

## 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

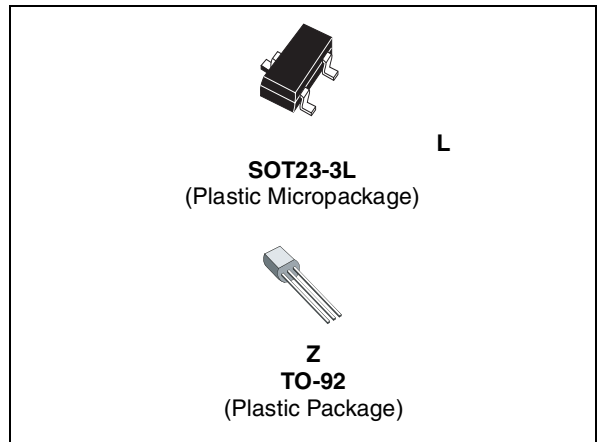
### Description

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.

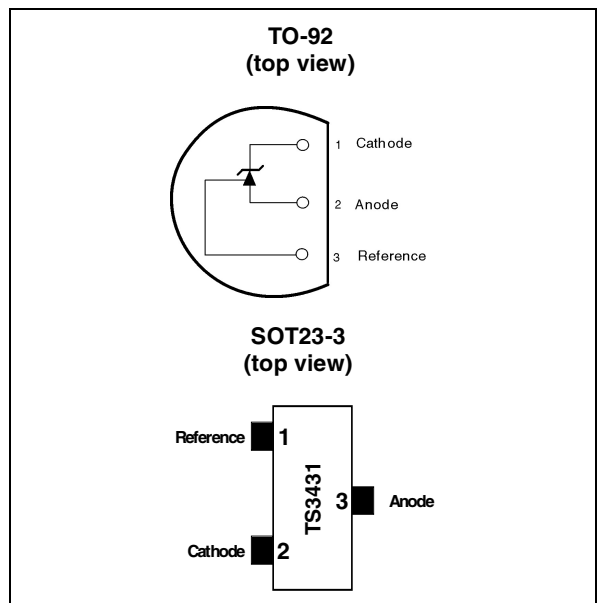
Available in SOT23-3 surface mount package, it can be designed in applications where space saving is a critical issue.

### 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			Bulk	
TS3431IZT/AIZT/BIZT/CIZT		TO-92	Tape & Reel	
TS3431IZ-AP/AIZ-AP/BIZ-AP/CIZ-AP			Ammo pack	

## 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 <sup>1</sup> 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
$T_{lead}$	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

## 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	
$\Delta V_K$	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
$I_{K\text{MIN}}$	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_{\text{ref}}}{\Delta V_{\text{ka}}} \right $	Ratio of change in reference input voltage to change in cathode to anode voltage	$I_K=10\text{mA}$ $V_K= 24 \text{ to } 1.24\text{V}$		1.2	1.5	mV/V
		$-40^\circ\text{C} < T < +125^\circ\text{C}$			2	
$I_{\text{REF}}$	Reference input current $I_K=10\text{mA}$ , $R1=10\text{K}\Omega$ , $R2=+\infty$	$T=25^\circ\text{C}$		0.9	1.5	$\mu\text{A}$
		$-40^\circ\text{C} < T < +125^\circ\text{C}$			2	
$\Delta I_{\text{REF}}$	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	$\mu\text{A}$
		$-40^\circ\text{C} < T < +125^\circ\text{C}$		0.9	1.5	
$I_{\text{OFF}}$	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	
$R_{\text{KA}}$	Reverse Static Impedance	$I_K = 1 \text{ to } 100\text{mA}$		0.2	0.4	$\Omega$
$E_N$	Wideband Noise	$I_K = 10\text{mA}$ $1\text{kHz} < f < 100\text{kHz}$		100		$\text{nV}/\sqrt{\text{Hz}}$

