

## PROGRAMMABLE SHUNT VOLTAGE REFERENCE

- ADJUSTABLE OUTPUT VOLTAGE  
2.5 to 24V
- SEVERAL PRECISION @ 25°C  
±2%, ±1% and ±0.5%
- SINK CURRENT CAPABILITY  
1 to 100mA
- INDUSTRIAL TEMPERATURE RANGE:  
-40 to +105°C
- PERFORMANCES COMPATIBLE WITH  
INDUSTRY STANDARD TL431

### 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 2.5V 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.

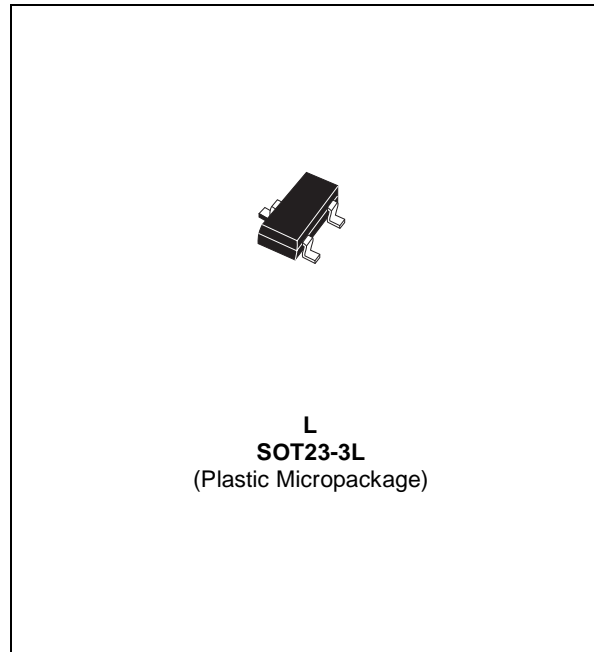
### APPLICATION

- Computers
- Instrumentation
- Battery chargers
- Switch Mode Power Supply
- Battery operated equipments

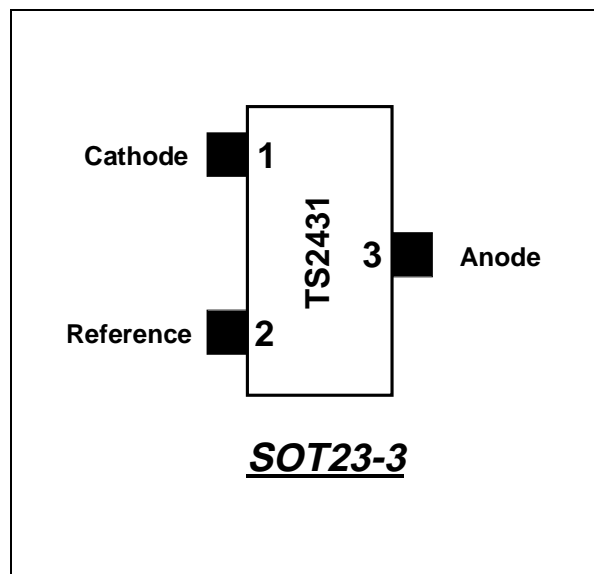
### ORDER CODE

| Precision                               | Part Number in SOT23-3 | SOT23 Marking |
|---|------------------------|---------------|
| 2%                                      | TS2431ILT              | L285          |
| 1%                                      | TS2431AILT             | L286          |
| 0.5%                                    | TS2431BILT             | L287          |
| Single temperature range: -40 to +105°C |                        |               |

LT = Tiny Package (SOT23-3) - only available in Tape & Reel (LT)



### PIN CONNECTIONS (top view)



**ABSOLUTE MAXIMUM RATINGS**

| Symbol            | Parameter                                | Value        | Unit |
|-------------------|--|--------------|------|
| V <sub>ka</sub>   | Cathode to Anode voltage                 | 25           | V    |
| I <sub>K</sub>    | Reverse Breakdown Current                | -100 to +150 | mA   |
| I <sub>REF</sub>  | Reference input current range            | -0.05 to +10 | mA   |
| P <sub>d</sub>    | Power Dissipation <sup>1)</sup> SOT23-3  | 360          | mW   |
| T <sub>std</sub>  | Storage Temperature                      | -65 to +150  | °C   |
| ESD               | Human Body Model (HBM)                   | 2            | kV   |
|                   | Machine Model (MM)                       | 200          | V    |
| T <sub>LEAD</sub> | Lead Temperature (soldering, 10 seconds) | 260          | °C   |

1. P<sub>d</sub> has been calculated with T<sub>amb</sub> = 25°C, T<sub>junction</sub> = 150°C and R<sub>thja</sub> = 340°C/W for the SOT23-3 package

**OPERATING CONDITIONS**

| Symbol            | Parameter                               | Value                  | Unit |
|-------------------|---|------------------------|------|
| V <sub>KA</sub>   | Cathode to Anode voltage                | V <sub>REF</sub> to 24 | V    |
| I <sub>K</sub>    | Cathode operating current <sup>1)</sup> | 1 to 100               | mA   |
| T <sub>oper</sub> | Operating Free Air Temperature Range    | -40 to +105            | °C   |

