

TL431 Series

Adjustable Precision Shunt Regulator

Description

The TL431 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 2.5 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 Precise Output Voltage from 2.5V to 36V
- High Stability under Capacitive Load
- Low Temperature Deviation: 4.5mV Typical
- Low Dynamic Output Resistance: 0.2Ω Typical
- Sink Current Capacity from 1mA to 100 mA
- Low Output Noise
- Wide Operating Range of -40 to $125\text{ }^{\circ}\text{C}$
- Low Equivalent Full-range Temperature Coefficient with 20PPM/ $^{\circ}\text{C}$ Typical

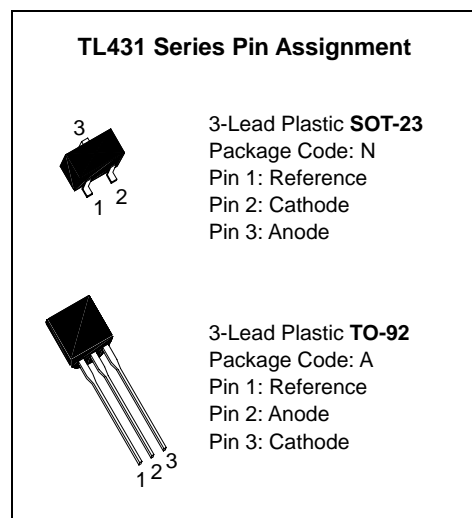
Absolute Maximum Ratings

(Operating temperature range applies unless otherwise specified)

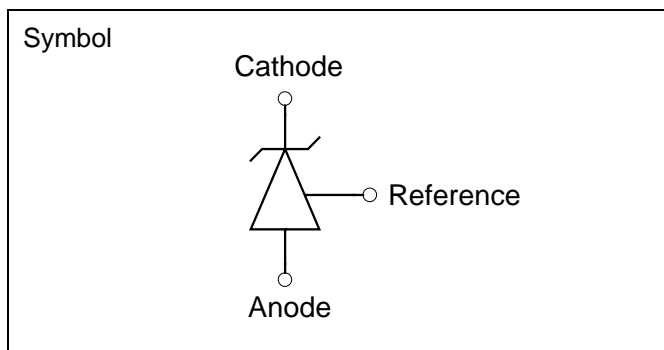
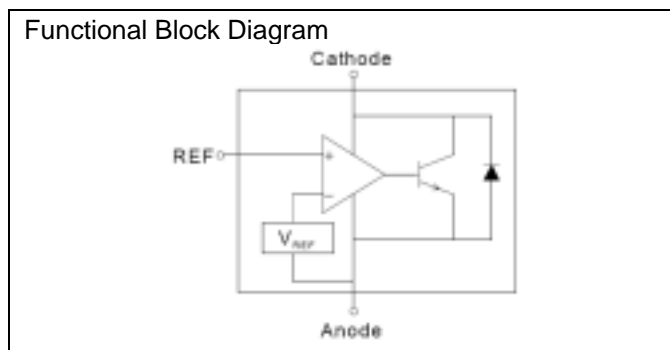
Characteristics	Symbol	Value		Unit
Cathode Voltage	V_{KA}	40		V
Cathode Current Range (Continuous)	I_K	-100~+150		mA
Reference Input Current Range	I_{REF}	0.05~+10		mA
Power Dissipation	P_D	SOT-23	370	mW
		TO-92	770	
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		--	--	
Operating Temperature Range (Max.)	T_{opr}	-40~+125		$^{\circ}\text{C}$
Storage Temperature Range	T_{stg}	-65~+150		$^{\circ}\text{C}$

