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Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832

Email & Skype: info@chipsmall.com Web: www.chipsmall.com

Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China



Description

The TL431 and TL432 are three terminal adjustable shunt regulators offering excellent temperature stability and output current handling capability up to 100mA. The output voltage may be set to any chosen voltage between 2.5 and 36 volts by selection of two external divider resistors.

The devices can be used as a replacement for zener diodes in many applications requiring an improvement in zener performance. Diodes' TL431 has the same electrical specifications as the industry standard '431 and is available in 2 grades with initial tolerances of 1% and 0.5% for the A and B grades respectively.

Features

- Temperature range -40 to +125°C
- Reference Voltage Tolerance at 25°C
 - TL431A: 2.495V ± 1.0%
 - TL431B: 2.495V ± 0.5%
- Low Output Noise
- 0.2Ω Typical Output Impedance
- Sink Current Capability: 1mA to 100mA
- Adjustable Output Voltage: V_{REF} to 36V
- All devices are:
 - Totally Lead-Free & Fully RoHS compliant (Notes 1 & 2)
 - Halogen and Antimony Free. "Green" Device (Note 3)

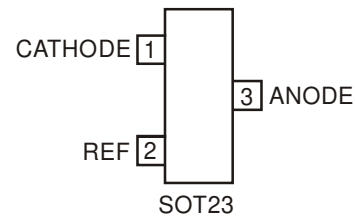
Applications

- Opto-Coupler Linearisers
- Shunt Regulators
- Improved Zener
- Variable Reference

Pin Assignments

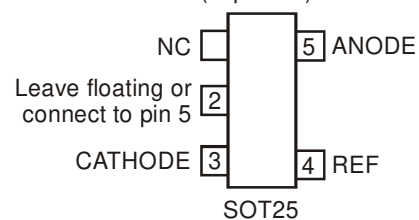
TL431

(Top View)



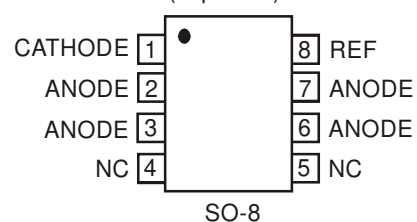
SOT23

(Top View)



SOT25

(Top View)

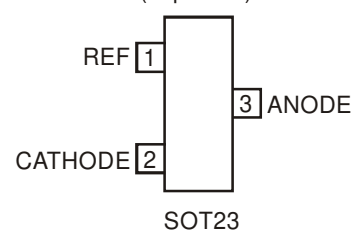


SO-8

SO-8 is a future product

TL432

(Top View)



SOT23

Notes: 1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
 2. See http://www.diodes.com/quality/lead_free.html for more information about Diodes Incorporated's definitions of Halogen and Antimony free, "Green" and Lead-Free.
 3. Halogen and Antimony free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Absolute Maximum Ratings (Note 4)

| Symbol | Parameter | | Rating | Unit |
|-----------|--------------------------------|-------|---------------|------|
| V_{KA} | Cathode Voltage | | 40 | V |
| I_{KA} | Continuous Cathode Current | | 150 | mA |
| I_{REF} | Reference Input Current | | -0.050 to +10 | mA |
| T_J | Operating Junction Temperature | | +150 | °C |
| T_{ST} | Storage Temperature | | -55 to +150 | °C |
| P_D | Power Dissipation (Notes 5, 6) | SOT23 | 330 | mW |
| | | SOT25 | 500 | |
| | | SO-8* | 700 | |

- Notes:
4. Operation above the absolute maximum rating may cause device failure. Operation at the absolute maximum ratings, for extended periods, may reduce device reliability. Unless otherwise stated voltages specified are relative to the ANODE pin.
 5. $T_J, MAX = 150^\circ C$.
 6. Ratings apply to ambient temperature at $25^\circ C$.

Recommended Operating Conditions

| Symbol | Parameter | Min | Max | Unit |
|----------|-------------------------------|-----------|------|------|
| V_{KA} | Cathode Voltage | V_{REF} | 36 | V |
| I_{KA} | Cathode Current | 1 | 100 | mA |
| T_A | Operating Ambient Temperature | -40 | +125 | °C |

