

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 0.2Ω . 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

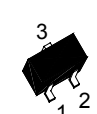
(Operating temperature range applies unless otherwise specified)

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

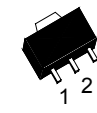
Operating Conditions

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

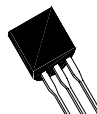
AX431 Series Pin Assignment



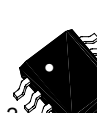
3-Lead Plastic **SOT-23**
 Package Code: N
 Pin 1: Reference
 Pin 2: Cathode
 Pin 3: Anode



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

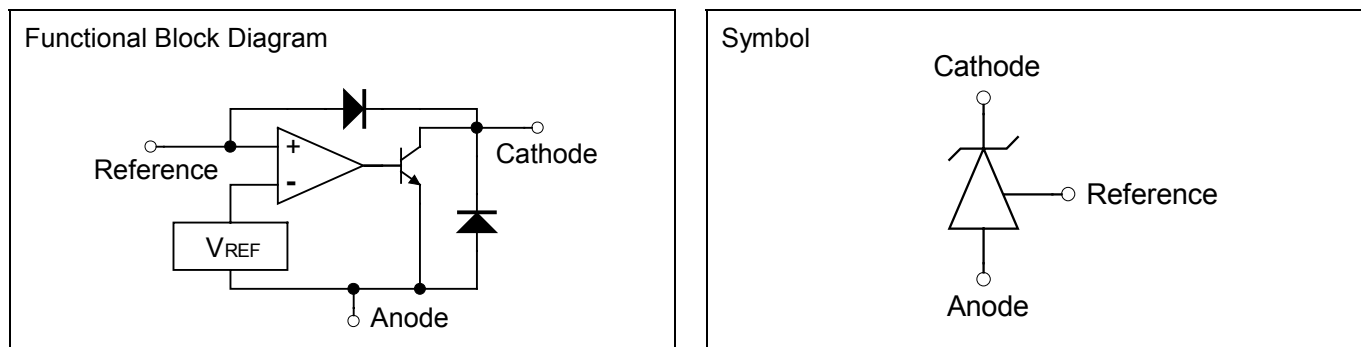


3-Lead Plastic **TO-92**
 Package Code: A
 Pin 1: Reference
 Pin 2: Anode
 Pin 3: Cathode