Operating Conditions

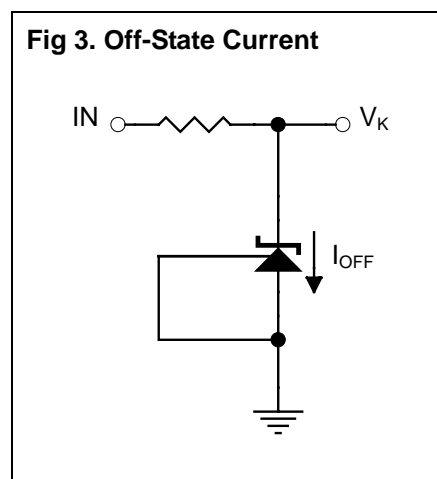
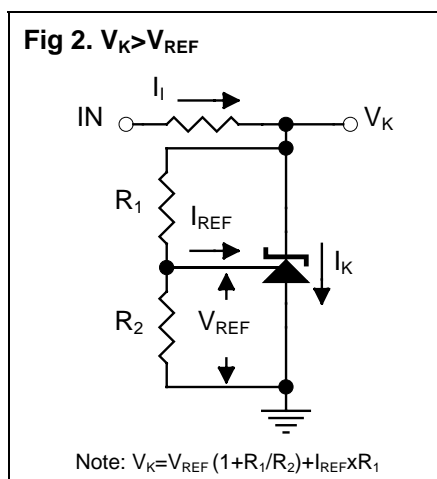
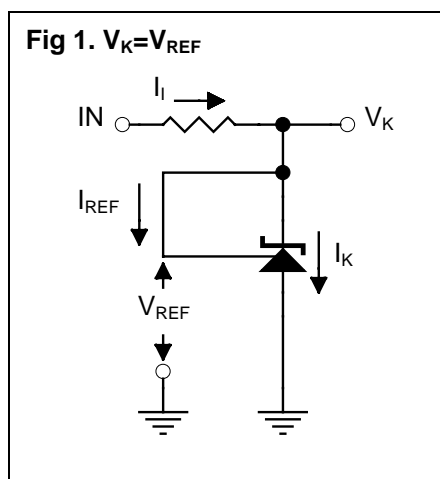
Characteristics	Symbol	Min.	Max.	Unit
Cathode Voltage	V_{KA}	V_{REF}	36	V
Cathode Current Range (Continuous)	I_K	1	100	mA
Operating Ambient Temperature Range		-40	125	$^{\circ}\text{C}$



Functional Block Diagram & Symbol



Test Circuits

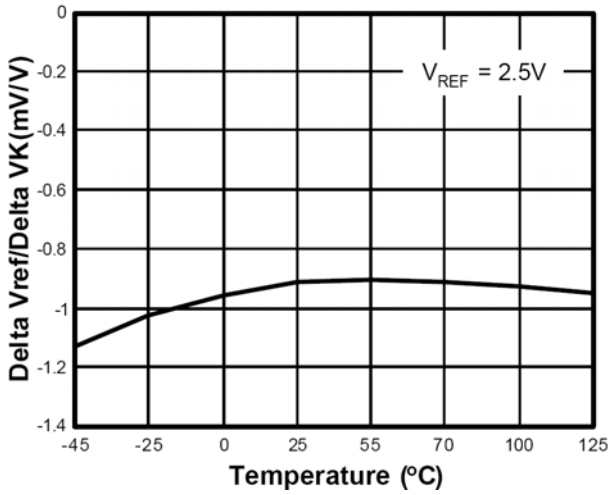


Electrical Characteristics ($T_A = 25^\circ\text{C}$ unless otherwise specified)

