



# THE DATASHEET OF TS3431AIZT



## 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**

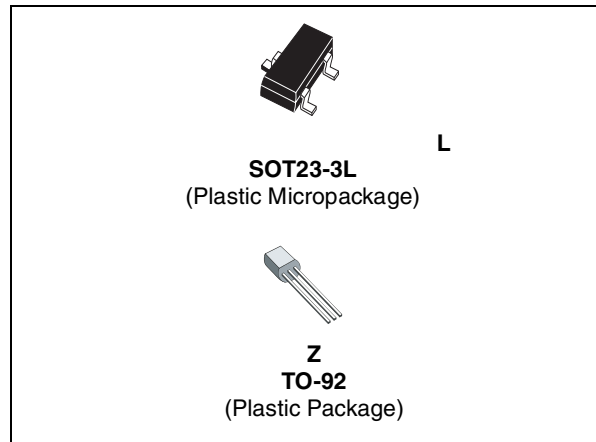
### Description

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.

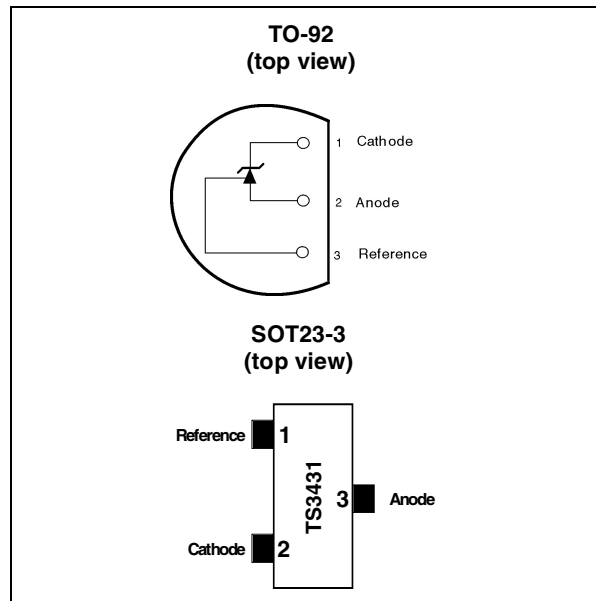
Available in SOT23-3 surface mount package, it can be designed in applications where space saving is a critical issue.

### 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<br>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<br>TO92 | 360<br>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   |

## 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   |                              |
| $\frac{ \Delta V_{\text{ref}} }{ \Delta V_{\text{ka}} }$ | Ratio of change in reference input voltage to change in cathode to anode voltage        | $I_K=10\text{mA}$<br>$V_K= 24 \text{ to } 1.24\text{V}$  |       | 1.2  | 1.5   | mV/V                         |
|  |   | $-40^\circ\text{C} < T < +125^\circ\text{C}$             |       |      | 2     |                              |
| $I_{\text{REF}}$   | Reference input current<br>$I_K=10\text{mA}$ , $R1=10\text{K}\Omega$ , $R2=+\infty$     | $T=25^\circ\text{C}$                                     |       | 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<br>$I_K=10\text{mA}$ , $R1=10\text{K}\Omega$ , $R2=+$ | $0^\circ\text{C} < T < +70^\circ\text{C}$                |       | 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  | $I_K = 10\text{mA}$<br>$1\text{kHz} < f < 100\text{kHz}$ |       | 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

