

## 1.24 V programmable shunt voltage reference

Datasheet — production data

### Features

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

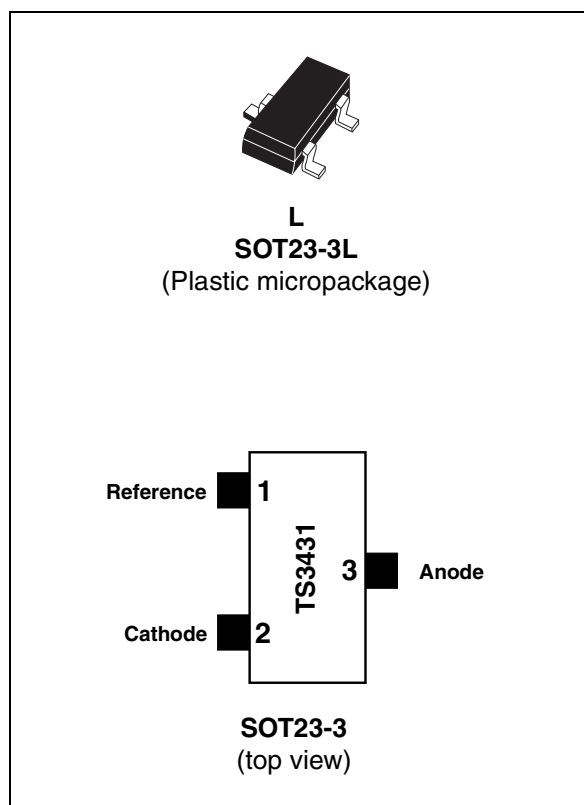
### Applications

- Computers
- Instrumentation
- Battery chargers
- Switch mode power supply
- Battery operated equipment

### Description

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

Available in SOT23-3 surface mount package, it can be used in application designs where space saving is critical.



Contents

1      **Block diagram** ..... 3

2      **Absolute maximum ratings** ..... 4

3      **Electrical characteristics** ..... 5

4      **Package mechanical data** ..... 9

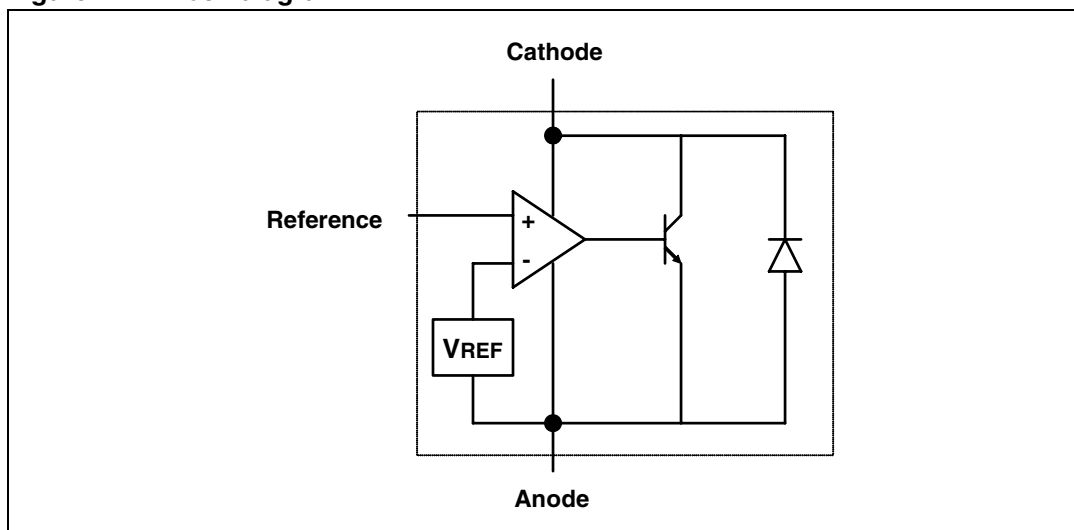
5      **Ordering information** ..... 11

6      **Revision history** ..... 12



# 1 Block diagram

Figure 1. Block diagram



## 2 Absolute maximum ratings

**Table 1. Absolute maximum ratings (AMR)**

| 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> SOT23-3L | 360          | mW   |
| $T_{stg}$  | 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.  $P_d$  is calculated with  $T_{amb} = 25^{\circ}\text{C}$ ,  $T_j = 150^{\circ}\text{C}$ ,  $R_{thjc} = 110^{\circ}\text{C/W}$ ,  $R_{thja} = 340^{\circ}\text{C/W}$ .

