

**Description**

The ZR431 is a three terminal adjustable shunt regulator 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 20 volts by selection of two external divider resistors.

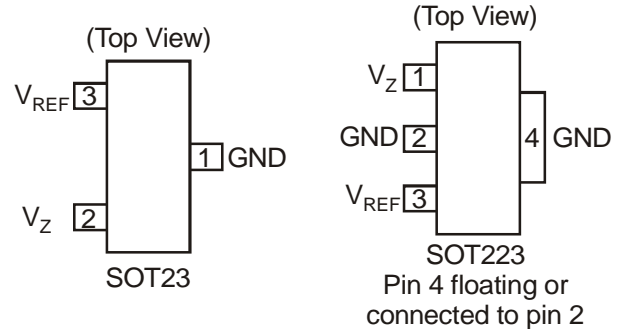
The devices can be used as a replacement for zener diodes in many applications requiring an improvement in zener performance.

**Features**

- Surface mount SOT223 and SOT23 packages
- 2%, 1 % and 0.5% tolerance
- Max. temperature coefficient 55 ppm/°C
- Temperature compensated for operation over the full temperature range
- Programmable output voltage
- 50µA to 100mA current sink capability
- Low output noise
- All package options available in “Green” Molding Compound (No Br, Sb) and Lead Free Finish/ RoHS Compliant (Note 1)

Notes: 1. EU Directive 2002/95/EC (RoHS). All applicable RoHS exemptions applied. Please visit our website at [http://www.diodes.com/products/lead\\_free.html](http://www.diodes.com/products/lead_free.html).

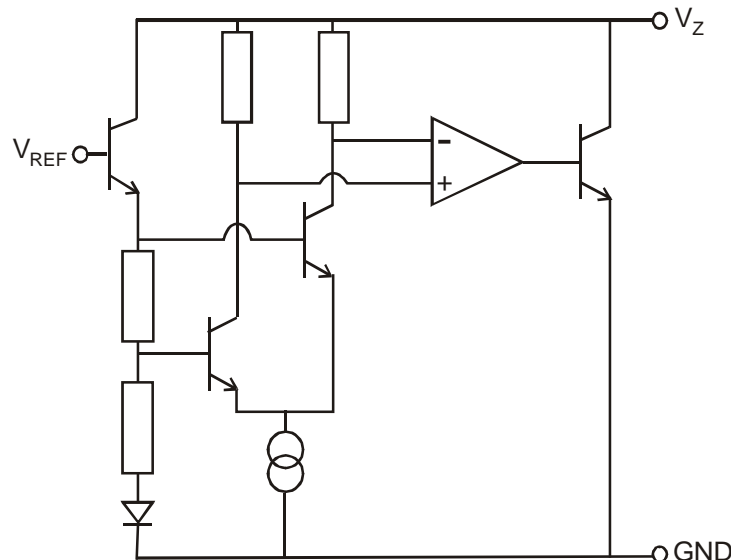
**Pin Assignments**



**Applications**

- Shunt regulator
- Series regulator
- Voltage monitor
- Over voltage/ under voltage protection
- Switch mode power supplies

**Typical Application Circuit**



### Absolute Maximum Ratings (Note 2)

| Symbol   | Parameter                      | Rating      | Unit |    |
|----------|--------------------------------|-------------|------|----|
| $V_Z$    | Cathode Voltage                | 20          | V    |    |
| $I_Z$    | Cathode Current                | 150         | mA   |    |
| $T_A$    | Operating Temperature          | -40 to +85  | °C   |    |
| $T_{ST}$ | Storage Temperature            | -55 to +125 | °C   |    |
| $P_D$    | Power Dissipation (Notes 3, 4) | SOT23       | 330  | mW |
|          |                                | SOT223      | 2    | W  |

Notes: 2. 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.  
 3.  $T_J$ , max = 150°C.  
 4. Ratings apply to ambient temperature at 25°C.