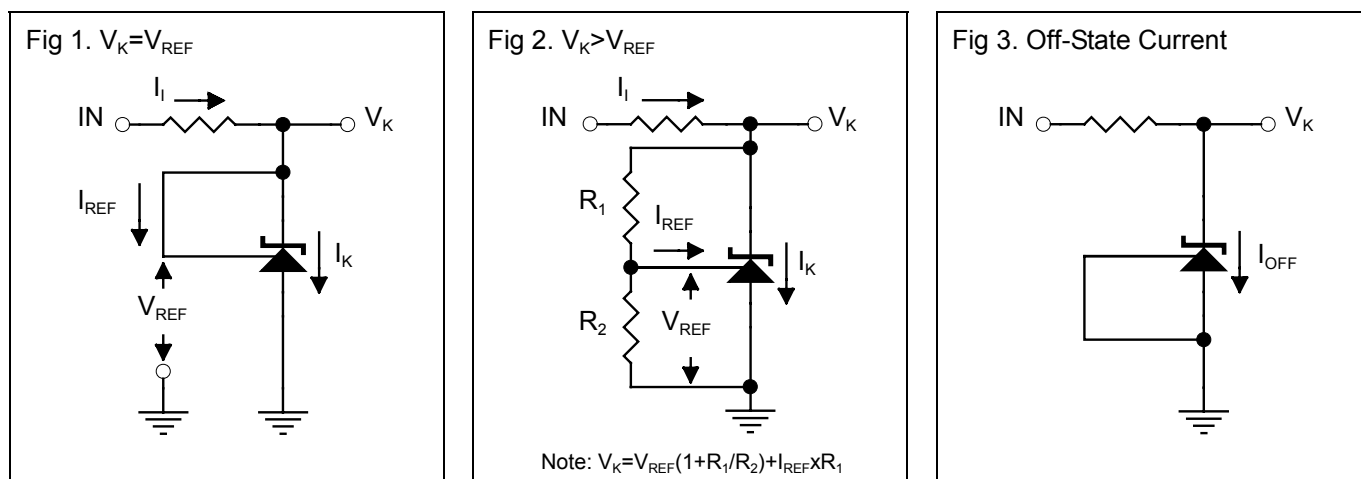


3-Lead Plastic **SO-8**
 Package Code: S
 Pin 1: Cathode
 Pin 2/3/6/7: Anode
 Pin 4/5: NC
 Pin 8: Reference

Functional Block Diagram & Symbol



