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TS3431

1.24V Programmable Shunt Voltage Reference

- **Adjustable output voltage: 1.24 to 24V**
- **Several precision @ 25°C**
±2%, ±1%, ±0.5% and ±0.25%
- **Sink current capability: 0.4 to 100mA**
- **Industrial temperature range: -40 to +125°C**
- **Performances compatible with industry standard TL431**

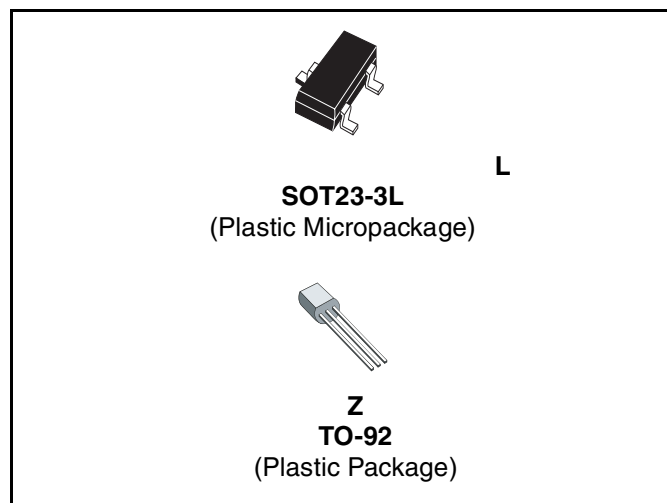
Description

The TS3431 is a programmable shunt voltage reference with guaranteed temperature stability over the entire temperature range of operation (-40 to +125°C). The output voltage may be set to any value between 1.24V and 24V with an external resistor bridge.

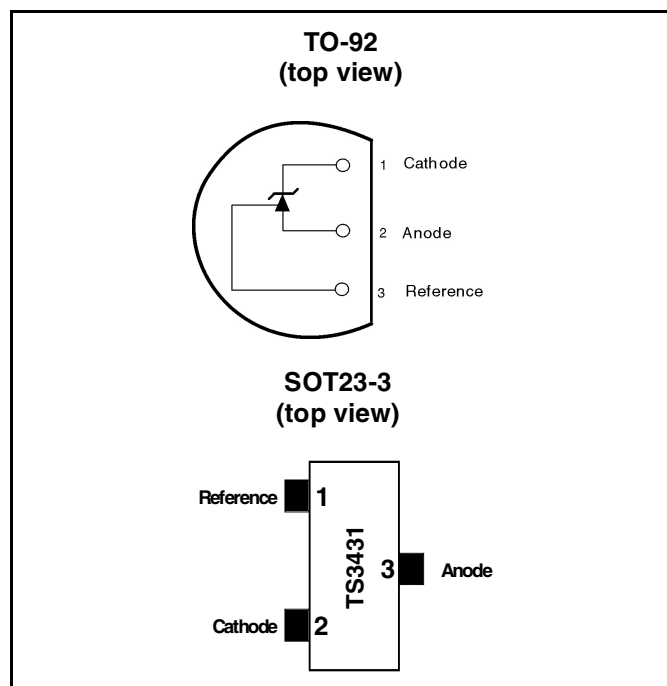
Available in SOT23-3 surface mount package, it can be designed in applications where space saving is a critical issue.

Applications

- **Computers**
- **Instrumentation**
- **Battery chargers**
- **Switch mode power supply**
- **Battery operated equipments**



Pin Connections (top view)



Order Codes

Part Number	Temperature Range	Package	Packaging	Marking
TS3431ILT/AILT/BILT/CILT	-40, +125°C	SOT23-3L	Tape & Reel	L280-L281 L282-L283
TS3431IZ/AIZ/BIZ/CIZ		TO-92	Bulk	
TS3431IZT/AIZT/BIZT/CIZT			Tape & Reel	
TS3431IZ-AP/AIZ-AP/BIZ-AP/CIZ-AP			Ammo pack	

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Absolute Maximum Ratings

1 Absolute Maximum Ratings

Table 1. Key parameters and their absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{KA}	Cathode to Anode Voltage	25	V
I_K	Reverse Breakdown Current	-100 to +150	mA
I_{REF}	Reference Current	-0.05 to 10	mA
P_D	Power Dissipation ¹ SOT23-3 TO92	360 625	mW
T_{std}	Storage Temperature	-65 to +150	°C
ESD	Human Body Model (HBM)	2	kV
	Machine Model (MM)	200	V
Tlead	Lead Temperature (soldering, 10 seconds)	250	°C

1) P_d has been calculated with $T_{amb} = 25^{\circ}\text{C}$ and $T_j = 150^{\circ}\text{C}$ and $R_{thjc} = 66^{\circ}\text{C/W}$, $R_{thja} = 200^{\circ}\text{C/W}$ for the TO92 package
 $R_{thjc} = 110^{\circ}\text{C/W}$, $R_{thja} = 340^{\circ}\text{C/W}$ for the SOT23-3L package