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

**ELECTRICAL CHARACTERISTICS**

T<sub>AMBIENT</sub> = 25°C (unless otherwise specified)

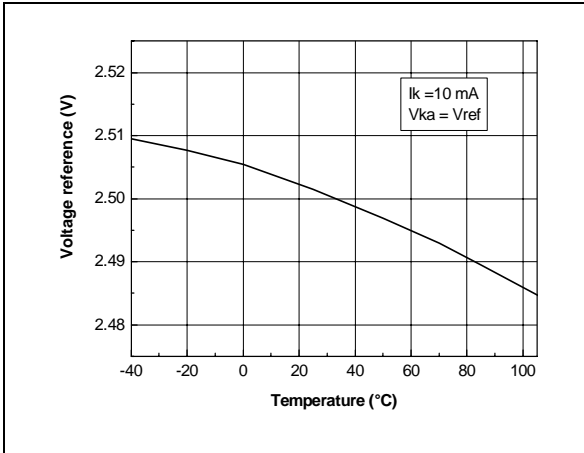
| Symbol   | Parameter  | Test Condition  | Min.  | Typ. | Max.  | Unit   |
|--|--|---|-------|------|-------|--------|
| V <sub>REF</sub>                                   | Reference input Voltage  | V <sub>K</sub> =V <sub>REF</sub> , I <sub>K</sub> =10mA                 |       | 2.5  |       | V      |
|  |  | TS2431 (2%)   | 2.45  |      | 2.55  |        |
|  |  | TS2431A (1%)  | 2.475 |      | 2.525 |        |
|  |  | TS2431B (0.5%)  | 2.488 |      | 2.512 |        |
| ΔV <sub>REF</sub>                                  | Reference input Voltage deviation over temperature, V <sub>K</sub> =V <sub>REF</sub> , I <sub>K</sub> =10mA (note 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 <sub>C</sub>                                     | Temperature coefficient (note 2)   | -40°C < T < +105°C  |       | 50   | 100   | ppm/°C |
| I <sub>KMIN</sub>                                  | Minimum Operating Current  | T = 25°C  |       | 0.3  | 0.8   | mA     |
|  |  | -40°C < T < +105°C  |       |      | 1     |        |
| $\left  \frac{\Delta V_{ref}}{\Delta V_k} \right $ | Ratio of change in reference input voltage to change in cathode to anode voltage                                       | I <sub>K</sub> =10mA<br>V <sub>ka</sub> = 24 to 2.5V                    |       | 0.3  | 2     | mV/V   |
| I <sub>REF</sub>                                   | Reference input current<br>I <sub>K</sub> =10mA, R1=10KΩ, R2=+∞ (note 3)   | T=25°C  |       | 0.5  | 2.5   | μA     |
|  |  | -40°C < T < +105°C  |       |      | 3     |        |
| ΔI <sub>REF</sub>                                  | Reference input current deviation<br>I <sub>K</sub> =10mA, R1=10KΩ, R2=+∞ (note 3)                                     | -40°C < T < +105°C  |       | 0.4  | 1.2   | μA     |
| I <sub>OFF</sub>                                   | Off-state cathode current  | V <sub>K</sub> =24V, V <sub>REF</sub> =GND                              |       | 10   | 500   | nA     |
| Z <sub>KA</sub>                                    | Reverse dynamic impedance  | V <sub>K</sub> =V <sub>REF</sub><br>ΔI <sub>K</sub> =1 to 50mA, f<10kHz |       | 0.5  | 0.75  | Ω      |
| E <sub>N</sub>                                     | Wide Band Noise  | I <sub>k</sub> = 10mA<br>10Hz < f < 10kHz                               |       | 300  |       | nV/√Hz |

**Note 1:** Limits are 100% production tested at 25°C. Limits over temperature are guaranteed through correlation and by design.

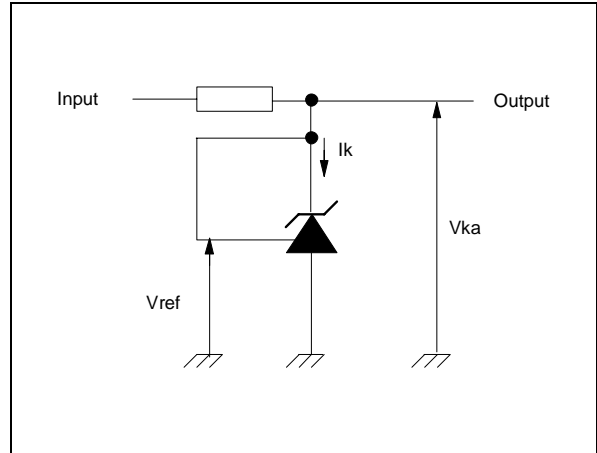
**Note 2:** |ΔV<sub>REF</sub>| is defined as the difference between the maximum and minimum values of V<sub>REF</sub> obtained over the full temperature range

