



**LOW VOLTAGE ADJUSTABLE SHUNT REFERENCE**

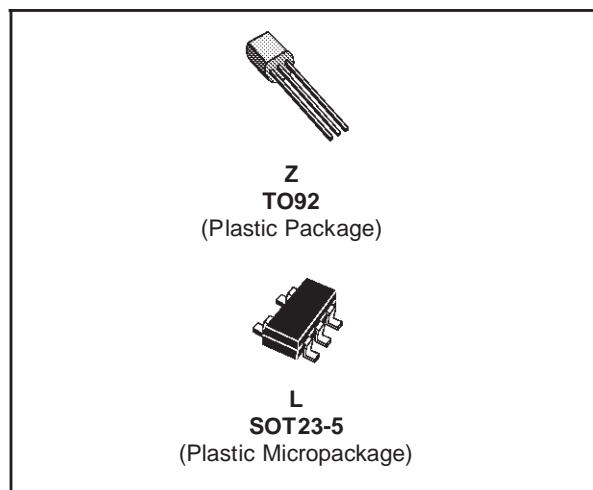
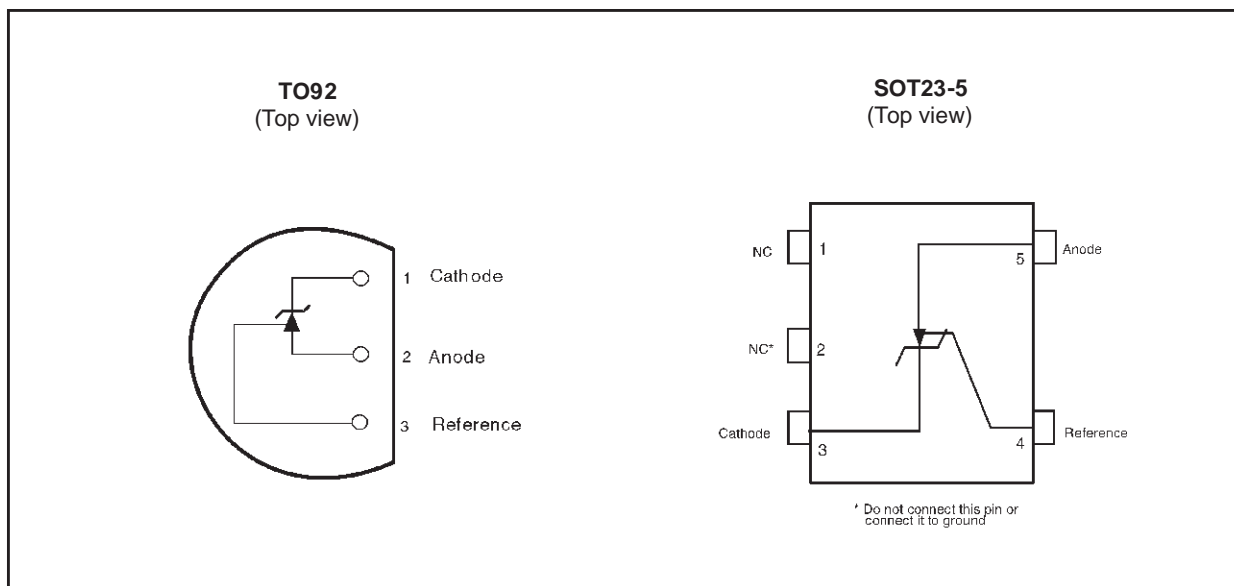
- **LOW VOLTAGE OPERATION : 1.24 TO 6V**
- **2% AND 1% VOLTAGE PRECISION**
- **WIDE OPERATING RANGE CATHODE CURRENT : 60 $\mu$ A TO 30mA**
- **LOW OUTPUT IMPEDANCE : 0.2 $\Omega$**
- **TYPICALLY STABLE FOR ANY CAPACITIVE LOADS**
- **ESD PROTECTION :**  
2kV (Human Body Model)  
200V (Machine Model)
- **100ppm/ $^{\circ}$ C TEMPERATURE COEFFICIENT**

**DESCRIPTION**

The TS431 is a low voltage three terminals programmable shunt Voltage Reference. The output voltage can be set to any value between Vref (1.24V) and 6V with two external resistors. The TS431 is able to operate at a lower voltage (1.24V) and lower cathode current than the widespread TL431 and TL1431 shunt voltage reference.

