

## 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

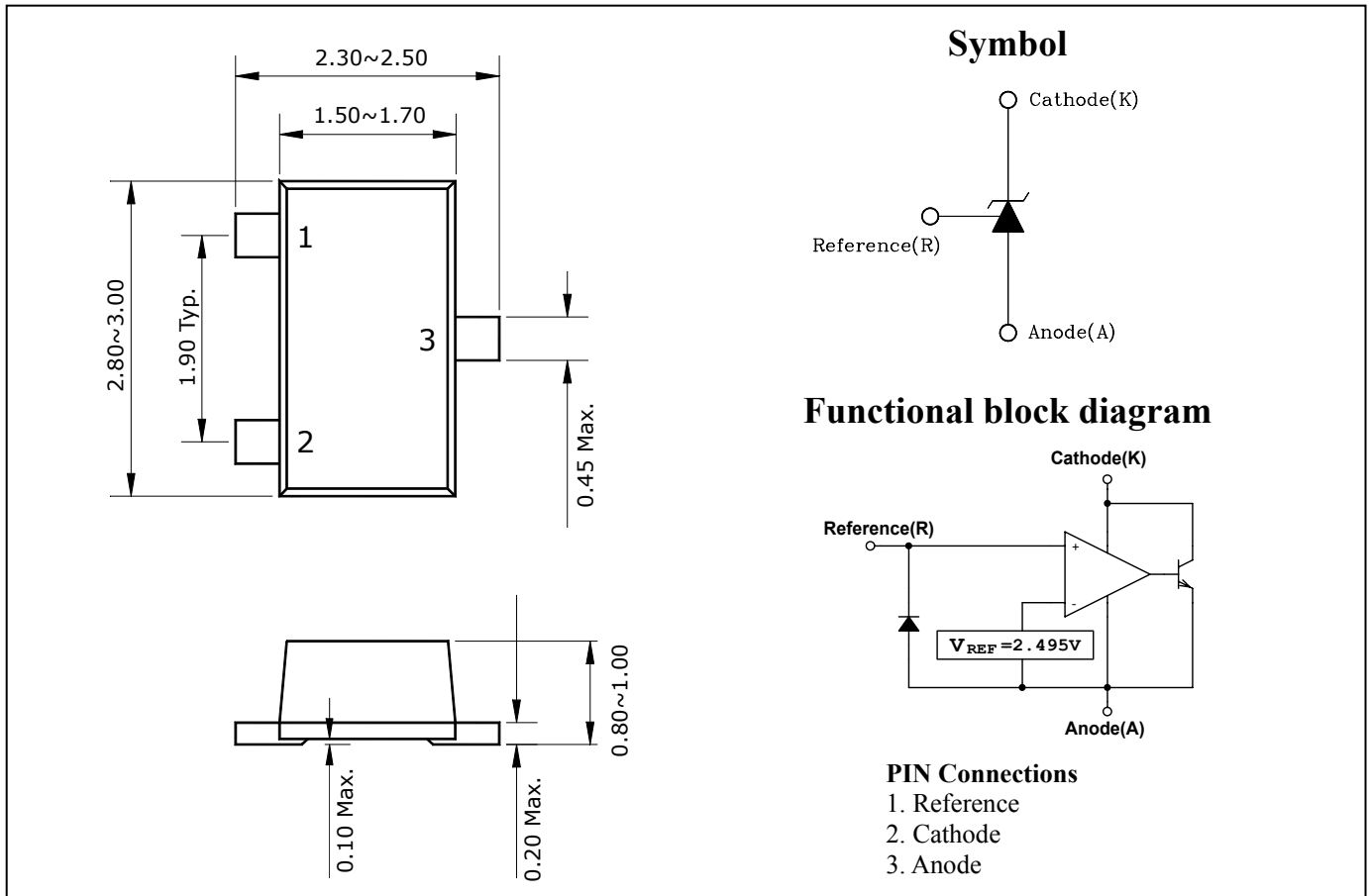
- Programmable output voltage from 2.495V to 16V
- Voltage reference tolerance :  $\pm 0.5\%$ ,  $\pm 1.0\%$
- Cathode current capability of 1 mA to 100 mA

## Ordering Information

Type NO.	Marking	Package Code
AF431xSF	□41	SOT-23F

□: 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	$P_D^*$	350	mW
Junction Temperature	$T_J$	150	°C
Operating temperature range	$T_{opr}$	-40 ~ +85	°C
Storage temperature range	$T_{stg}$	-55 ~ +150	°C

\* With PCB(8×8mm copper area) at glass epoxy board(t=1.7mm, area : 20×20mm)