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

| Symbol | Parameter | Test Conditions | Min | Typ. | Max | Unit | |
|--|---|--|---|-------|-------|-------|------|
| V _{REF} | Reference voltage | V _{KA} = V _{REF} , I _{KA} = 10mA | TL431A | 2.470 | 2.495 | 2.520 | V |
| | | | TL431B | 2.482 | 2.495 | 2.507 | |
| V _{DEV} | Deviation of reference voltage over full temperature range (Note 5) | V _{KA} = V _{REF} , I _{KA} = 10mA | T _A = 0 to 70°C | | 6 | 16 | mV |
| | | | T _A = -40 to +85°C | | 14 | 34 | |
| | | | T _A = -40 to +125°C | | 14 | 34 | |
| $\frac{\Delta V_{REF}}{\Delta V_{KA}}$ | Ratio of the change in reference voltage to the change in cathode voltage | I _{KA} = 10mA | V _{KA} = 10V to V _{REF} | | -1.4 | -2.7 | mV/V |
| | | | V _{KA} = 36V to 10V | | -1 | -2 | |
| I _{REF} | Reference input current | I _{KA} = 10mA, R1 = 10KΩ, R2 = ∞ | | 1 | 4 | μA | |
| ΔI _{REF} | I _{REF} deviation over full temperature range (Note 7) | I _{KA} = 10mA, R1 = 10KΩ, R2 = ∞ | T _A = 0 to 70°C | | 0.8 | 1.2 | μA |
| | | | T _A = -40 to +85°C | | 0.8 | 2.5 | |
| | | | T _A = -40 to +125°C | | 0.8 | 2.5 | |
| I _{KA(MIN)} | Minimum cathode current for regulation | V _{KA} = V _{REF} | | 0.4 | 0.7 | mA | |
| I _{KA(OFF)} | Off-state current | V _{KA} = 36V, V _{REF} = 0V | | 0.05 | 0.5 | μA | |
| Z _{KA} | Dynamic output impedance (Note 8) | V _{KA} = V _{REF} , f = 0Hz | | 0.2 | 0.5 | Ω | |
| θ _{JA} | Thermal Resistance Junction to Ambient | SOT23 | | 380 | | °C/W | |
| | | SOT25 | | 250 | | | |
| | | SO-8* | | 70 | | | |

Notes: 7. Deviation of V_{DEV}, and ΔI_{REF} are defined as the maximum variation of the values over the full temperature range.

The average temperature coefficient of the reference input voltage αV_{REF} is defined as:

$$|\alpha V_{REF}| = \left(\frac{V_{DEV}}{V_{REF @ 25^\circ C}} \right) \times 10^6 \text{ ppm/}^\circ C$$

Where:

T₂ - T₁ = full temperature change.

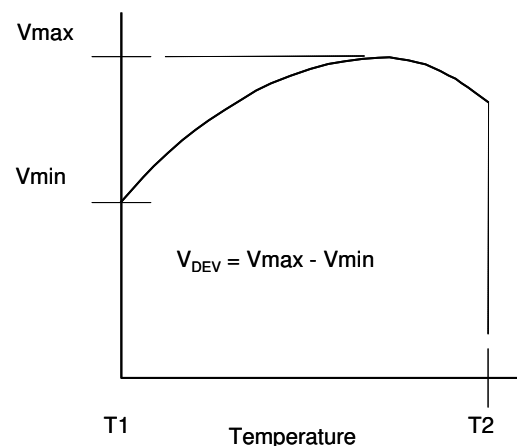
αV_{REF} can be positive or negative depending on whether the slope is positive or negative.

Notes: 8. The dynamic output impedance, R_Z, is defined as:

$$|Z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_{KA}}$$

When the device is programmed with two external resistors R1 and R2, the dynamic output impedance of the overall circuit, is defined as:

$$|Z'| = \frac{\Delta V}{\Delta I} \approx |Z_{KA}| \left(1 + \frac{R1}{R2} \right)$$