When driving an optocoupler, the TS431 is particularly interesting to regulate 3.3V switching power supplies.

**PIN CONNECTIONS (top view)**



**ORDER CODE**

Part Number	Temperature Range	Package		SOT-23 Marking
		Z	L	
TS431I	-40 $^{\circ}$ C, +125 $^{\circ}$ C	•	•	L272
TS431AI		•	•	L271

Z = TO92 Plastic package  
LT = Tiny Package (SOT23-5) - only available in Tape & Reel (LT)

## ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit	
$V_{KA}$	Cathode to Anode Voltage	10	V	
$I_k$	Continuous Cathode Current Range	-20 to +40	mA	
$I_{ref}$	Reference Input Current Range	-0.05 to +3	mA	
$P_d$	Power Dissipation <sup>1)</sup>	TO92 package SOT23-5 package	625 500	mW
$T_{oper}$	Operating Free Air Temperature Range	-40 to +125	°C	
$T_{std}$	Storage Temperature Range	-65 to +150	°C	

1.  $T_j=150^\circ\text{C}$ ,  $T_{amb}=25^\circ\text{C}$  with  $R_{thja}=200^\circ\text{C/W}$  for TO92 package and  $R_{thja}=250^\circ\text{C/W}$  for SOT23-5L package

## OPERATING CONDITIONS

Symbol	Parameter	Value	Unit
$V_{KA}$	Cathode to Anode Voltage	1.24 to 6	V
$I_k$	Cathode Current	0.06 to 30	mA

## ELECTRICAL CHARACTERISTICS

TS431  $T_{amb} = 25^\circ\text{C}$  (unless otherwise specified)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
$V_{ref}$	Output Voltage $V_{KA} = V_{ref}$ @ $I_k = 100\mu\text{A}$	$T_{amb} = 25^\circ\text{C}$	1.215	1.240	1.265	V
$\Delta V_{ref}$	Output Voltage Change <sup>1) 2)</sup> $I_k = 100\mu\text{A}$ , $V_{KA} = V_{ref}$	$0 < T_{amb} < +70^\circ\text{C}$ $-40 < T_{amb} < +85^\circ\text{C}$ $-40 < T_{amb} < +105^\circ\text{C}$ $-40 < T_{amb} < +125^\circ\text{C}$			9 16 18 21	mV
$\frac{ \Delta V_{ref} }{ \Delta V_{ka} }$	Ratio of Change in Reference Input Voltage to Change in Cathode to Anode Voltage	$I_k = 10\text{mA}$ $V_{KA} = 6\text{V to } V_{ref}$		1.8	2.7	mV/V
$I_{ref}$	Reference Input Current	$I_k = 10\text{mA}$		70	160	nA
$\Delta I_{ref}$	Reference Input Current Deviation Over Temperature Range	$I_k=10\text{mA}$ $R_1=10\text{k}\Omega$ $R_2=\infty$ $-40 < T_{amb} < +85^\circ\text{C}$ $-40 < T_{amb} < +125^\circ\text{C}$		70 90	160 240	nA
$I_{min}$	Minimum Cathode Current for Regulation	$V_{KA} = V_{ref}$		40	60	$\mu\text{A}$
$I_{off}$	Off-State Cathode Current	$V_{KA} = 6\text{V}$ , $V_{ref} = 0$		0.001	0.1	$\mu\text{A}$
$R_{KA}$	Static Impedance	$V_{KA} = V_{ref}$ $I_k = 0.1$ to $15\text{mA}$		0.2	0.4	$\Omega$

1. Limits are 100% production tested at  $25^\circ\text{C}$ . Limits over temperature are guaranteed through correlation and by design.

