

Description

The A431 series are 3-terminal precision shunt regulators that are programmable over a wide voltage range of 2.495V to 16V with $\pm 0.5\%$, $\pm 1.0\%$ tolerance. The A431 series have a low dynamic impedance of $0.15\ \Omega$. These features make the A431 series an excellent replacement for zener diodes in numerous applications circuits that require a precision reference voltage.

Features

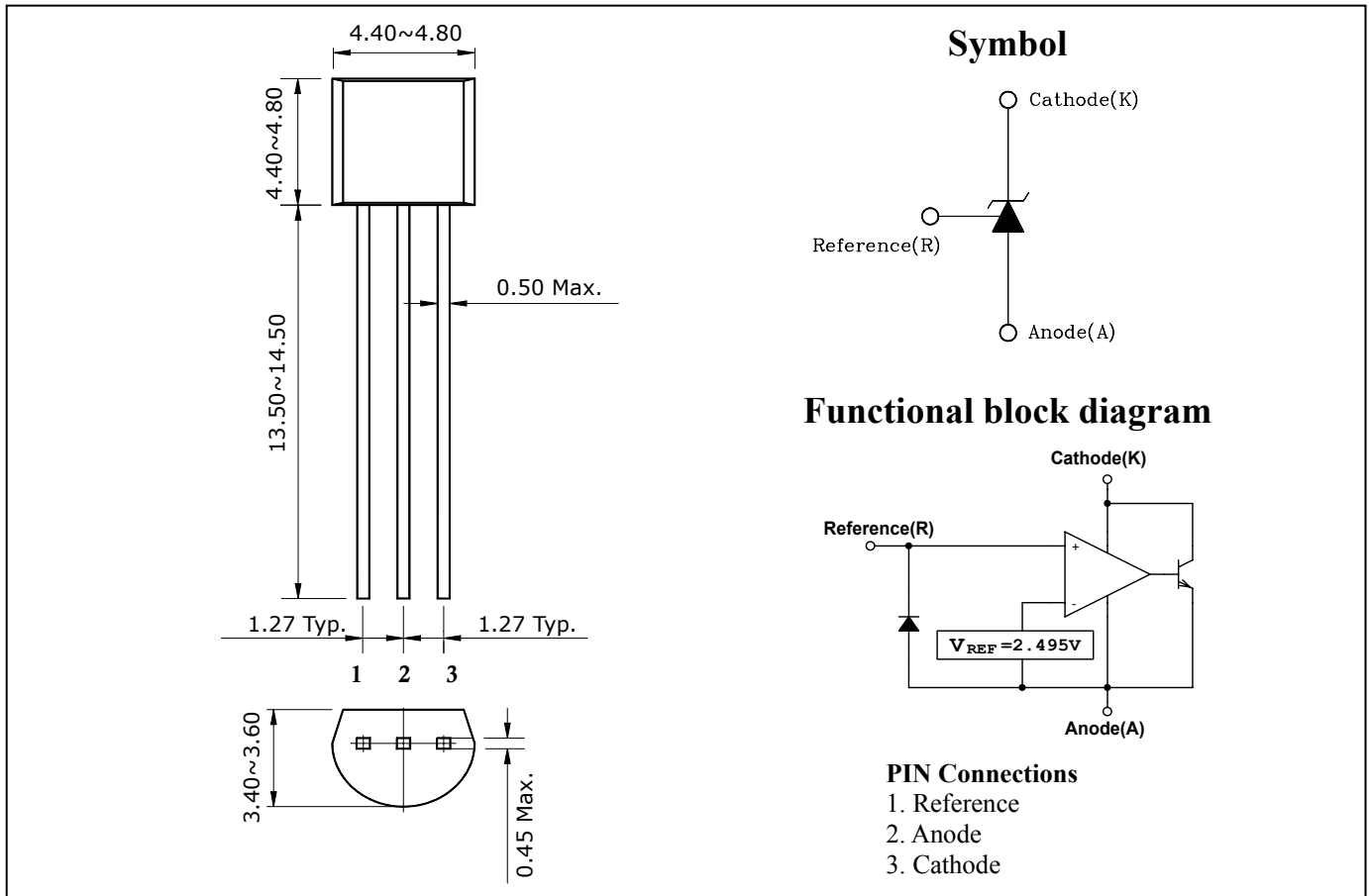
- Programmable output voltage from 2.495V to 16V
- Voltage reference tolerance : $\pm 0.5\%$, $\pm 1.0\%$
- Cathode current capability of 1mA to 100mA