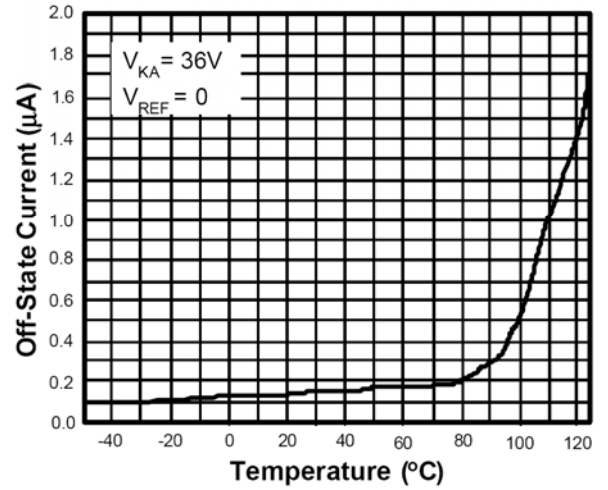
Characteristics	Symbol	Test Conditions	Min	Typ	Max	Unit
Reference Input Voltage (Fig1)	V_{REF}	$V_K = V_{REF}, I_K = 10\text{mA}$	0.4%	2.49	2.51	V
			0.8%	2.48	2.52	
Deviation of Reference Input Voltage Over-Temperature (Fig1)	$V_{REF(\text{dev})}$	$V_K = V_{REF}, I_K = 10\text{mA}$ $T_{\text{min}} \leq T_a \leq T_{\text{max}} (-40 \sim +125^\circ\text{C})$	-	4.5	16	mV
Ratio of Change in Reference Input Voltage to the Change in Cathode Voltage (Fig2)	$\Delta V_{REF} / \Delta V_K$	$I_K = 10\text{mA},$ $\Delta V_K = 10\text{V to } V_{REF}$	-	1.0	2.7	mV/V
		$I_K = 10\text{mA},$ $\Delta V_K = 36\text{V to } 10\text{V}$	-	0.5	2.0	mV/V
Reference Input Current (Fig2)	I_{REF}	$I_K = 10\text{mA}, R_1 = 10\text{k}\Omega,$ $R_2 = \infty$	-	0.7	4	μA
Deviation of Reference Input Current Over Full Temperature Range (Fig2)	$I_{REF(\text{dev})}$	$I_K = 10\text{mA}, R_1 = 10\text{k}\Omega,$ $R_2 = \infty, T_a = -40 \sim +125^\circ\text{C}$	-	0.4	1.2	μA
Minimum Cathode Current for Regulation (Fig1)	$I_{K(\text{min})}$	$V_K = V_{REF}$	-	0.4	1.0	mA
Off-State Cathode Current (Fig3)	$I_{K(\text{off})}$	$V_K = 36\text{V}, V_{REF} = 0$	-	0.05	1.0	μA
Dynamic Output Impedance (Fig1)	Z_K	$V_K = V_{REF}, f \leq 1\text{kHz}$ $I_K = 1 \text{ to } 100\text{mA}$	-	0.15	0.5	Ω