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

Figure 1. Reference voltage vs. temperature

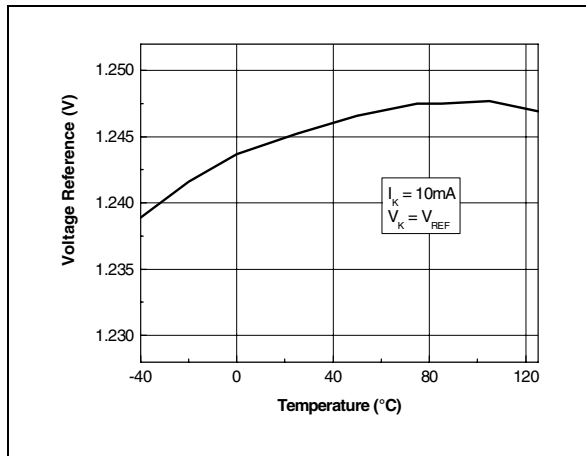


Figure 2. Cathode voltage vs cathode current

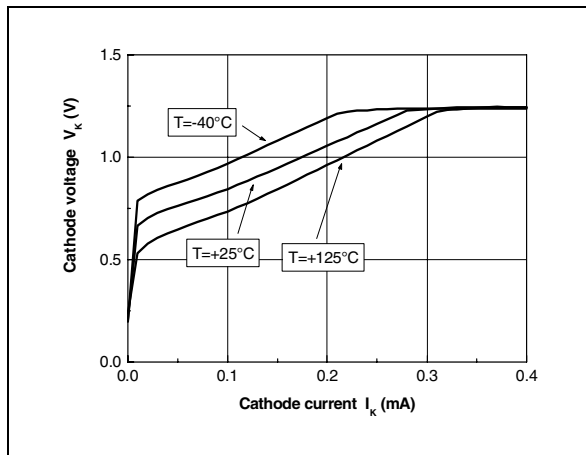


Figure 3. Reference input current vs temperature

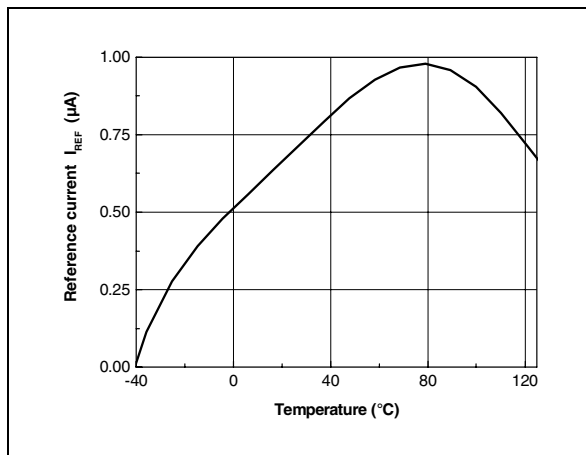


Figure 4. Test circuit for V\_K = V\_ref

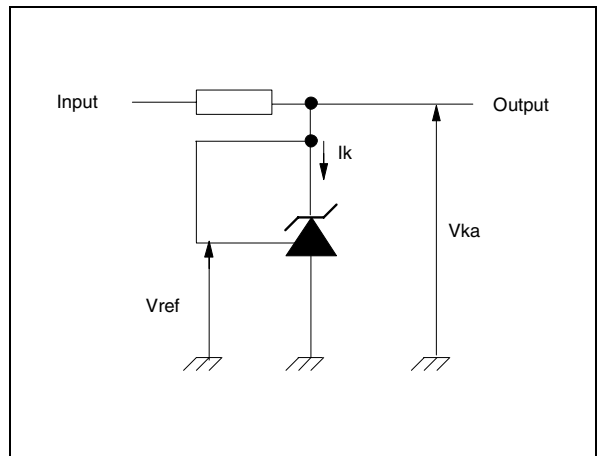