Test Circuits

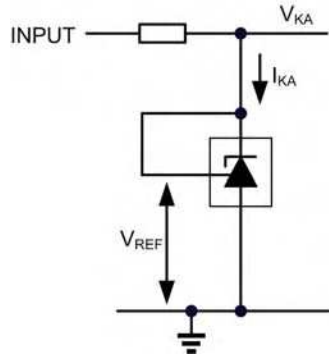


Figure 1. Test circuit for $V_{KA} = V_{REF}$

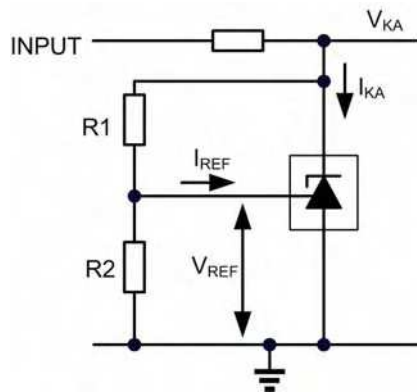


Figure 2. Test circuit for $V_{KA} > V_{REF}$

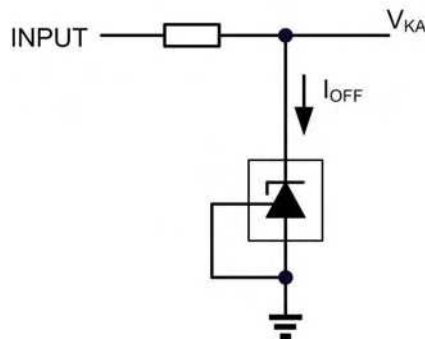
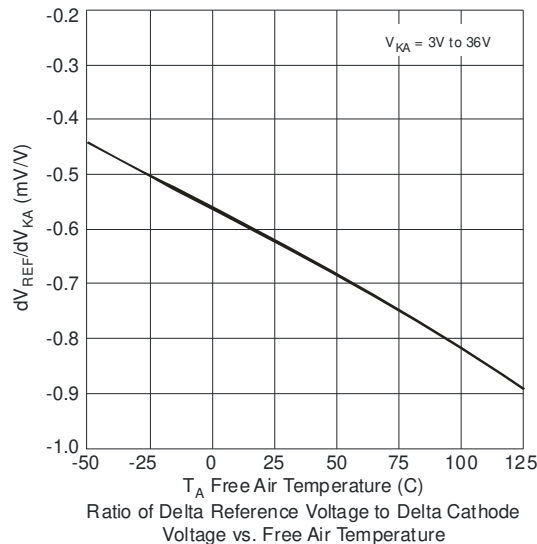
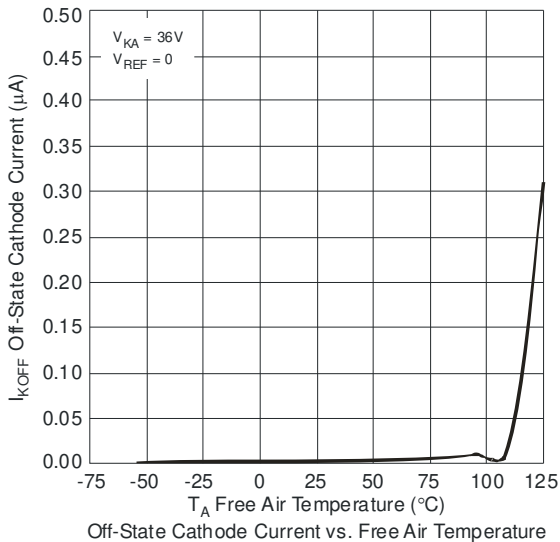
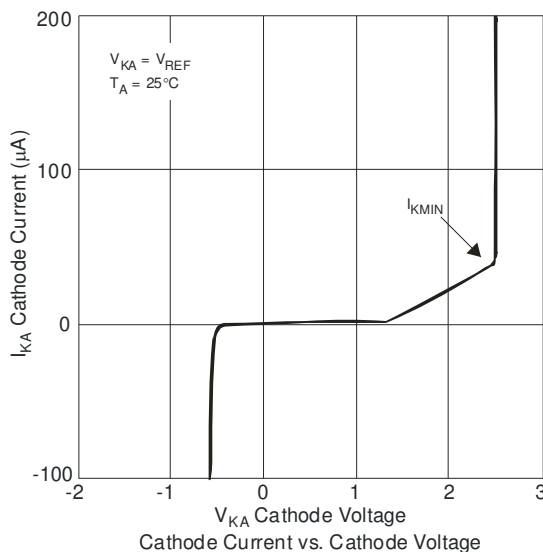
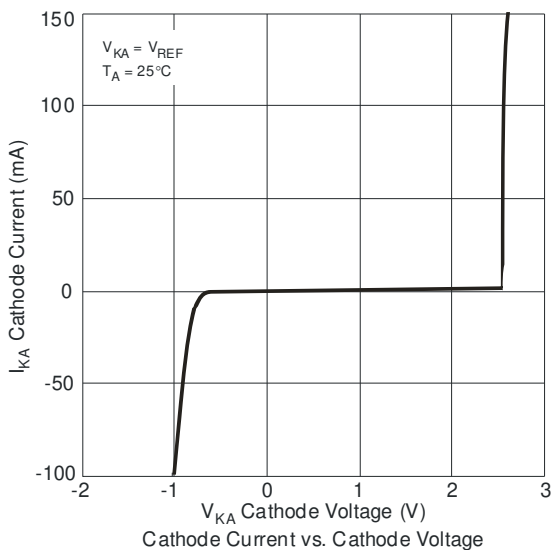
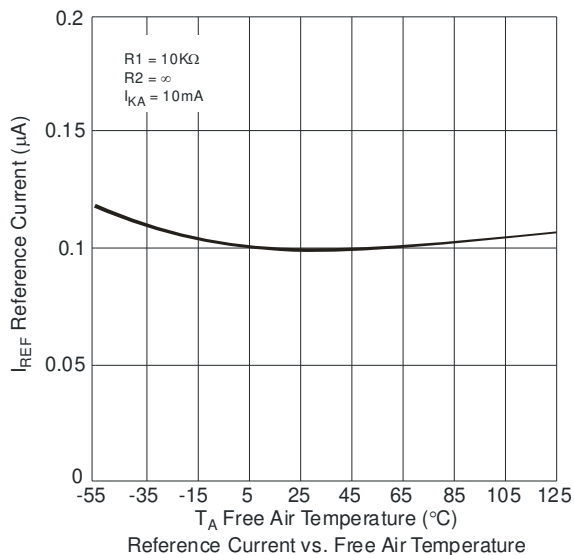
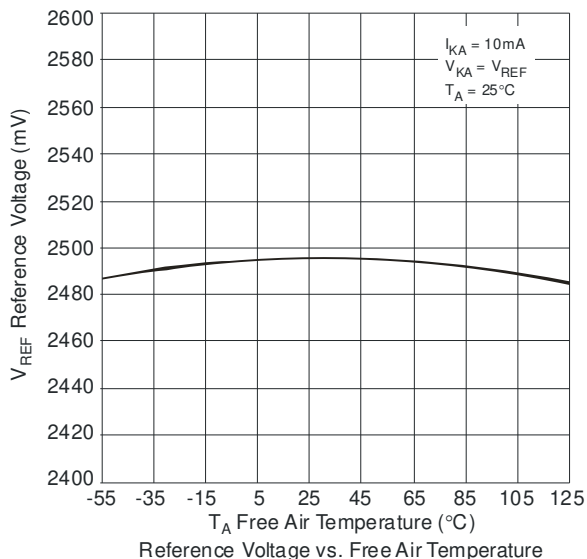


Figure 3. Test circuit for I_{OFF}

Typical Performance Characteristics



Typical Performance Characteristics (cont.)