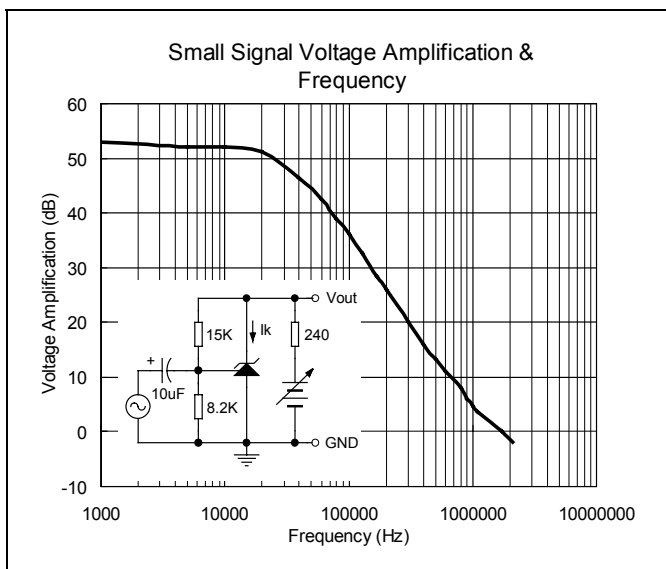
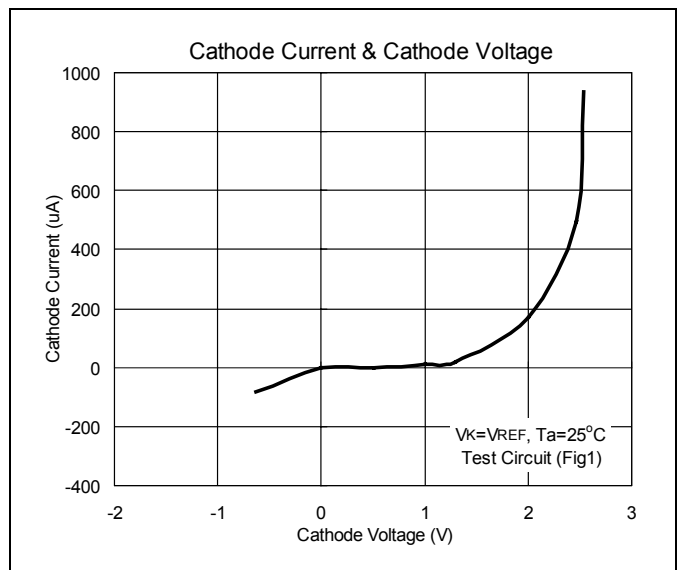
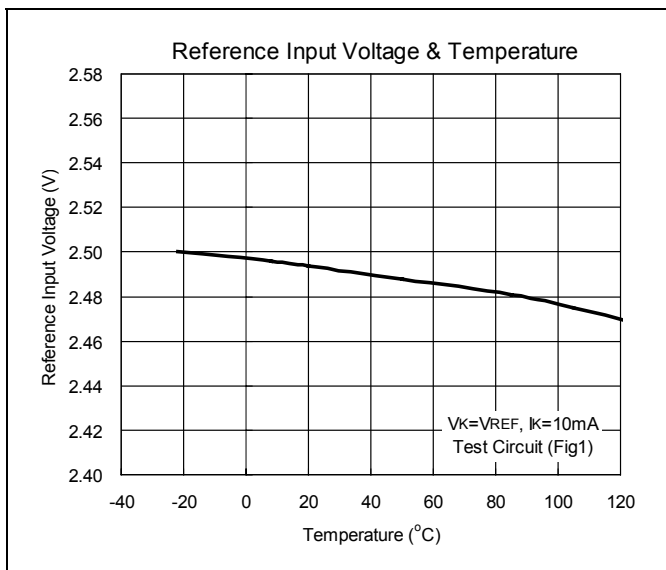
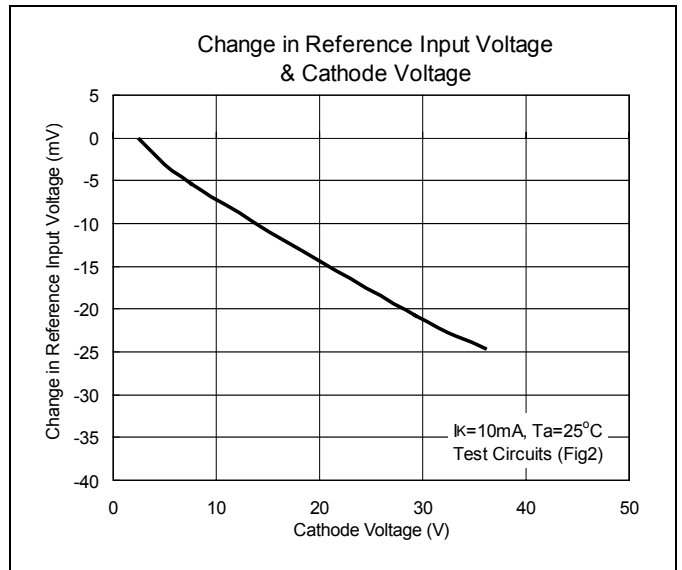
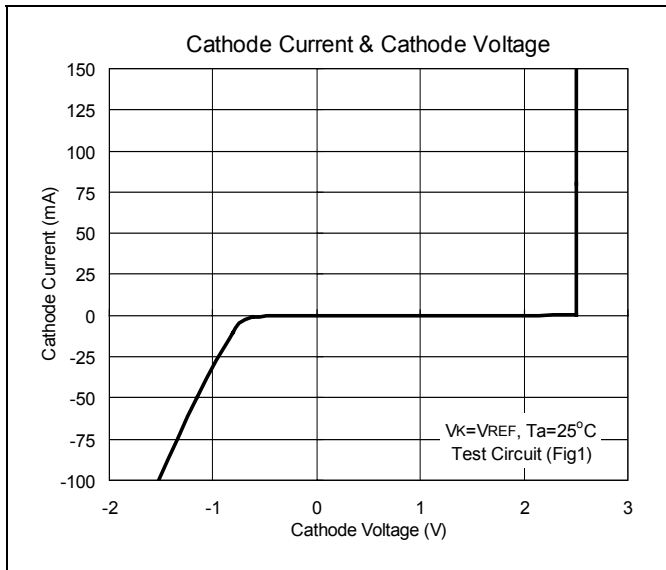
Test Circuits