Figure 5. Minimum operating current vs temperature

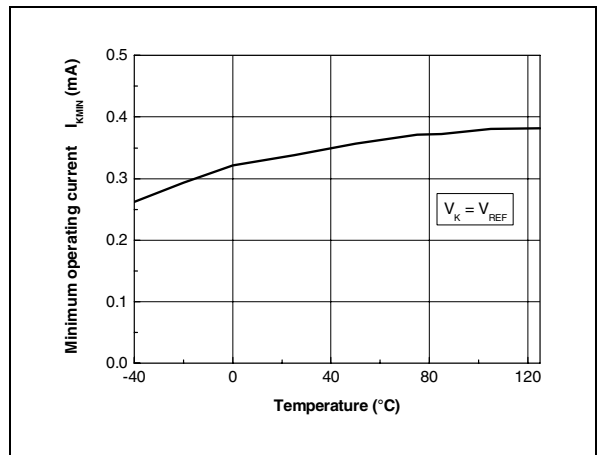


Figure 6. Dynamic impedance vs frequency

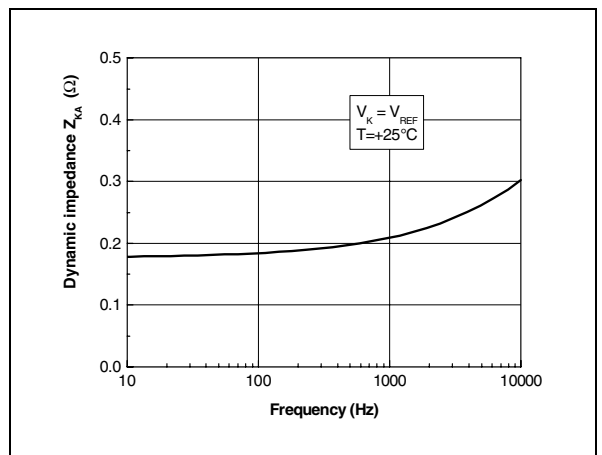


Figure 7. Off-State current vs temperature

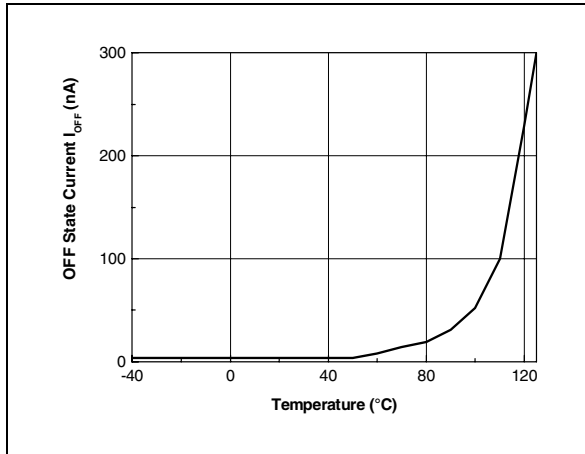


Figure 8. Ratio of change in reference input voltage to change in  $V_{ka}$  voltage vs temperature