Typical Performance Characteristics

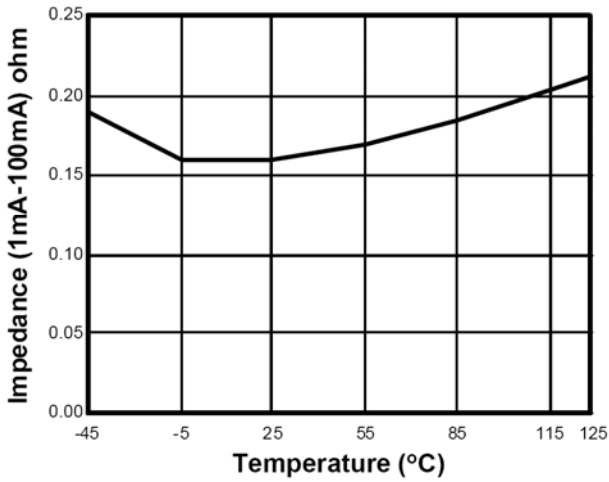
Delta Reference Voltage vs. Temperature



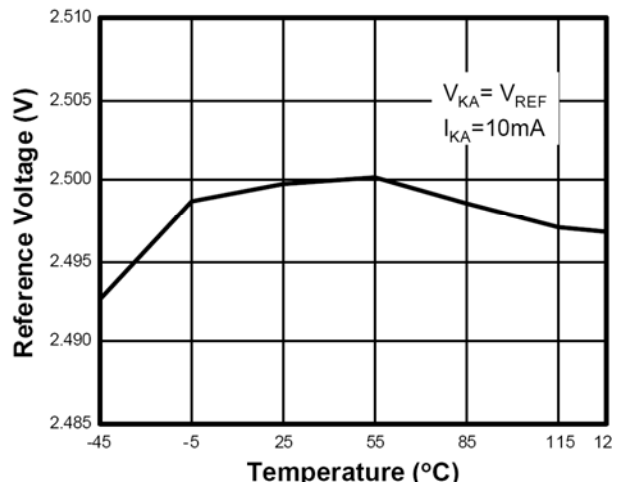
Off-State Current vs. Temperature



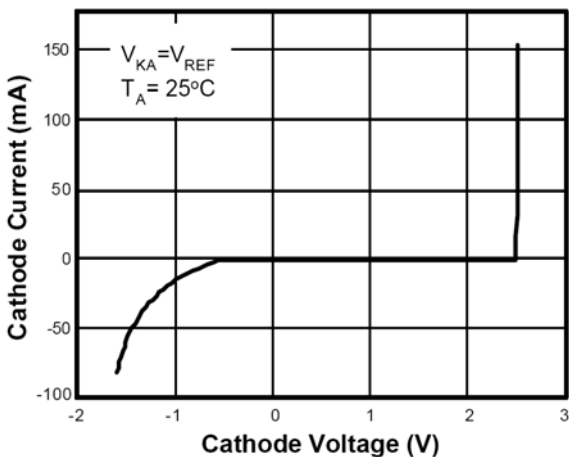
Impedance vs. Temperature



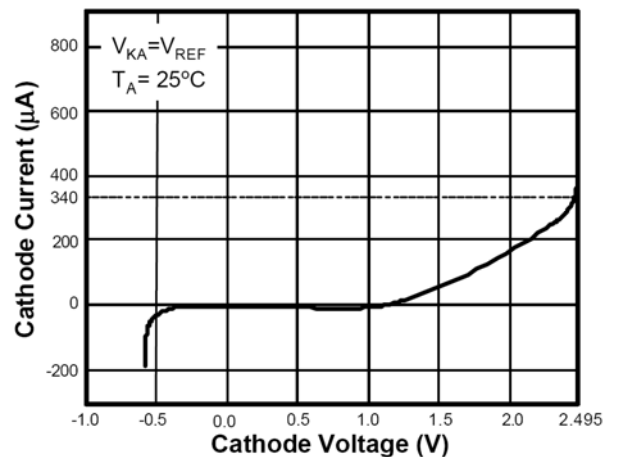
Reference Voltage vs. Temperature



Cathode Current vs. Cathode Voltage

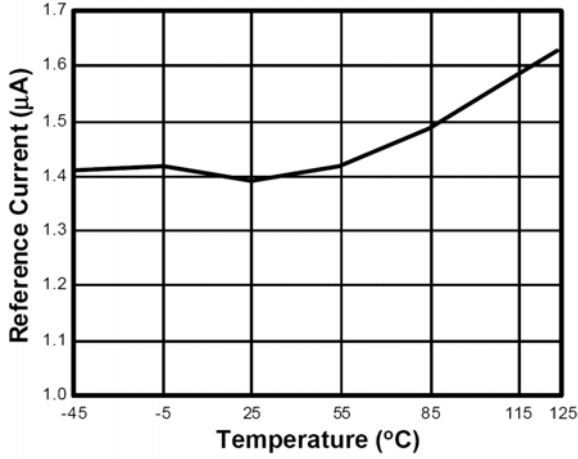


Current vs. Cathode Voltage

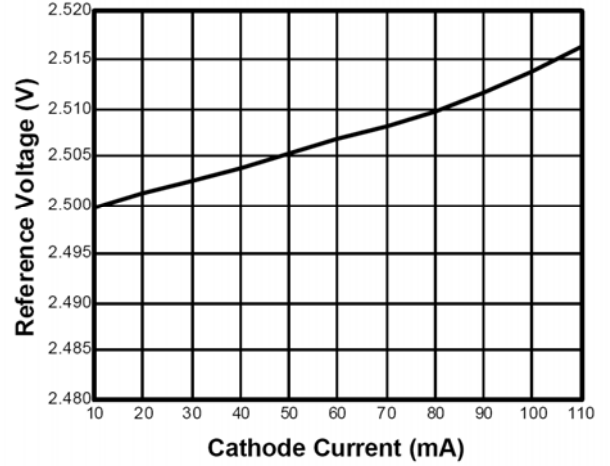


Typical Performance Characteristics (Continued)