### Recommended Operating Conditions ( $T_A = 25^\circ\text{C}$ )

| Symbol | Parameter       | Min       | Max | Unit |
|--------|-----------------|-----------|-----|------|
| $V_Z$  | Cathode Voltage | $V_{REF}$ | 20  | V    |
| $I_Z$  | Cathode Current | 0.05      | 100 | mA   |

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

| Symbol                              | Parameter   | Test Conditions  | Min  | Typ.  | Max  | Unit          |   |
|-------------------------------------|---|--|------|-------|------|---------------|---|
| $V_{REF}$                           | Reference voltage (Note 5)  | $I_L = 10\text{mA}$ (Fig 1), $V_Z = V_{REF}$   | 2%   | 2.45  | 2.50 | 2.55          | V |
|                                     |   |  | 1%   | 2.475 | 2.50 | 2.525         |   |
|                                     |   |  | 0.5% | 2.487 | 2.50 | 2.513         |   |
| $V_{DEV}$                           | Deviation of reference input voltage over temperature                     | $I_L = 10\text{mA}$ , $V_Z = V_{REF}$<br>$T_A = \text{Full range}$ (Fig 1)                       |      | 8.0   | 17   | mV            |   |
| $\frac{\Delta V_{REF}}{\Delta V_Z}$ | Ratio of the change in reference voltage to the change in cathode voltage | $V_Z$ from $V_{REF}$ to 10V<br>$I_Z = 10\text{mA}$ (Fig 2)                                       |      | -1.85 | -2.7 | mV/V          |   |
|                                     |   | $V_Z$ from 10V to 20V<br>$I_Z = 10\text{mA}$ (Fig 2)   |      | -1.0  | -2.0 |               |   |
| $I_{REF}$                           | Reference input current   | $R1 = 10\text{k}$ , $R2 = \text{O/C}$ , $I_L = 10\text{mA}$ (Fig 2)                              |      | 0.12  | 1.0  | $\mu\text{A}$ |   |
| $\Delta I_{REF}$                    | Deviation of reference input current over temperature                     | $R1 = 10\text{k}$ , $R2 = \text{O/C}$ , $I_L = 10\text{mA}$<br>$T_A = \text{Full range}$ (Fig 2) |      | 0.04  | 0.2  | $\mu\text{A}$ |   |
| $I_{Z(MIN)}$                        | Minimum cathode current for regulation                                    | $V_Z = V_{REF}$ (Fig 1)  |      | 35    | 50   | $\mu\text{A}$ |   |
| $I_{Z(OFF)}$                        | Off-state current   | $V_Z = 20\text{V}$ , $V_{REF} = 0\text{V}$ (Fig 3)   |      |       | 0.1  | $\mu\text{A}$ |   |
| $R_Z$                               | Dynamic output impedance  | $V_Z = V_{REF}$ (Fig 1), $f = 0\text{Hz}$  |      |       | 0.75 | $\Omega$      |   |

Note 5: 0.5% and 1% SOT23 only

For definitions of reference voltage temperature coefficient and dynamic output impedance see NOTES following DC TEST CIRCUITS