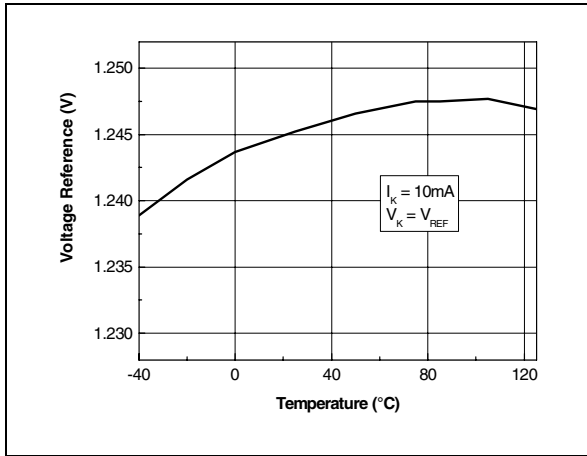


Figure 4. Test circuit for  $V_K = V_{REF}$

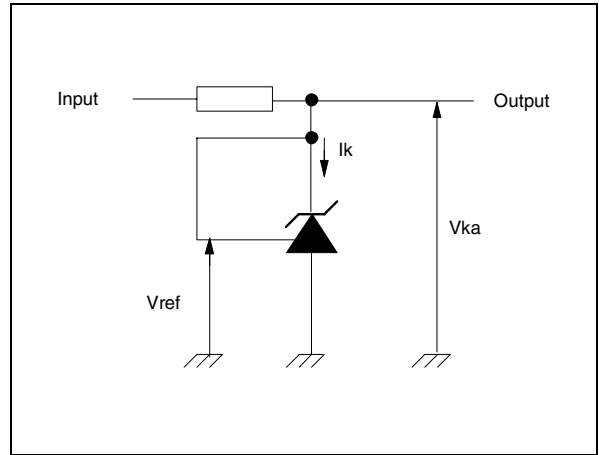


Figure 2. Cathode voltage vs cathode current

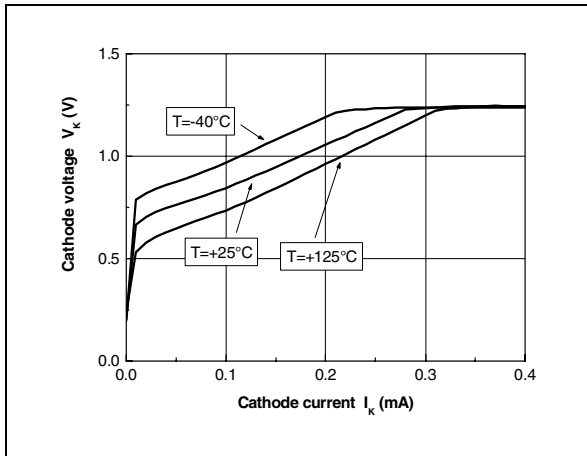


Figure 5. Minimum operating current vs temperature

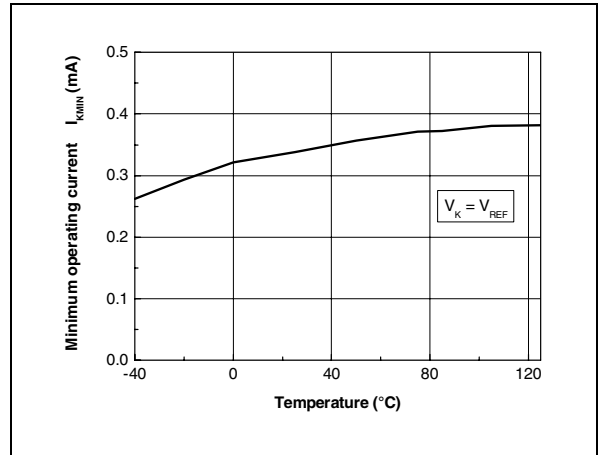


Figure 3. Reference input current vs temperature

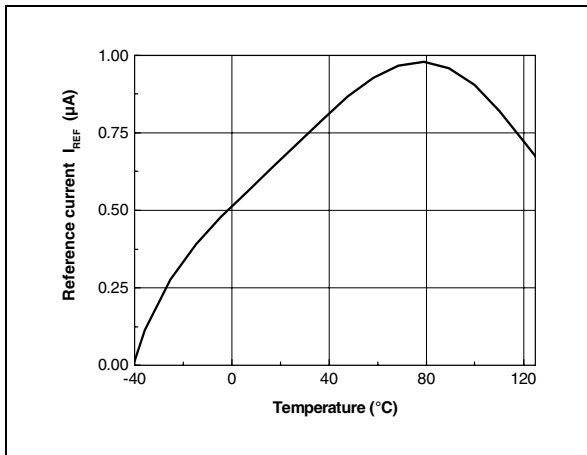


Figure 6. Dynamic impedance vs frequency

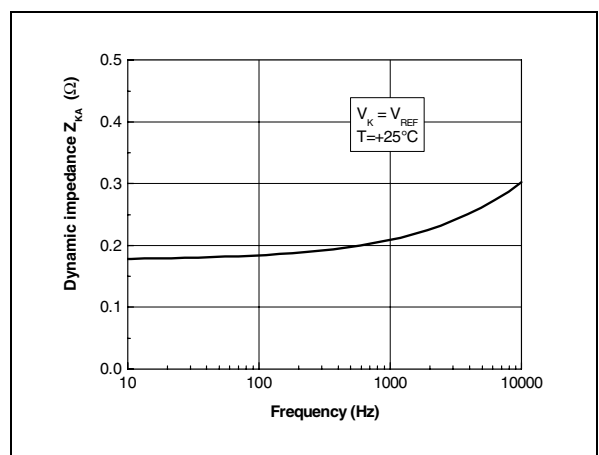


Figure 7. Off-State current vs temperature

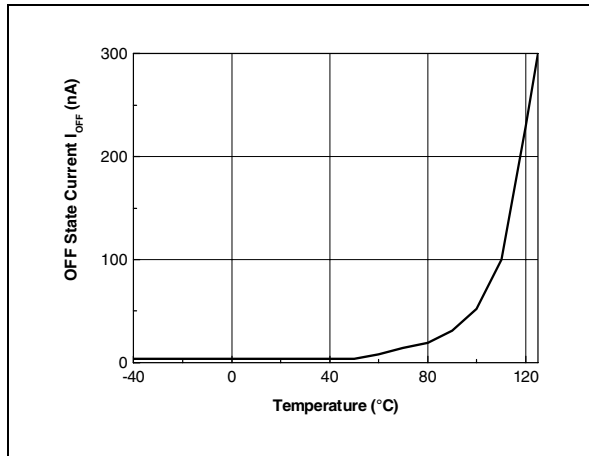


Figure 8. Ratio of change in reference input voltage to change in V<sub>K</sub> voltage vs temperature

