

Programmable shunt voltage reference

Features

- Adjustable output voltage: 2.5 to 24 V
- Precision selection at 25° C: $\pm 2\%$, $\pm 1\%$ and $\pm 0.5\%$
- Sink current capability: 1 to 100 mA
- Industrial temperature range: -40 to +105° C
- Performances compatible with industry-standard TL431

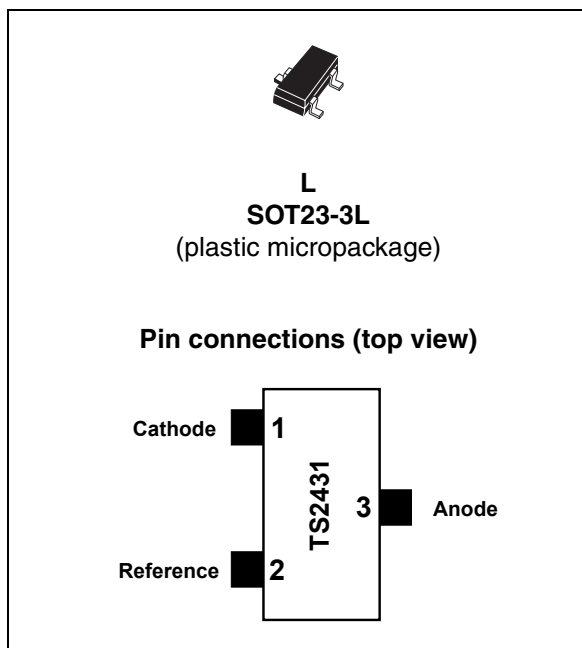
Applications

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

Description

The TS2431 is a programmable shunt voltage reference with guaranteed temperature stability over the entire temperature range of operation -40 to +105° C. The output voltage may be set to any value between 2.5 and 24 V with an external resistor bridge.

Available in a SOT23-3 surface mount package, the device can be implemented in applications where space-saving is of utmost importance.



1 Absolute maximum ratings and operating conditions

Table 1. 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 input current range | -0.05 to +10 | mA |
| P _d | Power dissipation ⁽¹⁾ SOT23-3 | 360 | mW |
| T _{std} | Storage temperature | -65 to +150 | °C |
| ESD | Human body model (HBM) ⁽²⁾ | 2 | kV |
| | Machine model (MM) ⁽³⁾ | 200 | V |
| T _{LEAD} | Lead temperature (soldering, 10 seconds) | 260 | °C |

1. P_d has been calculated with T_{amb} = 25°C, T_{junction} = 150°C, R_{thjc} = 110°C/W and R_{thja} = 340°C/W for the SOT23-3 package.
2. Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 kΩ resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
3. Machine model: a 200 pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 Ω). This is done for all couples of connected pin combinations while the other pins are floating.

Table 2. Operating conditions

| Symbol | Parameter | Value | Unit |
|-------------------|--|------------------------|------|
| V _{KA} | Cathode to anode voltage | V _{REF} to 24 | V |
| I _K | Cathode operating current ⁽¹⁾ | 1 to 100 | mA |
| T _{oper} | Operating free air temperature range | -40 to +105 | °C |

1. Maximum power dissipation must be strictly observed to avoid damaging the component.

2 Electrical characteristics

Table 3. Electrical characteristics (T_{amb} = 25° C unless otherwise specified)

