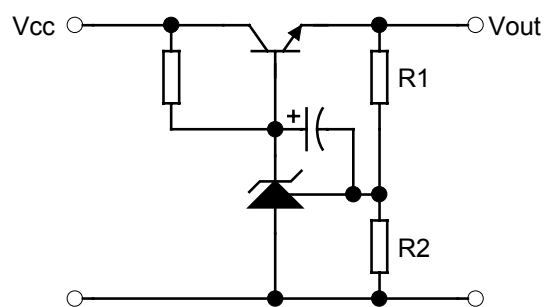
$$V_{out} = (1 + R_1/R_2)V_{REF}$$

Fig 6. Output Control of a Three-Terminal Fixed Regulator



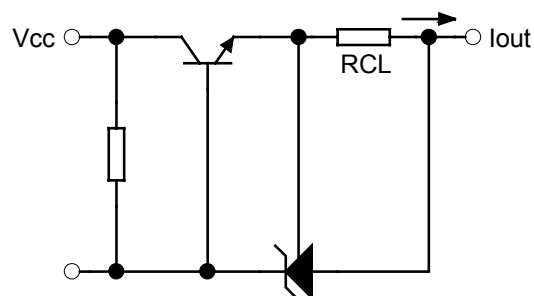
$$V_{out} = (1 + R_1/R_2)V_{REF}; V_{out(min)} = V_{REF} + 5V$$

Fig 7. Series Pass Regulator



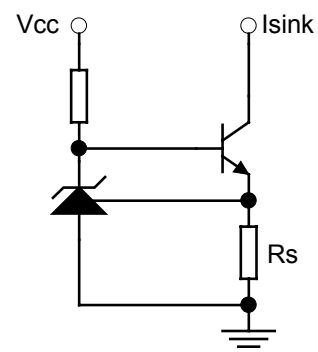
$$V_{out} = (1 + R_1/R_2)V_{REF}; V_{out(min)} = V_{REF} + V_{BE}$$

Fig 8. Current Limiter or Current Source



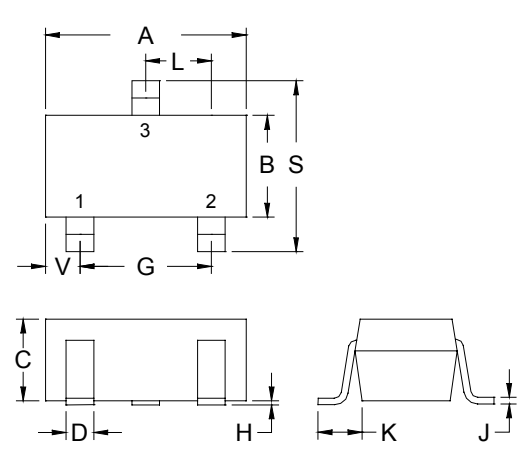
$$I_{out} = V_{REF}/R_{CL}$$

Fig 9. Constant Current Sink



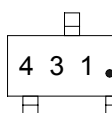
$$I_{sink} = V_{REF}/R_S$$

## SOT-23 Dimension



3-Lead SOT-23 Plastic  
 Surface Mounted Package  
 AVANTICS Package Code: N

**Marking:**



Pb Free Mark  
 Pb-Free: "●" (Note)  
 Normal: None

Note: Pb-free product can distinguish by the green label or the extra description on the right side of the label.

Pin Style: 1.Reference 2.Cathode 3.Anode

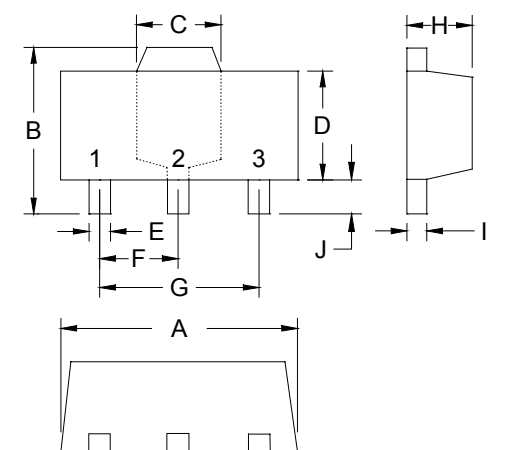
**Material:**

- Lead solder plating: Sn60/Pb40 (Normal), Sn/3.0Ag/0.5Cu or Pure-Tin (Pb-free)
- Mold Compound: Epoxy resin family, flammability solid burning class: UL94V-0