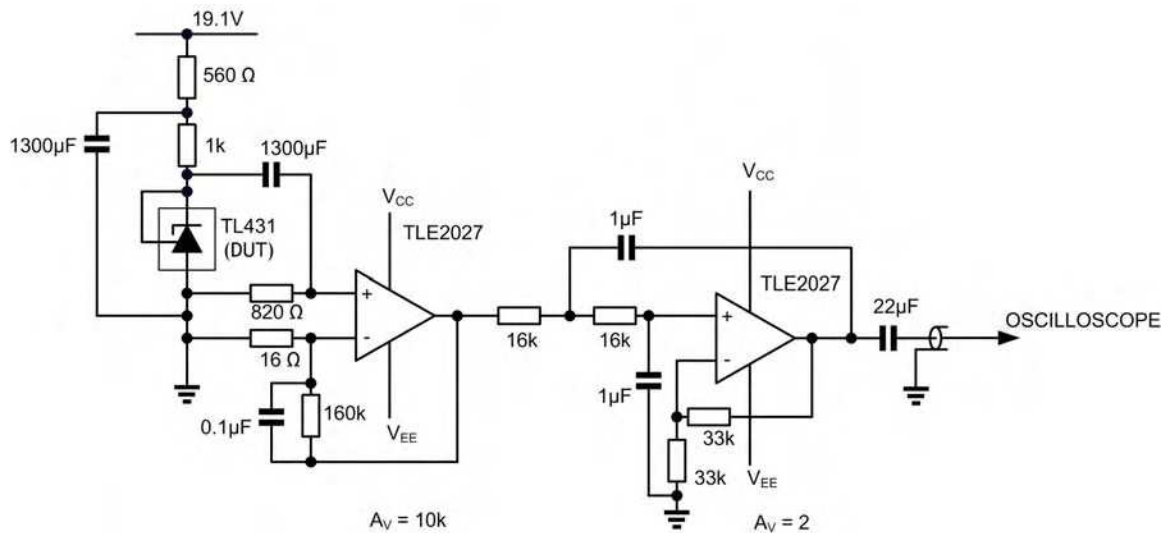
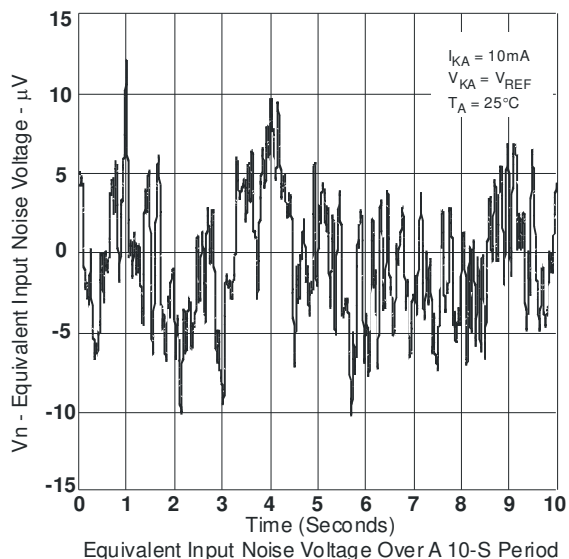
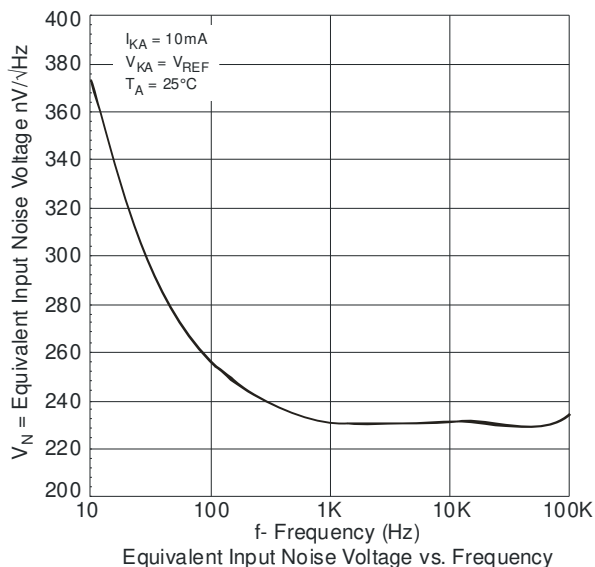
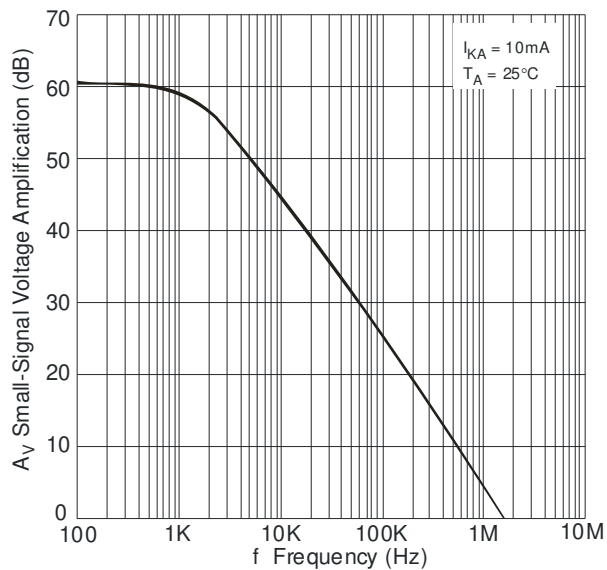
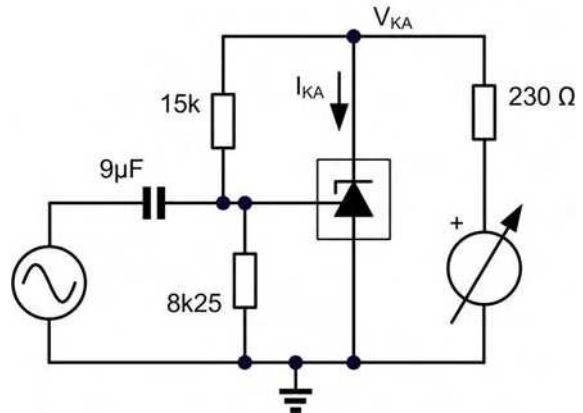