Ordering Information

| Type NO. | Marking | Package Code |
|----------|---------|--------------|
| A431x | A431□ | TO-92 |

□ : Grade => A: $\pm 1\%$, B: $\pm 0.5\%$

Outline Dimensions (Unit : mm)



Absolute maximum ratings

[Ta=25°C]

| Characteristic | Symbol | Rating | Unit |
|-----------------------------|-----------|------------|------|
| Cathode to Anode voltage | V_{KA} | 18 | V |
| Cathode current | I_K | 150 | mA |
| Reference input current | I_{ref} | 10 | mA |
| Power Dissipation | P_D | 625 | mW |
| Junction Temperature | T_J | 150 | °C |
| Operating temperature range | T_{opr} | -40 ~ +85 | °C |
| Storage temperature range | T_{stg} | -55 ~ +150 | °C |

Recommended operating conditions

| Characteristic | Symbol | Rating | | Unit |
|--------------------------|----------|-----------|------|------|
| | | Min. | Max. | |
| Cathode to Anode voltage | V_{KA} | V_{ref} | 16 | V |
| Cathode current | I_K | 1 | 100 | mA |

Electrical Characteristics (Ta=25°C, unless otherwise noted.)

| Characteristic | Symbol | Condition | Min. | Typ. | Max. | Unit | |
|---|--|--|-------|-------|-------|-------|---|
| Reference voltage (Fig.1) | V_{ref} | $V_{KA}=V_{ref}, I_K=10mA$ | A431B | 2.482 | 2.495 | 2.508 | V |
| | | | A431A | 2.470 | | 2.520 | |
| Reference input voltage deviation over temperature (Fig.1, Note1,2) | ΔV_{ref} | $V_{KA}=V_{ref}, I_K=10mA$ @ 0°C ≤ Ta ≤ 70°C | - | 7 | 30 | mV | |
| Ratio of delta reference input voltage to delta cathode voltage (Fig.2) | $\frac{\Delta V_{ref}}{\Delta V_{KA}}$ | $I_K=10mA$ $V_{ref} \leq V_{KA} \leq 16V$ | - | -1.0 | -2.7 | mV/V | |
| | | $\Delta V_{ref}=V_{ref(16V)}-V_{ref}$ $\Delta V_{KA}=V_{KA(16V)}-V_{ref}$ | | | | | |
| Reference current (Fig.2) | I_{ref} | $I_K=10mA$ $R1=10K\Omega, R2=\infty$ | - | 1.8 | 4.0 | μA | |
| Reference input current deviation over temperature (Fig.2, Note 1,2) | ΔI_{ref} | $I_K=10mA$ $R1=10K\Omega, R2=\infty$ @ 0°C ≤ Ta ≤ 70°C | - | 0.4 | 2.5 | μA | |
| Minimum cathode current for regulation | $I_{K(MIN)}$ | $V_{KA}=V_{ref}$ | - | 0.35 | 1.0 | mA | |
| Off-state cathode current (Fig.3) | $I_{K(off)}$ | $V_{KA}=16V, V_{ref}=0V$ | - | 2.7 | 1000 | nA | |
| Dynamic impedance (Fig.1, Note3) | Z_{KA} | $V_{KA}=V_{ref}, f \leq 1.0KHz$ $1.0mA \leq I_K \leq 100mA$ | - | 0.15 | 0.5 | Ω | |