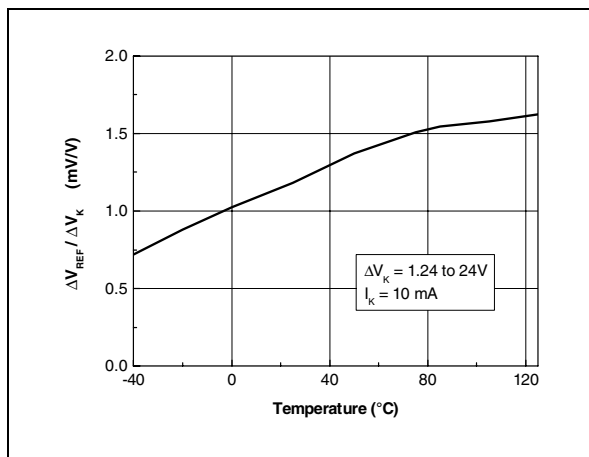


Figure 9. Phase and gain vs frequency

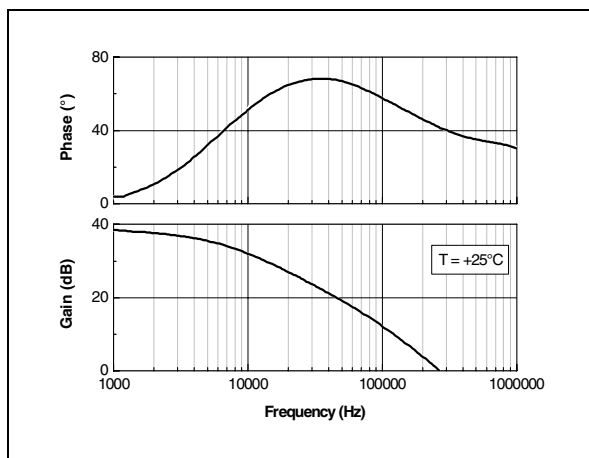


Figure 10. Test circuit for off-state current measurement

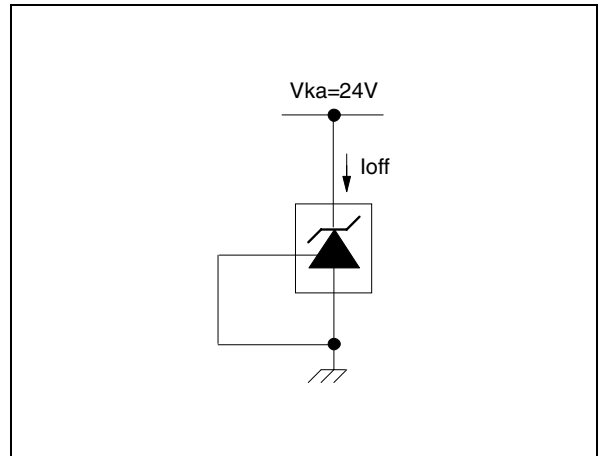


Figure 11. Test circuit for V<sub>K</sub> > V<sub>REF</sub>

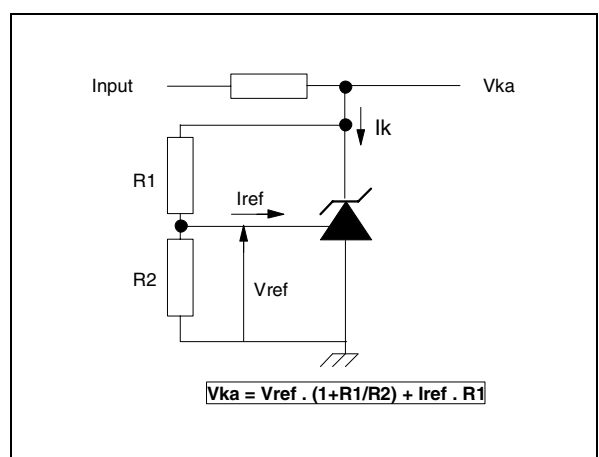