Table 2. Operating Conditions

Symbol	Parameter	Value	Unit
I_K	Cathode Operating Current	0.5 to 100	mA
V_K	Cathode Operating Voltage	1.24 to 24	V
T_{oper}	Operating Free Air Temperature Range	-40 to +125	°C

Electrical Characteristics

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2 Electrical Characteristics

Table 3. Tamb = 25°C (unless otherwise specified)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V_K	Reference input voltage $I_K = 10\text{mA}$	TS3431 (2%)	1.215	1.24	1.265	V
		TS3431A (1%)	1.228		1.252	
		TS3431B (0.5%)	1.234		1.246	
		TS3431C (0.25%)	1.237		1.243	
ΔV_K	Variation of reference input voltage over temperature	$0^\circ\text{C} < T < +70^\circ\text{C}$			10	mV
		$-40^\circ\text{C} < T < +105^\circ\text{C}$			18	
		$-40^\circ\text{C} < T < +125^\circ\text{C}$			21	
T_C	Temperature coefficient	$-40^\circ\text{C} < T < +125^\circ\text{C}$			100	ppm/°C
I_{KMIN}	Minimum Operating Current	$T = 25^\circ\text{C}$		0.35	0.4	mA
		$-40^\circ\text{C} < T < +125^\circ\text{C}$			0.5	
$\left \frac{\Delta V_{ref}}{\Delta V_{ka}} \right $	Ratio of change in reference input voltage to change in cathode to anode voltage	$I_K=10\text{mA}$ $V_K=24$ to 1.24V		1.2	1.5	mV/V
		$-40^\circ\text{C} < T < +125^\circ\text{C}$			2	
I_{REF}	Reference input current $I_K=10\text{mA}$, $R1=10\text{K}\Omega$, $R2=+\infty$	$T=25^\circ\text{C}$		0.9	1.5	μA
		$-40^\circ\text{C} < T < +125^\circ\text{C}$			2	
ΔI_{REF}	Reference input current deviation $I_K=10\text{mA}$, $R1=10\text{K}\Omega$, $R2=+$	$0^\circ\text{C} < T < +70^\circ\text{C}$		0.5	1	μA
		$-40^\circ\text{C} < T < +125^\circ\text{C}$		0.9	1.5	
I_{OFF}	Off-state cathode current $V_K=24\text{V}$	$T=25^\circ\text{C}$		35	500	nA
		$-40^\circ\text{C} < T < +105^\circ\text{C}$			1000	
		$-40^\circ\text{C} < T < +125^\circ\text{C}$			2000	
R_{KA}	Reverse Static Impedance	$I_K = 1$ to 100mA		0.2	0.4	Ω
E_N	Wideband Noise	$I_K = 10\text{mA}$ $1\text{kHz} < f < 100\text{kHz}$		100		nV/ $\sqrt{\text{Hz}}$

Note: Limits are 100% production tested at 25°C. Limits over temperature are guaranteed through correlation and by design.

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Figure 1. Reference voltage vs. temperature