Fig. 1 Test circuit for $V_{KA}=V_{ref}$

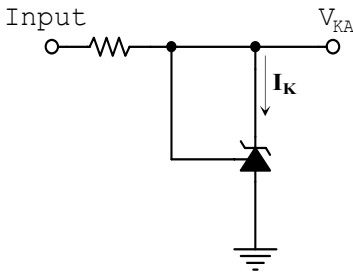
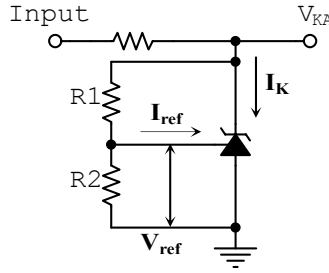
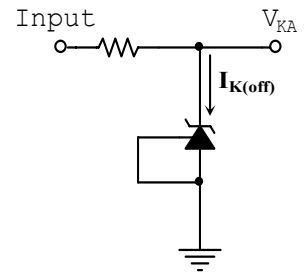


Fig. 2 Test circuit for $V_{KA}>V_{ref}$



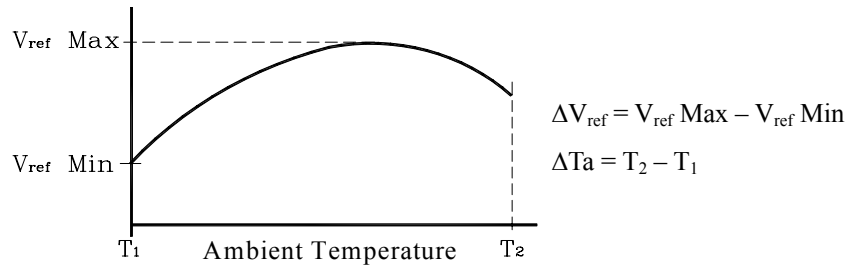
$$V_{KA} = V_{ref} \times \left(1 + \frac{R_1}{R_2}\right) + I_{ref} \times R_1$$

Fig. 3 Test circuit for $I_{K(off)}$



Note.

1. Ambient temperature range: $T_{LOW} = 0^\circ\text{C}$, $T_{HIGH} = 70^\circ\text{C}$
2. The deviation parameters ΔV_{ref} and ΔI_{ref} are defined as the difference between the maximum value and minimum value obtained over the full operating ambient temperature range that applied.



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

$$\alpha V_{ref} \left(\frac{\text{ppm}}{^\circ\text{C}}\right) = \frac{\left(\frac{\Delta V_{ref}}{V_{ref}(T_a = 25^\circ\text{C})} \times 10^6\right)}{\Delta T_a}$$

αV_{ref} can be positive or negative depending on whether $V_{ref} \text{ Min}$ or $V_{ref} \text{ Max}$ occurs at the lower ambient temperature, refer to Fig. 8

Example : $\Delta V_{ref} = 30\text{mV}$ and the slope is positive,

$$\Delta V_{ref} @ 25^\circ\text{C} = 2.495\text{V}$$

$$\Delta T_a = 70^\circ\text{C}$$

$$\alpha V_{ref} \left(\frac{\text{ppm}}{^\circ\text{C}}\right) = \frac{\left(\frac{0.03}{2.495}\right) \times 10^6}{70} = 171\text{ppm}/^\circ\text{C}$$

3. The dynamic impedance Z_{KA} is defined as:

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

When the device is operating with two external resistors, R1 and R2, (refer to Fig.2) the total dynamic impedance of the circuit is given by:

$$|Z_{KA}'| = |Z_{KA}| \times \left(1 + \frac{R_1}{R_2}\right)$$

Electrical Characteristics Curves (Continue)

Fig.4 I_K vs V_{KA} (1)