DIM	Min.	Max.
A	2.80	3.04
B	1.20	1.60
C	0.89	1.30
D	0.30	0.50
G	1.70	2.30
H	0.013	0.10
J	0.085	0.177
K	0.32	0.67
L	0.85	1.15
S	2.10	2.75
V	0.25	0.65

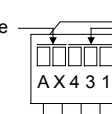
\*: Typical, Unit: mm

## SOT-89 Dimension



3-Lead SOT-89 Plastic  
 Surface Mounted Package  
 AVANTICS Package Code: M

**Marking:**



Date Code      Control Code  
 Pb Free Mark  
 Pb-Free: "●" (Note)  
 Normal: None

Note: Green label is used for pb-free packing

Pin Style: 1.Reference 2.Anode 3.Cathode

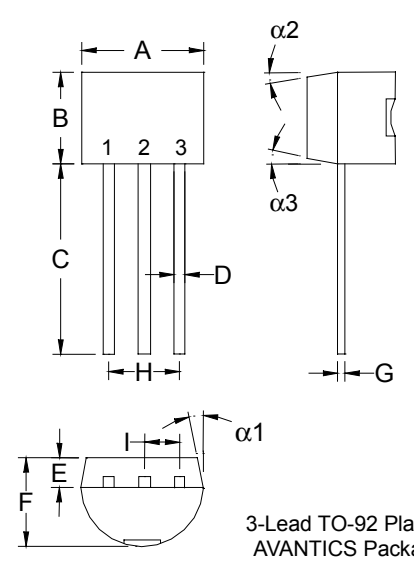
**Material:**

- Lead solder plating: Sn60/Pb40 (Normal), Sn/3.0Ag/0.5Cu or Pure-Tin (Pb-free)
- Mold Compound: Epoxy resin family, flammability solid burning class: UL94V-0

DIM	Min.	Max.
A	4.40	4.60
B	4.05	4.25
C	1.50	1.70
D	2.40	2.60
E	0.36	0.51
F	*1.50	-
G	*3.00	-
H	1.40	1.60
I	0.35	0.41

\*: Typical, Unit: mm

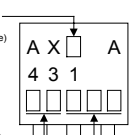
## TO-92 Dimension



3-Lead TO-92 Plastic Package  
AVANTICS Package Code: A

**Marking:**

Pb Free Mark  
Pb-Free: \*●<sup>(Note)</sup>  
Normal: None



Date Code      Control Code

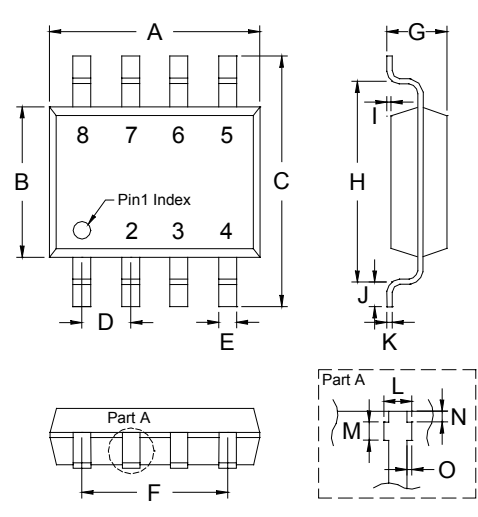
Note: Green label is used for pb-free packing  
Pin Style: 1.Reference 2.Anode 3.Cathode

Material:  
• Lead solder plating: Sn60/Pb40 (Normal), Sn/3.0Ag/0.5Cu or Pure-Tin (Pb-free)  
• Mold Compound: Epoxy resin family, flammability solid burning class: UL94V-0

DIM	Min.	Max.
A	4.33	4.83
B	4.33	4.83
C	12.70	-
D	0.36	0.56
E	-	*1.27
F	3.36	3.76
G	0.36	0.56
H	-	*2.54
I	-	*1.27
α1	-	*5°
α2	-	*2°
α3	-	*2°

\*: Typical, Unit: mm

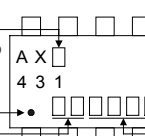
## SO-8 Dimension



8-Lead SO-8 Plastic Surface Mounted Package  
AVANTICS Package Code: S

**Marking:**

Pb Free Mark  
Pb-Free: \*●<sup>(Note)</sup>  
Normal: None



Pin 1 Mark      Date Code      Control Code

Note: Green label is used for pb-free packing  
Pin Style: 1.Cathode 2/3/6/7.Anode 4/5.NC 8.Reference

Material:  
• Lead solder plating: Sn60/Pb40 (Normal), Sn/3.0Ag/0.5Cu or Pure-Tin (Pb-free)  
• Mold Compound: Epoxy resin family, flammability solid burning class: UL94V-0