**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   |

### 3 Electrical characteristics

**Table 3.**  $T_{amb} = 25^{\circ}\text{C}$  (unless otherwise specified) <sup>(1)</sup>

| Symbol                                     | Parameter                                                                               | Test conditions                                          | Min.  | Typ. | Max.  | Unit                    |
|--------------------------------------------|-----------------------------------------------------------------------------------------|----------------------------------------------------------|-------|------|-------|-------------------------|
| $V_K$                                      | Reference input voltage $I_K = 10\text{ mA}$ ,<br>$V_{ka} = V_{ref}$                    | 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, $V_{ka} = V_{ref}$               | $0^{\circ}\text{C} < T < +70^{\circ}\text{C}$            |       |      | 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/ $^{\circ}\text{C}$ |
| $I_{Kmin}$                                 | Minimum operating current                                                               | $T = 25^{\circ}\text{C}$                                 |       | 0.35 | 0.4   | mA                      |
|                                            |                                                                                         | $-40^{\circ}\text{C} < T < +125^{\circ}\text{C}$         |       |      | 0.5   |                         |
| $\frac{ \Delta V_{ref} }{ \Delta V_{ka} }$ | Ratio of change in reference input voltage to change in cathode to anode voltage        | $I_K=10\text{mA}$<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     |                         |
| $I_{REF}$                                  | 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     |                         |
| $\Delta I_{REF}$                           | 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   |                         |
| $I_{OFF}$                                  | 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                                                                | $I_K = 1\text{ to }100\text{mA}$                         |       | 0.2  | 0.4   | W                       |
| $E_N$                                      | Wideband noise                                                                          | $I_K = 10\text{mA}$<br>$1\text{kHz} < f < 100\text{kHz}$ |       | 100  |       | nV/ $\sqrt{\text{Hz}}$  |