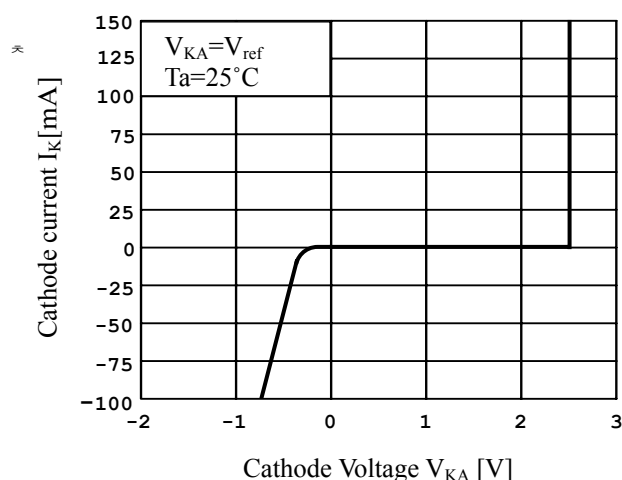


Fig.5 I_K vs V_{KA} (2)

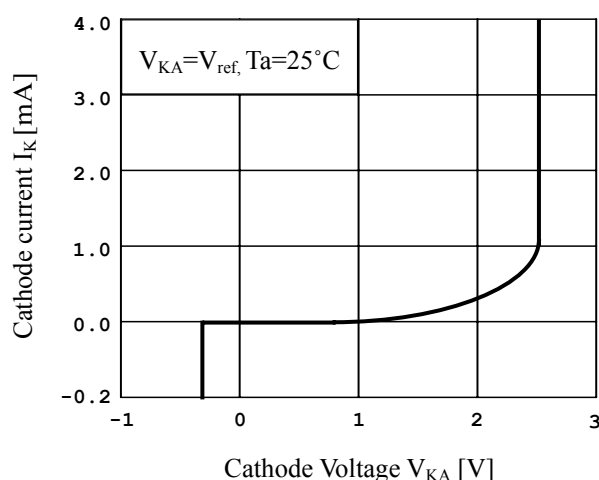


Fig.6 $I_{K(off)}$ vs V_{KA}

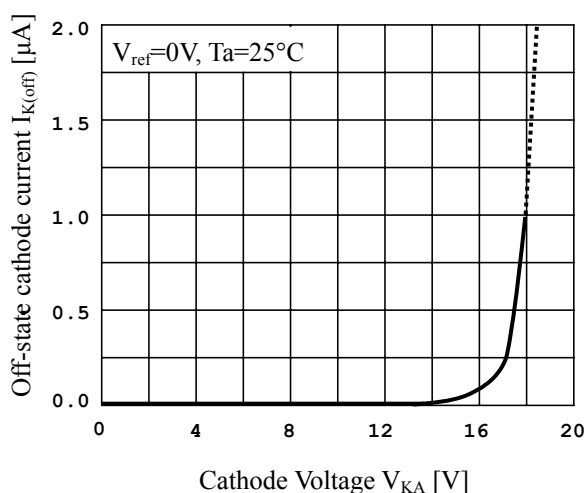


Fig.7 $\Delta V_{ref} / \Delta V_{KA}$ vs T_a

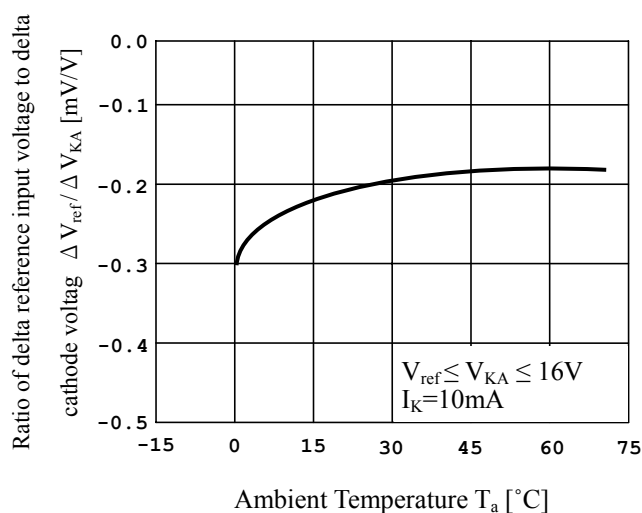


