

### GENERAL 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 2.495 volts) and 40 volts with two external resistors. These devices have a typical dynamic output impedance of  $0.2\Omega$ . 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  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .



TO-92



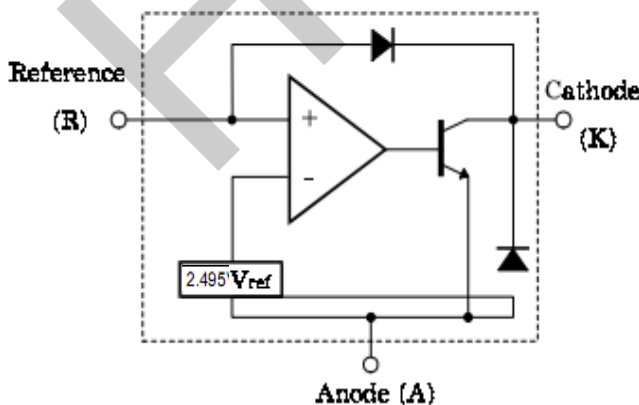
SOT-23

### FEATURES

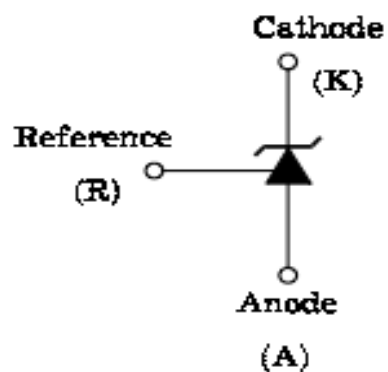
- ◆ Programmable output voltage to 36V
- ◆ Low dynamic output Impedance  $0.2\Omega$ .
- ◆ Sink current capability of 1 mA to 100 mA.
- ◆ Equivalent full-range temperature coefficient of  $50 \text{ ppm}/^{\circ}\text{C}$
- ◆ Temperature compensated for operation over full Rated operating Temperature Range
- ◆ Low output noise voltage .
- ◆ Fast turn on respons.
- ◆ Provided pb-free packages.
- ◆ ESD tolerance (human body model) 2000V.
- ◆ Package outline: TO-92, SOT-23.

### Internal Function Block Diagram

FUNCTIONAL BLOCK DIAGRAM



SYMBOL



### ABSOLUTE MAXIMUM RATINGS

Characteristic	Symbol	Value	Unit
Cathode voltage	$V_{KA}$	40	V
Cathode current range (Continuous)	$I_K$	100	mA
Reference input current range	$I_{REF}$	0.05 ~ 10	mA
Power dissipation at 25°C: TO – 92 Package (RJA = 178°C/W) SOT – 23 Package (RJA = 625°C/W)	$P_D$	0.7 0.2	W W
Junction temperature range	$T_J$	0 ~ 150	°C
Operating temperature range	$T_g$	-40~+125	°C
Storage temperature range	$T_{stg}$	-65 ~ +150	°C

### RECOMMENDED OPERATING CONDITIONS

Characteristic	Symbol	Test Condition	Min	Typ	Max	Unit
Cathode voltage	$V_{KA}$		$V_{REF}$		37	V
Cathode current	$I_{KA}$		0.5		100	mA