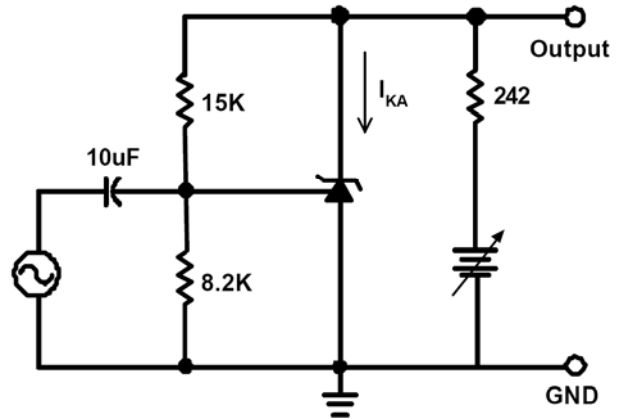
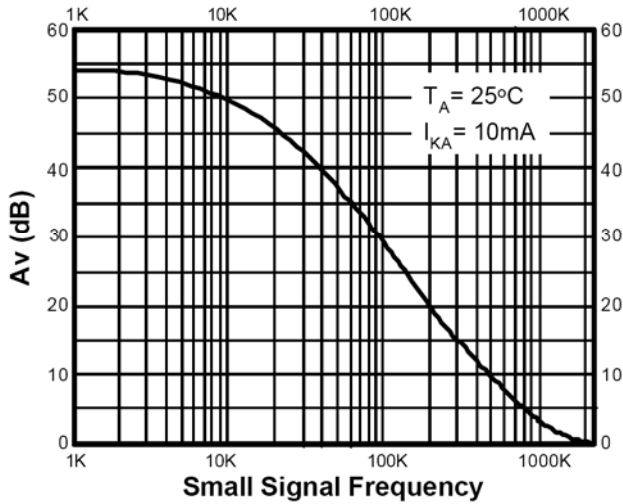
Reference Current vs. Temperature



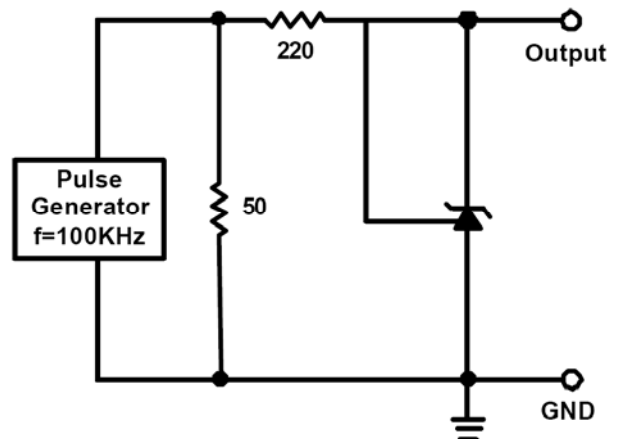
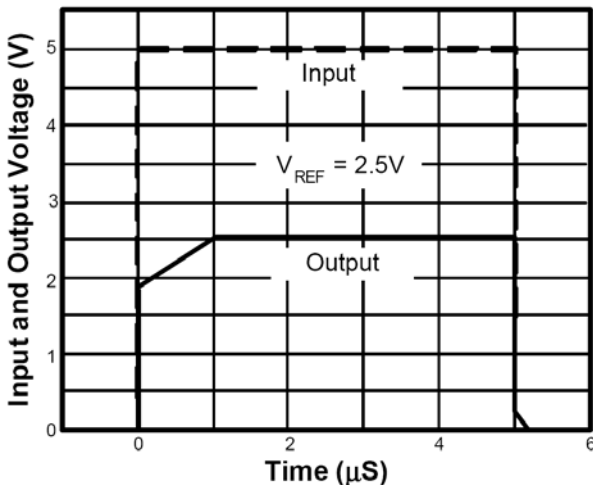
Reference Voltage vs. Cathode Current