Electrical Characteristics ($T_A = 25^\circ\text{C}$ unless otherwise specified)

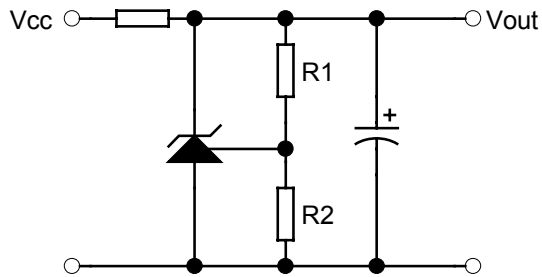
Characteristics		Symbol	Test Conditions	Min	Typ	Max	Unit
Reference Input Voltage ^(Fig1)	AX431AN/AM/AA/AS	V_{REF}	$V_K = V_{REF}, I_K = 10\text{mA}$	2.445	2.495	2.545	V
	AX431BN/BM/BA/BS			2.470	2.495	2.520	
	AX431CN/CM/CA/CS			2.483	2.495	2.507	
Deviation of Reference Input Voltage Over-Temperature ^(Fig1)		$V_{REF(dev)}$	$V_K = V_{REF}, I_K = 10\text{mA}$ $T_{min} \leq T_a \leq T_{max}$	-	4	17	mV
Ratio of Change in Reference Input Voltage to the Change in Cathode Voltage ^(Fig2)		$\Delta V_{REF} / \Delta V_K$	$I_K = 10\text{mA},$ $\Delta V_K = 10\text{V to } V_{REF}$	-	-1.4	-2.7	mV/V
			$I_K = 10\text{mA},$ $\Delta V_K = 36\text{V to } 10\text{V}$	-	-1.0	-2.0	mV/V
Reference Input Current ^(Fig2)		I_{REF}	$I_K = 10\text{mA}, R_1 = 10\text{k}\Omega,$ $R_2 = \infty$	-	2	4	μA
Deviation of Reference Input Current Over Full Temperature Range ^(Fig2)		$I_{REF(dev)}$	$I_K = 10\text{mA}, R_1 = 10\text{k}\Omega,$ $R_2 = \infty, T_a = \text{Full Range}$	-	0.4	1.2	μA
Minimum Cathode Current for Regulation ^(Fig1)		$I_{K(min)}$	$V_K = V_{REF}$	-	0.4	1.0	mA
Off-State Cathode Current ^(Fig3)		$I_{K(off)}$	$V_K = 36\text{V}, V_{REF} = 0$	-	0.1	1.0	μA
Dynamic Output Impedance ^(Fig1)		Z_K	$V_K = V_{REF}, f \leq 1\text{kHz}$ $I_K = 1 \text{ to } 100\text{mA}$	-	0.2	0.5	Ω

Characteristics Curve



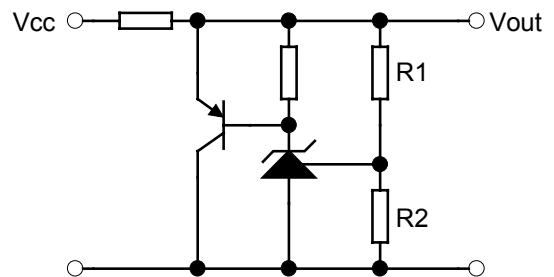
Typical Application

Fig 4. Shunt Regulator



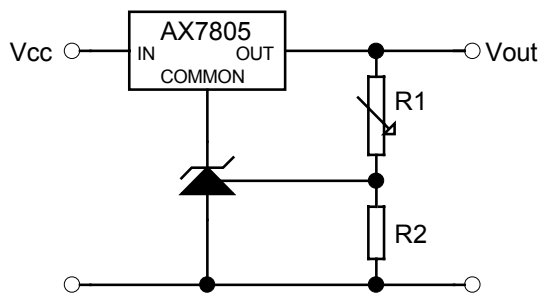
$$V_{out} = (1 + R_1/R_2)V_{REF}$$

Fig 5. High Current Shunt Regulator



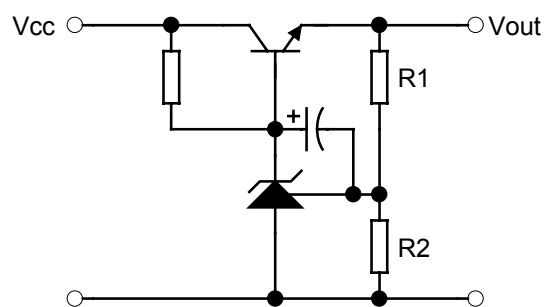
$$V_{out} = (1 + R_1/R_2)V_{REF}$$

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



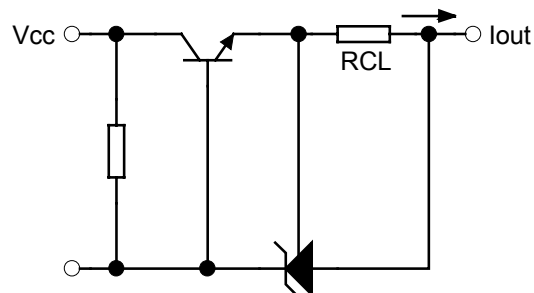
$$V_{out} = (1 + R_1/R_2)V_{REF}; V_{out(min)} = V_{REF} + 5V$$