Fig.8 V_{ref} vs T_a

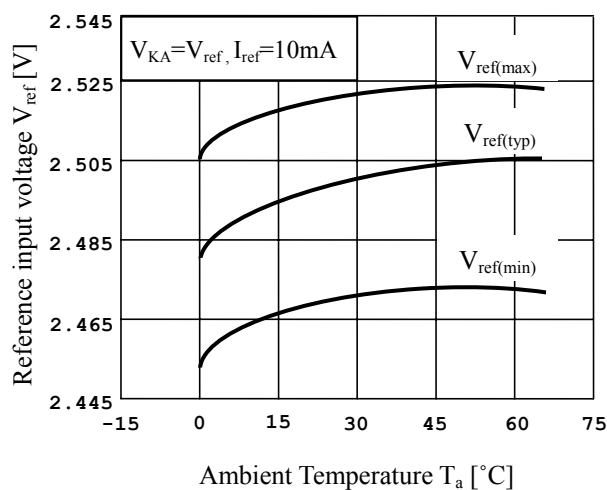
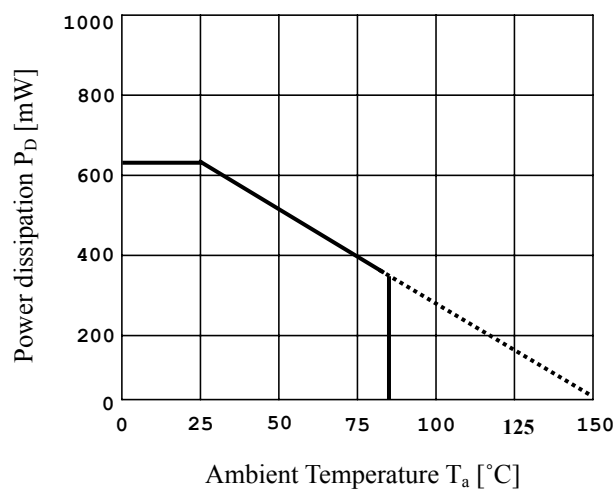


Fig.9 P_D vs T_a



Electrical Characteristics Curves

Fig.10 Pulse Response

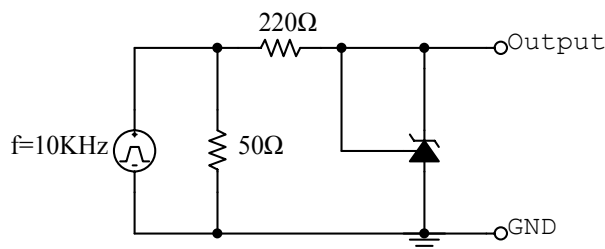
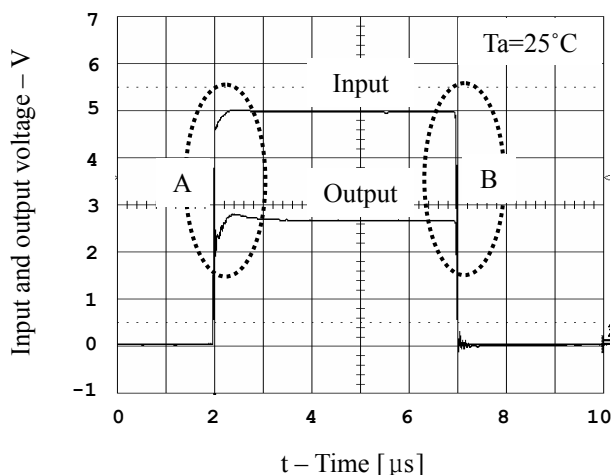