Figure 12. Test circuit for phase and gain measurement

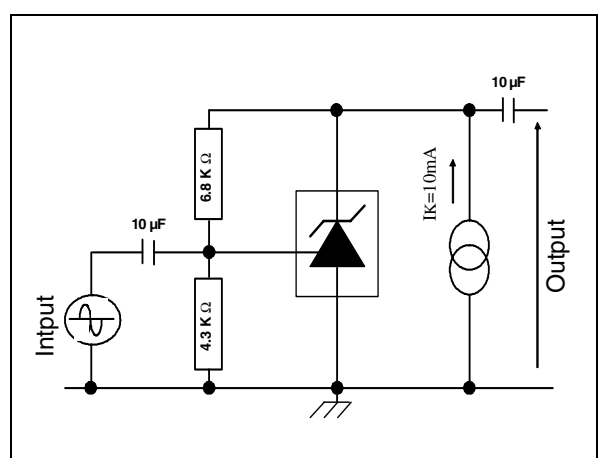


Figure 13. Pulse response at  $I_k=1\text{mA}$

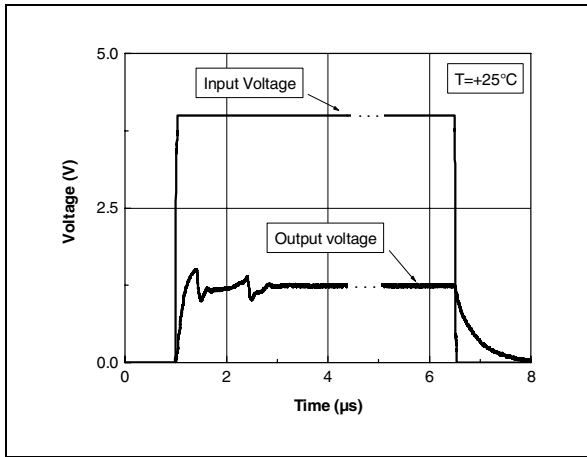


Figure 14. Pulse response at  $I_k = 10\text{mA}$

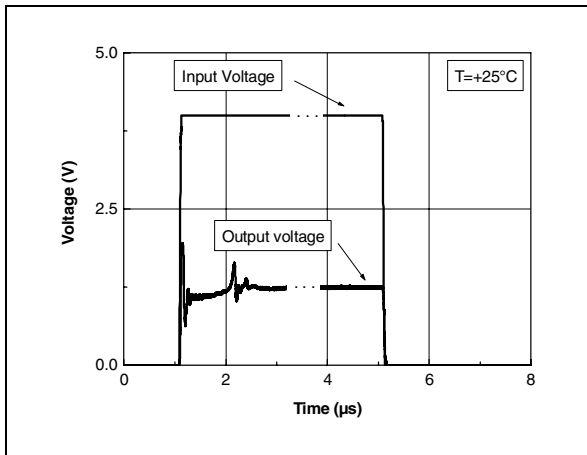


Figure 15. Block diagram