### TL431- 0.3% ELECTRICAL CHARACTERISTIC ( $T_A=25^\circ\text{C}$ , unless otherwise specified)

CHARACTERISTIC	SYMBOL	CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Reference input Voltage	$V_{REF}$	1	$V_{KA}=V_{REF}, I_K=10\text{mA}$	2.487V	2.495V	2.502V	
Deviation of reference Input voltage over Full temperature range	$\Delta V_{REF}/\Delta T$	1	$V_{KA}=V_{REF}, I_K=10\text{mA}$ $T_A=\text{Full Range}$		3	17	mV
Ratio of change in reference Input voltage to the change in cathode voltage	$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	2	$I_K=10\text{mA}$	$\Delta V_{KA}=10\text{V}-V_{REF}$	-1.4	-2.7	mV/V
				$\Delta V_{KA}=36\text{V}-10\text{V}$	-1	-2	
Reference input current	$I_{REF}$	2	$I_{KA}=10\text{mA}, R_1=10\text{K}\Omega, R_2=\infty$		1.8	4	$\mu\text{A}$
Deviation of reference input Current Over Full Temperature Range	$\Delta I_{REF}/\Delta T$	2	$I_K=10\text{mA}, R_1=10\text{K}\Omega, R_2=\infty$ $T_A=\text{Full Range}$		0.4	1.2	$\mu\text{A}$
Minimum Cathode Current for regulation	$I_{KA\text{MIN}}$	1	$\Delta V_{KA}=V_{REF}$		0.5	1	mA
Off-State Cathode Current	$I_{KA\text{OFF}}$	3	$V_{KA}=36\text{V}, V_{REF}=0$		0.2	1	$\mu\text{A}$
Dynamic Impedance	$Z_{KA}$	1	$V_{KA}=V_{REF}, I_K=1\text{mA}\sim 100\text{mA},$ $F \leq 1\text{KHz}$		0.2	0.5	$\Omega$

### TL431-0.5% ELECTRICAL CHARACTERISTIC (TA=25°C, unless otherwise specified)

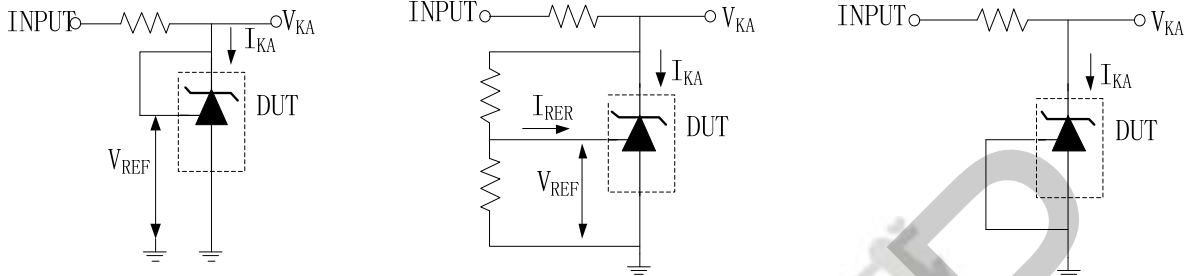
CHARACTERISTIC	SYMBOL	CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Reference Input Voltage	V <sub>REF</sub>	1	V <sub>KA</sub> =V <sub>REF</sub> , I <sub>K</sub> =10mA	2.482V	2.495V	2.507V	
Deviation of Reference Input Voltage Over Full Temperature Range	ΔV <sub>REF</sub> /ΔT	1	V <sub>KA</sub> =V <sub>REF</sub> , I <sub>K</sub> =10 mA T <sub>A</sub> =Full Range		3	17	mV
Ratio of Change in Reference Input Voltage to the Change in Cathode Voltage	ΔV <sub>REF</sub> /ΔV <sub>KA</sub>	2	I <sub>K</sub> =10 mA	ΔV <sub>KA</sub> =10V-V <sub>REF</sub>	-1.4	-2.7	mv/V
				ΔV <sub>KA</sub> =36V-10V	-1	-2	
Reference Input Current	I <sub>REF</sub>	2	I <sub>KA</sub> =10mA, R1=10KΩ, R2=		1.8	4	uA
Deviation of Reference Input Current Over Full Temperature Range	ΔI <sub>REF</sub> /ΔT	2	I <sub>K</sub> =10mA, R1=10KΩ, R2=		0.4	1.2	uA
Minimum Cathode Current for Regulation	I <sub>KMIN</sub>	1	ΔV <sub>KA</sub> =V <sub>REF</sub>		0.5	1	mA
Off-State Cathode Current	I <sub>KAOFF</sub>	3	V <sub>KA</sub> =36V, V <sub>REF</sub> =0		0.2	1	uA
Dynamic Impedance	Z <sub>KA</sub>	1	V <sub>KA</sub> =V <sub>REF</sub> , I <sub>K</sub> =1mA~100mA f ≤ 1KHZ		0.2	0.5	Ω