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|---|---|--|-------|------|-------|--------|
| V _{REF} | Reference input voltage | V _K = V _{REF} I _K = 10 mA | | 2.5 | | V |
| | | TS2431 (2%) | 2.45 | | 2.55 | |
| | | TS2431A (1%) | 2.475 | | 2.525 | |
| | | TS2431B (0.5%) | 2.488 | | 2.512 | |
| ΔV _{REF} | Reference input voltage deviation over temperature V _K = V _{REF} I _K = 10 mA ⁽¹⁾ (2) | 0° C < T < +70° C | | 10 | 20 | mV |
| | | -40° C < T < +85° C | | 17 | 30 | |
| | | -40° C < T < +105° C | | 20 | 35 | |
| T _C | Temperature coefficient (note 2) | -40° C < T < +105° C | | 50 | 100 | ppm/°C |
| I _{KMIN} | Minimum operating current | T = 25° C | | 0.3 | 0.8 | mA |
| | | -40° C < T < +105° C | | | 1 | |
| $\frac{ \Delta V_{ref} }{ \Delta V_K }$ | Ratio of change in reference input voltage to change in cathode to anode voltage | I _K = 10 mA V _{ka} = 24 to 2.5 V | | 0.3 | 2 | mV/V |
| I _{REF} | Reference input current I _K = 10 mA, R1 = 10 KΩ, R2 = +∞ ⁽³⁾ | T = 25° C | | 0.5 | 2.5 | μA |
| | | -40° C < T < +105° C | | | 3 | |
| ΔI _{REF} | Reference input current deviation I _K = 10 mA, R1 = 10 KΩ, R2 = +∞ ⁽³⁾ | -40° C < T < +105° C | | 0.4 | 1.2 | μA |
| I _{OFF} | Off-state cathode current | V _K = 24 V, V _{REF} = GND | | 10 | 500 | nA |
| Z _{KAL} | Reverse dynamic impedance | V _K = V _{REF} ΔI _K = 1 to 50 mA, f < 10 kHz | | 0.5 | 0.75 | W |
| E _N | Wide band noise | I _K = 10 mA 10 Hz < f < 10 kHz | | 300 | | nV/√Hz |

- Limits are 100% production tested at 25° C. Limits over temperature are guaranteed through correlation and by design.
- |ΔV_{REF}| is defined as the difference between the maximum and minimum values of V_{REF} obtained over the full temperature range.
- Refer to [Figure 4: Test circuit for V_{ka} = V_{ref} on page 4.](#)