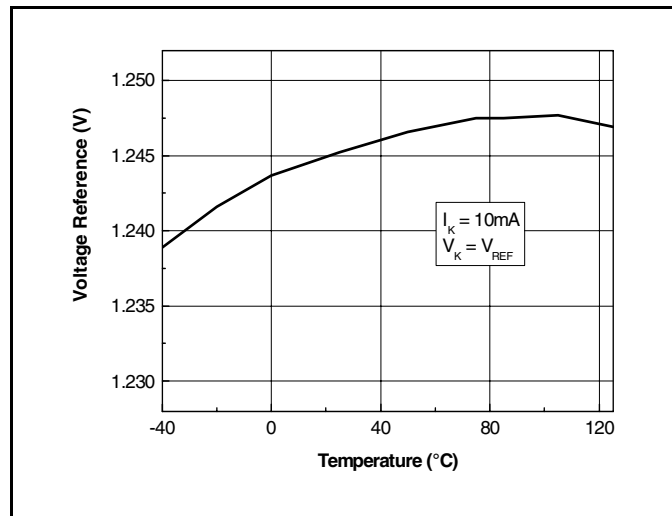


Figure 2. Cathode voltage vs cathode current

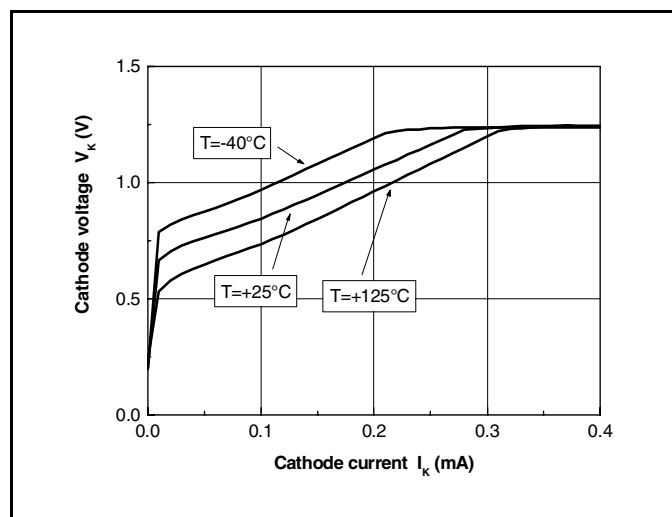


Figure 3. Reference input current vs temperature

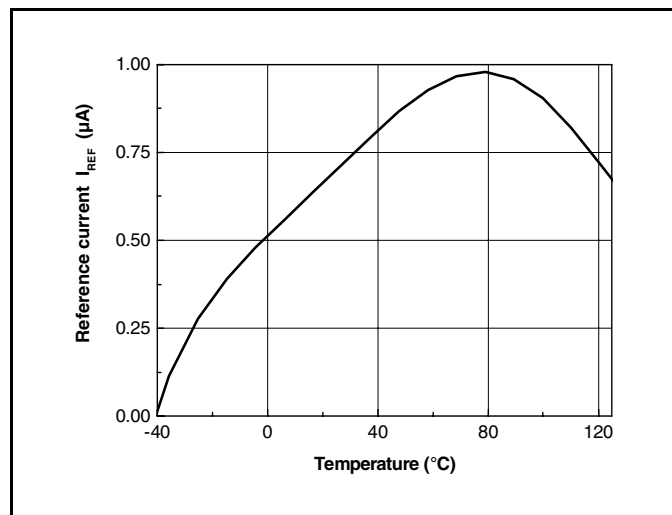


Figure 4. Test circuit for $V_K = V_{ref}$

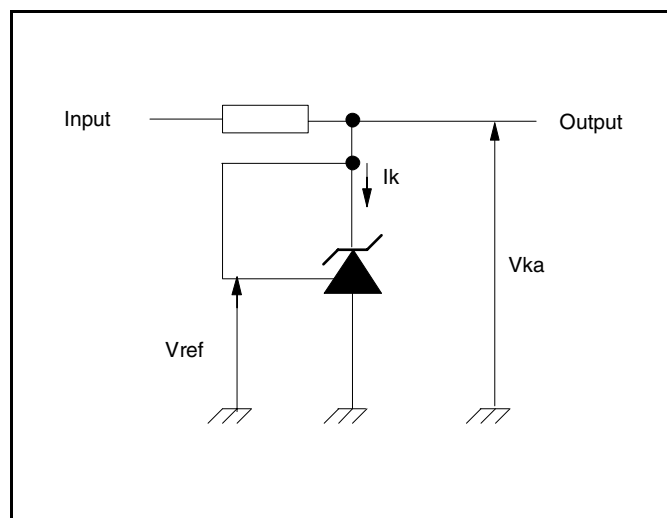


Figure 5. Minimum operating current vs temperature

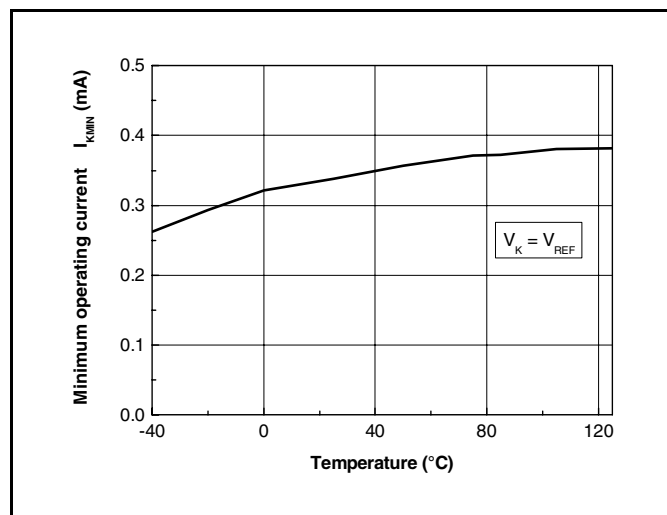
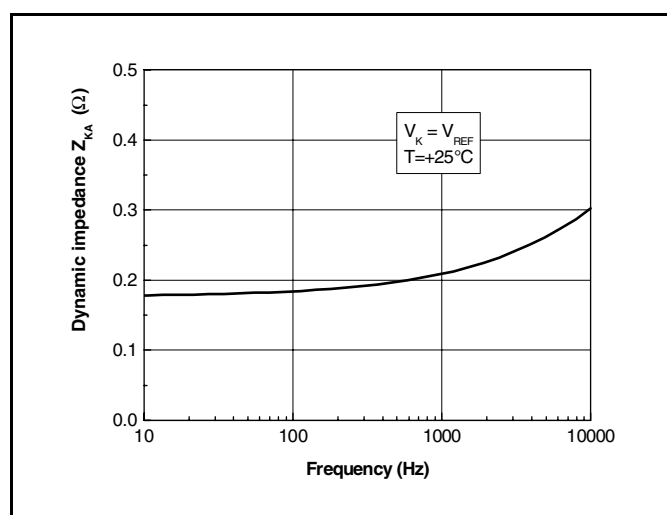


Figure 6. Dynamic impedance vs frequency



Electrical Characteristics

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Figure 7. Off-State current vs temperature