Small Signal Voltage Gain vs. Frequency

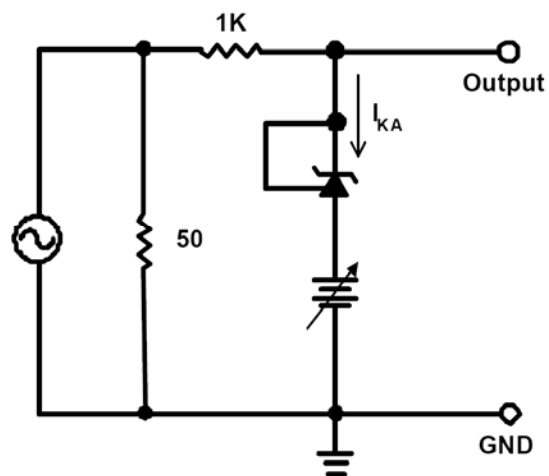
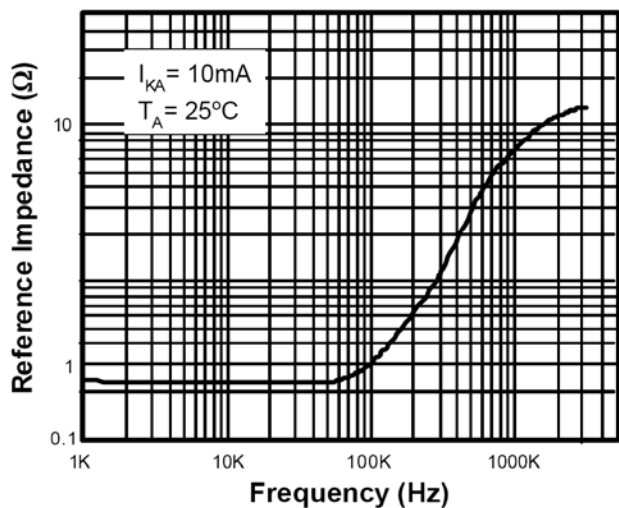


Small Signal Voltage Gain vs. Frequency

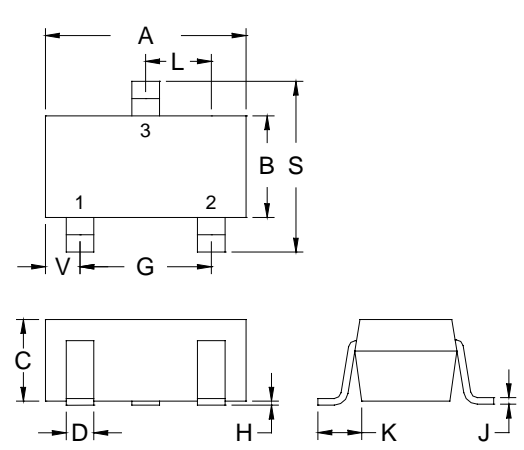


Typical Performance Characteristics (Continued)

Reference Impedance vs. Frequency

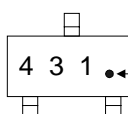


SOT-23 Dimension



3-Lead SOT-23 Plastic Surface Mounted Package
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:

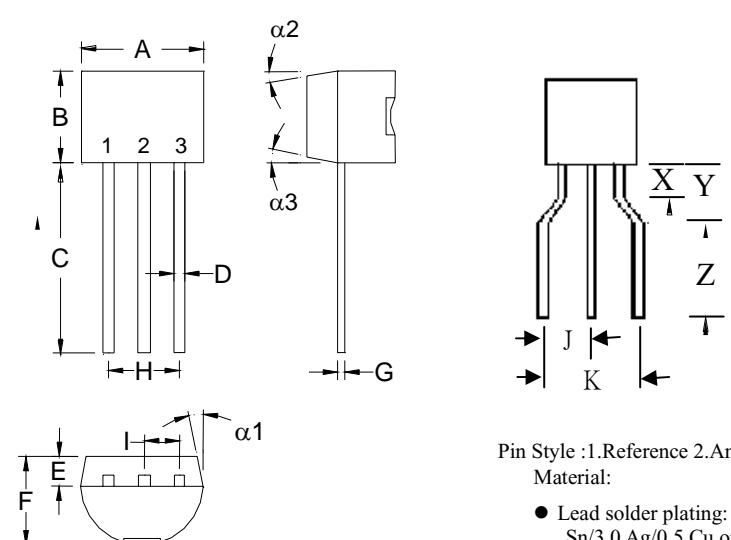
- Lead solder plating: Sn60/Pb40 (Normal), Sn/3.0Ag/0.5Cu or Pure-Tin (Pb-free)
- Mold Compound: Epoxy resin family, flammability solid burning class: UL94V-0