## 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)	$V_{ref}$	$V_{KA}=V_{ref}, I_K=10mA$	AF431BSF	2.482	2.495	2.508	V
			AF431ASF	2.470		2.520	
Reference input voltage deviation over temperature (Fig.1, Note1,2)	$\Delta V_{ref}$	$V_{KA}=V_{ref}, I_K=10mA$ @ 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	
		$\Delta V_{ref}=V_{ref}-V_{ref(16V)}$ $\Delta V_{KA}=V_{KA(16V)}-V_{ref}$					
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)	$\Delta I_{ref}$	$I_K=10mA$ $R1=10K\Omega, R2=\infty$ @ 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  $V_{KA}=V_{ref}$

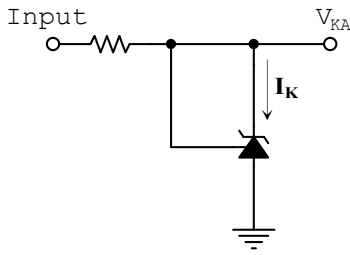
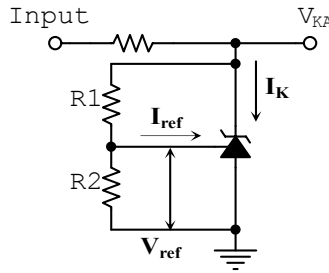
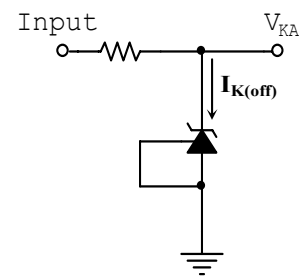


Fig. 2 Test circuit for  $V_{KA}>V_{ref}$



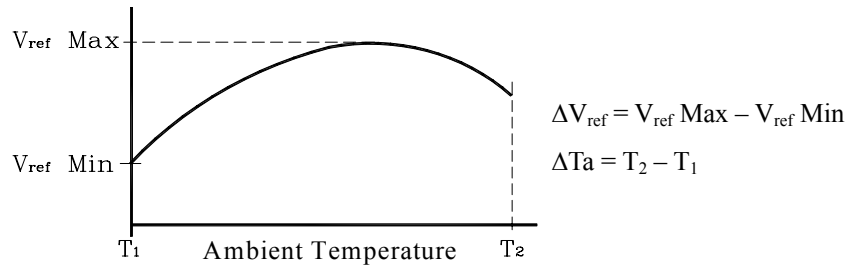
$$V_{KA} = V_{ref} \times \left(1 + \frac{R_1}{R_2}\right) + I_{ref} \times R_1$$

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  $\Delta V_{ref}$  and  $\Delta I_{ref}$  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,  $\alpha V_{ref}$  is defined as:

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

$\alpha V_{ref}$  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)

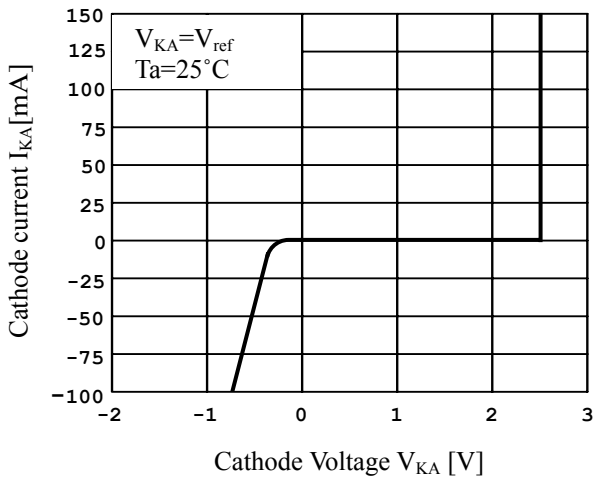


Fig.5  $I_K$  vs  $V_{KA}$  (2)