Figure 1. Reference voltage vs temperature

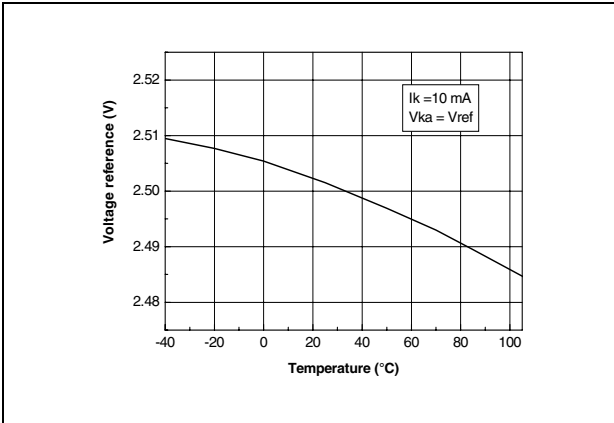


Figure 2. Cathode voltage vs cathode current

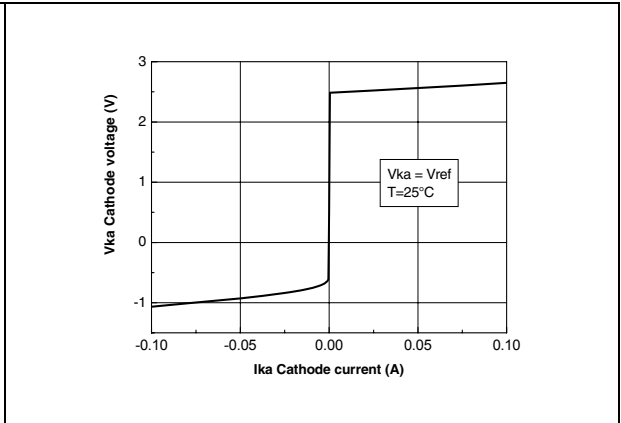


Figure 3. Reference input current vs temperature

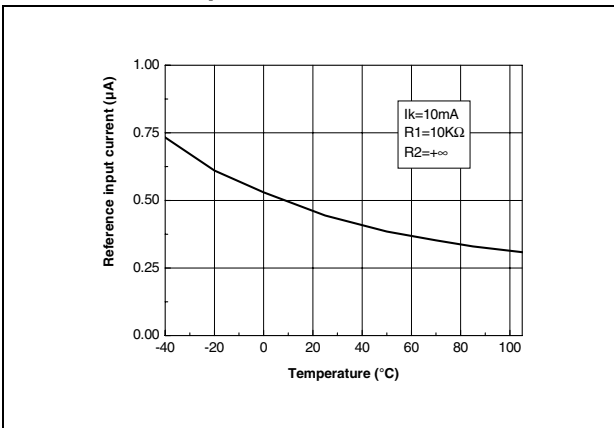


Figure 4. Test circuit for Vka = Vref

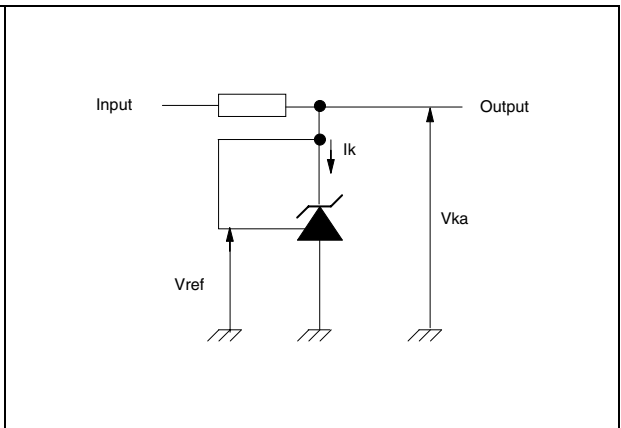