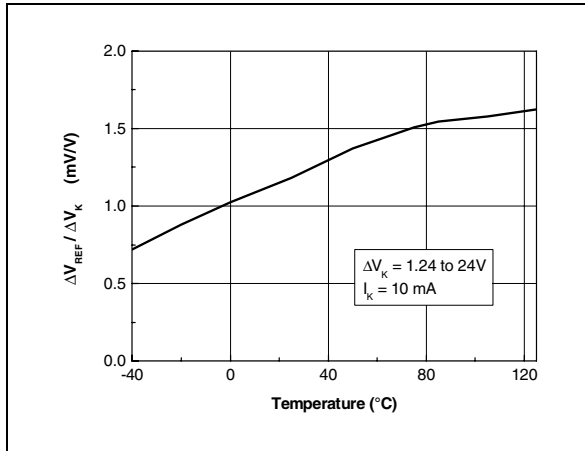


Figure 9. Phase and gain vs frequency

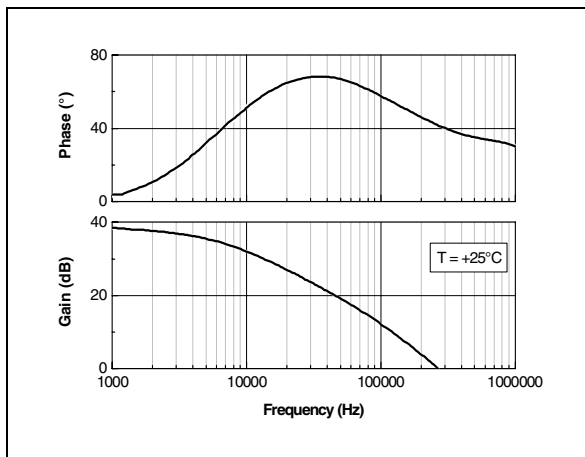


Figure 10. Test circuit for off-state current measurement

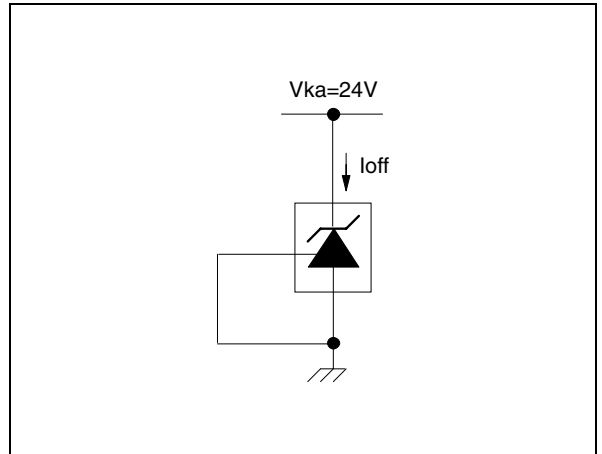


Figure 11. Test circuit for  $V_K > V_{REF}$

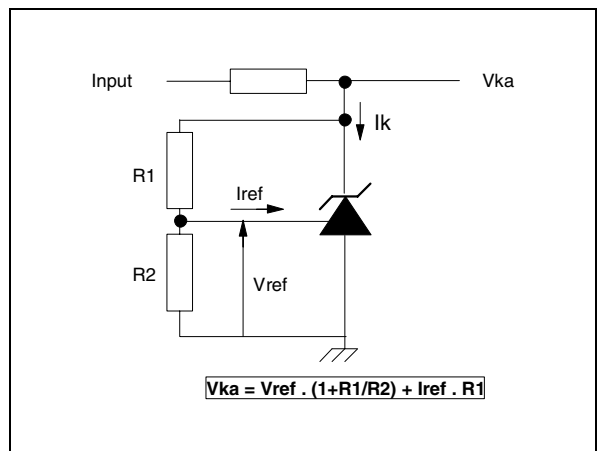