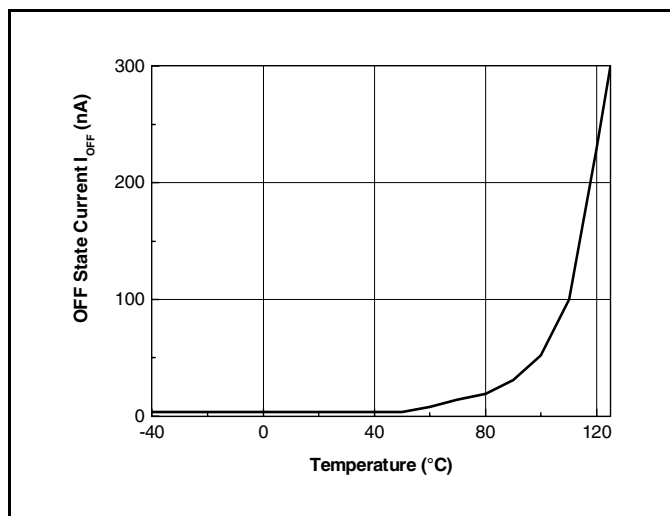


Figure 8. Ratio of change in reference input voltage to change in V_{ka} voltage vs temperature

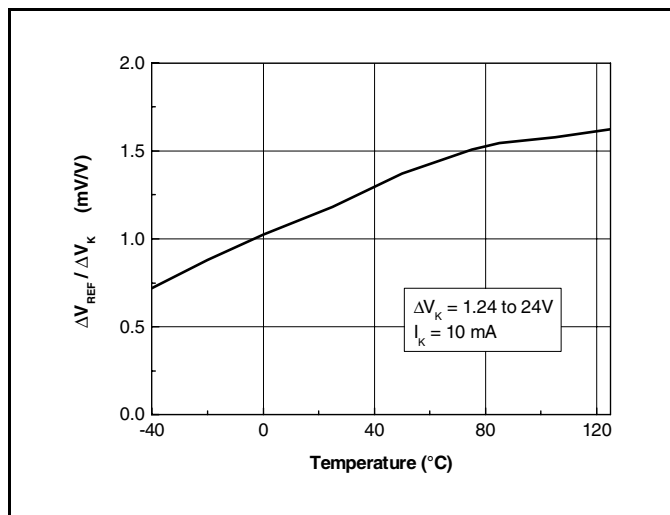


Figure 9. Phase and gain vs frequency

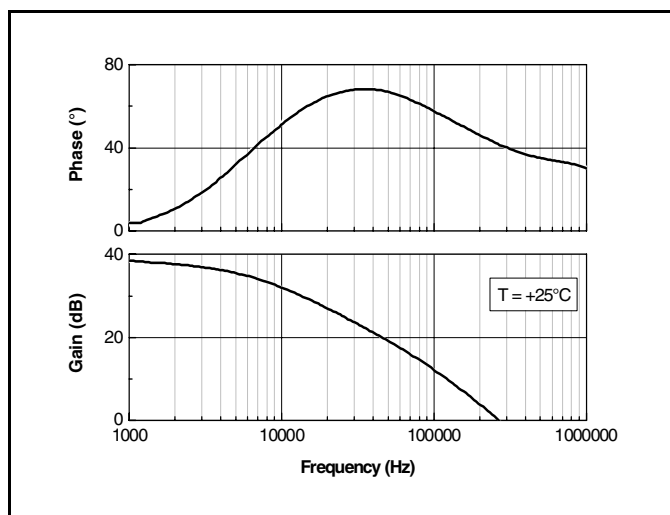


Figure 10. Test circuit for off-state current measurement

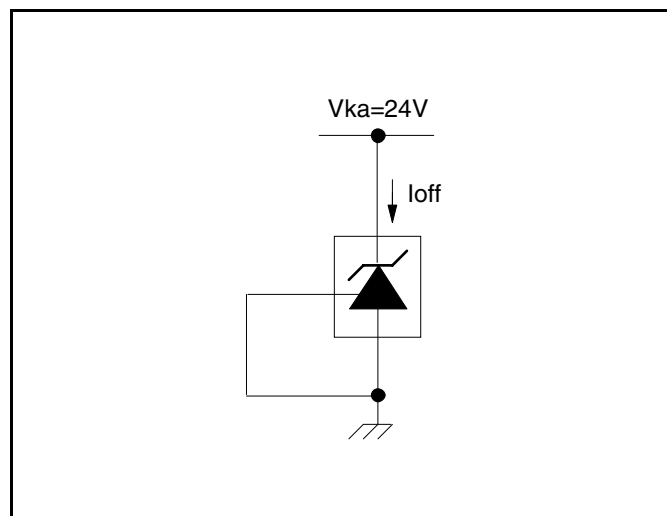


Figure 11. Test circuit for $V_K > V_{REF}$

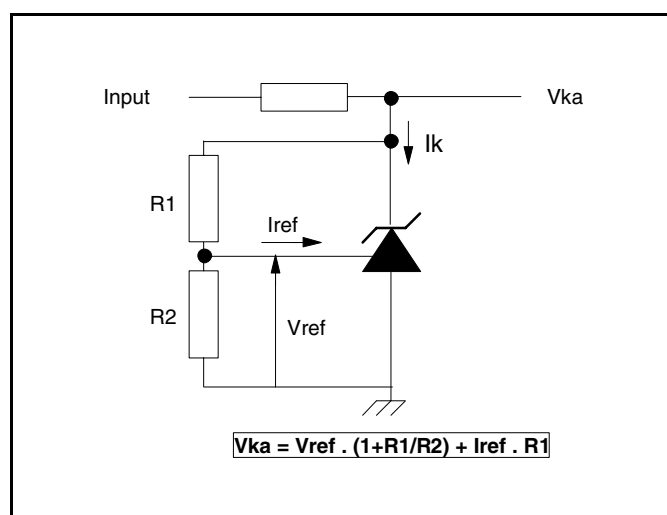
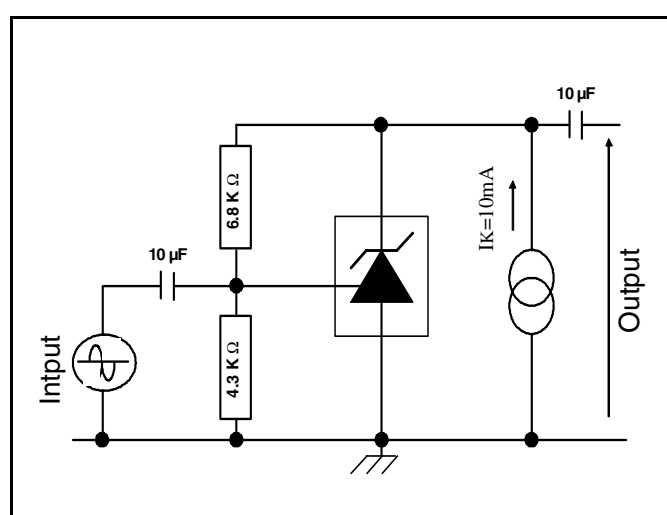