2.  $\Delta V_{ref}$  is defined as the difference between the maximum and minimum values obtained over the full temperature range.  
 $\Delta V_{ref} = V_{ref\ max.} - V_{ref\ min.}$



## TS431

### ELECTRICAL CHARACTERISTICS

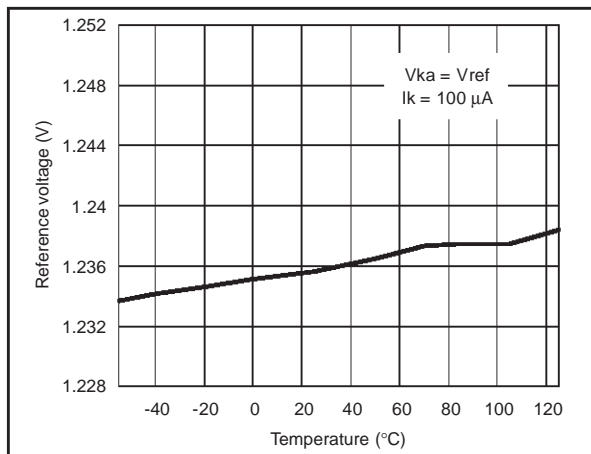
TS431A  $T_{amb} = 25^{\circ}\text{C}$  (unless otherwise specified)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
$V_{ref}$	Output Voltage $V_{KA} = V_{ref}$ @ $I_k = 100\mu\text{A}$	$T_{amb} = 25^{\circ}\text{C}$	1.228	1.240	1.252	V
$\Delta V_{ref}$	Output Voltage Change <sup>1) 2)</sup> $I_k = 100\mu\text{A}$ , $V_{KA} = V_{ref}$	$0 < T_{amb} < +70^{\circ}\text{C}$ $-40 < T_{amb} < +85^{\circ}\text{C}$ $-40 < T_{amb} < +105^{\circ}\text{C}$ $-40 < T_{amb} < +125^{\circ}\text{C}$			9 16 18 21	mV
$\frac{ \Delta V_{ref} }{ \Delta V_{ka} }$	Ratio of Change in Reference Input Voltage to Change in Cathode to Anode Voltage	$I_k = 10\text{mA}$ $V_{KA} = 6\text{V to } V_{ref}$		1.8	2.7	mV/V
$I_{ref}$	Reference Input Current	$I_k = 10\text{mA}$		70	160	nA
$\Delta I_{ref}$	Reference Input Current Deviation Over Temperature Range	$I_k = 10\text{mA}$ $R_1 = 10\text{k}\Omega$ $R_2 = \infty$ $-40 < T_{amb} < +85^{\circ}\text{C}$ $-40 < T_{amb} < +125^{\circ}\text{C}$		70 90	160 240	nA
$I_{min}$	Minimum Cathode Current for Regulation	$V_{KA} = V_{ref}$		40	60	$\mu\text{A}$
$I_{off}$	Off-State Cathode Current	$V_{KA} = 6\text{V}$ , $V_{ref} = 0$		0.001	0.1	$\mu\text{A}$
$R_{KA}$	Static Impedance	$V_{KA} = V_{ref}$ , $I_k = 0.1 \text{ to } 15\text{mA}$		0.2	0.4	$\Omega$

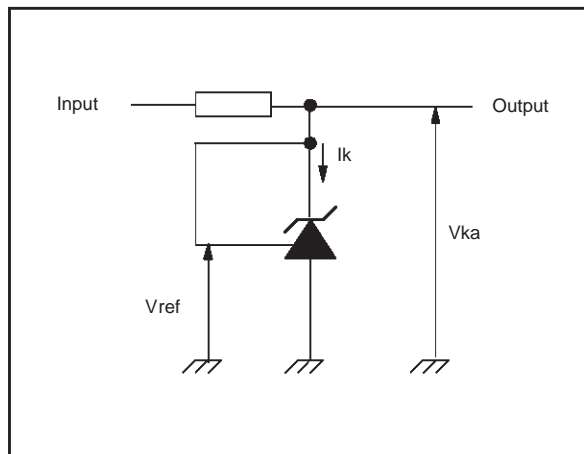
- Limits are 100% production tested at  $25^{\circ}\text{C}$ . Limits over temperature are guaranteed through correlation and by design.
- $\Delta V_{ref}$  is defined as the difference between the maximum and minimum values obtained over the full temperature range.  
 $\Delta V_{ref} = V_{ref \text{ max.}} - V_{ref \text{ min.}}$