Figure 5. Cathode voltage vs cathode current

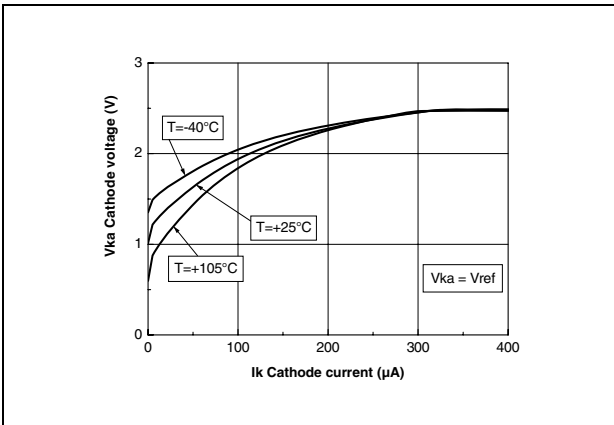


Figure 6. Dynamic impedance vs frequency

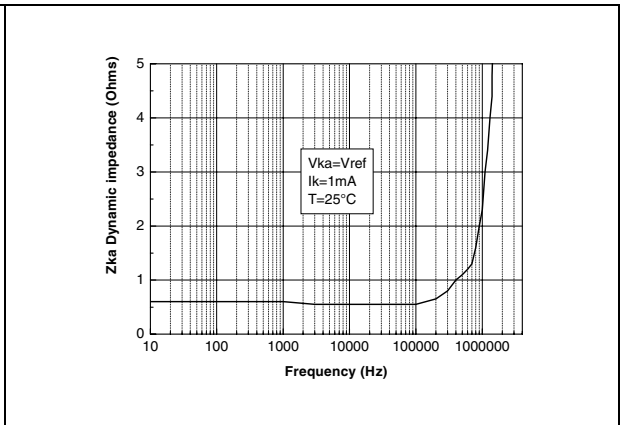


Figure 7. Off-state current vs temperature

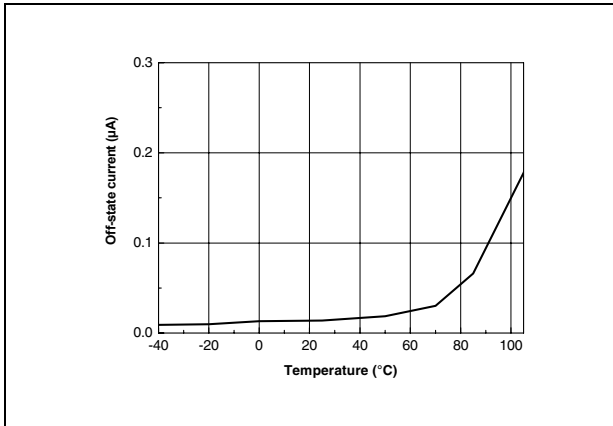


Figure 8. Ratio of change in reference input voltage to change in Vka voltage vs temperature

