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)

Applications

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


Typical Application Circuit
Absolute Maximum Ratings (Note 2)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_Z$</td>
<td>Cathode Voltage</td>
<td>20</td>
<td>V</td>
</tr>
<tr>
<td>$I_Z$</td>
<td>Cathode Current</td>
<td>150</td>
<td>mA</td>
</tr>
<tr>
<td>$T_A$</td>
<td>Operating Temperature</td>
<td>-40 to +85</td>
<td>°C</td>
</tr>
<tr>
<td>$T_{ST}$</td>
<td>Storage Temperature</td>
<td>-55 to +125</td>
<td>°C</td>
</tr>
<tr>
<td>$P_D$</td>
<td>Power Dissipation (Notes 3, 4)</td>
<td>SOT23</td>
<td>330</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SOT223</td>
<td>2</td>
</tr>
</tbody>
</table>

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 (TA = 25°C)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_Z$</td>
<td>Cathode Voltage</td>
<td>$V_{REF}$</td>
<td>20</td>
<td>V</td>
</tr>
<tr>
<td>$I_Z$</td>
<td>Cathode Current</td>
<td>0.05</td>
<td>100</td>
<td>mA</td>
</tr>
</tbody>
</table>

Electrical Characteristics (TA = 25°C unless otherwise specified)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Test Conditions</th>
<th>Min</th>
<th>Typ.</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{REF}$</td>
<td>Reference voltage (Note 5)</td>
<td>$I_L = 10mA$ ($V_Z = V_{REF}$)</td>
<td>2.45</td>
<td>2.50</td>
<td>2.55</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_Z = 10mA$ ($V_Z = V_{REF}$)</td>
<td>2.475</td>
<td>2.50</td>
<td>2.525</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_Z = 10mA$ ($V_Z = V_{REF}$)</td>
<td>2.487</td>
<td>2.50</td>
<td>2.513</td>
<td>V</td>
</tr>
<tr>
<td>$V_{DEV}$</td>
<td>Deviation of reference input voltage over temperature</td>
<td>$I_L = 10mA$, $V_Z = V_{REF}$</td>
<td>$T_A$ = Full range ($V_{REF}$)</td>
<td>8.0</td>
<td>17</td>
<td>mV</td>
</tr>
<tr>
<td>$\Delta V_{REF}$</td>
<td>Ratio of the change in reference voltage to the change in cathode voltage</td>
<td>$V_Z$ from $V_{REF}$ to 10V</td>
<td>$I_Z = 10mA$ ($V_Z = V_{REF}$)</td>
<td>-1.85</td>
<td>-2.7</td>
<td>mV/V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_Z$ from 10V to 20V</td>
<td>-1.0</td>
<td>-2.0</td>
<td></td>
<td>mV/V</td>
</tr>
<tr>
<td>$I_{REF}$</td>
<td>Reference input current</td>
<td>$R_1 = 10k$, $R_2 = O/C$, $I_L = 10mA$ ($V_{REF}$)</td>
<td>0.12</td>
<td>1.0</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>$\Delta I_{REF}$</td>
<td>Deviation of reference input current over temperature</td>
<td>$R_1 = 10k$, $R_2 = O/C$, $I_L = 10mA$ ($V_{REF}$)</td>
<td>0.04</td>
<td>0.2</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>$I_{Z(MIN)}$</td>
<td>Minimum cathode current for regulation</td>
<td>$V_Z = V_{REF}$ ($V_Z = V_{REF}$)</td>
<td>35</td>
<td>50</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>$I_{Z(OFF)}$</td>
<td>Off-state current</td>
<td>$V_Z = 20V$, $V_{REF} = 0V$ ($V_{REF}$)</td>
<td>0.1</td>
<td></td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>$R_Z$</td>
<td>Dynamic output impedance</td>
<td>$V_Z = V_{REF}$ ($f = 0Hz$)</td>
<td>0.75</td>
<td></td>
<td></td>
<td>Ω</td>
</tr>
</tbody>
</table>

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
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, $R_1$ and $R_2$, (Fig 2), the dynamic output impedance of the overall circuit, $R'$, is defined as:

\[
R' = R_Z(1 + \frac{R_1}{R_2})
\]
Typical Characteristics

Reference Current vs. Temperature

Change in Reference Output Voltage vs. Cathode Voltage

Minimum Cathode Current vs. Temperature

Dynamic Impedance vs. Frequency

Reference Voltage vs. Temperature

Power Dissipation vs. Ambient Temperature
Typical Characteristics (cont.)

- **Open Loop Voltage Gain (dB)**
  
  ![Open Loop Voltage Gain Graph](image)

- **Gain vs. Frequency**

- **Voltage Swing (V)**

  ![Voltage Swing Graph](image)

- **Pulse Response**

  ![Pulse Response Graph](image)

- **Stability Boundary Conditions**

  ![Stability Boundary Conditions Graph](image)
Application Characteristics

SHUNT REGULATOR

\[ V_{OUT} = \left(1 + \frac{R_1}{R_2}\right) V_{REF} \]

HIGHER CURRENT SHUNT REGULATOR

\[ V_{OUT} = \left(1 + \frac{R_1}{R_2}\right) V_{REF} \]

OUTPUT CONTROL OF A THREE TERMINAL FIXED REGULATOR

\[ V_{OUT} = V_{REF} + V_{REG} \]

SERIES REGULATOR

\[ V_{OUT} = \left(1 + \frac{R_1}{R_2}\right) V_{REF} \]

SINGLE SUPPLY COMPARATOR WITH TEMPERATURE COMPENSATED THRESHOLD

\[ V_{TH} = 2.5\text{V} \]

\[ V_{ON} = 2\text{V} \]

\[ V_{OFF} = V_{+} \]