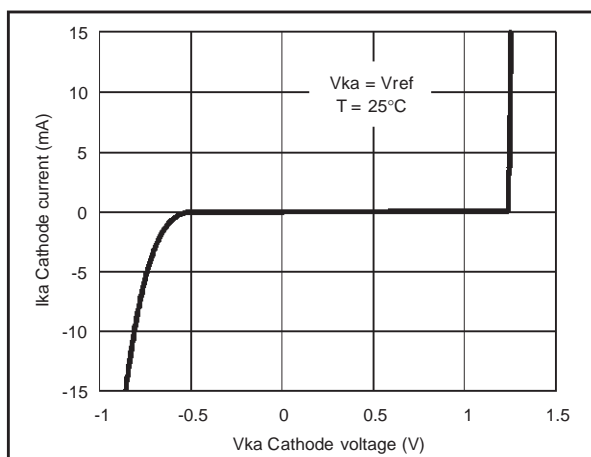
Reference voltage vs temperature



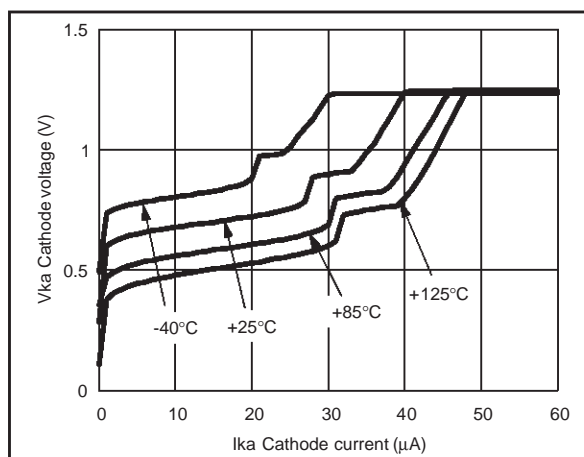
Test circuit for  $V_{ka} = V_{ref}$



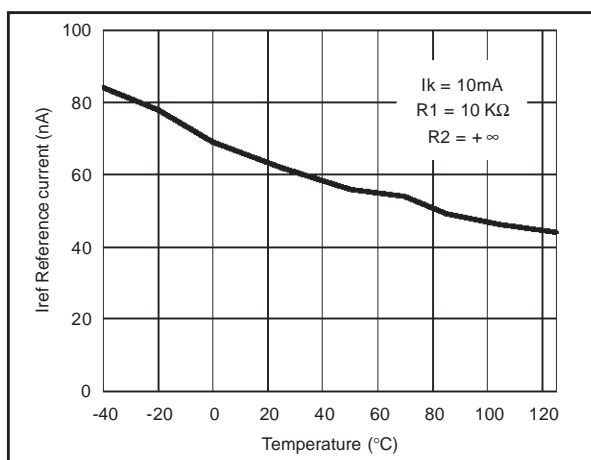
Cathode voltage vs cathode current



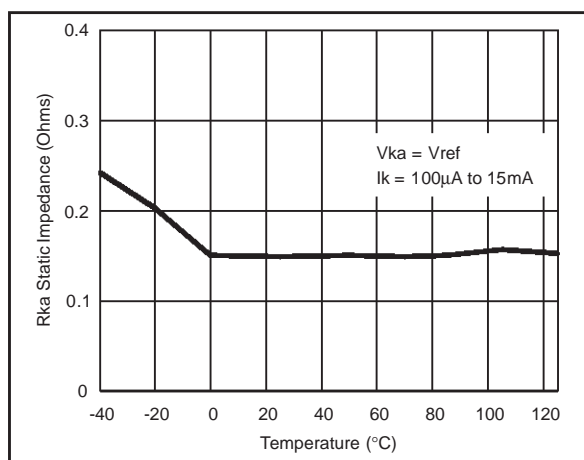
Cathode voltage vs cathode current



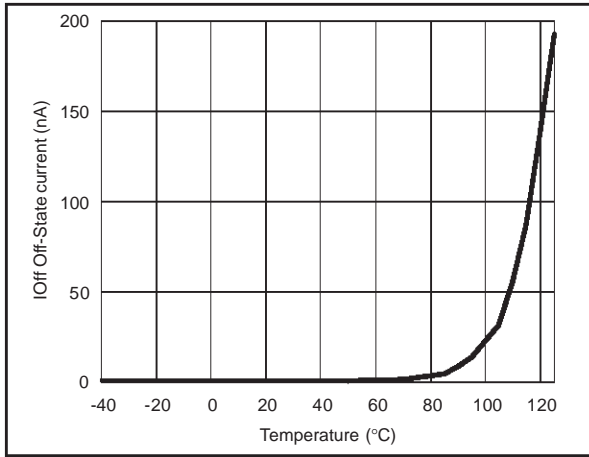
Reference input current vs temperature