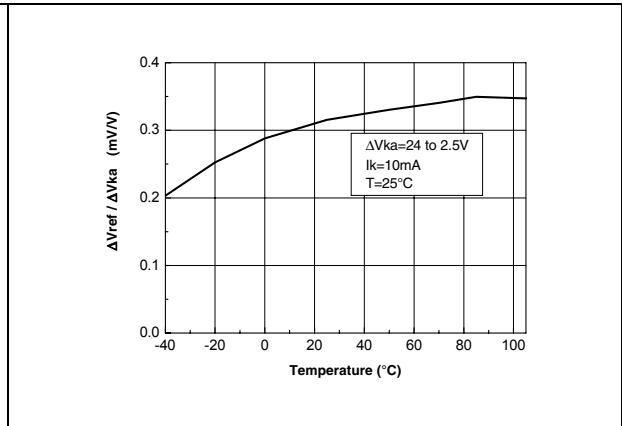


Figure 9. Phase and gain vs frequency

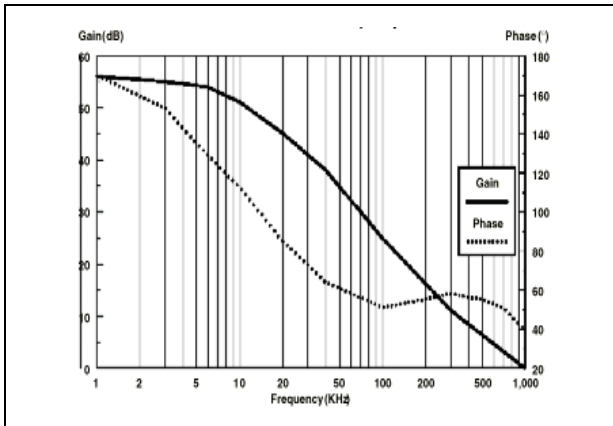


Figure 10. Test circuit for off-state current measurement

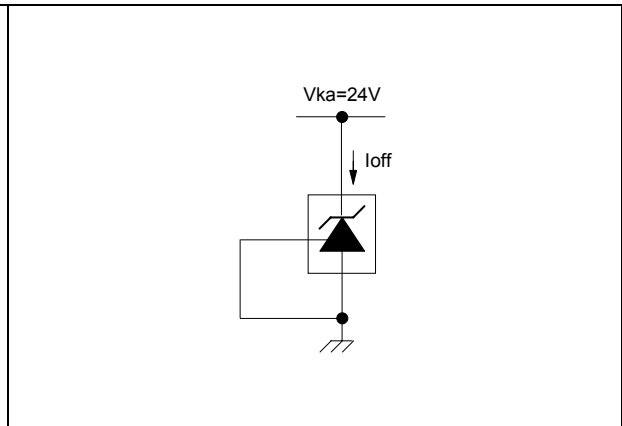


Figure 11. Test circuit for Vka > Vref

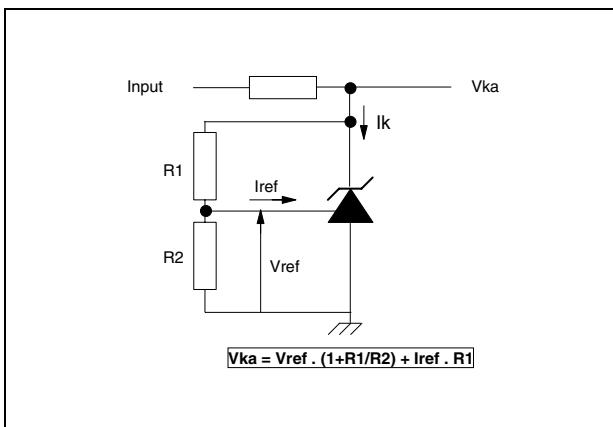


Figure 12. Test circuit for phase and gain measurement

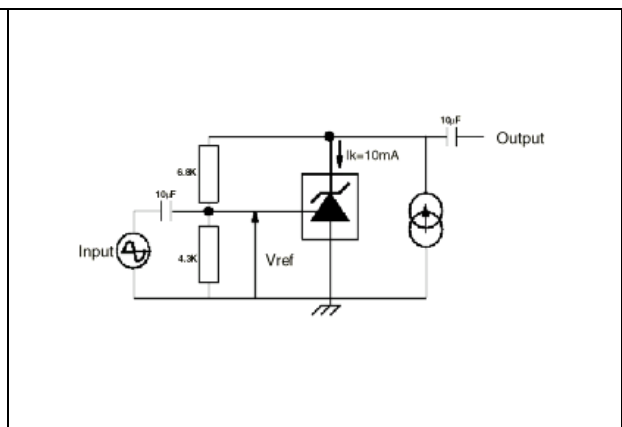


Figure 13. Pulse response at $I_k = 1\text{ mA}$

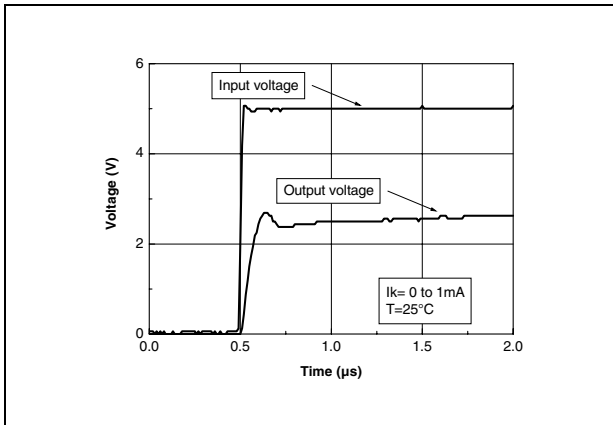


Figure 14. Pulse response at $I_k = 1\text{ mA}$