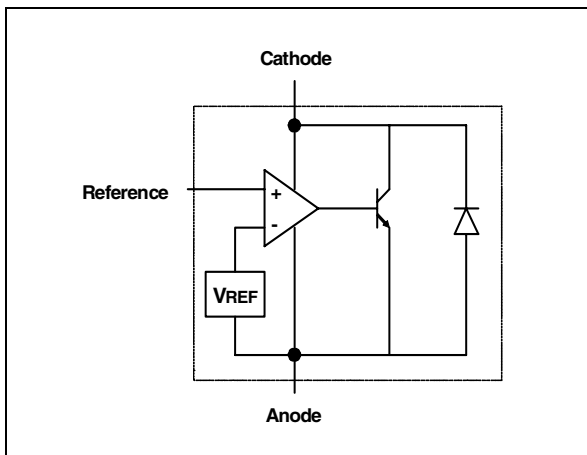


Figure 16. Test circuit for pulse response at  $I_k = 1\text{mA}$

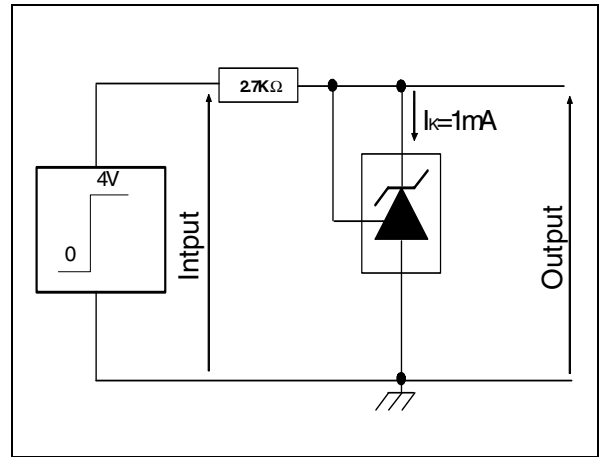


Figure 17. Test circuit for pulse response at  $I_k = 10\text{mA}$

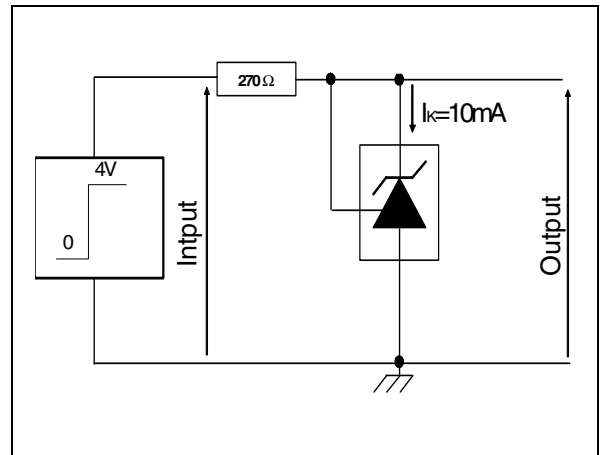
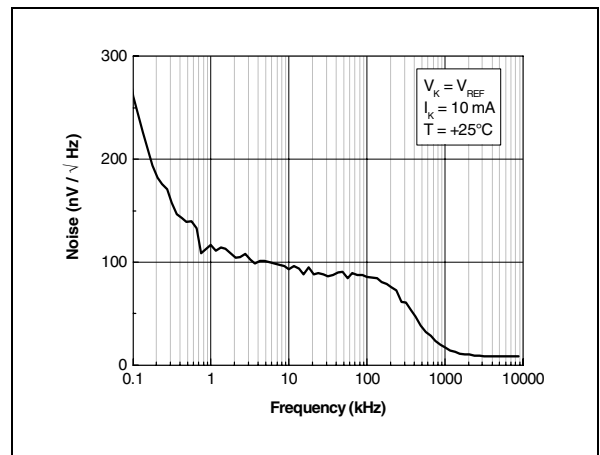
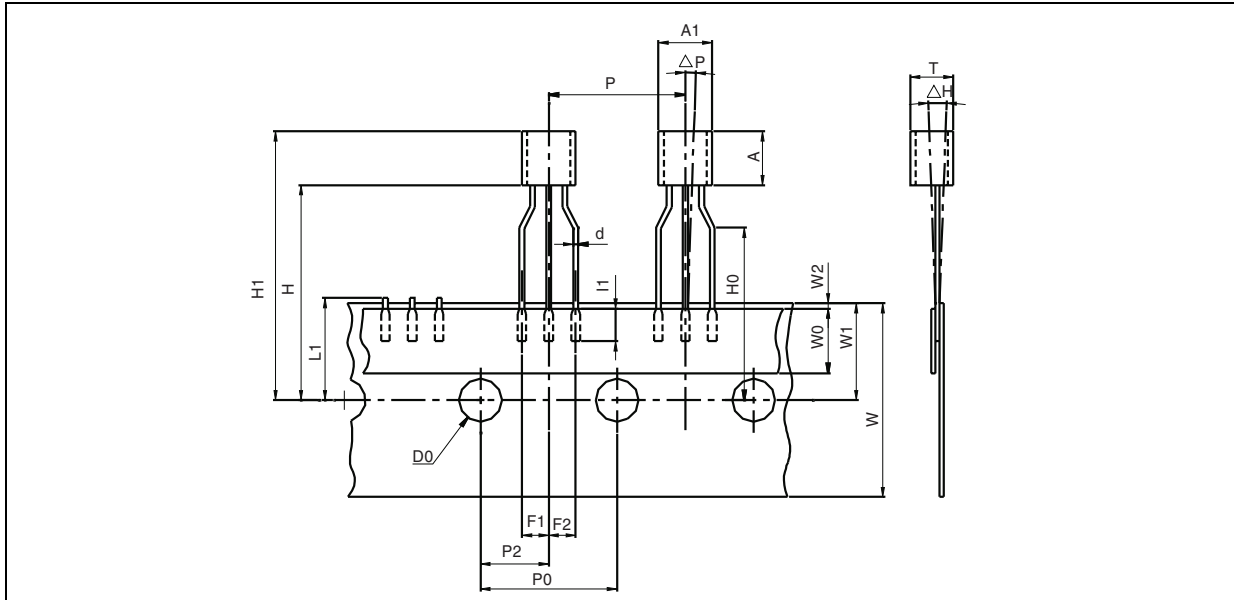