### TL431-1% ELECTRICAL CHARACTERISTIC (TA=25°C, unless otherwise specified)

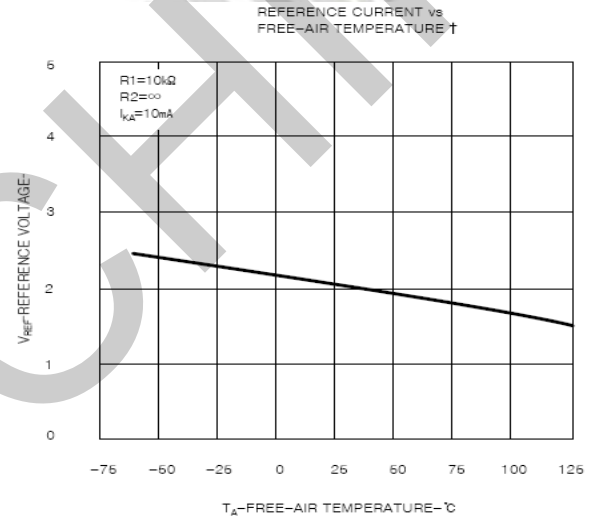
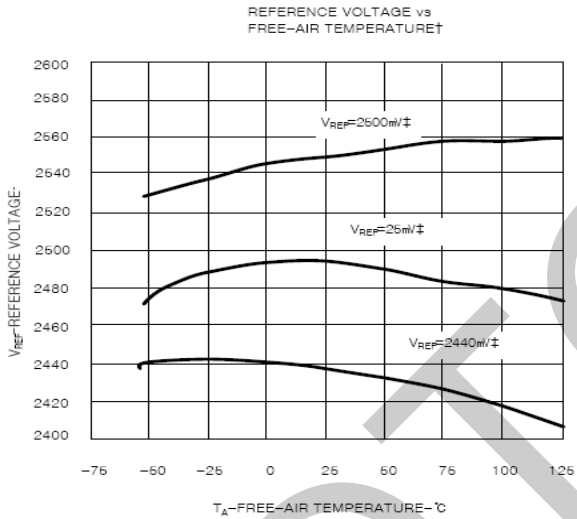
CHARACTERISTIC	SYMBOL	CIR-CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Reference Input Voltage	V <sub>REF</sub>	1	V <sub>KA</sub> =V <sub>REF</sub> , I <sub>K</sub> =10mA	2.47	2.495V	2.52	
Deviation of Reference Input Voltage Over Full Temperature Range	ΔV <sub>REF</sub> /ΔT	1	V <sub>KA</sub> =V <sub>REF</sub> , I <sub>K</sub> =10 mA T <sub>A</sub> =Full Range		3	17	mV
Ratio of Change in Reference Input Voltage to the Change in Cathode Voltage	ΔV <sub>REF</sub> /ΔV <sub>KA</sub>	2	I <sub>K</sub> =10 mA	ΔV <sub>KA</sub> =10V-V <sub>REF</sub>	-1.4	-2.7	mv/V
				ΔV <sub>KA</sub> =36V-10V	-1	-2	
Reference Input Current	I <sub>REF</sub>	2	I <sub>KA</sub> =10mA, R1=10KΩ, R2=		1.8	4	uA
Deviation of Reference Input Current Over Full Temperature Range	ΔI <sub>REF</sub> /ΔT	2	I <sub>K</sub> =10mA, R1=10KΩ, R2=		0.4	1.2	uA
Minimum Cathode Current for Regulation	I <sub>KMIN</sub>	1	ΔV <sub>KA</sub> =V <sub>REF</sub>		0.5	1	mA
Off-State Cathode Current	I <sub>KAOFF</sub>	3	V <sub>KA</sub> =36V, V <sub>REF</sub> =0		0.2	1	uA
Dynamic Impedance	Z <sub>KA</sub>	1	V <sub>KA</sub> =V <sub>REF</sub> , I <sub>K</sub> =1mA~100mA f ≤ 1KHZ		0.2	0.5	Ω