**DC Test Circuits**

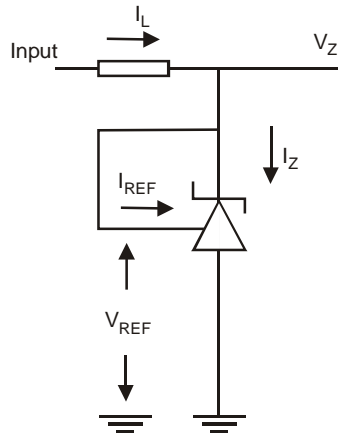


Fig. 1 Test Circuit for  $V_Z = V_{REF}$

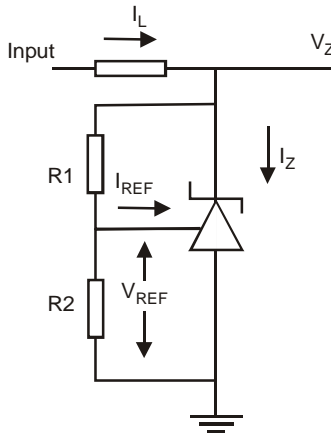


Fig. 2 Test Circuit for  $V_Z > V_{REF}$

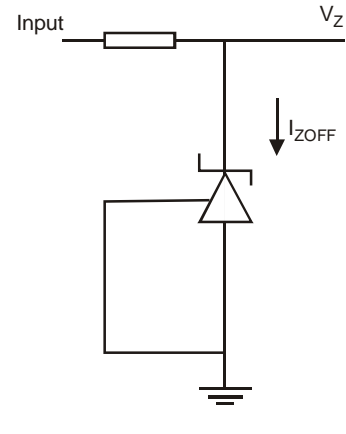
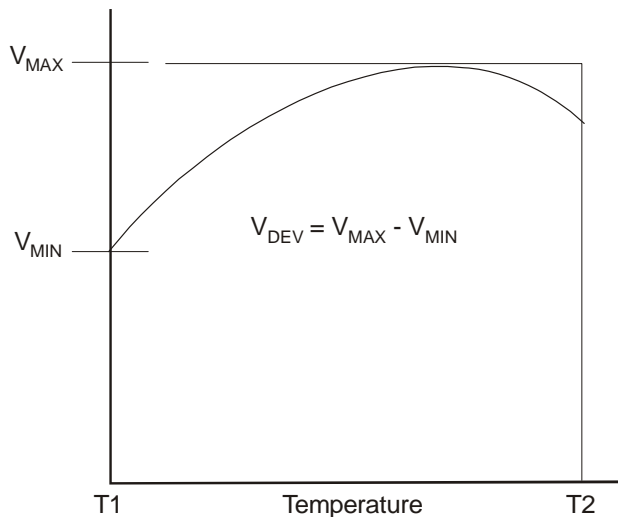


Fig.3 Test Circuit for Off State Current

Deviation of reference input voltage,  $V_{DEV}$ , is defined as the maximum variation of the reference input voltage over the full temperature range.

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



$$V_{ref} \text{ (ppm/}^\circ\text{C)} = \frac{V_{dev} \times 1000000}{V_{ref} (T1 - T2)}$$