OVER VOLTAGE/UNDER VOLTAGE PROTECTION CIRCUIT

\[ \text{Low limit} + \left(1 + \frac{R_{1B}}{R_{2B}}\right) V_{REF} \]

\[ \text{High limit} + \left(1 + \frac{R_{1A}}{R_{2A}}\right) V_{REF} \]
## Ordering Information

<table>
<thead>
<tr>
<th>Device</th>
<th>Tolerance</th>
<th>Package Code</th>
<th>Part Mark</th>
<th>Packaging</th>
<th>Quantity</th>
<th>Part Number Suffix</th>
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<tbody>
<tr>
<td>ZR431F005-7</td>
<td>0.5%</td>
<td>F</td>
<td>43R</td>
<td>SOT23</td>
<td>3000/Tape &amp; Reel</td>
<td>-7</td>
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<tr>
<td>ZR431F005TA</td>
<td>0.5%</td>
<td>F</td>
<td>43R</td>
<td>SOT23</td>
<td>3000/Tape &amp; Reel</td>
<td>TA</td>
</tr>
<tr>
<td>ZR431F01-7</td>
<td>1%</td>
<td>F</td>
<td>43B</td>
<td>SOT23</td>
<td>3000/Tape &amp; Reel</td>
<td>-7</td>
</tr>
<tr>
<td>ZR431F01TA</td>
<td>1%</td>
<td>F</td>
<td>43B</td>
<td>SOT23</td>
<td>3000/Tape &amp; Reel</td>
<td>TA</td>
</tr>
<tr>
<td>ZR431FTA</td>
<td>2%</td>
<td>F</td>
<td>43A</td>
<td>SOT23</td>
<td>3000/Tape &amp; Reel</td>
<td>TA</td>
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<tr>
<td>ZR431GTA</td>
<td>2%</td>
<td>G</td>
<td>ZR431</td>
<td>SOT223</td>
<td>1000/Tape &amp; Reel</td>
<td>TA</td>
</tr>
</tbody>
</table>

### Footer
- Diodes Incorporated
- October 2011
- www.diodes.com
- Document number: DS33255 Rev. 6 - 2

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**ZR431**

ADJUSTABLE PRECISION ZENER SHUNT REGULATOR
Package Outline Dimensions (All Dimensions in mm)

(1) Package Type: SOT23

(2) Package Type: SOT223

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**SOT23**

<table>
<thead>
<tr>
<th>Dim</th>
<th>Min</th>
<th>Max</th>
<th>Typ</th>
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<tbody>
<tr>
<td>A</td>
<td>0.37</td>
<td>0.51</td>
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<td>B</td>
<td>1.20</td>
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<td>1.30</td>
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<tr>
<td>C</td>
<td>2.30</td>
<td>2.50</td>
<td>2.40</td>
</tr>
<tr>
<td>D</td>
<td>0.89</td>
<td>1.03</td>
<td>0.915</td>
</tr>
<tr>
<td>F</td>
<td>0.45</td>
<td>0.60</td>
<td>0.535</td>
</tr>
<tr>
<td>G</td>
<td>1.78</td>
<td>2.05</td>
<td>1.83</td>
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<tr>
<td>H</td>
<td>2.80</td>
<td>3.00</td>
<td>2.90</td>
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<tr>
<td>J</td>
<td>0.013</td>
<td>0.10</td>
<td>0.05</td>
</tr>
<tr>
<td>K</td>
<td>0.903</td>
<td>1.10</td>
<td>1.00</td>
</tr>
<tr>
<td>K1</td>
<td>-</td>
<td>-</td>
<td>0.400</td>
</tr>
<tr>
<td>L</td>
<td>0.45</td>
<td>0.61</td>
<td>0.55</td>
</tr>
<tr>
<td>M</td>
<td>0.085</td>
<td>0.18</td>
<td>0.11</td>
</tr>
<tr>
<td>α</td>
<td>0°</td>
<td>8°</td>
<td>-</td>
</tr>
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</table>

All Dimensions in mm

---

**SOT223**

<table>
<thead>
<tr>
<th>Dim</th>
<th>Min</th>
<th>Max</th>
<th>Typ</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.55</td>
<td>1.65</td>
<td>1.60</td>
</tr>
<tr>
<td>A1</td>
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<td>0.15</td>
<td>0.05</td>
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<tr>
<td>b1</td>
<td>2.90</td>
<td>3.10</td>
<td>3.00</td>
</tr>
<tr>
<td>b2</td>
<td>0.60</td>
<td>0.80</td>
<td>0.70</td>
</tr>
<tr>
<td>C</td>
<td>0.20</td>
<td>0.30</td>
<td>0.25</td>
</tr>
<tr>
<td>D</td>
<td>6.45</td>
<td>6.55</td>
<td>6.50</td>
</tr>
<tr>
<td>E</td>
<td>3.45</td>
<td>3.55</td>
<td>3.50</td>
</tr>
<tr>
<td>E1</td>
<td>6.90</td>
<td>7.10</td>
<td>7.00</td>
</tr>
<tr>
<td>e</td>
<td>—</td>
<td>—</td>
<td>4.60</td>
</tr>
<tr>
<td>e1</td>
<td>—</td>
<td>—</td>
<td>2.30</td>
</tr>
<tr>
<td>L</td>
<td>0.85</td>
<td>1.05</td>
<td>0.95</td>
</tr>
<tr>
<td>Q</td>
<td>0.84</td>
<td>0.94</td>
<td>0.89</td>
</tr>
</tbody>
</table>

All Dimensions in mm
ADJUSTABLE PRECISION ZENER SHUNT REGULATOR

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