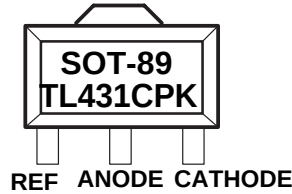


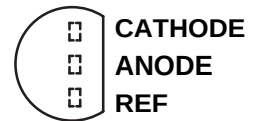
- Programmable Output Voltage to 36V
- Low Dynamic Output Impedance 0.2Ω
- Sink Current Capability of 0.1 mA to 100 mA
- Equivalent Full-Range Temperature Coefficient of 50 ppm/ $^{\circ}\text{C}$
- Temperature Compensated for Operation over Full Rated Operating Temperature Range
- Low Output Noise Voltage
- Fast Turn on Response

Pin Configuration



TO-92

TL431CLP



SOT-23

TL431LT1



1. REF

2. CATHODE

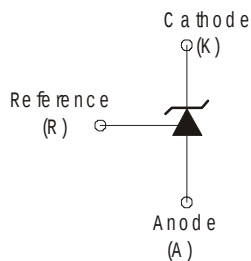
3. ANODE

DESCRIPTION

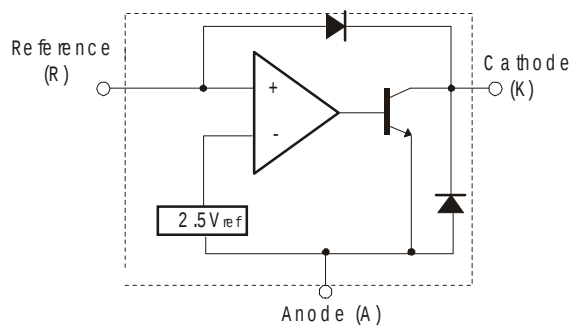
The TL431 is a three-terminal adjustable regulator series with a guaranteed thermal stability over applicable temperature ranges. The output voltage may be set to any value between V_{ref} (approximately 2.5 volts) and 36 volts with two external resistors. These devices have a typical dynamic output impedance of 0.2Ω . Active output circuitry provides a very sharp turn-on characteristic, making these devices excellent replacement for zener diodes in many applications.

The TL431 is characterized for operation from 0°C to $+70^{\circ}\text{C}$.

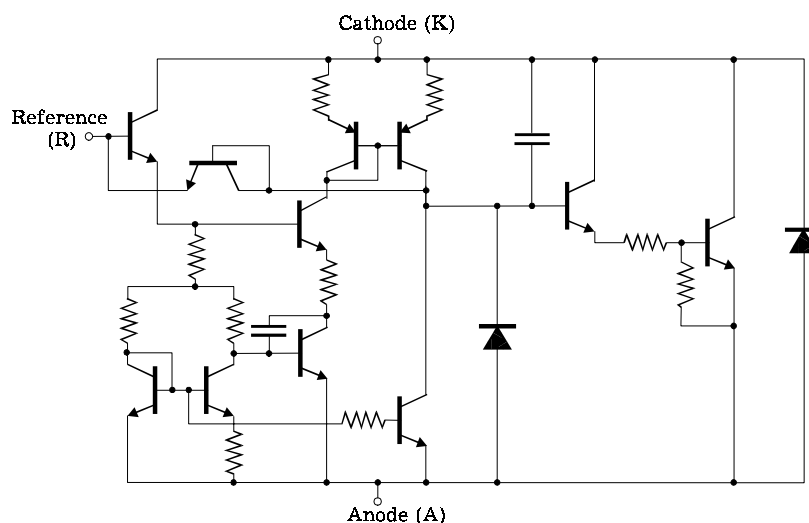
SYMBOL



FUNCTIONAL BLOCK DIAGRAM



SCHEMATIC DIAGRAM



WS

TL431

ABSOLUTE MAXIMUM RATINGS

(Operating temperature range applies unless otherwise specified)

Characteristic	Symbol	Value	Unit
Cathode Voltage	V_{KA}	37	V
Cathode Current Range (Continuous)	I_K	-100 ~ +150	mA
Reference Input Current Range	I_{REF}	0.05 ~ +10	mA
Operating Temperature Range	T_a	0 ~ +70	°C
Storage Temperature Range	T_{stg}	-65 ~ +150	°C

RECOMMENDED OPERATING CONDITIONS

Characteristic	Symbol	Test Condition	Min	Typ	Max	Unit
Cathode Voltage	V_{KA}		V_{REF}		36	V
Cathode Current	I_K		1.0		100	mA

ELECTRICAL CHARACTERISTICS

($T_a = 25^\circ\text{C}$, unless otherwise specified)