Fig 7. Series Pass Regulator



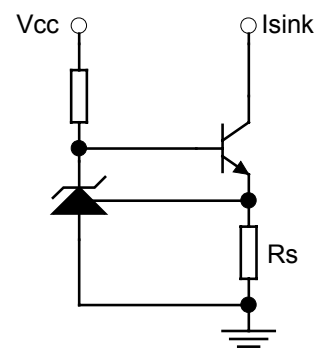
$$V_{out} = (1 + R_1/R_2)V_{REF}; V_{out(min)} = V_{REF} + V_{BE}$$

Fig 8. Current Limiter or Current Source



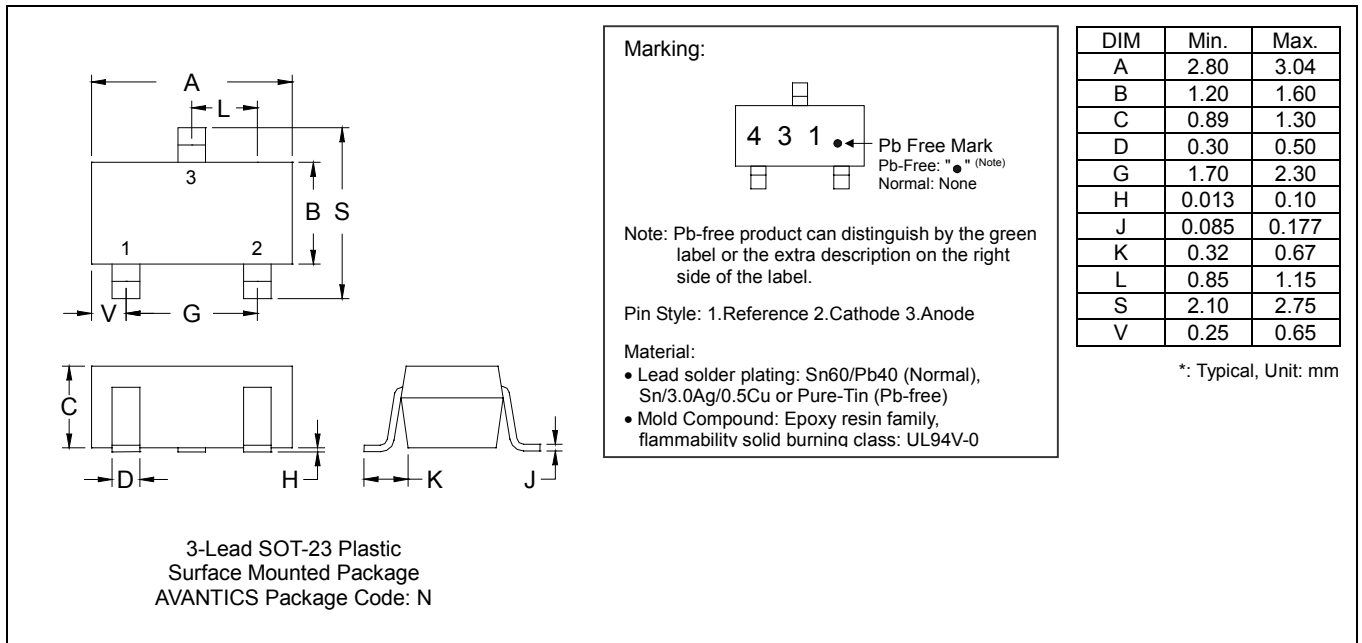
$$I_{out} = V_{REF}/R_{CL}$$

Fig 9. Constant Current Sink