Fig.11 Test circuit for Fig. 10

Fig.12 Pulse Response (Magnify A of Fig.10)

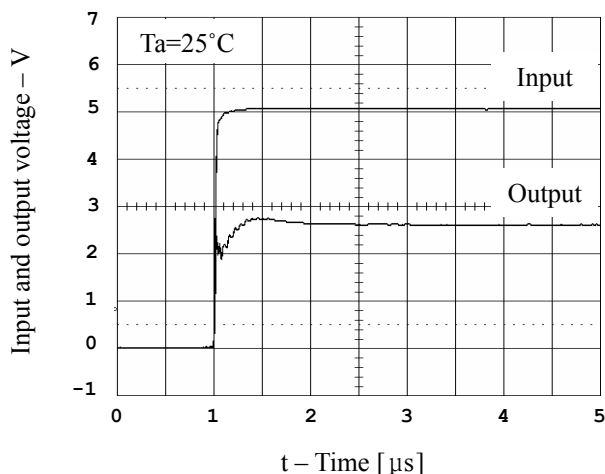


Fig.13 Pulse Response (Magnify B of Fig.10)

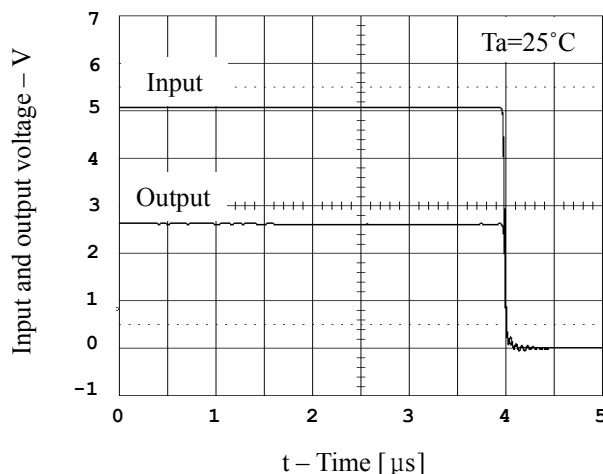
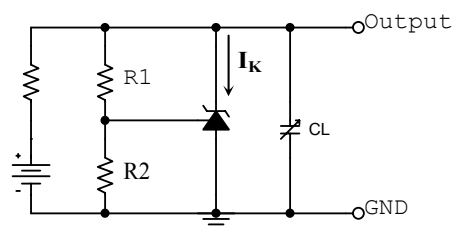
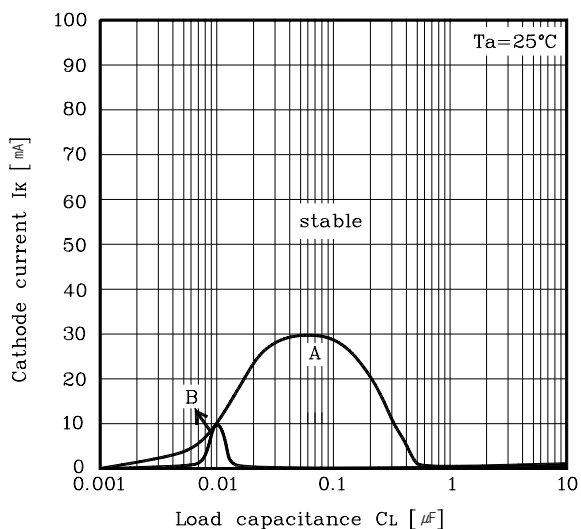


Fig.14 Stability Boundary Conditions



| Unstable Regions | V_{KA} | R_1 [K Ω] | R_2 [K Ω] |
|------------------|-----------|---------------------|---------------------|
| A | V_{ref} | 0 | ∞ |
| B | 10V | 10 | 3.325 |

Fig.15 Test circuit for Fig. 14

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