Figure 12. Test circuit for phase and gain measurement



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Electrical Characteristics

Figure 13. Pulse response at $I_K=1\text{mA}$

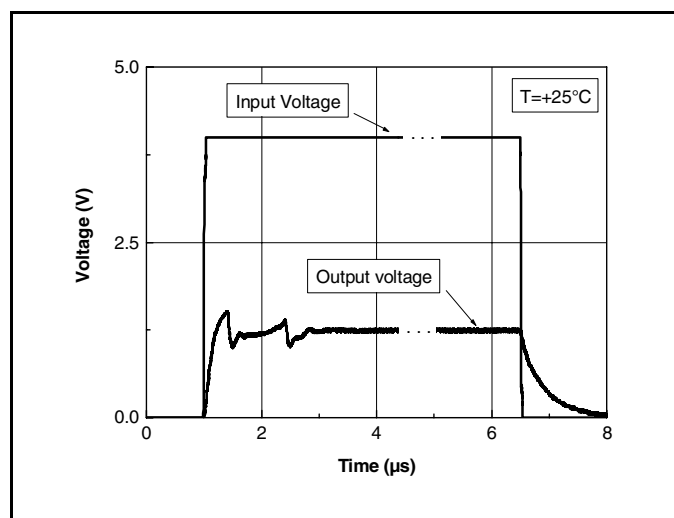


Figure 16. Test circuit for pulse response at $I_K = 1\text{mA}$

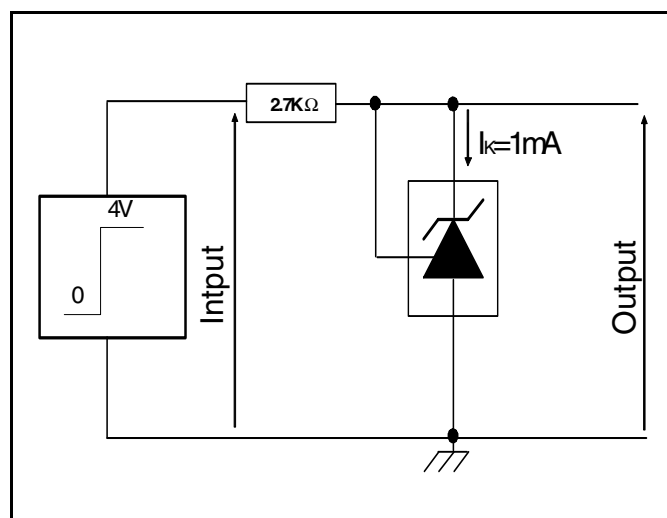