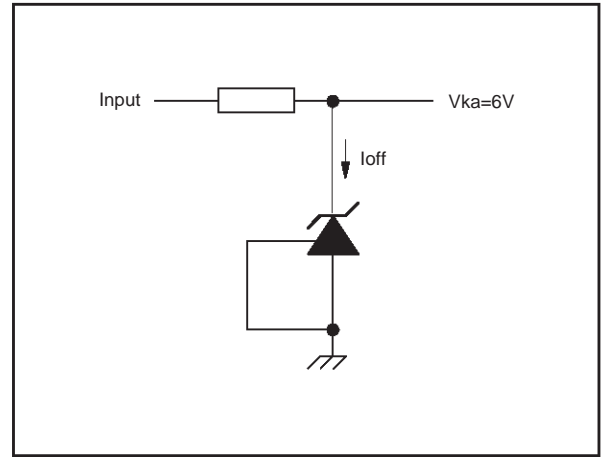
Static impedance vs temperature



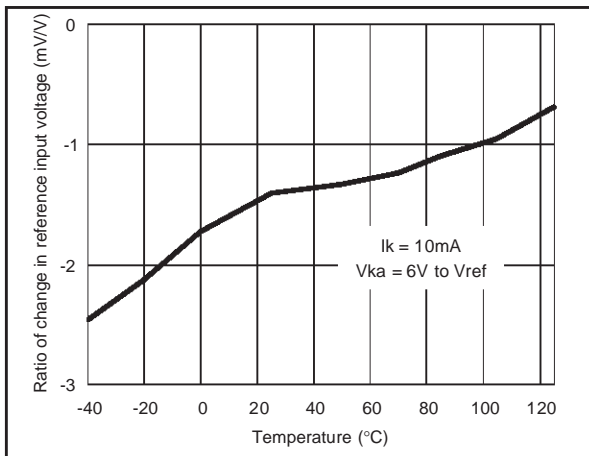
Off-State current vs temperature



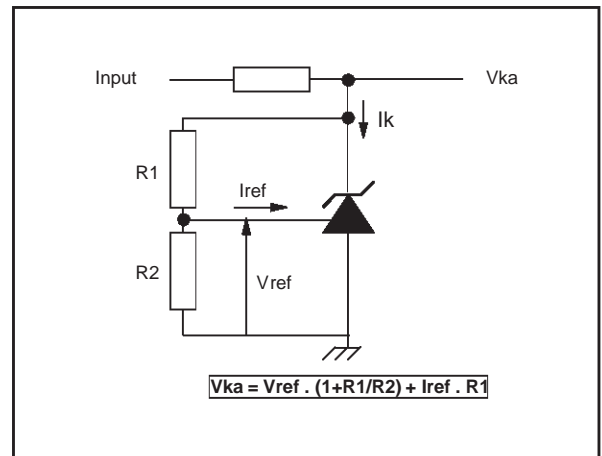
Test circuit for Off-State current measurement



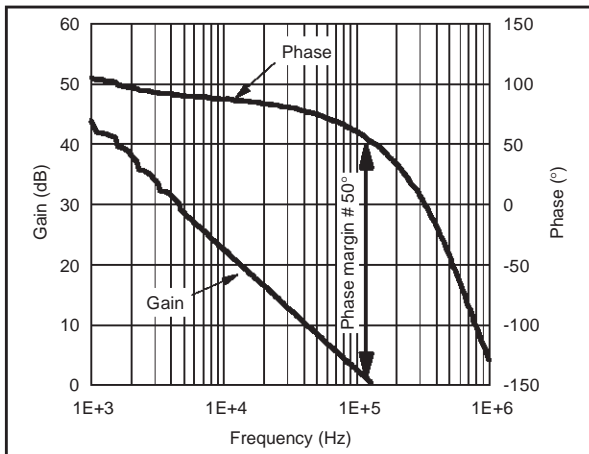
Ratio of change in reference input voltage to change in Vka voltage vs temperature