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

Figure 2. Reference voltage vs. temperature

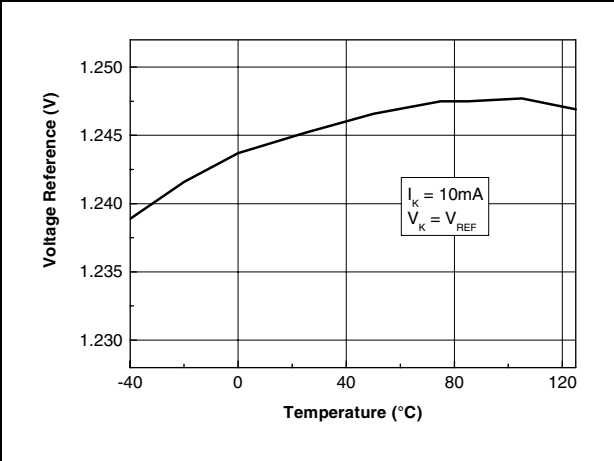


Figure 3. Test circuit for  $V_K = V_{REF}$

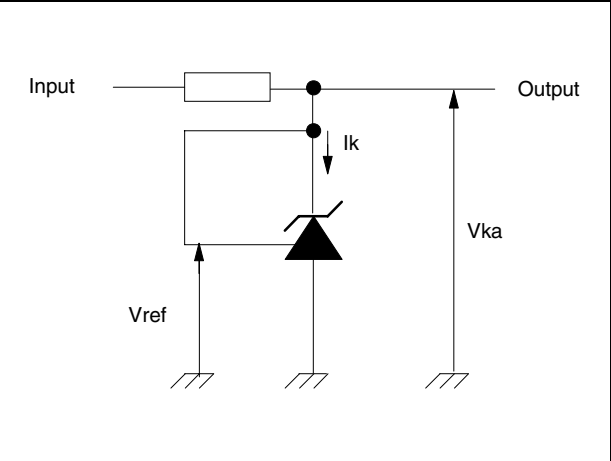


Figure 4. Cathode voltage vs. cathode current

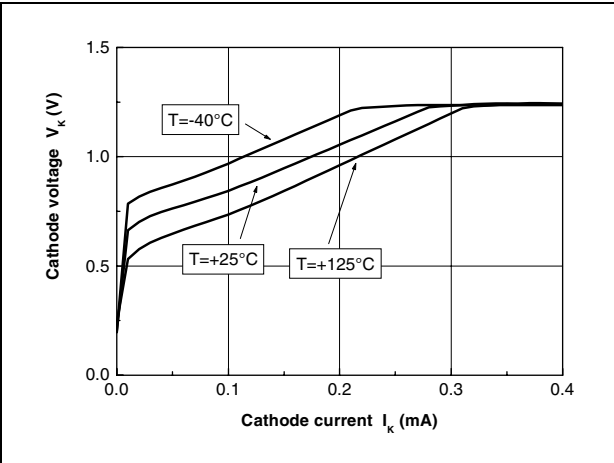


Figure 5. Minimum operating current vs. temperature

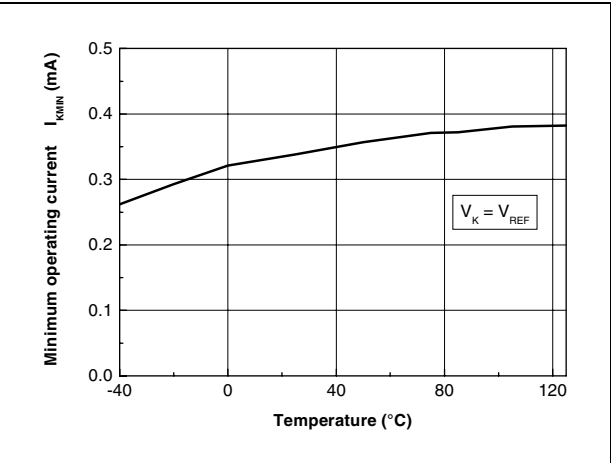


Figure 6. Reference input current vs. temperature