DIM	Min.	Max.
A	4.85	5.10
B	3.85	3.95
C	5.80	6.20
D	1.22	1.32
E	0.37	0.47
F	3.74	3.88
G	1.45	1.65
H	4.80	5.10
I	0.05	0.20
J	0.30	0.70
K	0.19	0.25
L	0.37	0.52
M	0.23	0.28
N	0.08	0.13
O	0.00	0.15

\*: Typical, Unit: mm

### Important Notice:

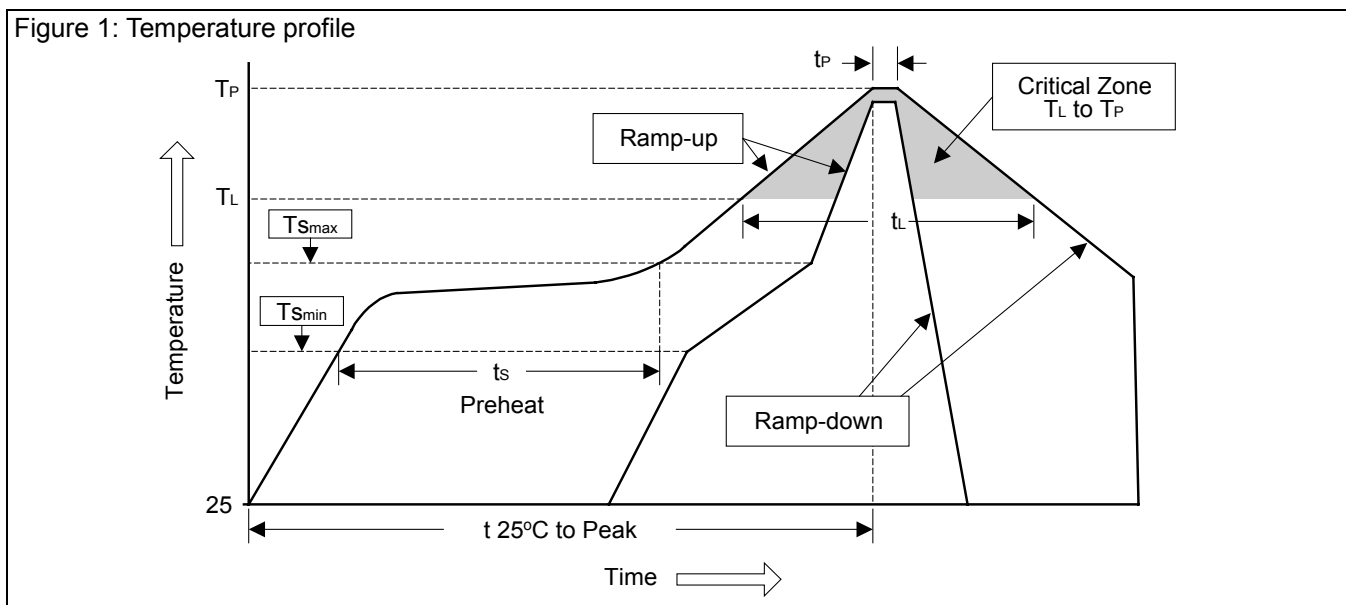
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## Soldering Methods for AVANTICS's Products

1. Storage environment: Temperature=10°C~35°C Humidity=65%±15%
2. Reflow soldering of surface-mount devices



Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average ramp-up rate ( $T_L$ to $T_P$ )	<3°C/sec	<3°C/sec
Preheat		
- Temperature Min ( $T_{smin}$ )	100°C	150°C
- Temperature Max ( $T_{smax}$ )	150°C	200°C
- Time (min to max) ( $t_s$ )	60~120 sec	60~180 sec
$T_{smax}$ to $T_L$		
- Ramp-up Rate	<3°C/sec	<3°C/sec
Time maintained above:		
- Temperature ( $T_L$ )	183°C	217°C
- Time ( $t_L$ )	60~150 sec	60~150 sec
Peak Temperature ( $T_P$ )	240°C +0/-5°C	260°C +0/-5°C
Time within 5°C of actual Peak Temperature ( $t_P$ )	10~30 sec	20~40 sec
Ramp-down Rate	<6°C/sec	<6°C/sec
Time 25°C to Peak Temperature	<6 minutes	<8 minutes

### 3. Flow (wave) soldering (solder dipping)

Products	Peak temperature	Dipping time
Pb devices.	245°C ±5°C	5sec ±1sec
Pb-Free devices.	260°C +0/-5°C	5sec ±1sec