**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  $I_{KA}$  (Off)



**TYPICAL PERFORMANCE CHARACTERISTIC**



† Data is applicable only within the recommended operating free-air temperature ranges of the various devices.  
‡ Data is for devices having the indicated value of  $I_{KA}$  at  $V_{KA}=10mV$ ,  $T_A=25^\circ C$

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Figure 4.

Figure 5.

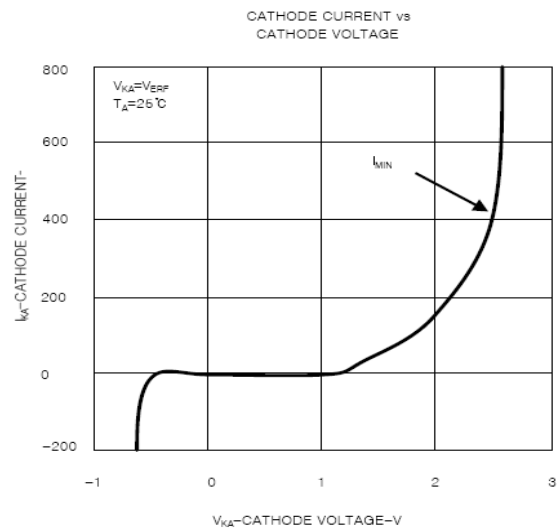
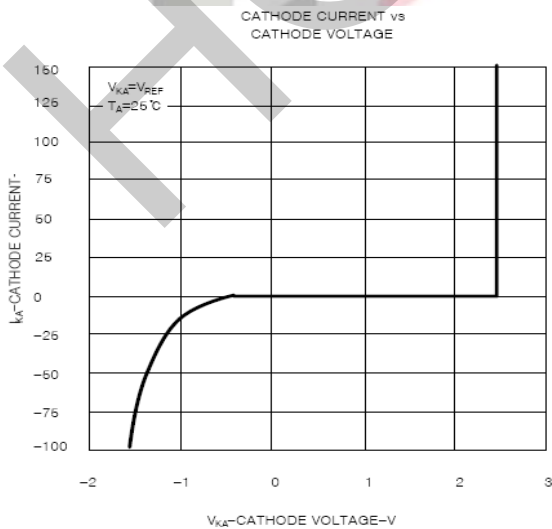
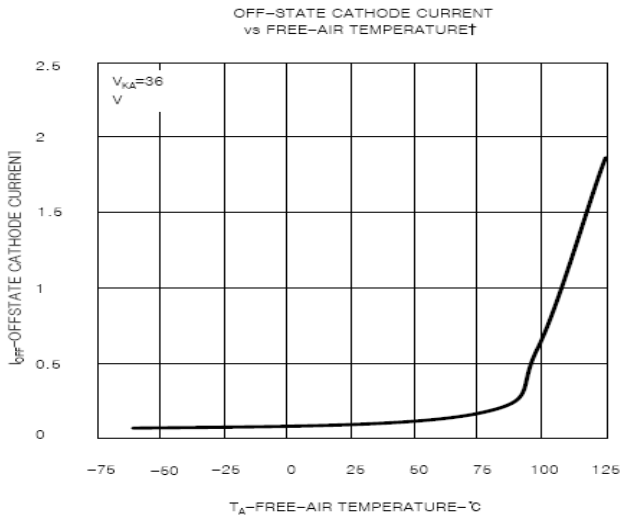