Figure 4. Test circuit for noise input voltage

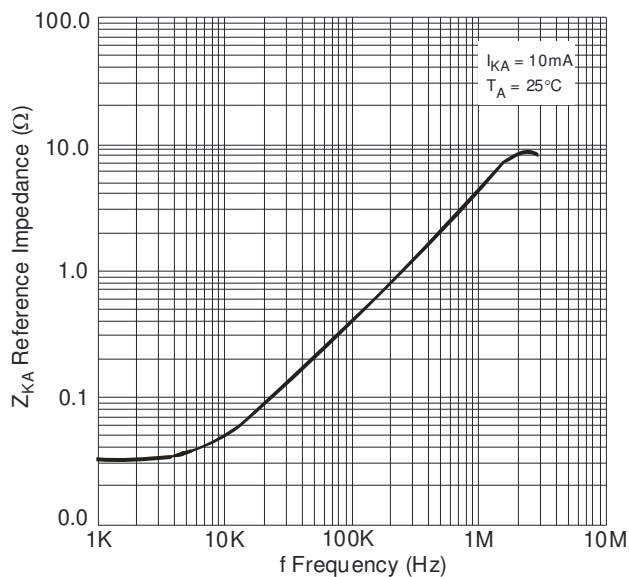
Typical Performance Characteristics (cont.)



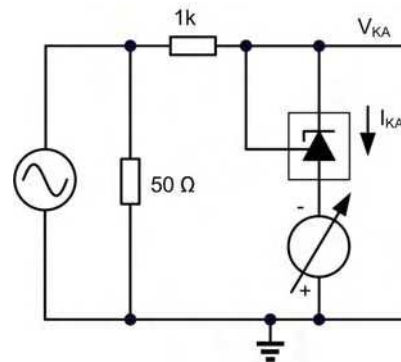
Small-Signal Voltage Amplification vs. Frequency



Test circuit for voltage amplification

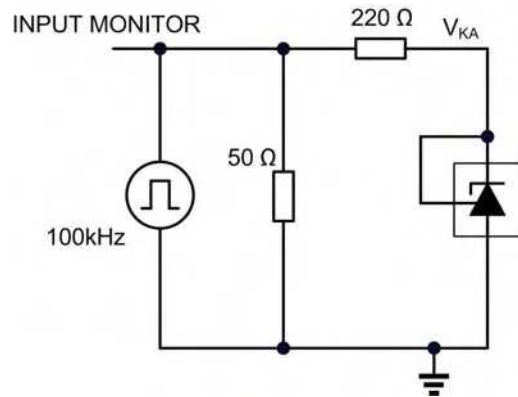
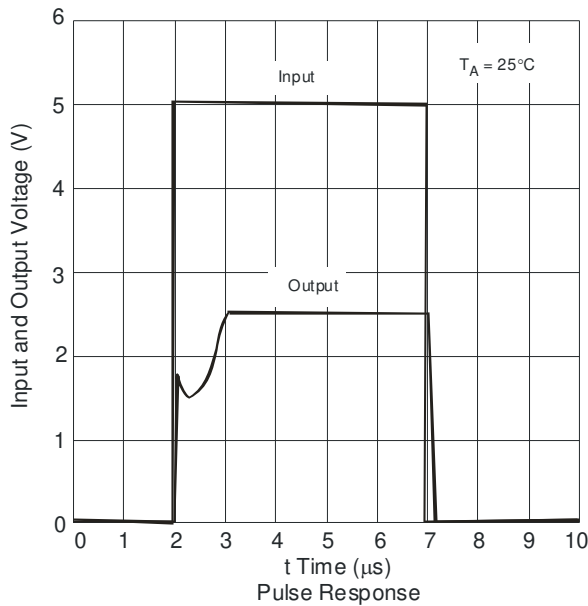