Figure 18. Equivalent input noise vs frequency



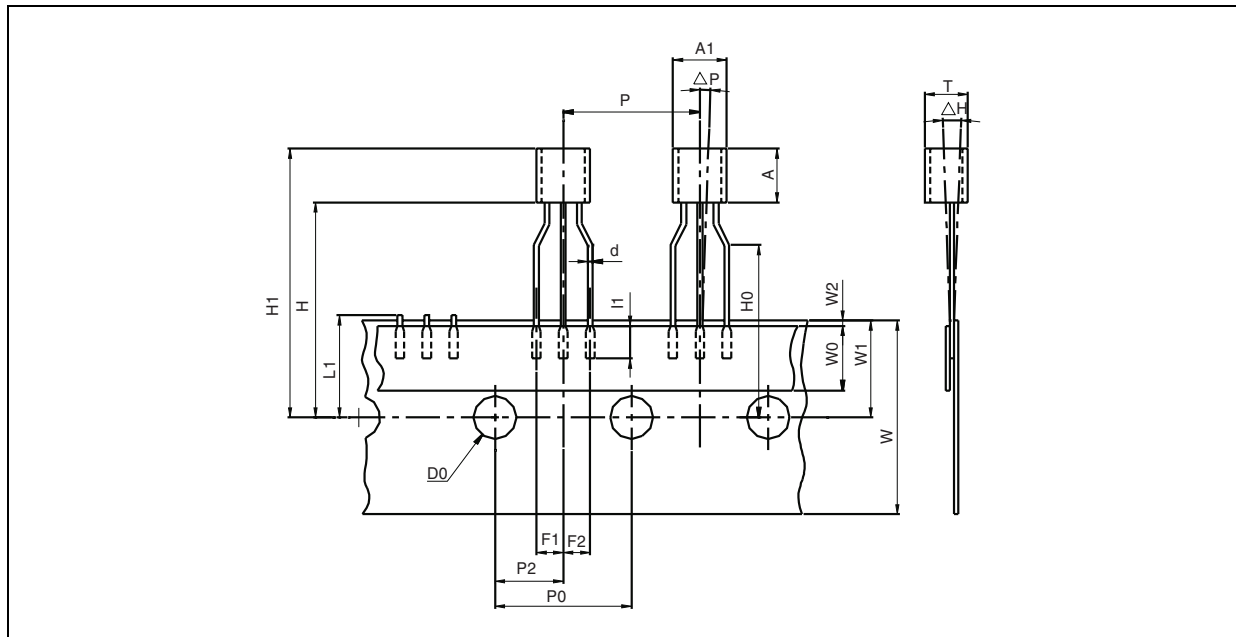
### 3 Package Mechanical Data

#### 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)

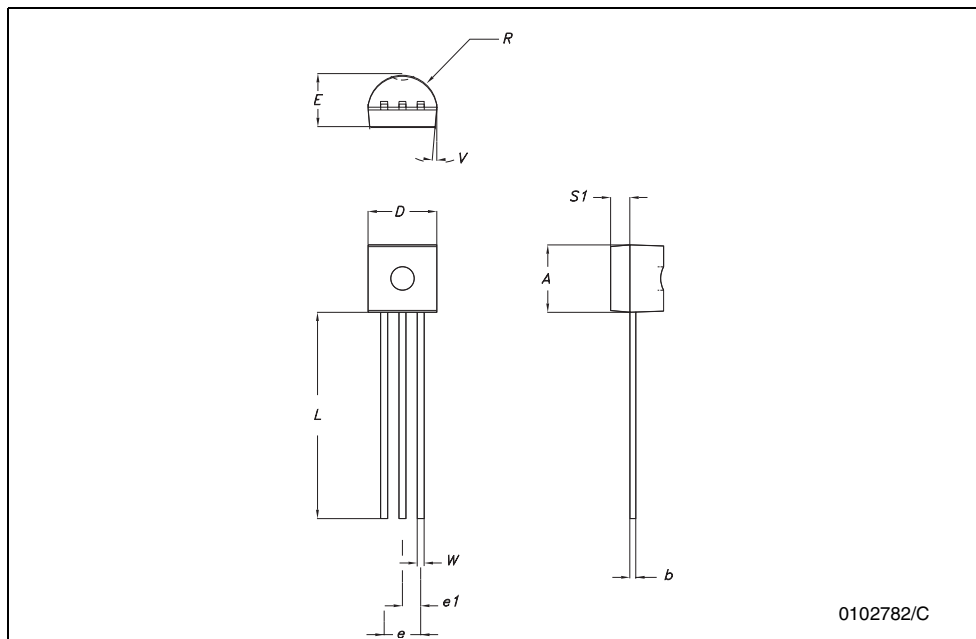


| Dim.  | Millimeters |      |      | Inches |       |       |
|-------|-------------|------|------|--------|-------|-------|
|       | Min.        | Typ. | Max. | Min.   | Typ.  | Max.  |