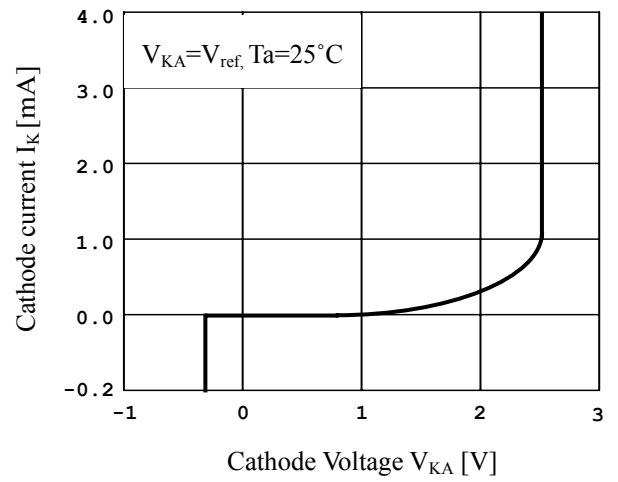


Fig.6  $I_{K(off)}$  vs  $V_{KA}$

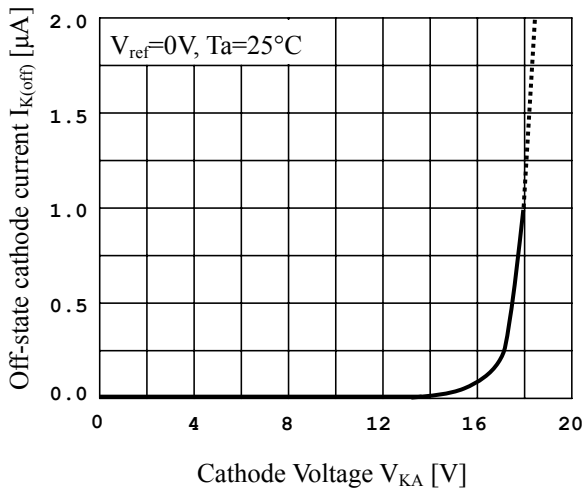


Fig.7  $\Delta V_{ref} / \Delta V_{KA}$  vs  $T_a$

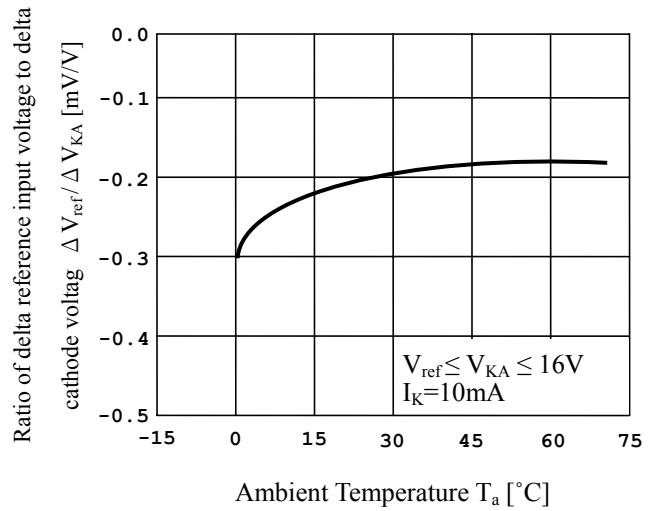


Fig.8  $V_{ref}$  vs  $T_a$

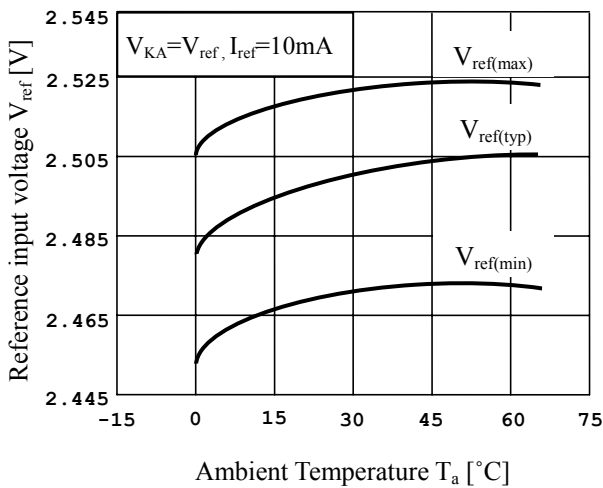
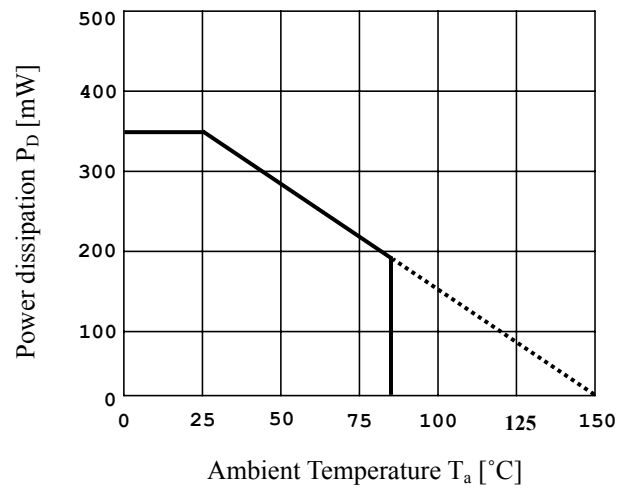