Figure 14. Pulse response at $I_K = 10\text{mA}$

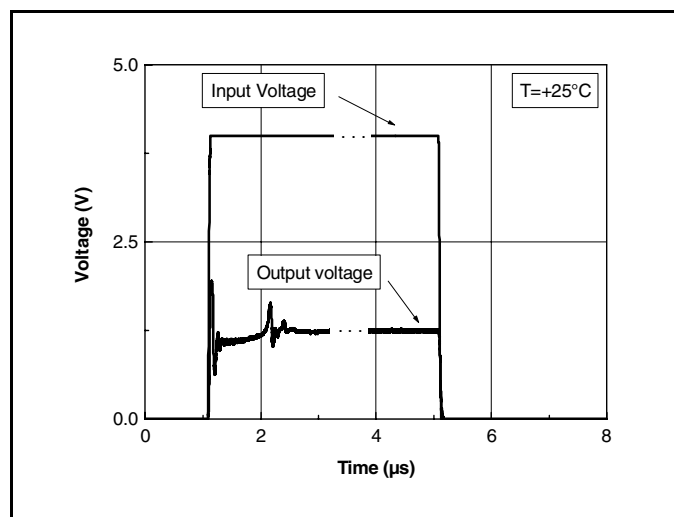


Figure 17. Test circuit for pulse response at $I_K = 10\text{mA}$

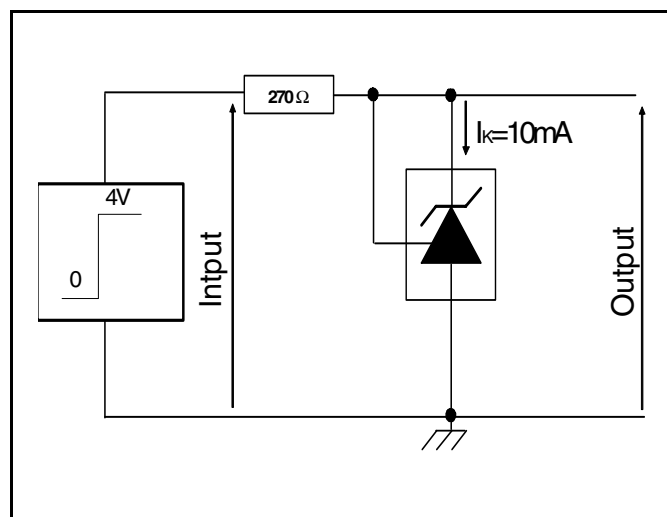


Figure 15. Block diagram

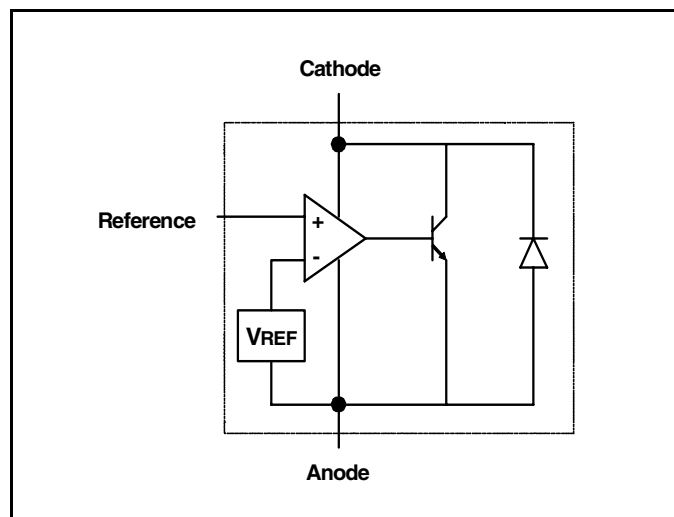
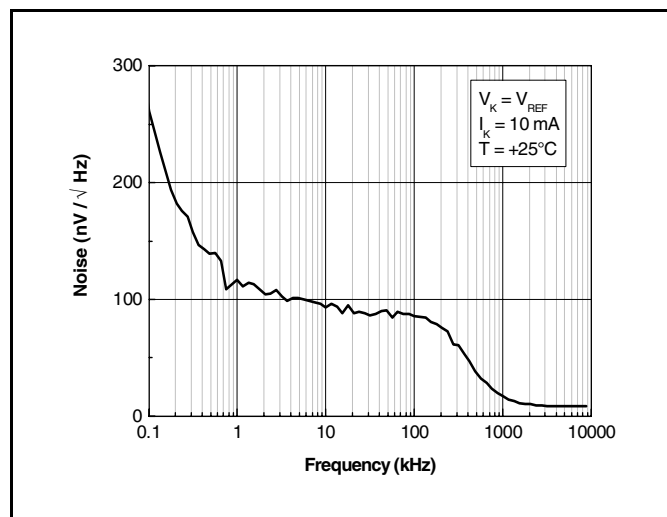