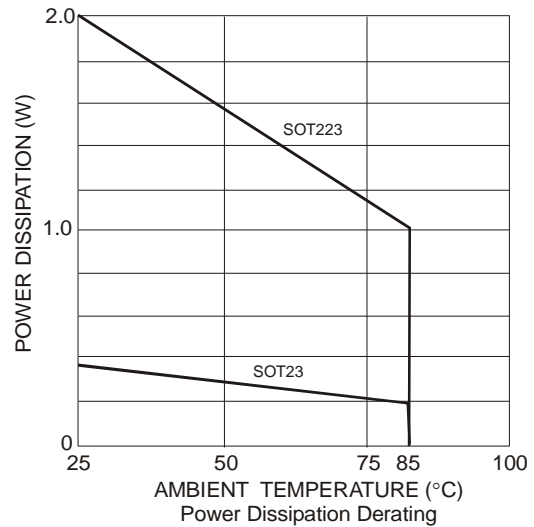
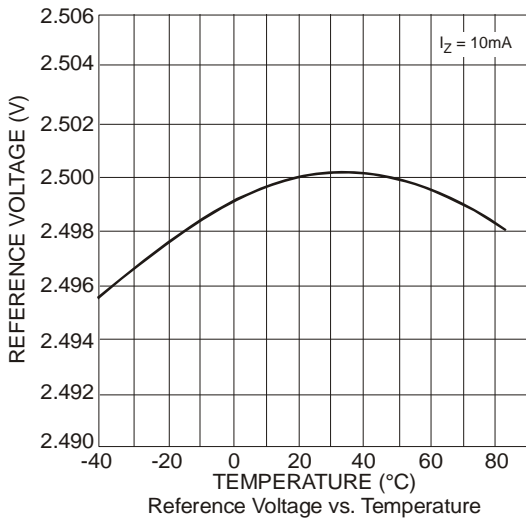
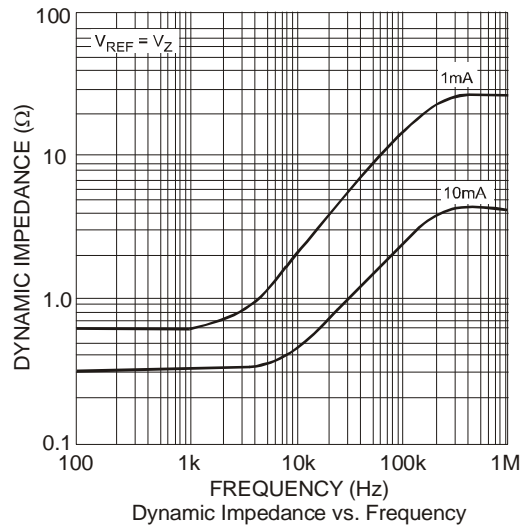
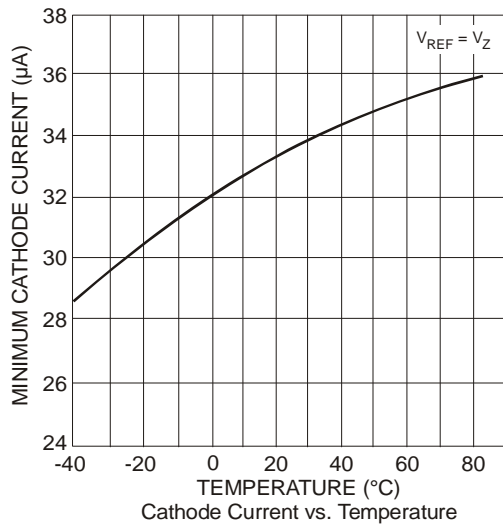
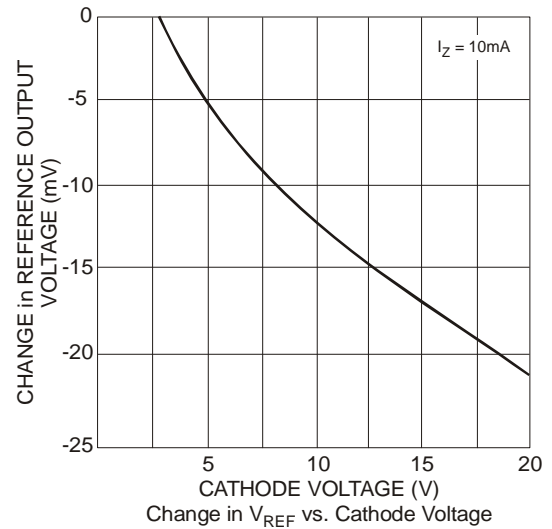
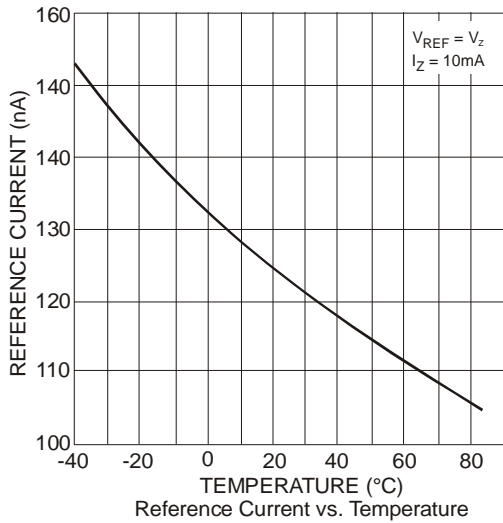
The dynamic output impedance,  $R_Z$  is defined as:

$$R_Z = \frac{\Delta V_Z}{\Delta I_Z}$$

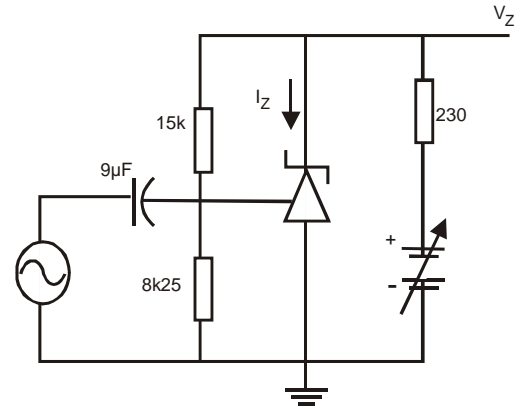
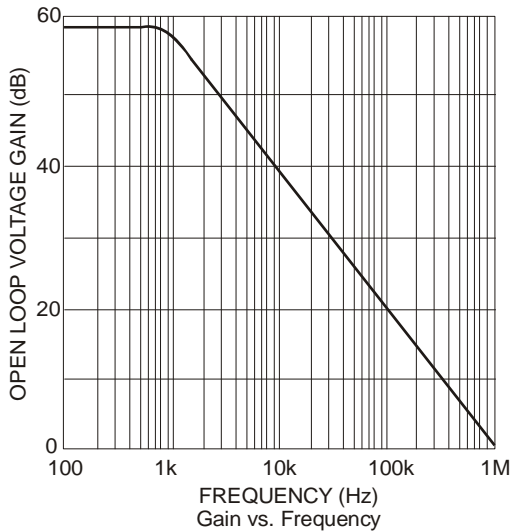
When the device is programmed with two external resistors,  $R1$  and  $R2$ , (Fig 2), the dynamic output impedance of the overall circuit,  $R'$ , is defined as:

$$R' = R_Z \left( 1 + \frac{R1}{R2} \right)$$

**Typical Characteristics**

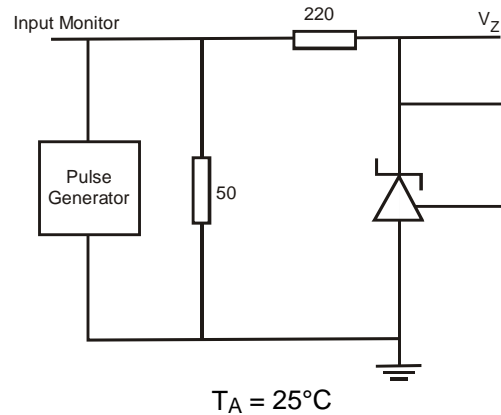
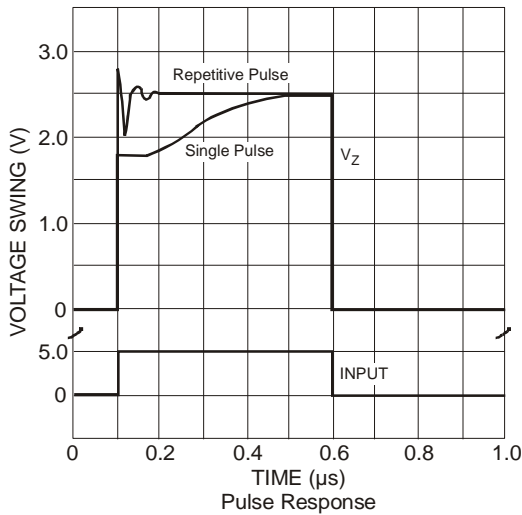


**Typical Characteristics (cont.)**



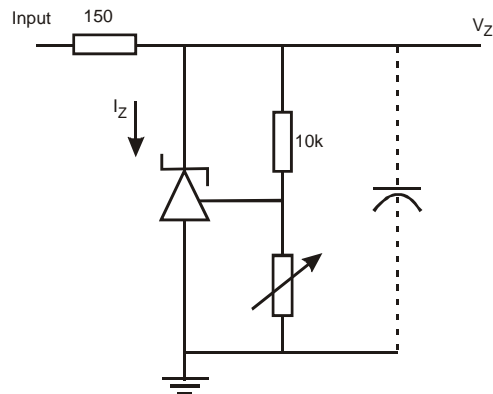
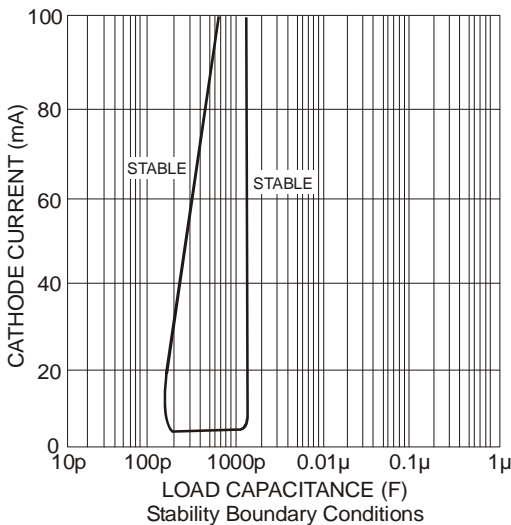
$I_Z = 10\text{mA}$ ,  $T_A = 25^\circ\text{C}$