| AL    |             |      | 5.0  |        |       | 0.197 |
| A     |             |      | 5.0  |        |       | 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 |
| P0    | 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  |

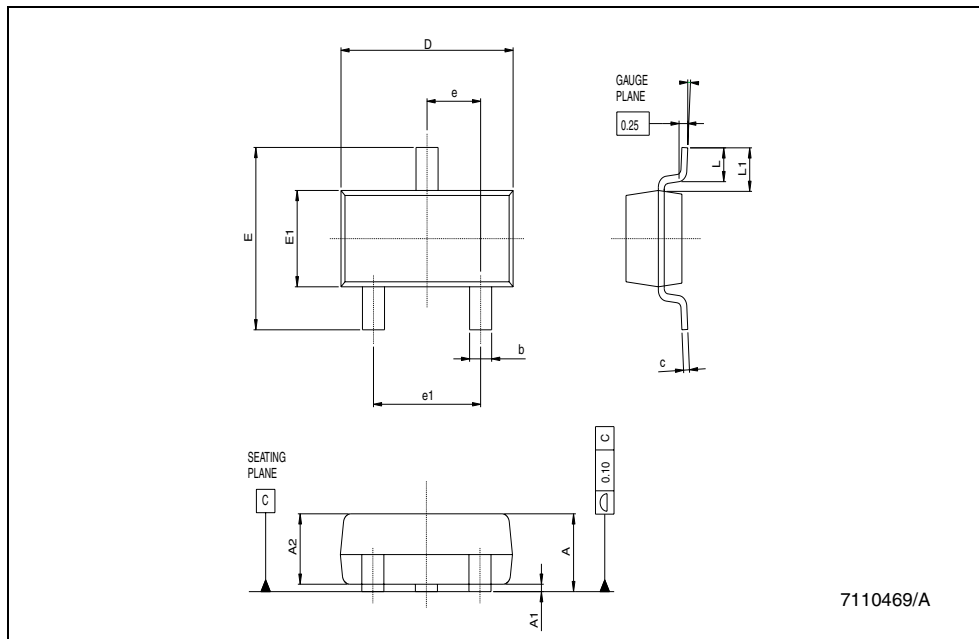


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3.4 SOT23-3L Package

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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