Figure 12. Test circuit for phase and gain measurement

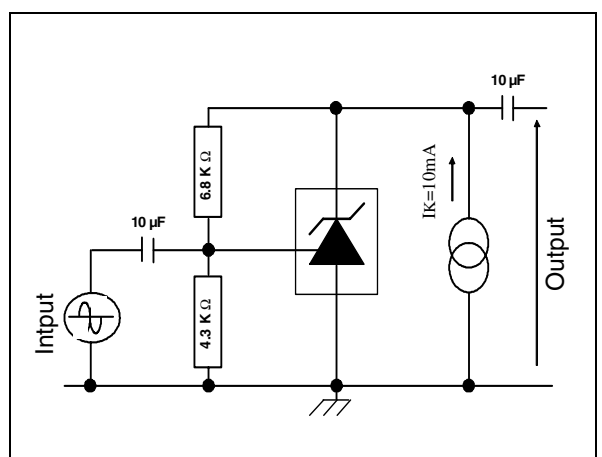


Figure 13. Pulse response at  $I_K=1\text{mA}$

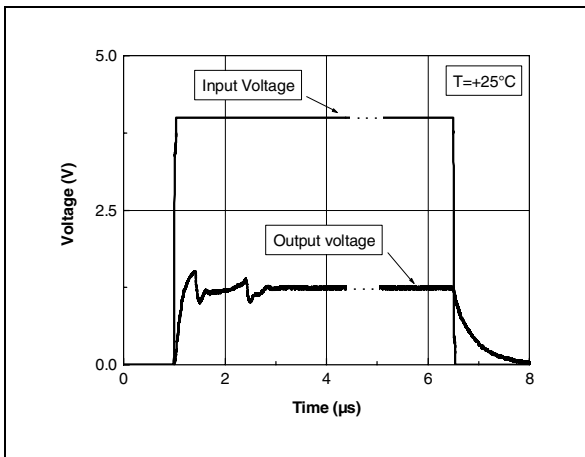


Figure 14. Pulse response at  $I_K = 10\text{mA}$

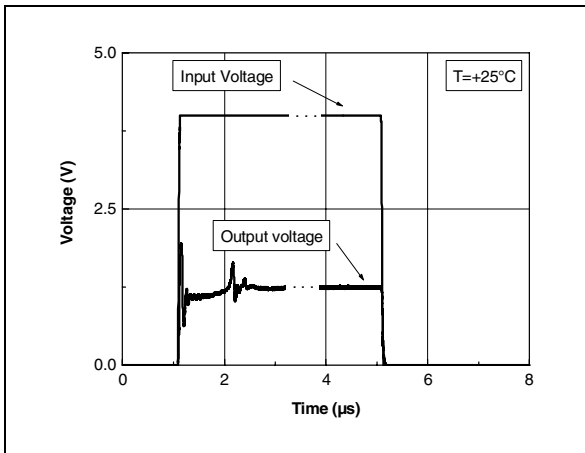


Figure 15. Block diagram

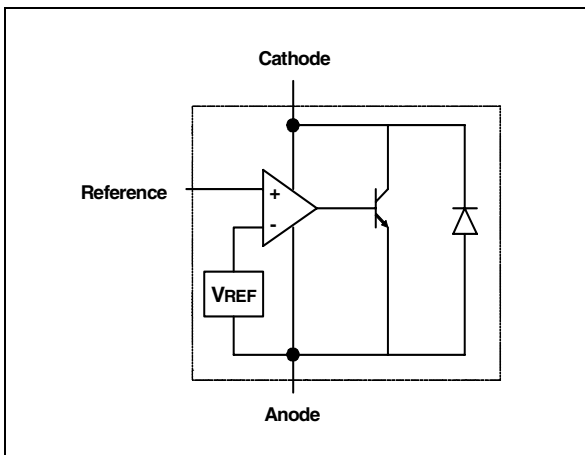


