KA431 / KA431A / KA431L
Programmable Shunt Regulator

Features
• Programmable Output Voltage to 36 V
• Low Dynamic Output Impedance: 0.2 Ω (Typical)
• Sink Current Capability: 1.0 to 100 mA
• Equivalent Full-Range Temperature Coefficient of 50 ppm/°C (Typical)
• Temperature Compensated for Operation Over Full Rated Operating Temperature Range
• Low Output Noise Voltage
• Fast Turn-on Response

Description
The KA431 / KA431A / KA431L are three-terminal adjustable regulators with a guaranteed thermal stability over the operating temperature range. The output voltage can be set to any value between V_REF (approximately 2.5 V) and 36 V with two external resistors. These devices have a typical dynamic output impedance of 0.2 Ω. Active output circuitry provides a sharp turn-on characteristic, making these devices excellent replacements for Zener diodes in many applications.

Ordering Information

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<th>Part Number</th>
<th>Operating Temperature Range</th>
<th>Output Voltage Tolerance</th>
<th>Top Mark</th>
<th>Package</th>
<th>Packing Method</th>
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<td>KA431DTF</td>
<td>-25 ~ +85°C</td>
<td>2%</td>
<td>431</td>
<td>8-SOIC</td>
<td>Tape and Reel</td>
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<td>431A</td>
<td>8-SOIC</td>
<td>Tape and Reel</td>
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<td>1%</td>
<td>KA431AZ</td>
<td>TO-92</td>
<td>Bulk</td>
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<td>KA431AZ</td>
<td>TO-92</td>
<td>Ammo</td>
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<td>0.5%</td>
<td>KA431LZ</td>
<td>TO-92</td>
<td>Ammo</td>
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Block Diagram

Figure 1. Block Diagram

Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only. Values are at $T_A = 25^\circ C$ unless otherwise noted.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
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<tr>
<td>$V_{KA}$</td>
<td>Cathode Voltage</td>
<td>37</td>
<td>V</td>
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<tr>
<td>$I_{KA}$</td>
<td>Cathode Current Range (Continuous)</td>
<td>-100 to +150</td>
<td>mA</td>
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<tr>
<td>$I_{REF}$</td>
<td>Reference Input Current Range</td>
<td>-0.05 to +10</td>
<td>mA</td>
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<td>$P_D$</td>
<td>Power Dissipation TO-92, 8-SOIC Packages</td>
<td>770</td>
<td>mW</td>
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<tr>
<td>$R_{\theta JA}$</td>
<td>Thermal Resistance, Junction to Ambient TO-92, 8-SOIC Packages</td>
<td>160</td>
<td>°C/W</td>
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<tr>
<td>$T_{OPR}$</td>
<td>Operating Temperature Range</td>
<td>-25 to +85</td>
<td>°C</td>
</tr>
<tr>
<td>$T_J$</td>
<td>Junction Temperature</td>
<td>150</td>
<td>°C</td>
</tr>
<tr>
<td>$T_{STG}$</td>
<td>Storage Temperature Range</td>
<td>-65 to +150</td>
<td>°C</td>
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Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to Absolute Maximum Ratings.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min.</th>
<th>Max.</th>
<th>Unit</th>
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<tr>
<td>$V_{KA}$</td>
<td>Cathode Voltage</td>
<td>$V_{REF}$</td>
<td>36</td>
<td>V</td>
</tr>
<tr>
<td>$I_{KA}$</td>
<td>Cathode Current</td>
<td>1</td>
<td>100</td>
<td>mA</td>
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</table>
# Electrical Characteristics

Values are at $T_A = 25^\circ C$ unless otherwise noted.