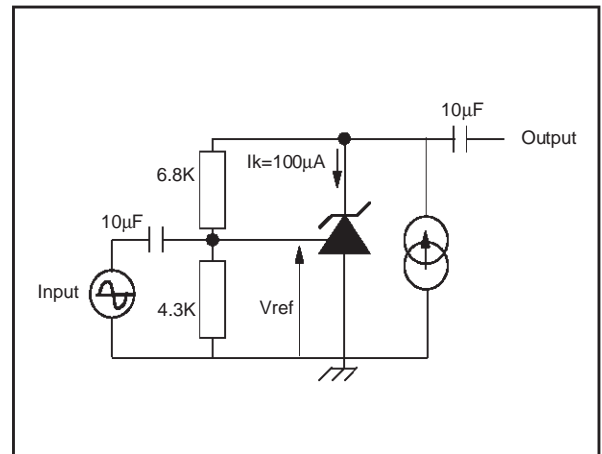
Test circuit for Vka > Vref



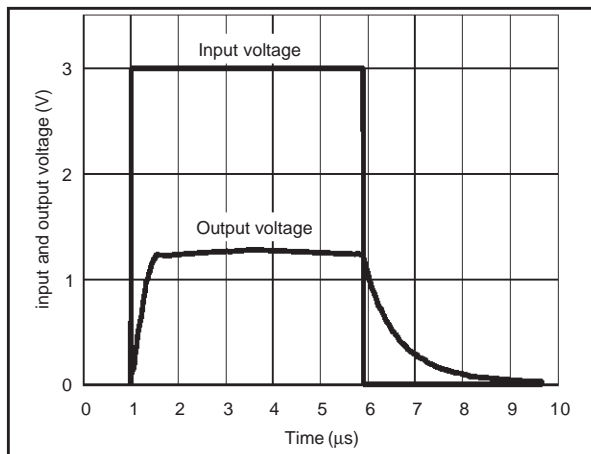
Phase and Gain vs frequency



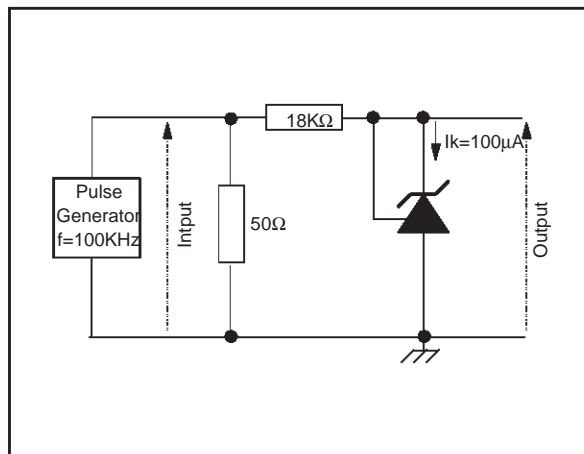
Test circuit for phase and gain measurement