Figure 16. Test circuit for pulse response at  $I_K = 1\text{mA}$

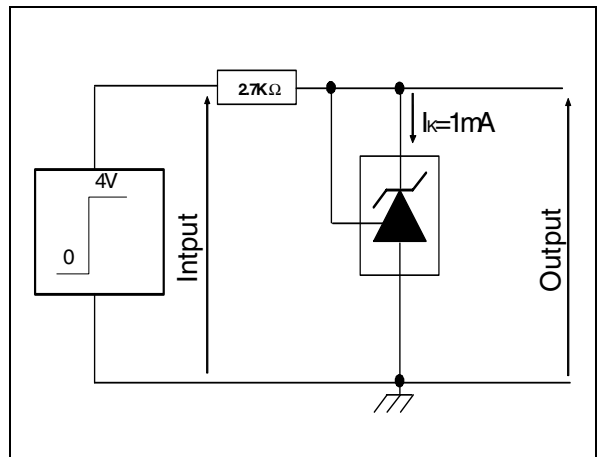


Figure 17. Test circuit for pulse response at  $I_K = 10\text{mA}$

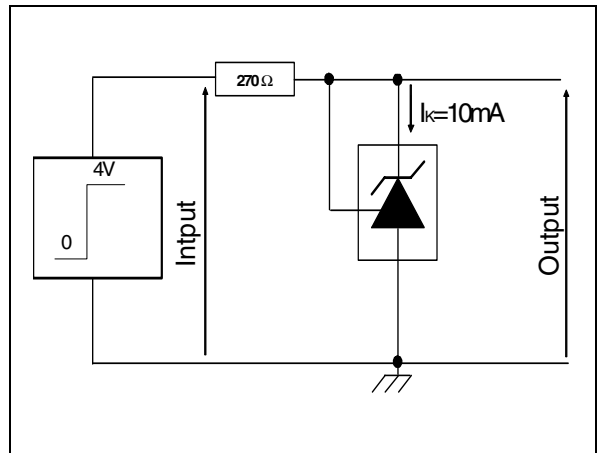
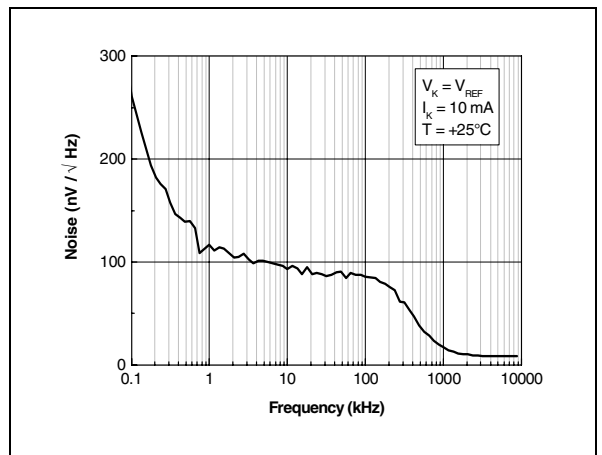
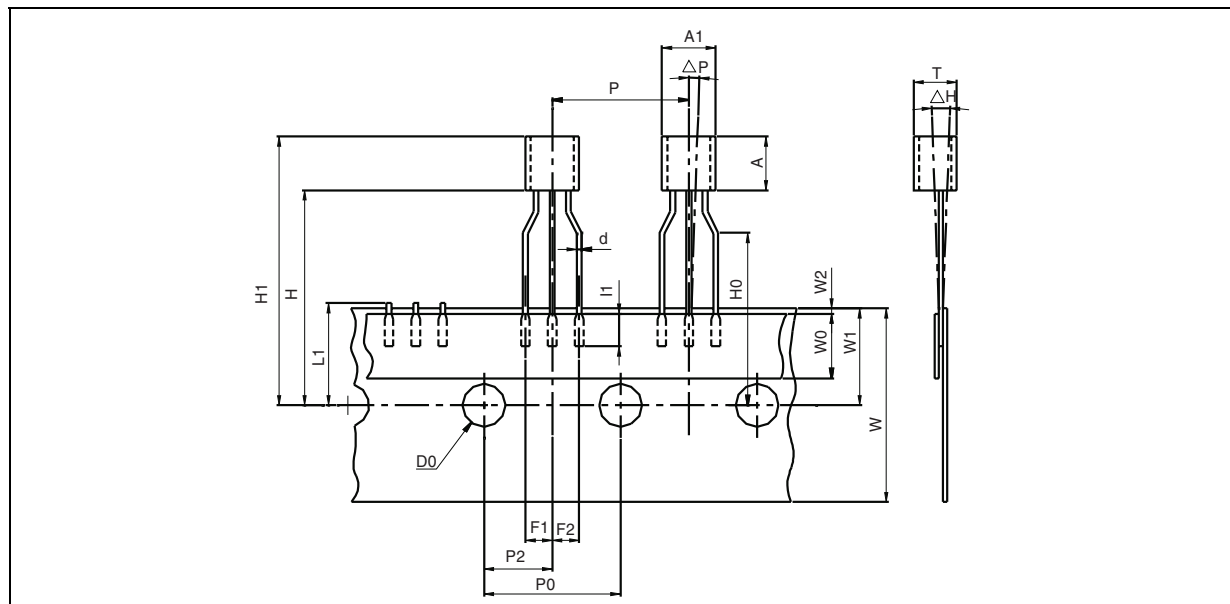