**Test Circuit for Open Loop Voltage Gain**



$T_A = 25^\circ\text{C}$

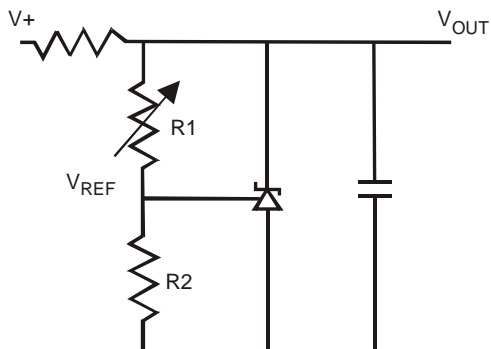
**Test Circuit for Pulse Response**



$V_{REF} < V_Z < 20$ ,  $I_Z = 10\text{mA}$ ,  $T_A = 25^\circ\text{C}$

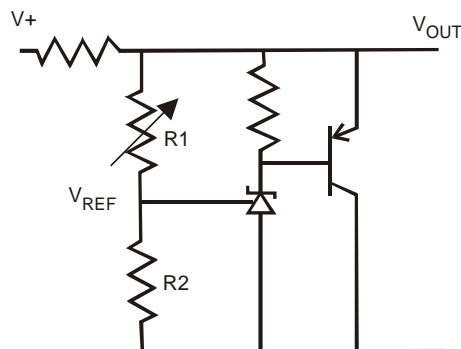
**Test Circuit for Stability Boundary Conditions**

**Application Characteristics**



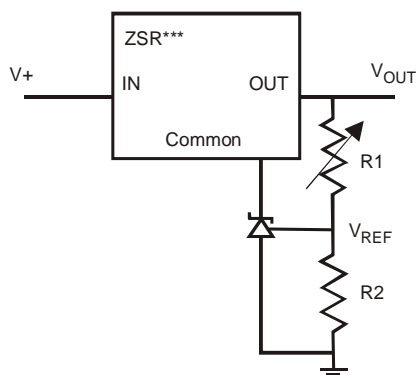
$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

**SHUNT REGULATOR**



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

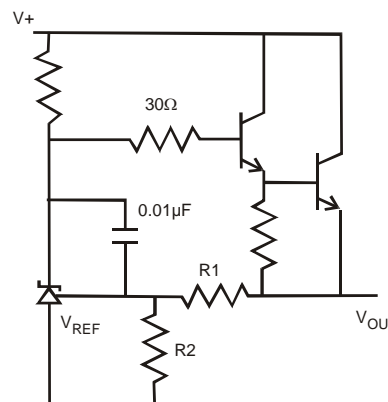
**HIGHER CURRENT SHUNT REGULATOR**



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

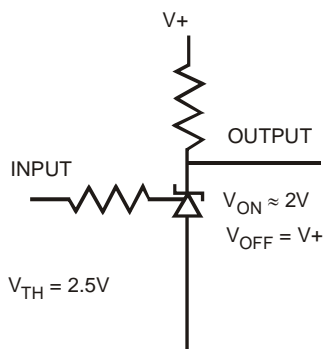
$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