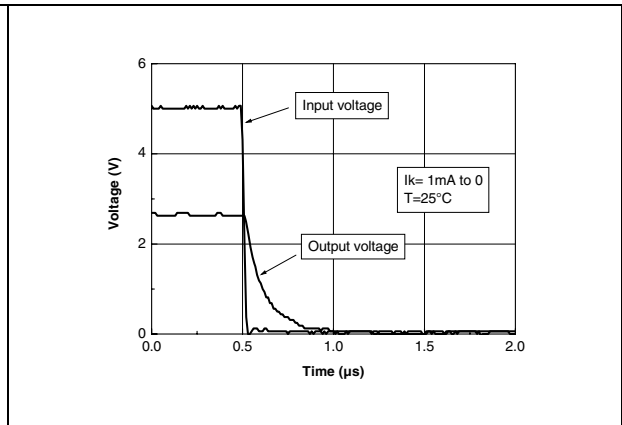


Figure 15. Stability boundary conditions

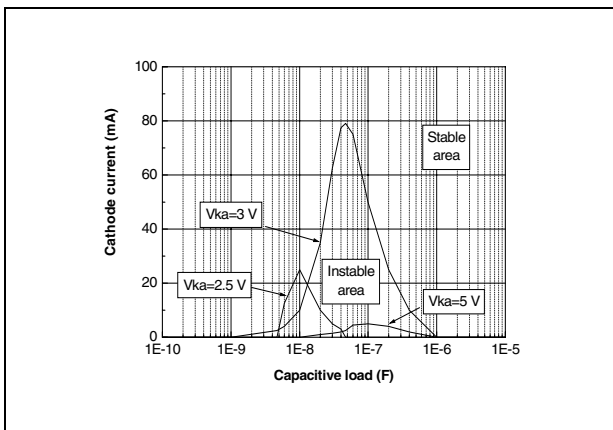


Figure 16. Test circuit for pulse response at $I_k = 1\text{ mA}$

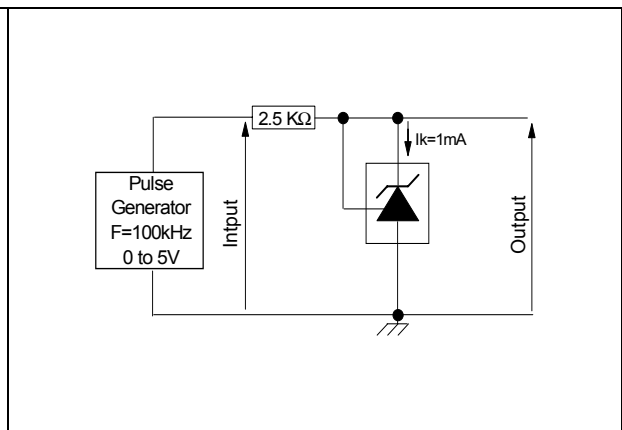


Figure 17. Equivalent input noise vs frequency

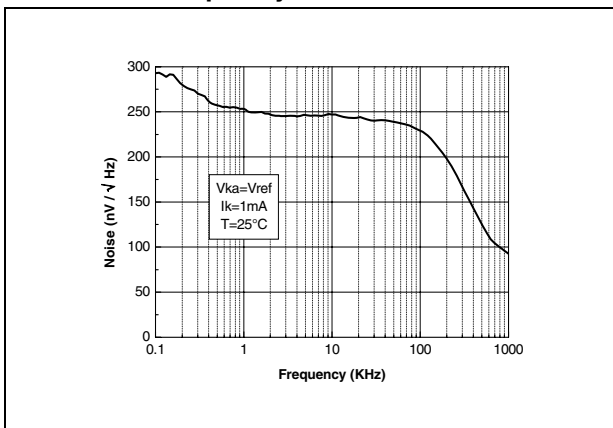
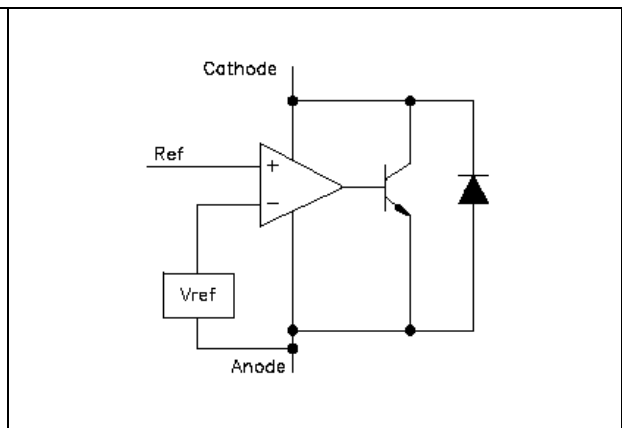


Figure 18. Block Diagram



3 Package information

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. ECOPACK[®] is an ST trademark.