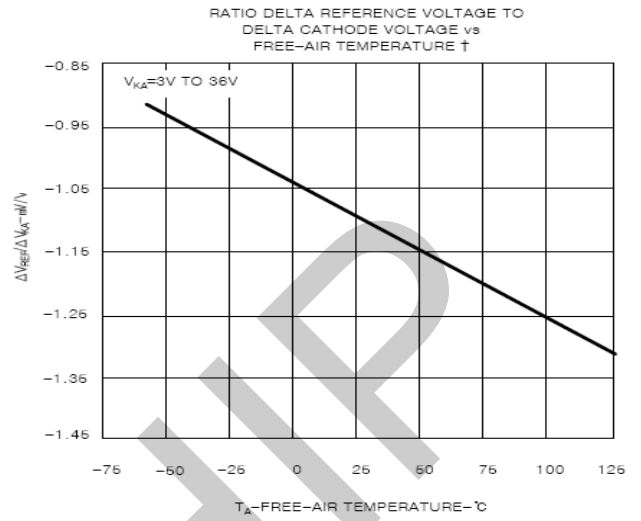
Figure 6.

Figure 7.



† Data is applicable only within the recommended operating free-air temperature ranges of the various devices.

Figure 8.



† Data is applicable only within the recommended operating free-air temperature ranges of the various devices.

Figure 9.

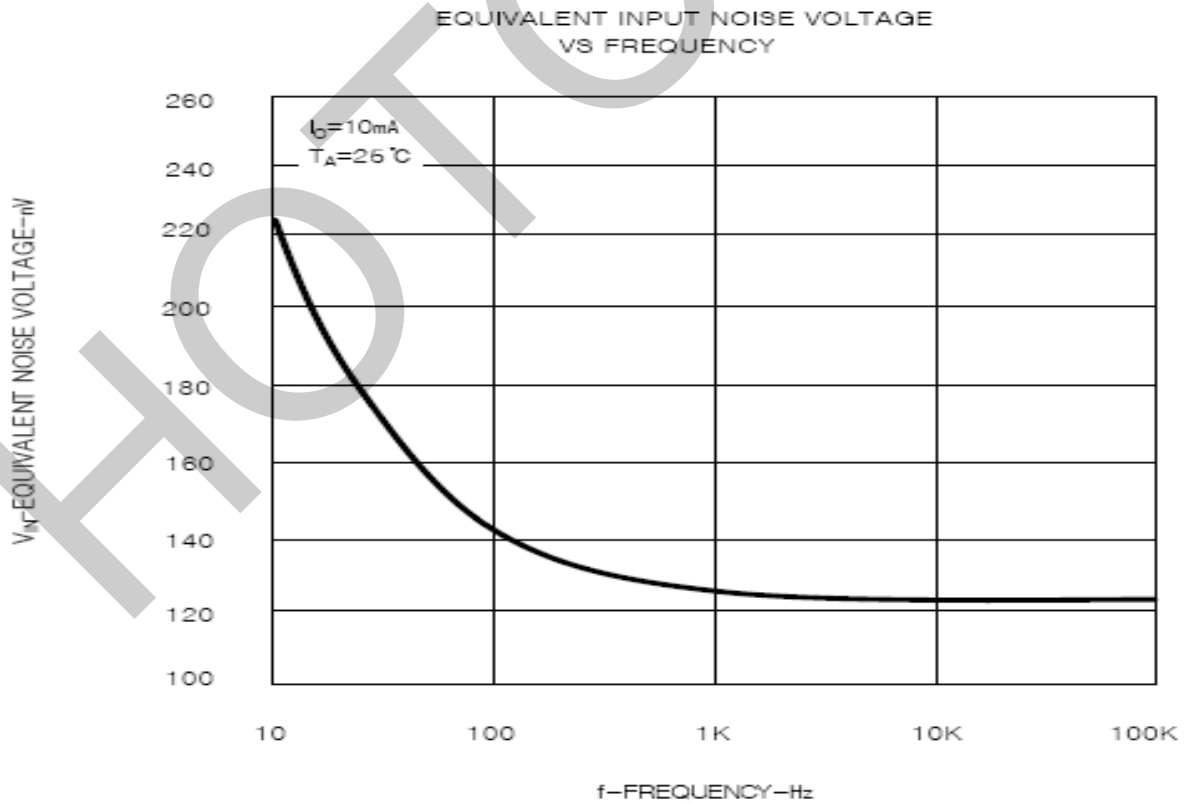
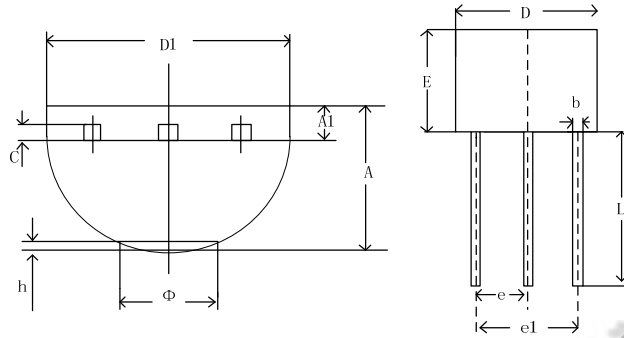