Reference Impedance vs. Frequency

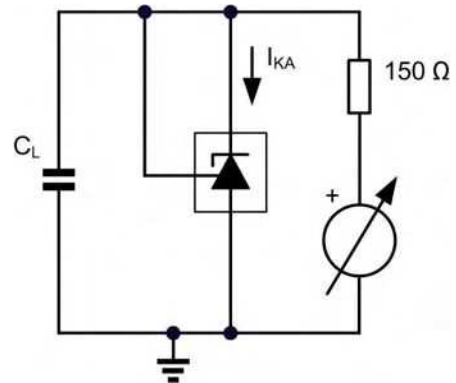
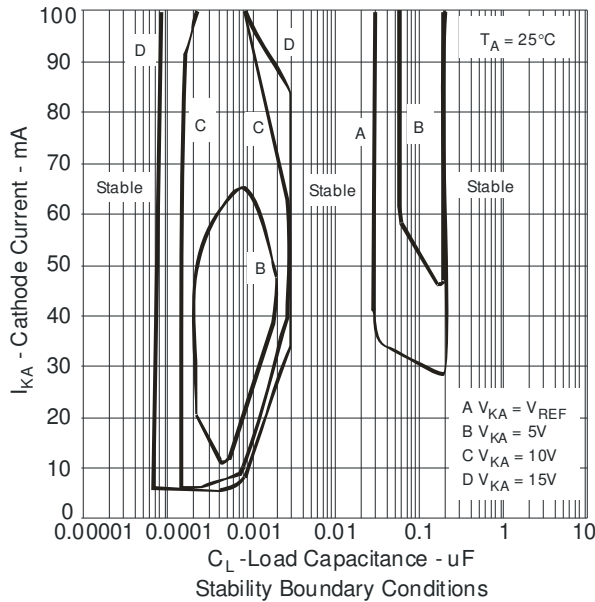


Test circuit for reference impedance

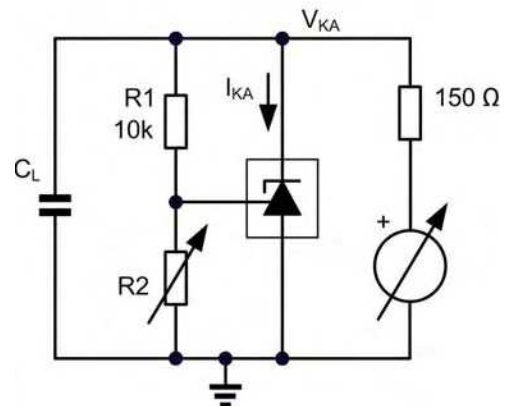
Typical Performance Characteristics (cont.)



Test Circuit for Pulse Response



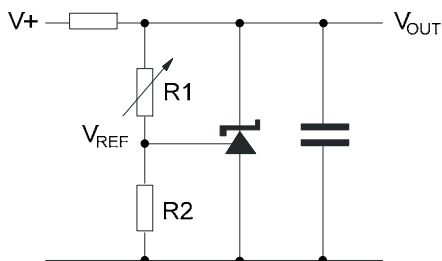
Test Circuit for Curve A



Test Circuit for Curves B, C, D

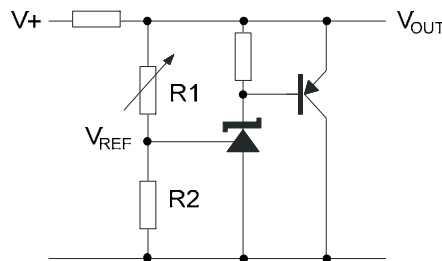
The device is stable under all conditions with a load capacitance not exceeding 50pF. The device is stable under all conditions with a load capacitance between 5nF and 20nF. The device is stable under all conditions with a load capacitance exceeding 300nF. With a cathode current not exceeding 5mA, the device is stable with any load capacitance.

Applications Information



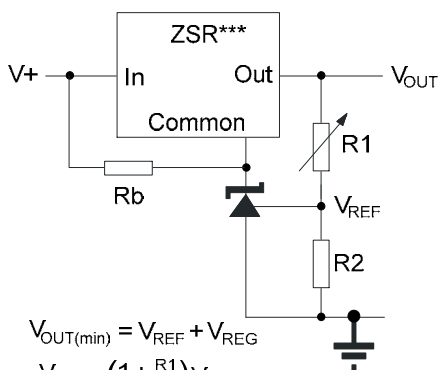
$$V_{OUT} = \left(1 + \frac{R1}{R2}\right)V_{REF}$$

Shunt Regulator



$$V_{OUT} = \left(1 + \frac{R1}{R2}\right)V_{REF}$$

Higher Current Shunt Regulator

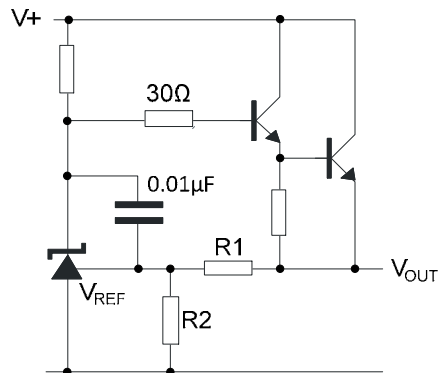


$$V_{OUT(min)} = V_{REF} + V_{REG}$$

$$V_{OUT} = \left(1 + \frac{R1}{R2}\right)V_{REF}$$

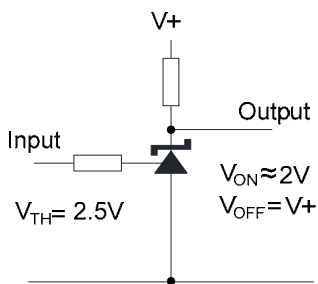
Rb - Optional to provide minimum cathode current