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<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>KA431</th>
<th>KA431A</th>
<th>KA431L</th>
<th>Unit</th>
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<tr>
<td>V&lt;sub&gt;REF&lt;/sub&gt;</td>
<td>Reference Input Voltage</td>
<td>$V_{KA} = V_{REF}$, $I_{KA} = 10 \text{ mA}$</td>
<td>2.450</td>
<td>2.500</td>
<td>2.550</td>
<td>V</td>
</tr>
<tr>
<td>$\Delta V_{REF}/\Delta T$</td>
<td>Deviation of Reference Input Voltage Over-Temperature</td>
<td>$V_{KA} = V_{REF}$, $I_{KA} = 10 \text{ mA}$</td>
<td>4.5</td>
<td>17.0</td>
<td>4.5</td>
<td>mV</td>
</tr>
<tr>
<td>$\Delta V_{REF}/\Delta V_{KA}$</td>
<td>Ratio of Change in Reference Input Voltage to the Change in Cathode Voltage</td>
<td>$I_{KA} = 10 \text{ mA}$</td>
<td>-1.0</td>
<td>-2.7</td>
<td>-1.0</td>
<td>mV / V</td>
</tr>
<tr>
<td>$\Delta I_{REF}/\Delta T$</td>
<td>Deviation of Reference Input Current Over Full Temperature Range</td>
<td>$I_{KA} = 10 \text{ mA}$, $R_1 = 10 \text{ k}\Omega$, $R_2 = \infty$</td>
<td>0.4</td>
<td>1.2</td>
<td>0.4</td>
<td>μA</td>
</tr>
<tr>
<td>$I_{KA(MIN)}$</td>
<td>Minimum Cathode Current for Regulation</td>
<td>$V_{KA} = V_{REF}$</td>
<td>0.45</td>
<td>1.00</td>
<td>0.45</td>
<td>mA</td>
</tr>
<tr>
<td>$I_{KA(OFF)}$</td>
<td>Off - Stage Cathode Current</td>
<td>$V_{KA} = 36 \text{ V}$, $V_{REF} = 0$</td>
<td>0.05</td>
<td>1.00</td>
<td>0.05</td>
<td>μA</td>
</tr>
<tr>
<td>$Z_{KA}$</td>
<td>Dynamic Impedance</td>
<td>$V_{KA} = V_{REF}$, $I_{KA} = 1 \text{ to } 100 \text{ mA}$</td>
<td>0.15</td>
<td>0.50</td>
<td>0.15</td>
<td>Ω</td>
</tr>
</tbody>
</table>

Note:

1. $T_{MIN} = -25^\circ C$, $T_{MAX} = +85^\circ C$. 
Test Circuits

Figure 2. Test Circuit for $V_{KA} = V_{REF}$

Figure 3. Test Circuit for $V_{KA} \geq V_{REF}$

Figure 4. Test Circuit for $I_{KA(OFF)}$
Typical Performance Characteristics

Figure 5. Cathode Current vs. Cathode Voltage

Figure 6. Cathode Current vs. Cathode Voltage

Figure 7. Change in Reference Input Voltage vs. Cathode Voltage

Figure 8. Dynamic Impedance Frequency

Figure 9. Small Signal Voltage Amplification vs. Frequency

Figure 10. Pulse Response
Typical Performance Characteristics (Continued)

Figure 11. Stability Boundary Conditions

![Stability Boundary Conditions Diagram]

- **A**: \( V_c = V_{ref} \)
- **B**: \( V_c = 5.0 \text{V} \) @ \( I_C = 10 \text{mA} \)
- **C**: \( V_c = 10 \text{V} \) @ \( I_C = 10 \text{mA} \)
- **D**: \( V_c = 15 \text{V} \) @ \( I_C = 10 \text{mA} \)
- \( T_A = 25^\circ \text{C} \)
Typical Application

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

Figure 12. Shunt Regulator

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

Figure 13. Output Control for Three-Terminal Fixed Regulator

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

Figure 14. High-Current Shunt Regulator

Figure 15. Current Limit or Current Source

Figure 16. Constant-Current Sink

Physical Dimensions

TO-92 Bulk Type

Figure 17. 3-Lead, TO-92, Molded, Standard Straight Lead

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Physical Dimensions (Continued)

TO-92 Ammo Type

Figure 18. 3-Lead, TO-92, Molded, 0.200 in Line Spacing Lead Form

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Physical Dimensions (Continued)

8-SOIC

Figure 19. 8-Lead, SOIC, JEDEC MS 0-12, 0.150 inch Narrow Body

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