Figure 10.

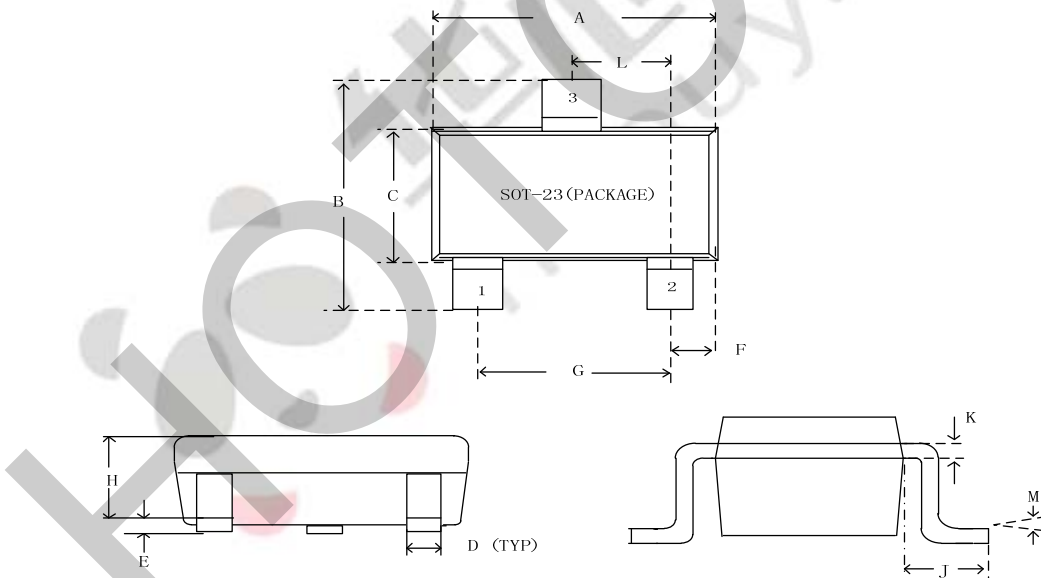
**Package Description**

TO- 92 Package outline dimensions



Symbol	Min	In millimeters		Symbol	Min	Max
		Max	Symbol			
A	3.3	3.7	E	4.3	4.7	
A1	1.4	1.4	e	1.27TYP		
b	0.38	0.55	e1	2.44	2.64	
c	0.36	0.51	L	14.1	14.5	
D	4.4	4.7	$\theta$		1.6	
D1	3.43		h	0.000	0.38	

SOT- 23 Package outline dimensions



Symbol	In millimeters		Symbol	In millimeters	
	Min	Max		Min	Max
A	2.7	3.1	G	1.9REF	
B	2.4	2.8	H	1.0	1.3
C	1.4	1.6	K	0.10	0.2
D	0.35	0.5	J	0.4	--
E	0	0.1	L	0.85	1.15
F	0.45	0.55	M	0°	10°