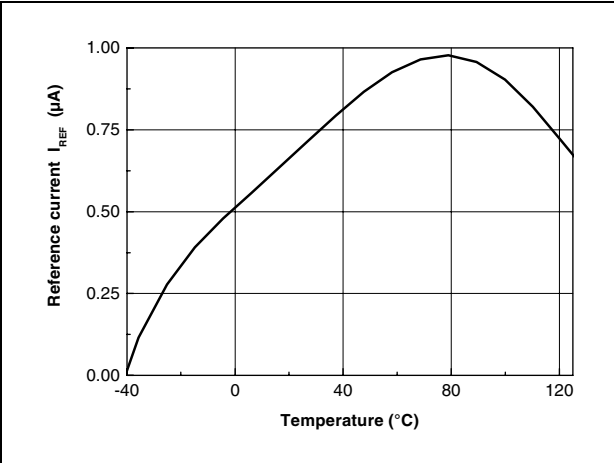


Figure 7. Dynamic impedance vs frequency

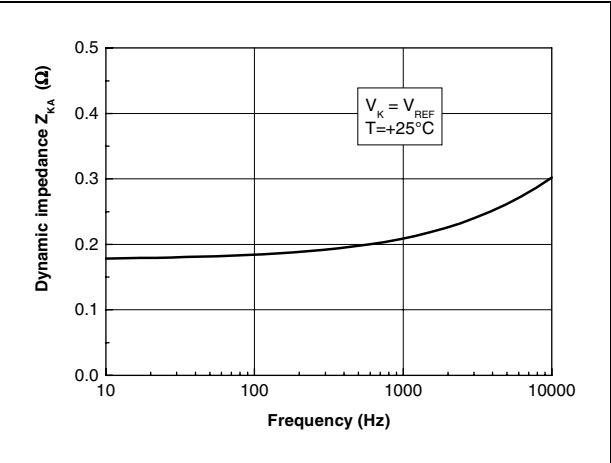


Figure 8. Off-state current vs temperature

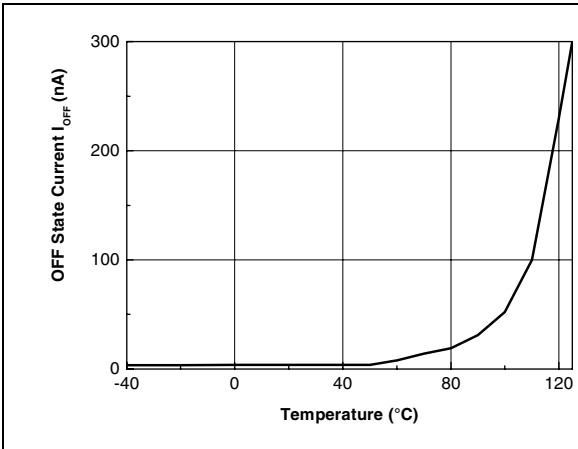


Figure 9. Test circuit for off-state current measurement

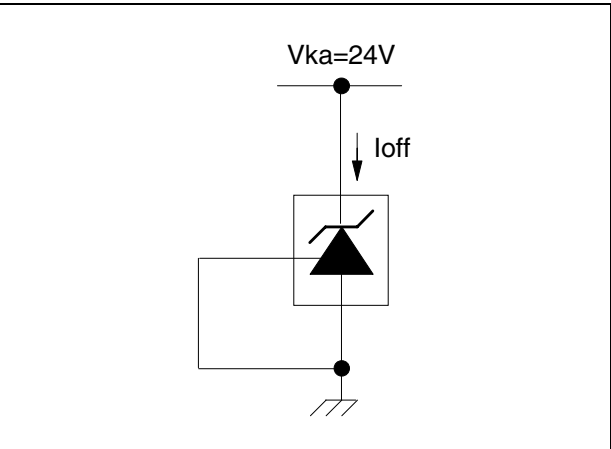


Figure 10. Ratio of change in reference input voltage to change in  $V_{KA}$  voltage vs. temperature