3.1 SOT23-3 package information

Figure 19. SOT23-3 package mechanical drawing

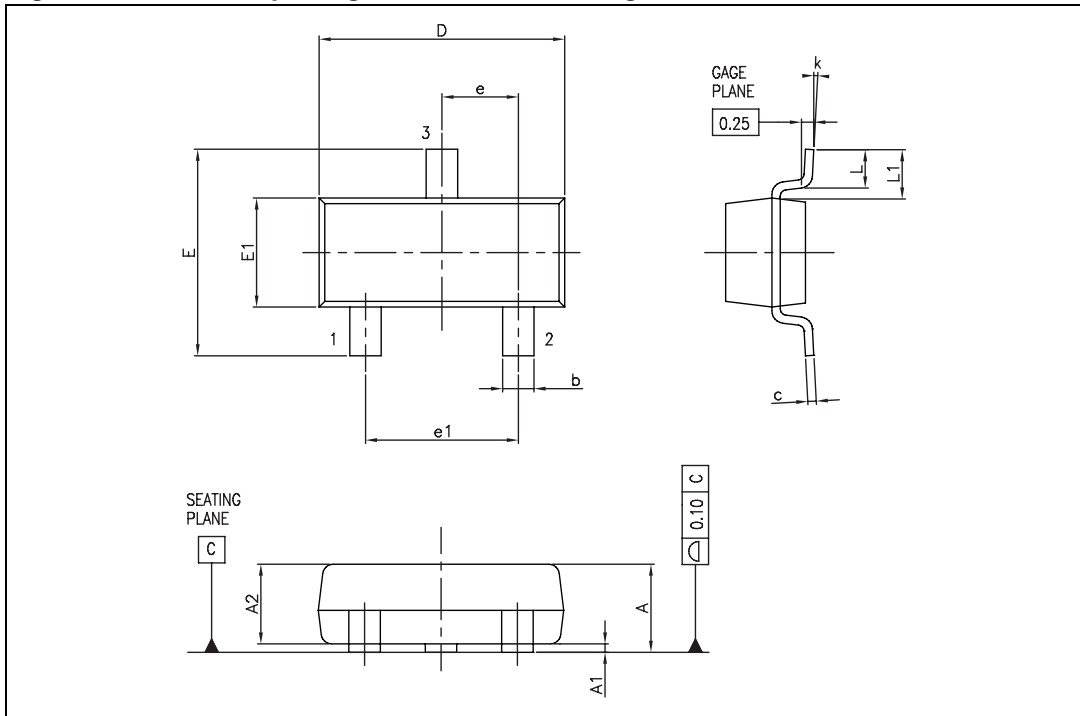


Table 4. SOT23-3 package mechanical data

| Dimensions | | | | | | |
|------------|-------------|------|------|--------|-------|-------|
| Ref. | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | 0.89 | | 1.12 | 0.035 | | 0.044 |
| A1 | 0.01 | | 0.10 | 0.0004 | | 0.004 |
| A2 | 0.88 | 0.95 | 1.02 | 0.035 | 0.037 | 0.040 |
| b | 0.30 | | 0.50 | 0.012 | | 0.020 |
| c | 0.08 | | 0.20 | 0.003 | | 0.008 |
| D | 2.80 | 2.90 | 3.04 | 0.110 | 0.114 | 0.120 |
| E | 2.10 | | 2.64 | 0.083 | | 0.104 |
| E1 | 1.20 | 1.30 | 1.40 | 0.047 | 0.051 | 0.055 |
| e | | 0.95 | | | 0.037 | |
| e1 | | 1.90 | | | 0.075 | |
| L | 0.40 | 0.50 | 0.60 | 0.016 | 0.020 | 0.024 |
| L1 | | 0.54 | | | 0.021 | |
| k | 0d | | 8d | | | |

4 Ordering information

Table 5. Order codes

| Order code | Temperature range | Package | Packing | Precision | Marking |
|----------------------------|-------------------|-------------------------------|-------------|-----------|---------|
| TS2431ILT | -40 to +105°C | SOT23-3 | Tape & reel | 2% | L285 |
| TS2431AILT | | | | 1% | L286 |
| TS2431BILT | | | | 0.5% | L287 |
| TS2431IYLT ⁽¹⁾ | | SOT23-3 (automotive grade) | | 2% | L289 |
| TS2431AIYLT ⁽¹⁾ | | | | 1% | L290 |
| TS2431BIYLT ⁽¹⁾ | | | | 0.5% | L291 |

1. Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent are on-going.

5 Revision history

Table 6. Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 01-Feb-2002 | 1 | Initial release. |
| 10-Sep-2009 | 2 | Updated document format. Modified footnote 1 under Table 1: Absolute maximum ratings on page 2 . Added HBM and MM notes under Table 1 . Added automotive grade order codes in Table 5: Order codes . |

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