**OUTPUT CONTROL OF A THREE TERMINAL FIXED REGULATOR**

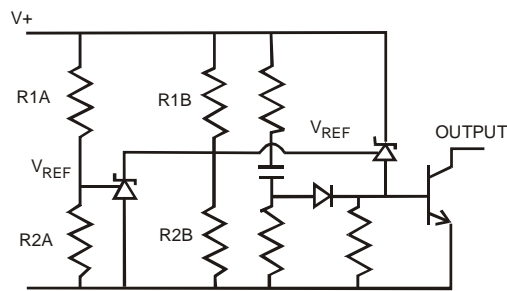


$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) V_{REF}$$

**SERIES REGULATOR**



**SINGLE SUPPLY COMPARATOR WITH TEMPERATURE COMPENSATED THRESHOLD**

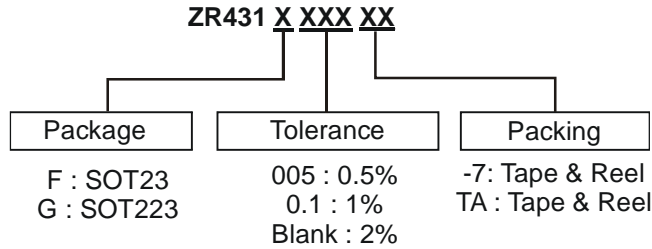


$$\text{Low limit} + \left(1 + \frac{R1B}{R2B}\right) V_{REF}$$

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

**OVER VOLTAGE/UNDER VOLTAGE PROTECTION CIRCUIT**

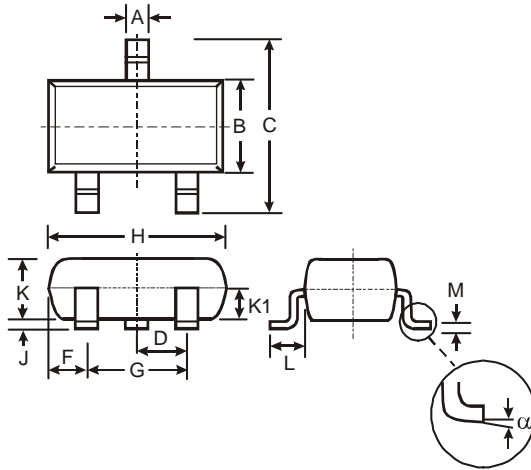
**Ordering Information**



| Device      | Tolerance | Package Code | Part Mark | Packaging | 7" Tape and Reel |                    |
|-------------|-----------|--------------|-----------|-----------|------------------|--------------------|
|             |           |              |           |           | Quantity         | Part Number Suffix |
| ZR431F005-7 | 0.5%      | F            | 43R       | SOT23     | 3000/Tape & Reel | -7                 |
| ZR431F005TA | 0.5%      | F            | 43R       | SOT23     | 3000/Tape & Reel | TA                 |
| ZR431F01-7  | 1%        | F            | 43B       | SOT23     | 3000/Tape & Reel | -7                 |
| ZR431F01TA  | 1%        | F            | 43B       | SOT23     | 3000/Tape & Reel | TA                 |
| ZR431FTA    | 2%        | F            | 43A       | SOT23     | 3000/Tape & Reel | TA                 |
| ZR431GTA    | 2%        | G            | ZR431     | SOT223    | 1000/Tape & Reel | TA                 |

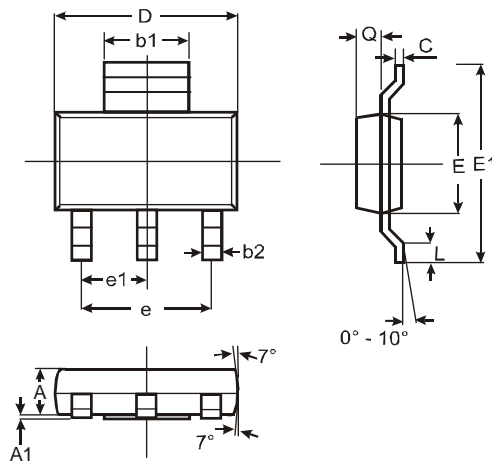
**Package Outline Dimensions (All Dimensions in mm)**

**(1) Package Type: 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 |       |      |       |

**(2) Package Type: SOT223**



| SOT223               |       |      |      |
|----------------------|-------|------|------|
| Dim                  | Min   | Max  | Typ  |
| A                    | 1.55  | 1.65 | 1.60 |
| A1                   | 0.010 | 0.15 | 0.05 |
| b1                   | 2.90  | 3.10 | 3.00 |
| b2                   | 0.60  | 0.80 | 0.70 |
| C                    | 0.20  | 0.30 | 0.25 |
| D                    | 6.45  | 6.55 | 6.50 |
| E                    | 3.45  | 3.55 | 3.50 |
| E1                   | 6.90  | 7.10 | 7.00 |
| e                    | —     | —    | 4.60 |
| e1                   | —     | —    | 2.30 |
| L                    | 0.85  | 1.05 | 0.95 |
| Q                    | 0.84  | 0.94 | 0.89 |
| All Dimensions in mm |       |      |      |



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