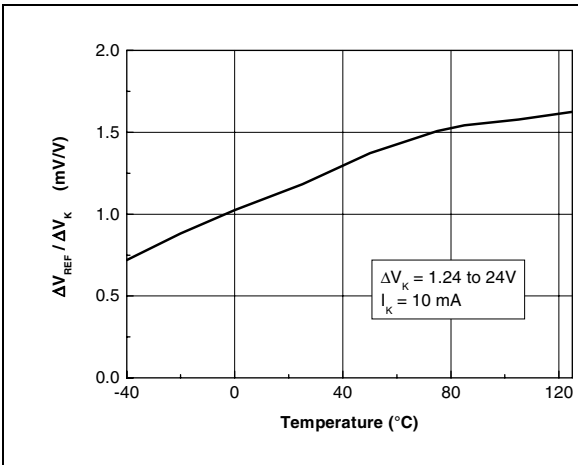


Figure 11. Test circuit for  $V_K > V_{REF}$

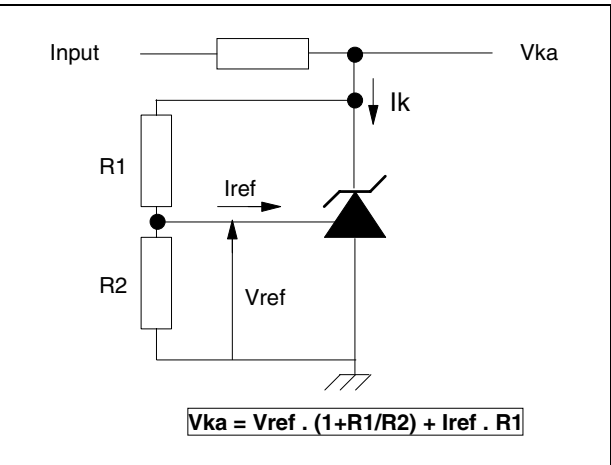


Figure 12. Pulse response at  $I_K=1mA$

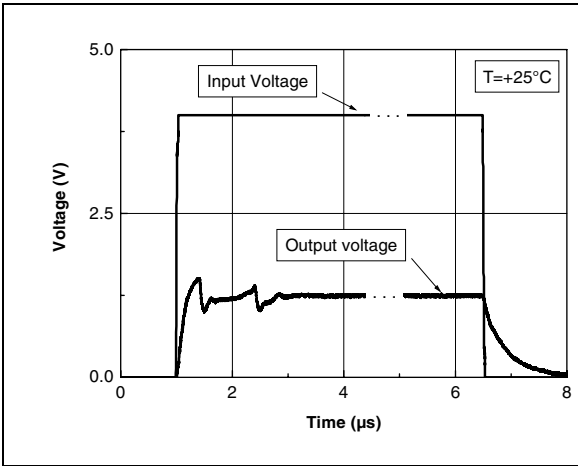


Figure 13. Test circuit for pulse response at  $I_K = 1mA$

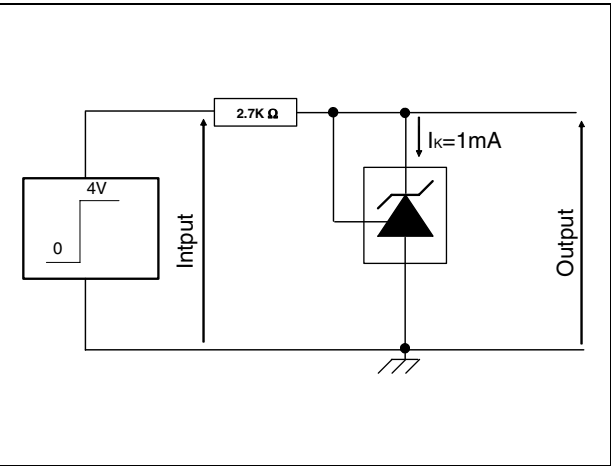


Figure 14. Pulse response at  $I_K = 10\text{mA}$

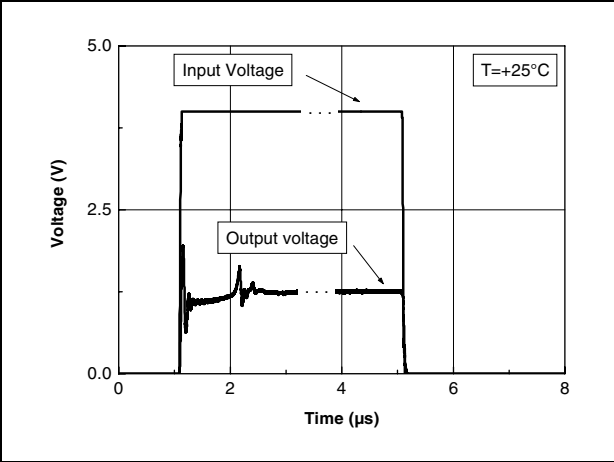


Figure 15. Test circuit for pulse response at  $I_K = 10\text{mA}$

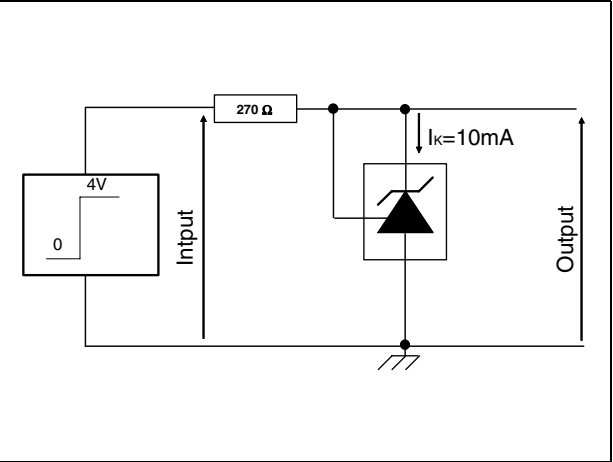


Figure 16. Phase and gain vs frequency

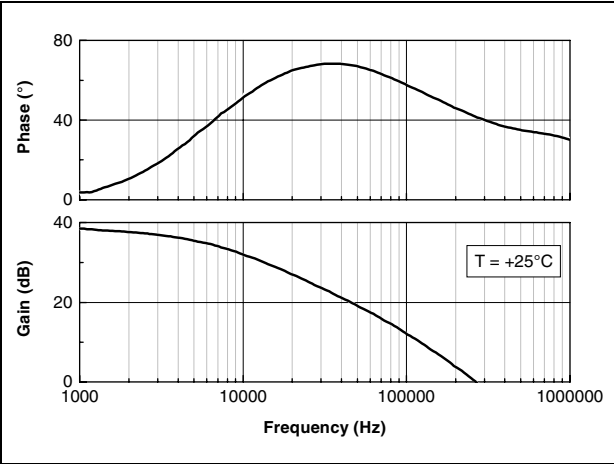


Figure 17. Equivalent input noise vs. frequency

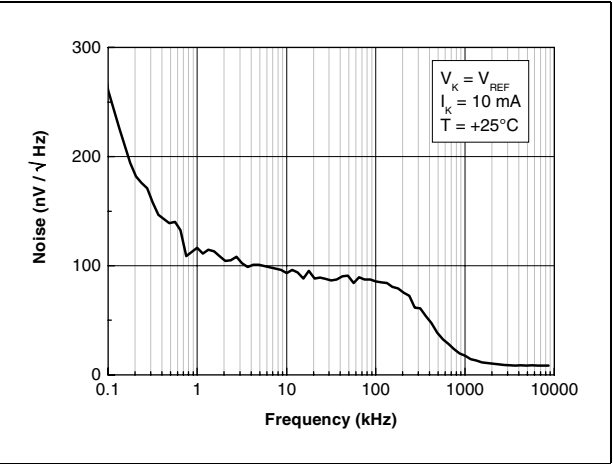
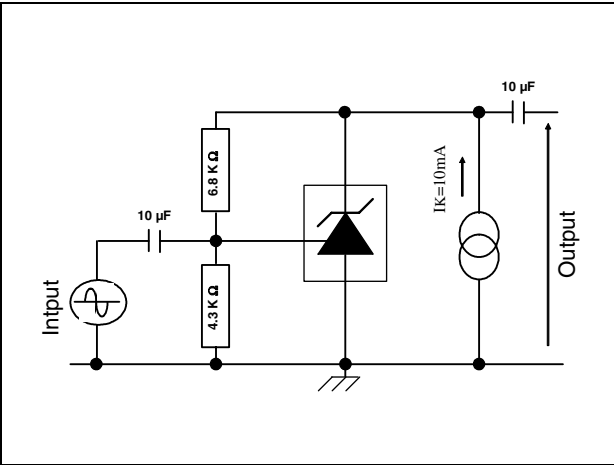


Figure 18. Test circuit for phase and gain measurement





## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK® is an ST trademark.

Table 4. SOT23-3L package mechanical data

| Ref. | Dimensions  |       |       |        |        |        |
|------|-------------|-------|-------|--------|--------|--------|
|      | Millimeters |       |       | 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    | 0°          |       | 8°    | 0°     |        | 8°     |

The mechanical drawing illustrates the SOT23-3L package geometry. The top view shows dimensions D (total width), e (lead width), e1 (pitch), and b (lead thickness). The side view shows dimensions A (total height), A1 (lead height), A2 (body height), E (total length), and E1 (body length). A detail view of the lead shows dimensions k (lead angle), L (lead length), and L1 (lead thickness). Gage and seating planes are indicated for measurement reference. The drawing is identified by the number 7110469/A.

## 5 Ordering information

**Table 5. Order codes**

| Part numbers                                        | Temperature range | Package  | Packaging   | Marking                      |
|-----------------------------------------------------|-------------------|----------|-------------|------------------------------|
| TS3431ILT<br>TS3431AILT<br>TS3431BILT<br>TS3431CILT | -40°C, +125°C     | SOT23-3L | Tape & reel | L280<br>L281<br>L282<br>L283 |

## 6 Revision history

**Table 6. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                              |
|-------------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1-Jan-2004  | 1        | Initial release.                                                                                                                                                                                                                                                                                                                                     |
| 1-Dec-2004  | 2        | Specific content changes as follows: <ul style="list-style-type: none"><li>– CI version added in <a href="#">Table 5: Order codes</a>.</li><li>– <math>R_{thjc}</math> information added in <a href="#">Table 1: Absolute maximum ratings (AMR)</a>.</li><li>– Test condition added in electrical characteristics <a href="#">Table 3</a>.</li></ul> |
| 26-Jun-2007 | 3        | Removed TO-92 package information and associated order codes.<br>Re-ordered electrical characteristics figures.                                                                                                                                                                                                                                      |
| 30-Aug-2012 | 4        | Added: $V_{ka} = V_{ref}$ parameter in <a href="#">Table 3 on page 5</a> .                                                                                                                                                                                                                                                                           |

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