Figure 18. Equivalent input noise vs frequency

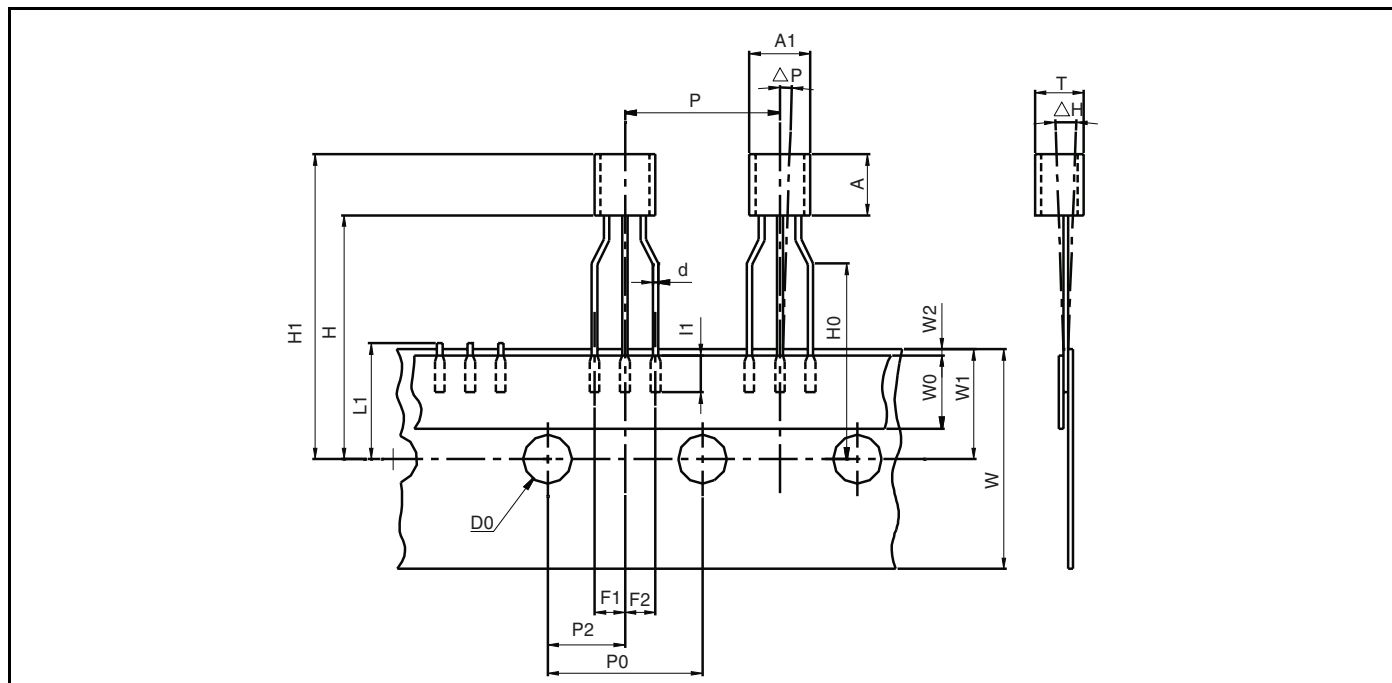


Package Mechanical Data

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3 Package Mechanical Data

3.1 3 Pins - Plastic Package TO-92 (tape & reel)

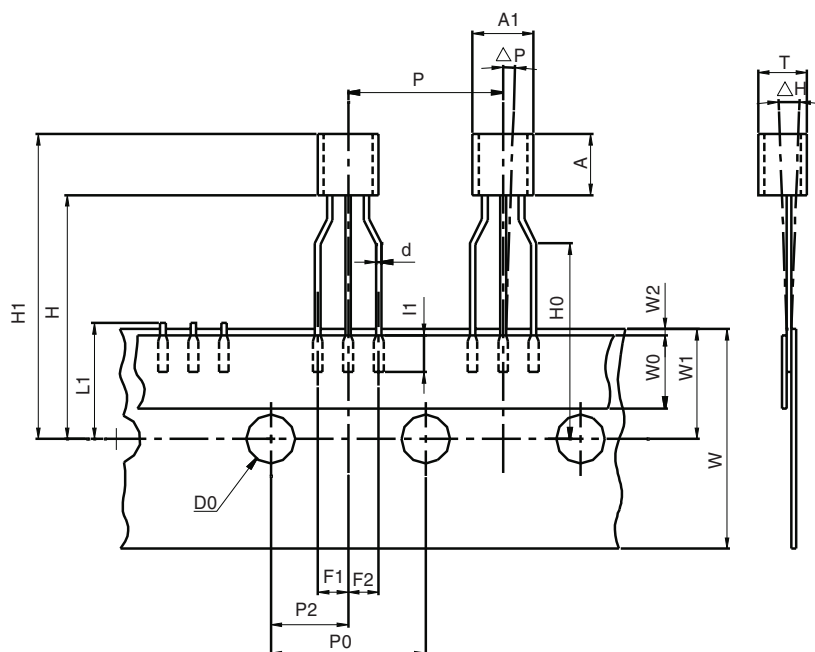


Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
AL			5.0			0.197
A			5.0			0.197
T			4.0			0.157
d		0.45			0.018	
I1	2.5			0.098		
P	11.7	12.7	13.7	0.461	0.500	0.539
PO	12.4	12.7	13	0.488	0.500	0.512
P2	5.95	6.35	6.75	0.234	0.250	0.266
F1/F2	2.4	2.5	2.8	0.094	0.098	0.110
Δh	-1	0	1	-0.039	0	0.039
ΔP	-1	0	1	-0.039	0	0.039
W	17.5	18.0	19.0	0.689	0.709	0.748
W0	5.7	6	6.3	0.224	0.236	0.248
W1	8.5	9	9.75	0.335	0.354	0.384
W2			0.5			0.020
H			20			0.787
H0	15.5	16	16.5	0.610	0.630	0.650
H1			25			0.984
DO	3.8	4.0	4.2	0.150	0.157	0.165
L1			11			0.433