Output Control of a Three Terminal Fixed Regulator

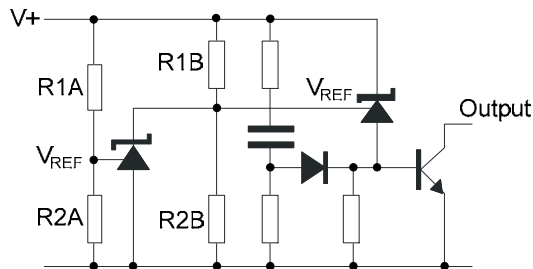


$$V_{OUT} = \left(1 + \frac{R1}{R2}\right)V_{REF}$$

Series Regulator



Single Supply Comparator with Temperature Compensated Threshold

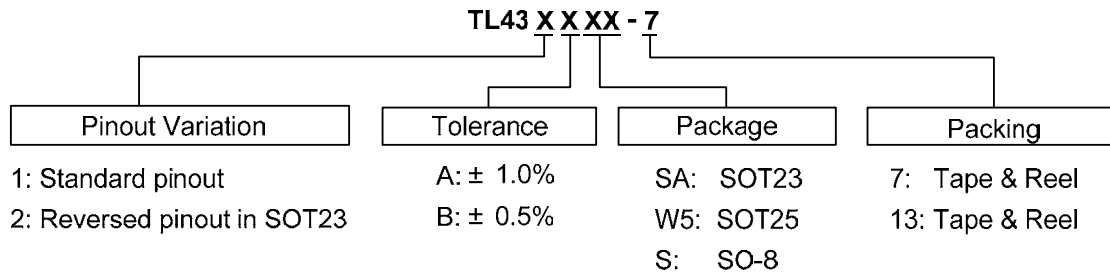






$$\text{Low Limit} = \left(1 + \frac{R1B}{R2B}\right)V_{REF}$$

$$\text{High Limit} = \left(1 + \frac{R1A}{R2A}\right)V_{REF}$$

Over Voltage / Under Voltage Protection Circuit

Ordering Information



| Device | Package Code | Packaging (Note 9) | 7" Tape and Reel | | Ammo Box | |
|--|--------------|--------------------|------------------|--------------------|----------|--------------------|
| | | | Quantity | Part Number Suffix | Quantity | Part Number Suffix |
|  TL431A(B)SA-7 | SA | SOT23 | 3000/Tape & Reel | -7 | NA | NA |
|  TL431A(B)W5-7 | W5 | SOT25 | 3000/Tape & Reel | -7 | NA | NA |
|  TL431A(B)S-13* | S | SO-8* | 2500/Tape & Reel | -13 | NA | NA |
|  TL432A(B)SA-7 | SA | SOT23 | 3000/Tape & Reel | -7 | NA | NA |

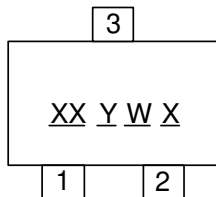
* Suffix "B" denotes TL431B device.

Notes: 9. Pad layout as shown on Diodes Inc. suggested pad layout document AP02001, which can be found on our website at <http://www.diodes.com/datasheets/ap02001.pdf>.

Marking Information

(1) SOT23

(Top View)

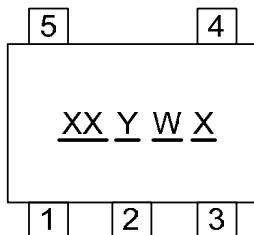


XX : Identification code
Y : Year 0~9
W : Week : A~Z : 1~26 week;
 a~z : 27~52 week; z represents
 52 and 53 week
X : A~Z : Green

| Device | Package | Identification Code |
|----------|---------|---------------------|
| TL431ASA | SOT23 | AA |
| TL431BSA | SOT23 | AB |
| TL432ASA | SOT23 | BA |
| TL432BSA | SOT23 | BB |

(2) SOT25

(Top View)

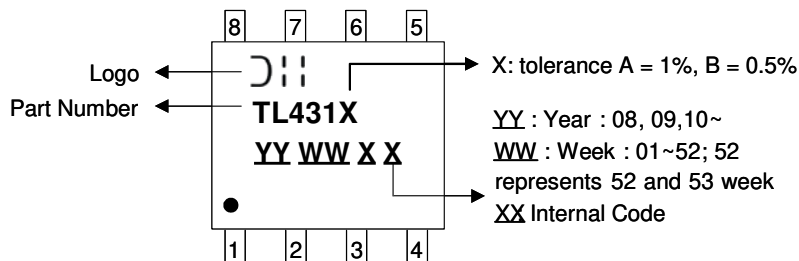


XX : Identification code
Y : Year 0~9
W : Week : A~Z : 1~26 week;
 a~z : 27~52 week; z represents
 52 and 53 week
X : A~Z : Green

| Device | Package | Identification Code |
|----------|---------|---------------------|
| TL431AW5 | SOT25 | AA |
| TL431BW5 | SOT25 | AB |