Characteristic	Symbol	Test Condition		Min	Typ	Max	Unit
Reference Input Voltage	V_{REF}	$V_{KA} = V_{REF}, I_K = 10\text{mA}$		2.44	2.495	2.55	V
Deviation of Reference Input Voltage Over-Temperature (Note 1)	$V_{REF(dev)}$	$V_{KA} = V_{REF}, I_K = 10\text{mA}$ $T_{min} \leq T_a \leq T_{max}$			4	17	mV
Ratio of Change in Reference Input Voltage to the Change in Cathode Voltage	$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	$I_K = 10\text{mA}$	$\Delta V_{KA} = 10\text{V} - V_{REF}$		-1.4	-2.7	mV/V
			$\Delta V_{KA} = 36\text{V} - 10\text{V}$		-1.0	-2.0	
Reference Input Current	I_{REF}	$I_K = 10\text{mA}, R_1 = 10\text{K}\Omega, R_2 = \infty$			2.0	4	μA
Deviation of Reference Input Current Over Full Temperature Range	$I_{REF(dev)}$	$I_K = 10\text{mA}, R_1 = 10\text{K}\Omega, R_2 = \infty$ $T_a = \text{Full Range}$			0.4	1.2	μA
Minimum Cathode Current for Regulation	$I_{K(min)}$	$V_{KA} = V_{REF}$			0.4	1.0	mA
Off-State Cathode Current	$I_{K(off)}$	$V_{KA} = 36\text{V}, V_{REF} = 0$			0.1	1.0	μA
Dynamic Impedance (Note2)	Z_{KA}	$V_{KA} = V_{REF}, I_K = 10\text{mA}$ to 100mA $f \leq 1.0\text{KHz}$			0.2	0.5	Ω

Note: 1. The deviation parameters $V_{REF(dev)}$ and $I_{REF(dev)}$ are defined as the differences between the maximum and minimum values obtained over the rated temperature range.

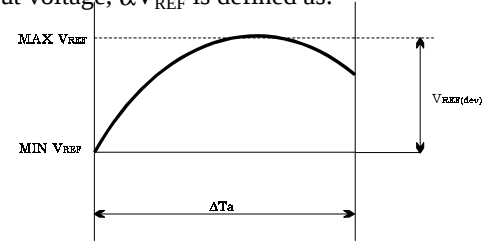
$$V_{REF(dev)} = V_{REF(max)} - V_{REF(min)}$$

The equivalent full-range temperature coefficient of the reference input voltage, αV_{REF} is defined as:

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

where ΔT_a is the rated operating free-air temperature range of the device.

αV_{REF} can be positive or negative depending on whether minimum V_{REF} or maximum V_{REF} respectively, occurs at the lower temperature.



2. The dynamic impedance is defined as:

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

When the device is operated with two external resistors (see Figure 2), the total dynamic impedance of the circuit is given by:

$$|Z| = \frac{\Delta V}{\Delta I} = |Z_{KA}| \left(1 + \frac{R_1}{R_2} \right)$$

TEST CIRCUITS

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

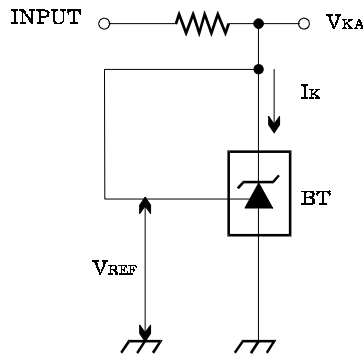


Fig.2. Test Circuit for $V_{KA} \geq V_{REF}$

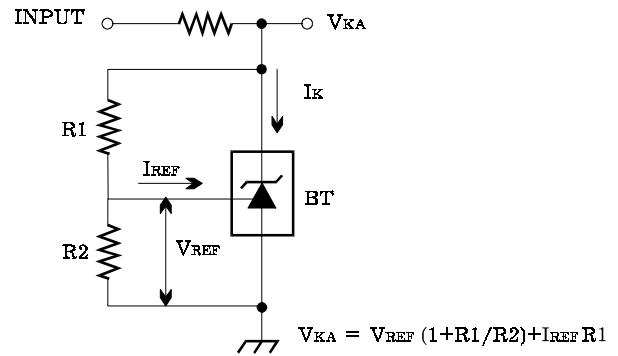
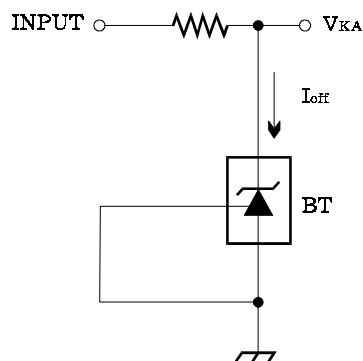
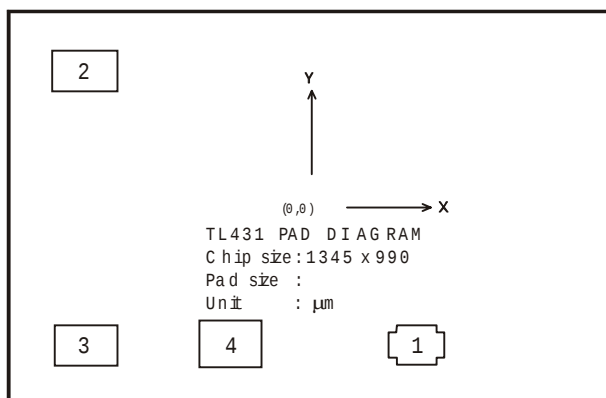


Fig.3. Test Circuit for I_{off}



PAD LAYOUT



PAD LOCATION

Unit: μm				
Pad No.	Pad Name	Description	X	Y
1	R	Reference	235	400
2	K	Cathode	-505	343.5
3	K	Cathode	-497.5	-346
4	A	Anode	-177.5	-341.5

Physical Characteristics		
Wafers	4 inch	460 $\pm$ 40 μm (thickness)
Size	1.35 $\times$ 0.99 mm	
Scribe width	90 μm	
Wafer's Backside	Ti – Ni – Ag: Ti - 0.1 $\pm$ 0.02 μm Ni - 0.5 $\pm$ 0.1 μm Ag - 0.6 $\pm$ 0.1 μm	
Passivation	PSG	