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Package Mechanical Data

3.2 3 Pins - Plastic Package TO-92 (tape ammo pack)



Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
AL			5.0			0.197
A			5.0			0.197
T			4.0			0.157
d		0.45			0.018	
l1	2.5			0.098		
P	11.7	12.7	13.7	0.461	0.500	0.539
PO	12.4	12.7	13	0.488	0.500	0.512
P2	5.95	6.35	6.75	0.234	0.250	0.266
F1/F2	2.4	2.5	2.8	0.094	0.098	0.110
Δh	-1	0	1	-0.039	0	0.039
ΔP	-1	0	1	-0.039	0	0.039
W	17.5	18.0	19.0	0.689	0.709	0.748
W0	5.7	6	6.3	0.224	0.236	0.248
W1	8.5	9	9.75	0.335	0.354	0.384
W2			0.5			0.020
H			20			0.787
H0	15.5	16	16.5	0.610	0.630	0.650
H1			25			0.984
DO	3.8	4.0	4.2	0.150	0.157	0.165
L1			11			0.433

Package Mechanical Data

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3.3 3 Pins - Plastic Package TO-92 (bulk)

TO-92 MECHANICA DATA						
DIM.	mm.			mils		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	4.32		4.95	170.1		194.9
b	0.36		0.51	14.2		20.1
D	4.45		4.95	175.2		194.9
E	3.30		3.94	129.9		155.1
e	2.41		2.67	94.9		105.1
e1	1.14		1.40	44.9		55.1
L	12.7		15.49	500.0		609.8
R	2.16		2.41	85.0		94.9
S1	0.92		1.52	36.2		59.8
W	0.41		0.56	16.1		22.0

The diagram illustrates the mechanical specifications of a TO-92 package. It includes three views: a top view showing the circular body with diameter D and lead spacing e; a side view showing the overall height A, lead length L, and lead thickness b; and a cross-sectional view showing the internal structure with dimensions R (radius), E (height), and V (lead angle). The dimensions are labeled as follows: A (height), b (lead thickness), D (body diameter), E (height), L (lead length), R (radius), S1 (lead spacing), W (lead width), e (lead spacing), and e1 (lead spacing).

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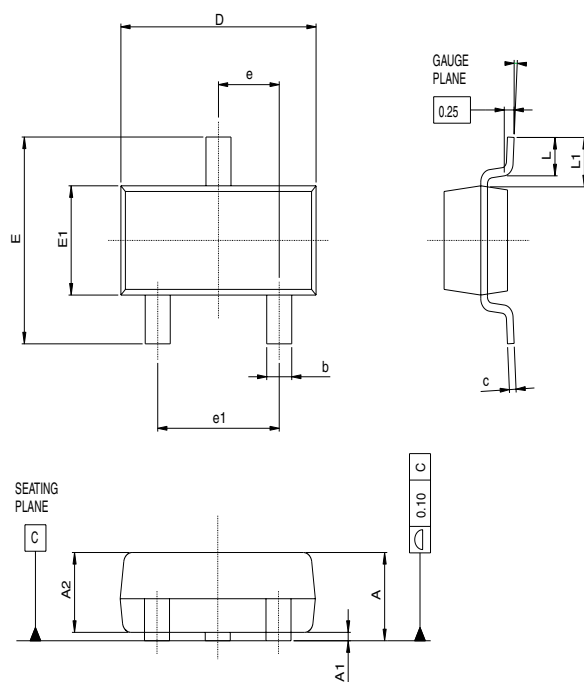
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Package Mechanical Data

3.4 SOT23-3L Package

SOT23-3L MECHANICAL DATA

DIM.	mm.			mils		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	0.890		1.120	35.05		44.12
A1	0.010		0.100	0.39		3.94
A2	0.880	0.950	1.020	34.65	37.41	40.17
b	0.300		0.500	11.81		19.69
C	0.080		0.200	3.15		7.88
D	2.800	2.900	3.040	110.26	114.17	119.72
E	2.100		2.64	82.70		103.96
E1	1.200	1.300	1.400	47.26	51.19	55.13
e		0.950			37.41	
e1		1.900			74.82	
L	0.400		0.600	15.75		23.63
L1		0.540			21.27	
k			8°			8°



7110469/A

Revision History

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4 Revision History

Date	Revision	Description of Changes
01 Jan. 2004	1	First Release
01 Dec. 2004	2	Specific content changes as follows: - CI version added in Table: Order Codes on page 1 - Rthjc information added in Table1: Key parameters and their absolute maximum ratings on page 2 - Test condition added in Table3: Tamb = 25°C (unless otherwise specified) on page 3

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