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

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

TO-92 Dimension



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

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
J	2.15	2.85
K	4.55	5.45
X	1.8	2.2
Y	2.75	3.85
Z	3.0	-
$\alpha 1$	-	*5°
$\alpha 2$	-	*2°
$\alpha 3$	-	*2°

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

Material:

- Lead solder plating: Sn60/Pb40 (Normal). Sn/3.0 Ag/0.5 Cu or Pure-Tin (Pb free)
- Mold compound: Epoxy resin family. Flammability solid burning class :UL 94V-0

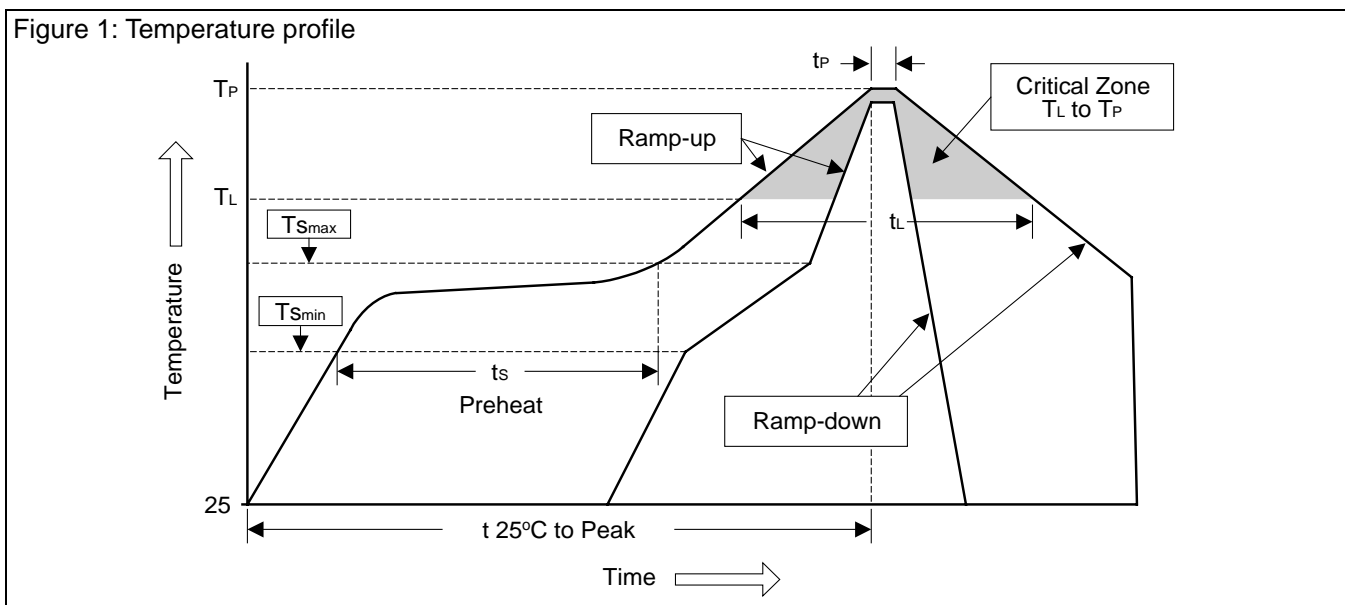
*: Typical, Unit: mm

Ordering Information

Package	V _{REF} : 2.5±0.8%	V _{REF} : 2.5±0.4%
SOT-23	TL431BN	TL431CN
TO-92	TL431BA	TL431CA

Soldering Methods for CTC 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