(3) SO-8*

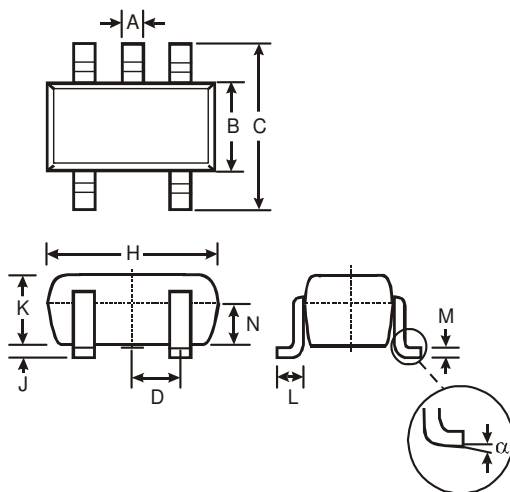
(Top View)



X: tolerance A = 1%, B = 0.5%
YY : Year : 08, 09, 10~
WW : Week : 01~52; 52
 represents 52 and 53 week
XX Internal Code

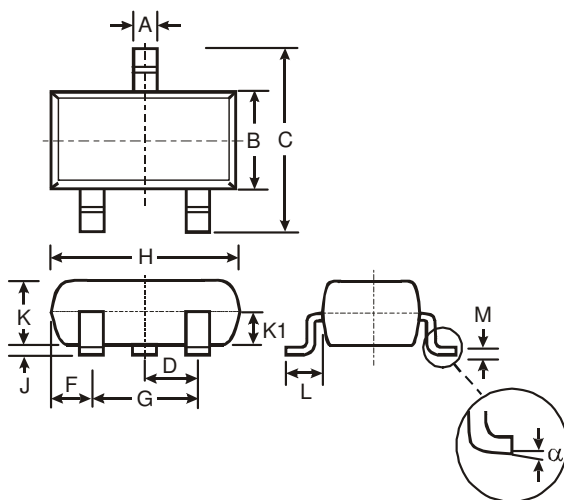
Package Outline Dimensions (All Dimensions in mm)

(1) Package type: SOT25



| SOT25 | | | |
|----------------------|-------|------|------|
| Dim | Min | Max | Typ |
| A | 0.35 | 0.50 | 0.38 |
| B | 1.50 | 1.70 | 1.60 |
| C | 2.70 | 3.00 | 2.80 |
| D | — | — | 0.95 |
| H | 2.90 | 3.10 | 3.00 |
| J | 0.013 | 0.10 | 0.05 |
| K | 1.00 | 1.30 | 1.10 |
| L | 0.35 | 0.55 | 0.40 |
| M | 0.10 | 0.20 | 0.15 |
| N | 0.70 | 0.80 | 0.75 |
| α | 0° | 8° | — |
| All Dimensions in mm | | | |

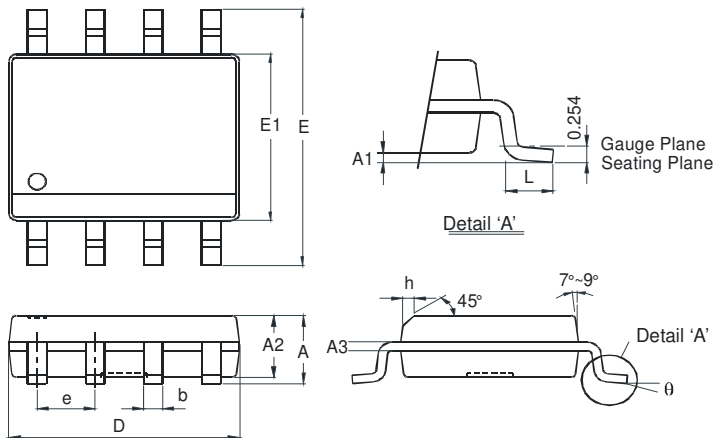
(2) Package Types: SOT23



| SOT23 | | | |
|----------------------|-------|------|-------|
| Dim | Min | Max | Typ |
| A | 0.37 | 0.51 | 0.40 |
| B | 1.20 | 1.40 | 1.30 |
| C | 2.30 | 2.50 | 2.40 |
| D | 0.89 | 1.03 | 0.915 |
| F | 0.45 | 0.60 | 0.535 |
| G | 1.78 | 2.05 | 1.83 |
| H | 2.80 | 3.00 | 2.90 |
| J | 0.013 | 0.10 | 0.05 |
| K | 0.903 | 1.10 | 1.00 |
| K1 | - | - | 0.400 |
| L | 0.45 | 0.61 | 0.55 |
| M | 0.085 | 0.18 | 0.11 |
| α | 0° | 8° | - |
| All Dimensions in mm | | | |

Package Outline Dimensions (All Dimensions in mm)

(3) Package Types: SO-8*



| SO-8* | | |
|----------------------|----------|------|
| Dim | Min | Max |
| A | - | 1.75 |
| A1 | 0.10 | 0.20 |
| A2 | 1.30 | 1.50 |
| A3 | 0.15 | 0.25 |
| b | 0.3 | 0.5 |
| D | 4.85 | 4.95 |
| E | 5.90 | 6.10 |
| E1 | 3.85 | 3.95 |
| e | 1.27 Typ | |
| h | - | 0.35 |
| L | 0.62 | 0.82 |
| θ | 0° | 8° |
| All Dimensions in mm | | |

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2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

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