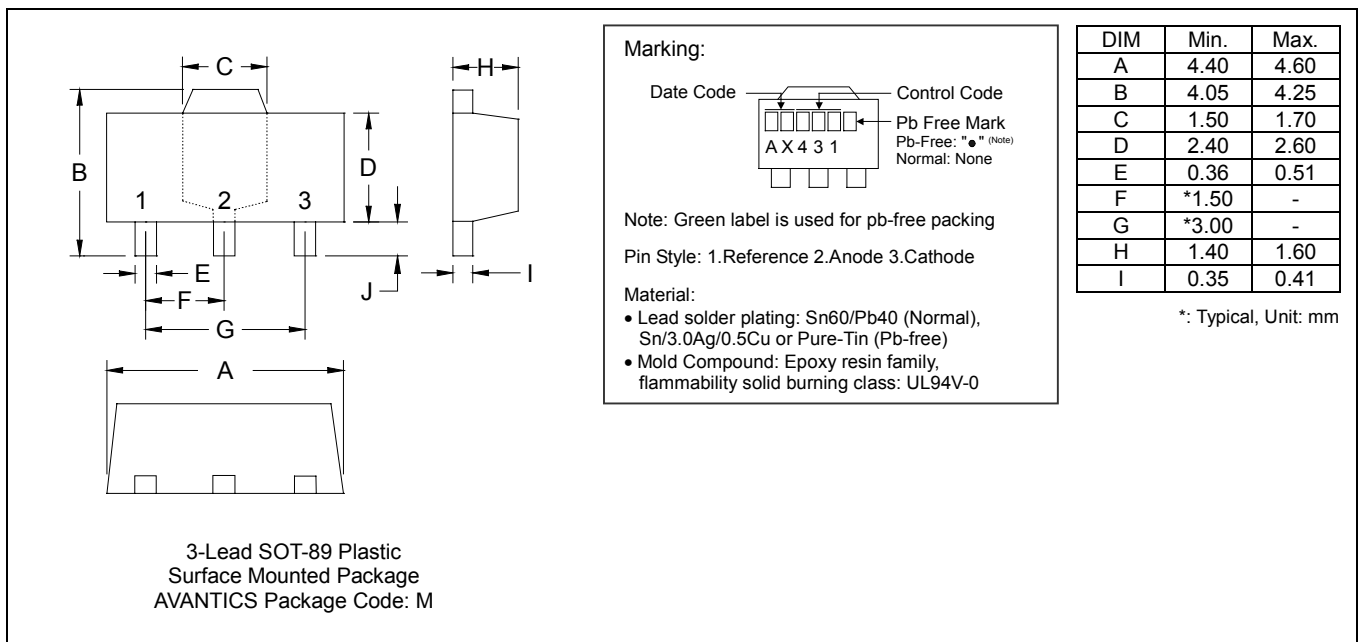


$$I_{sink} = V_{REF}/R_S$$

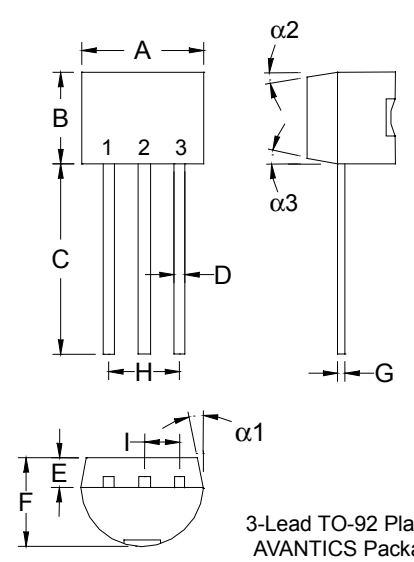
SOT-23 Dimension



SOT-89 Dimension



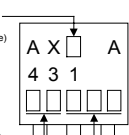
TO-92 Dimension



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

Marking:

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



Date Code Control Code

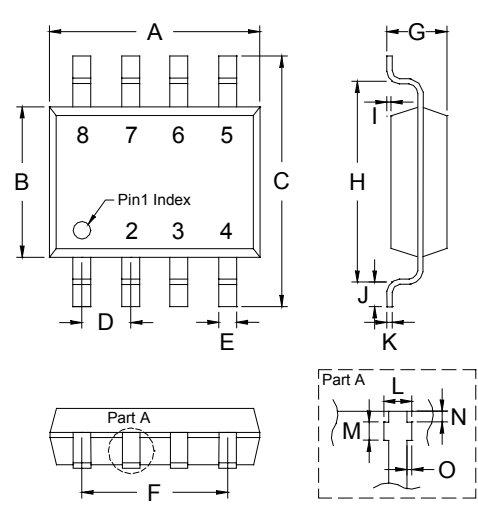
Note: Green label is used for pb-free packing
Pin Style: 1.Reference 2.Anode 3.Cathode

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

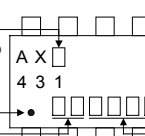
SO-8 Dimension



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

Marking:

Pb Free Mark
Pb-Free: *●* (Note)
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

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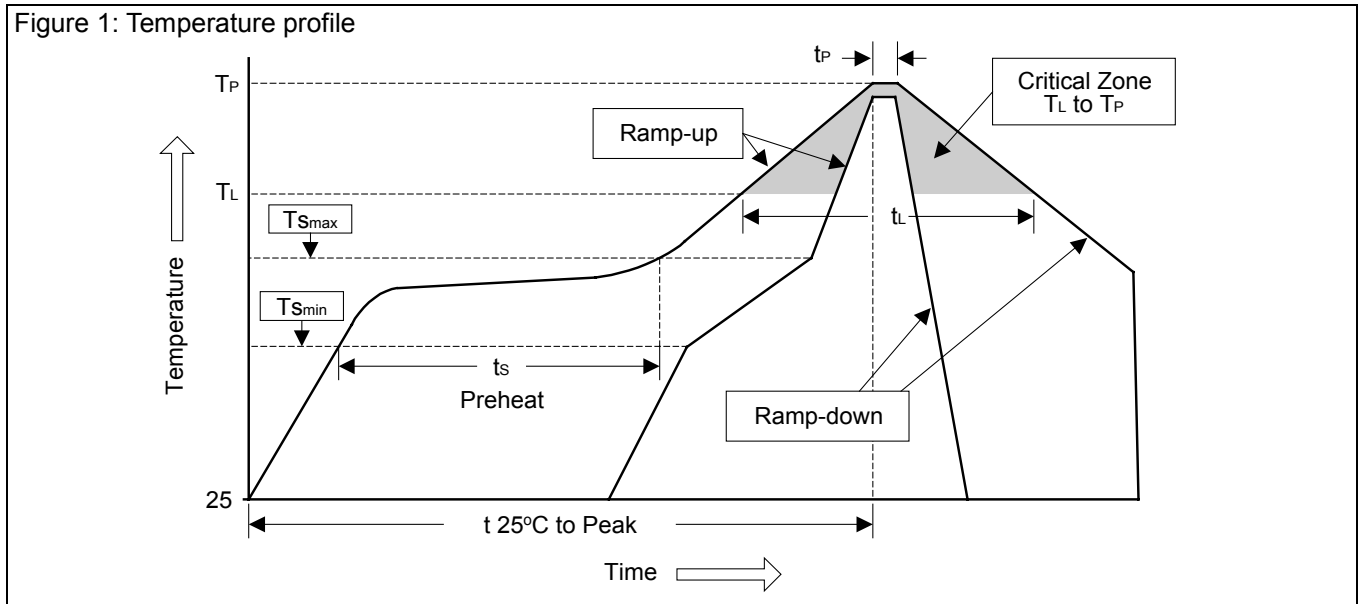
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Soldering Methods for AVANTICS's Products

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

Figure 1: Temperature profile



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