Figure 18. Equivalent input noise vs frequency



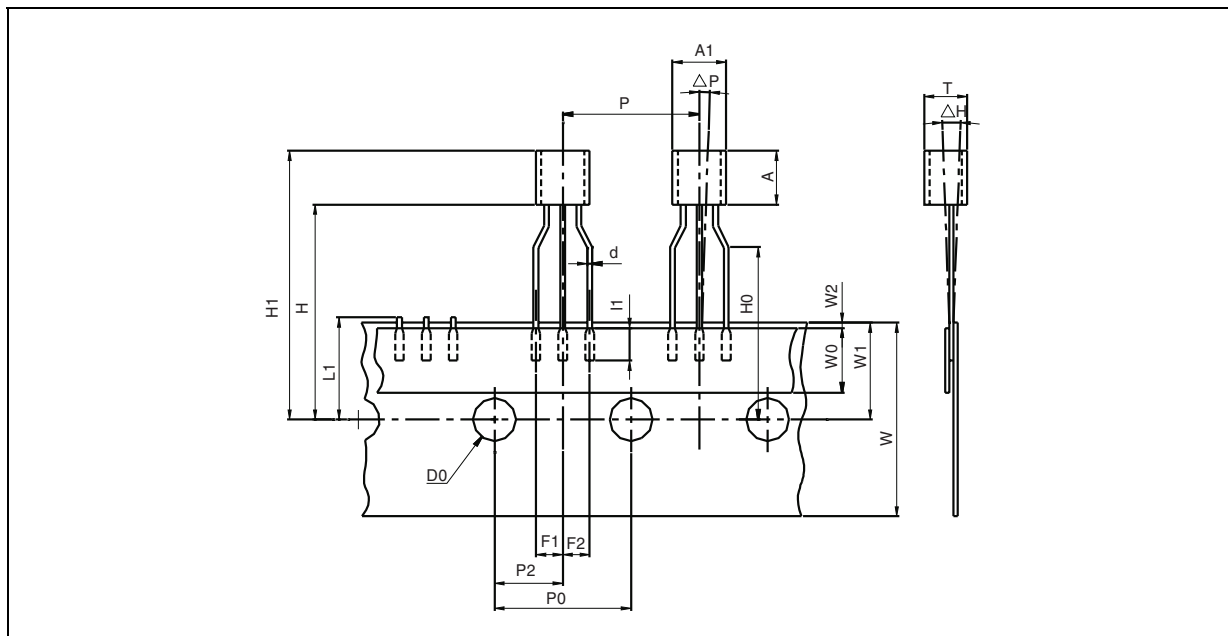
### 3 Package Mechanical Data

#### 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

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



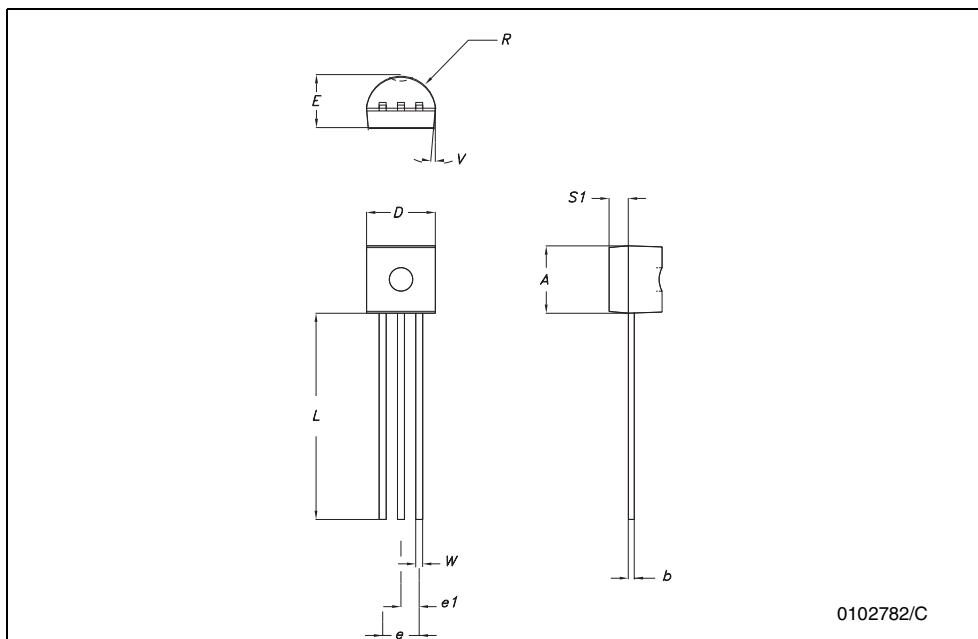
Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
AL			5.0			0.197
A			5.0			0.197
T			4.0			0.157
d		0.45			0.018	
l1	2.5			0.098		
P	11.7	12.7	13.7	0.461	0.500	0.539
PO	12.4	12.7	13	0.488	0.500	0.512
P2	5.95	6.35	6.75	0.234	0.250	0.266
F1/F2	2.4	2.5	2.8	0.094	0.098	0.110
Δh	-1	0	1	-0.039	0	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



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