Fig.9  $P_D$  vs  $T_a$



# Electrical Characteristics Curves

Fig.10 Pulse Response

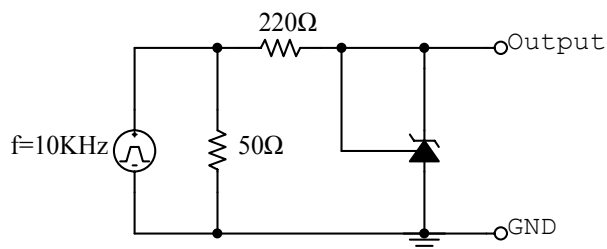
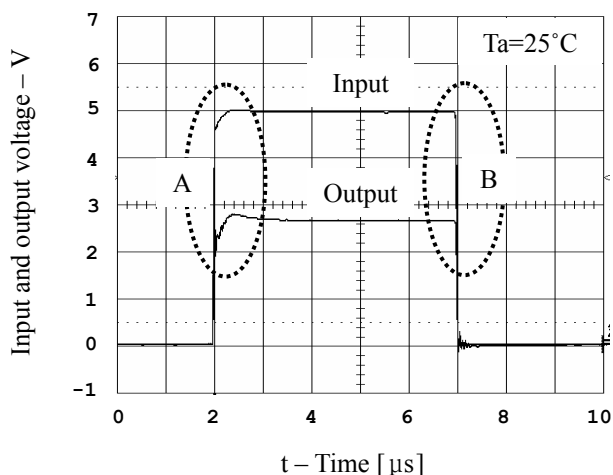


Fig.11 Test circuit for Fig. 10

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

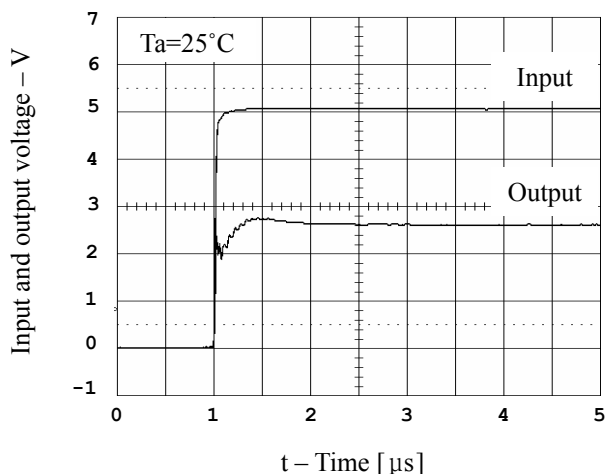


Fig.13 Pulse Response (Magnify B of Fig.10)

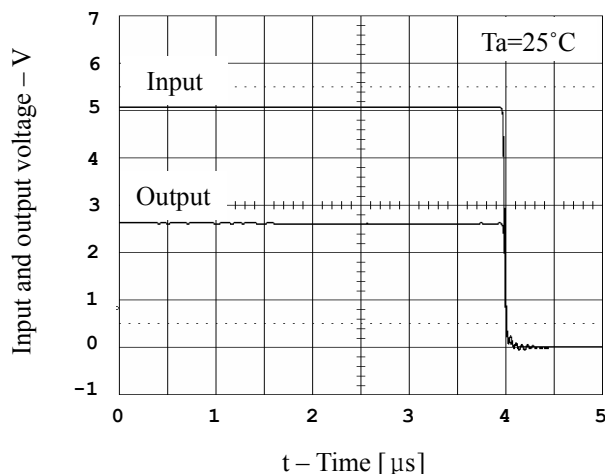
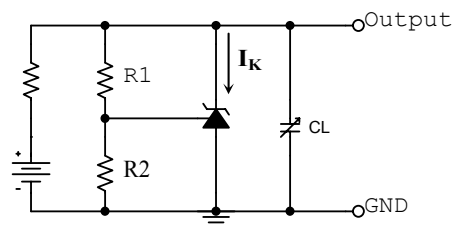
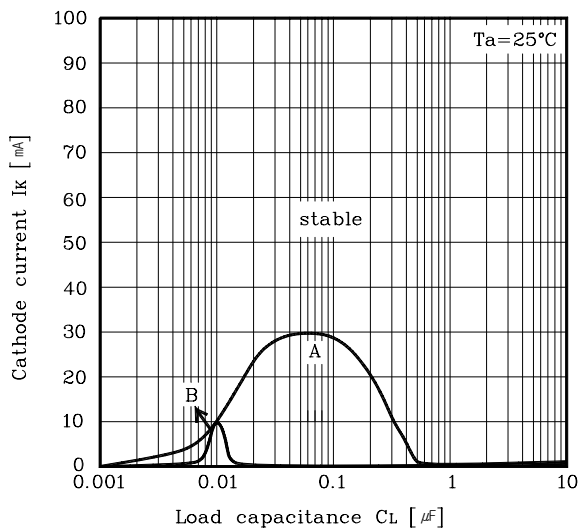


Fig.14 Stability Boundary Conditions



Unstable Regions	$V_{KA}$	$R_1$ [KΩ]	$R_2$ [KΩ]
A	$V_{ref}$	0	$\infty$
B	10V	10	3.325

Fig.15 Test circuit for Fig. 14

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