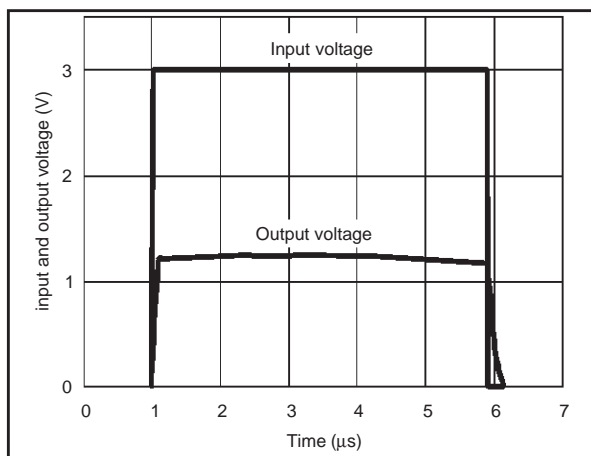
Pulse response at  $I_k=100\mu A$



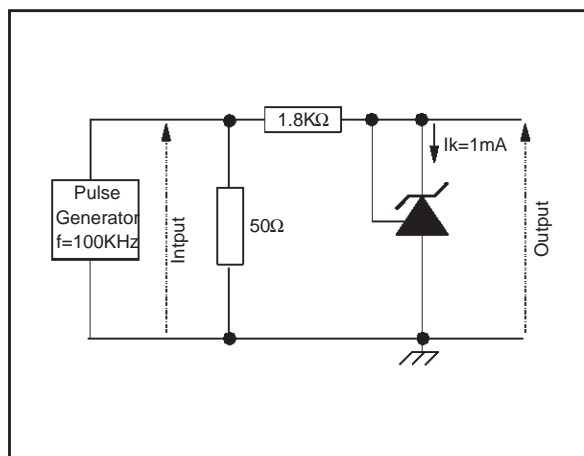
Test circuit for pulse response at  $I_k = 100\mu A$