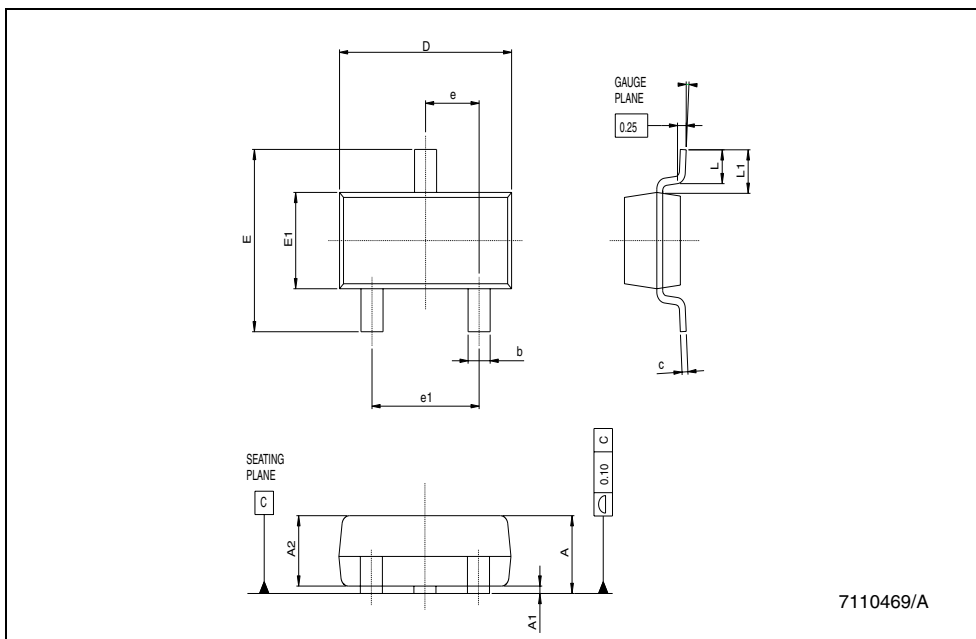


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3.4 SOT23-3L Package

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°



## 4 Revision History

Date	Revision	Description of Changes
01 Jan. 2004	1	First Release
01 Dec. 2004	2	Specific content changes as follows: <ul style="list-style-type: none"> <li>• CI version added in <i>Table: Order Codes</i> on page 1</li> <li>• Rthjc information added in <i>Table1: Key parameters and their absolute maximum ratings</i> on page 2</li> <li>• Test condition added in <i>Table3: Tamb = 25°C (unless otherwise specified)</i> on page 3</li> </ul>

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