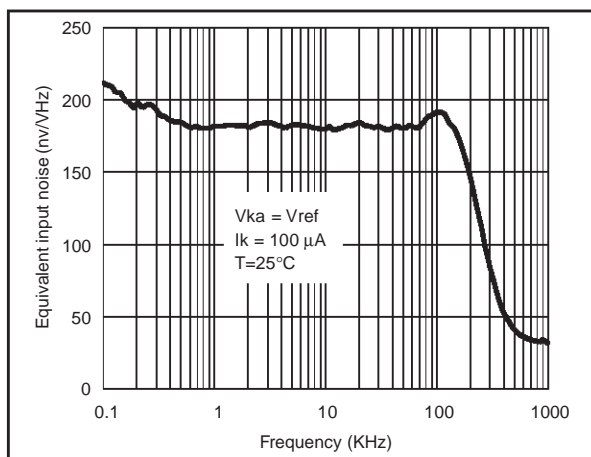
Pulse response at  $I_k = 1\text{ mA}$



Test circuit for pulse response at  $I_k = 1\text{ mA}$

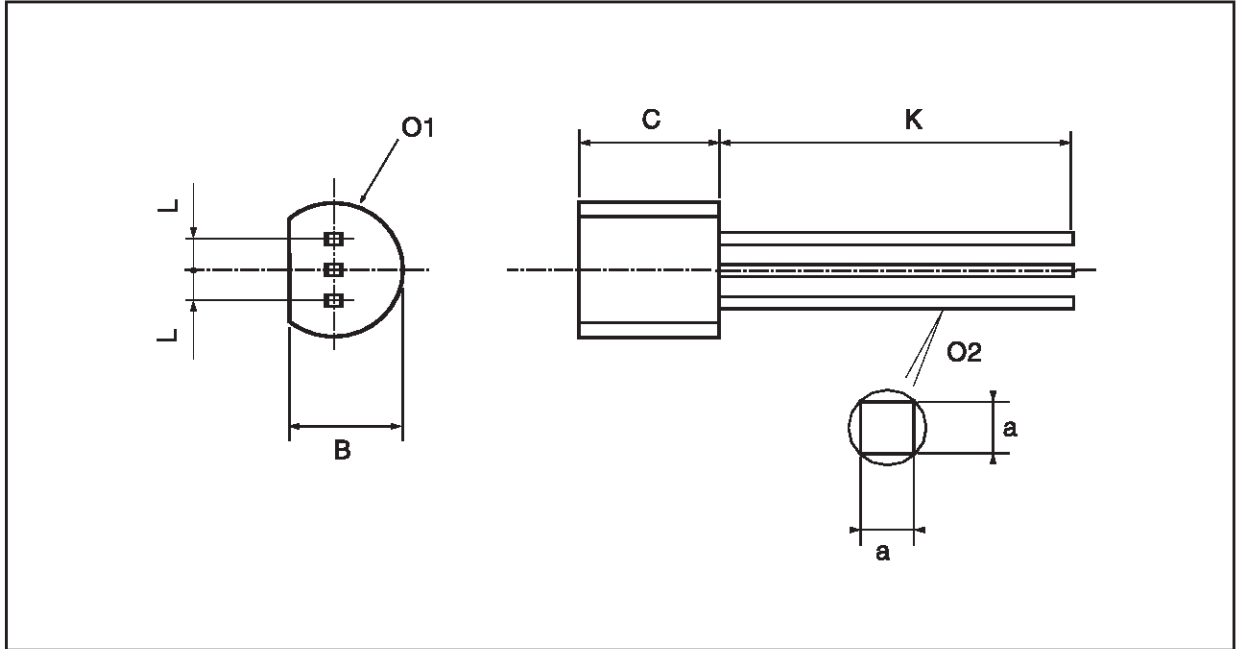


Equivalent input noise vs frequency



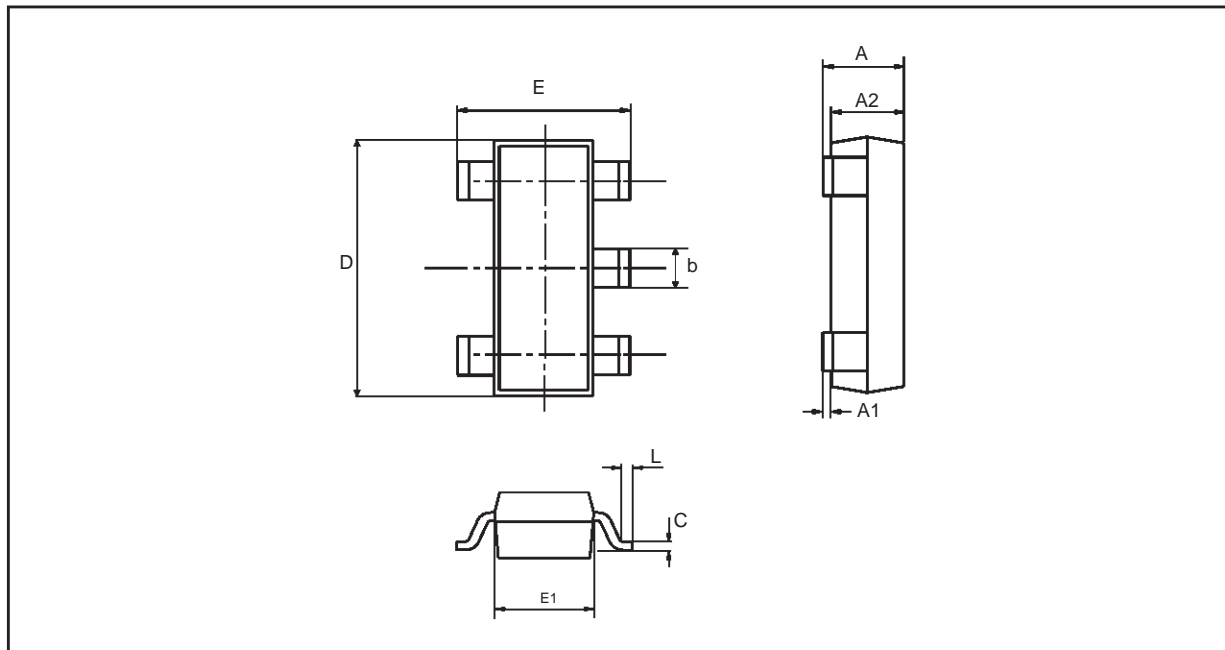
**TS431**

**PACKAGE MECHANICAL DATA**  
**3 PINS - PLASTIC PACKAGE TO92**



Dim.	Millimeters			Inches		
	Min	Typ.	Max.	Min.	Typ.	Max.
L		1.27			0.05	
B	3.2	3.7	4.2	0.126	0.1457	0.1654
O1	4.45	5.00	5.2	0.1752	0.1969	0.2047
C	4.58	5.03	5.33	0.1803	0.198	0.2098
K	12.7			0.5		
O2	0.407	0.5	0.508	0.016	0.0197	0.02
a	0.35			0.0138		

**PACKAGE MECHANICAL DATA**  
5 PINS - TINY PACKAGE (SOT23-5)



Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.90	1.20	1.45	0.035	0.047	0.057
A1	0		0.15			0.006
A2	0.90	1.05	1.30	0.035	0.041	0.051
B	0.35	0.40	0.50	0.014	0.016	0.020
C	0.09	0.15	0.20	0.004	0.006	0.008
D	2.80	2.90	3.00	0.110	0.114	0.118
D1		1.90			0.075	
e		0.95			0.037	
E	2.60	2.80	3.00	0.102	0.110	0.0118
F	1.50	1.60	1.75	0.059	0.063	0.069
L	0.10	0.5	0.60	0.004	0.014	0.024
K	0d		10d	0d		10d

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