**Note 3:** Refer to figure "Test circuit for V<sub>ka</sub>>V<sub>ref</sub>" page 4

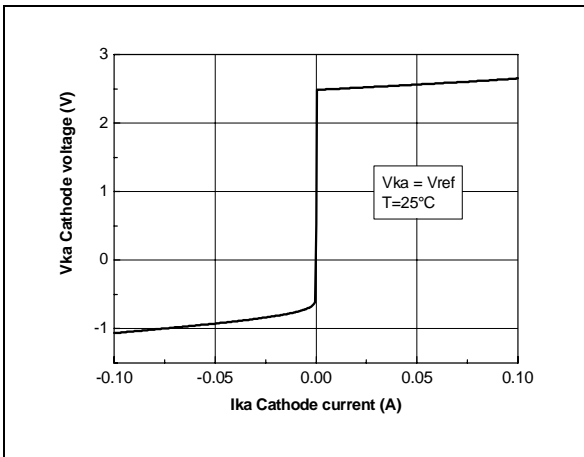
Reference voltage vs temperature



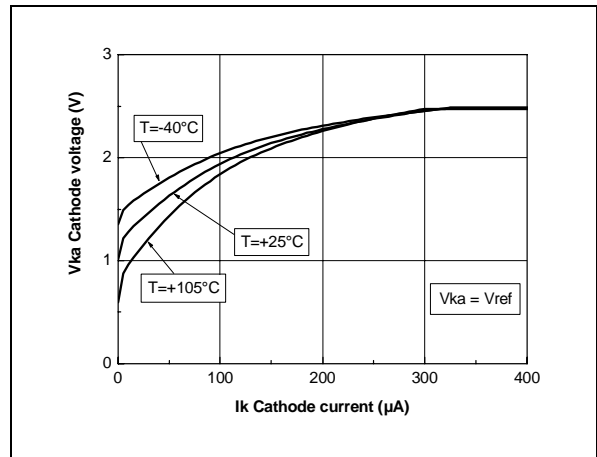
Test circuit for  $V_{ka} = V_{ref}$



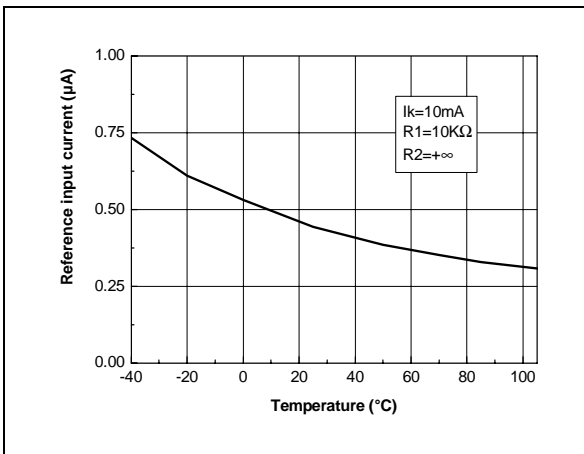
Cathode voltage vs cathode current



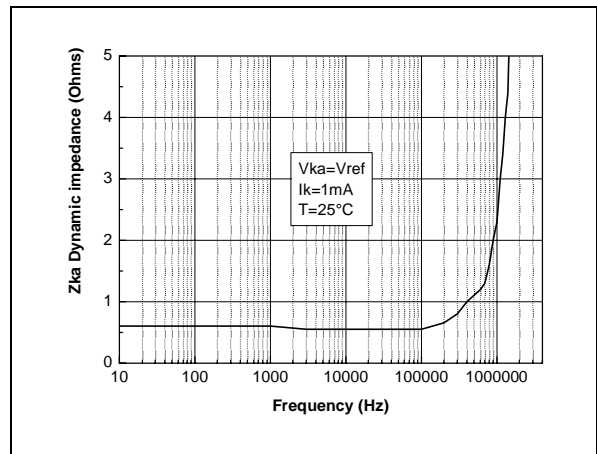
Cathode voltage vs cathode current



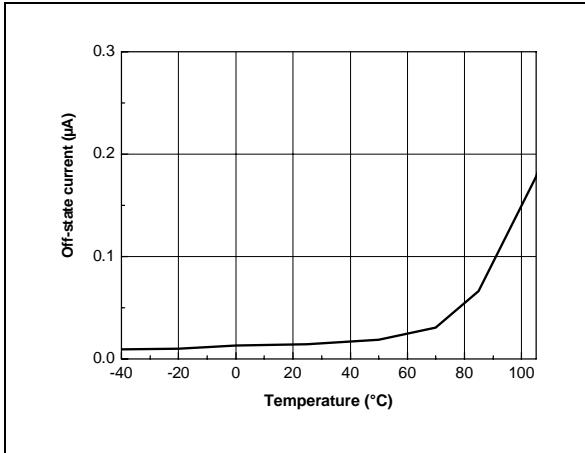
Reference input current vs temperature



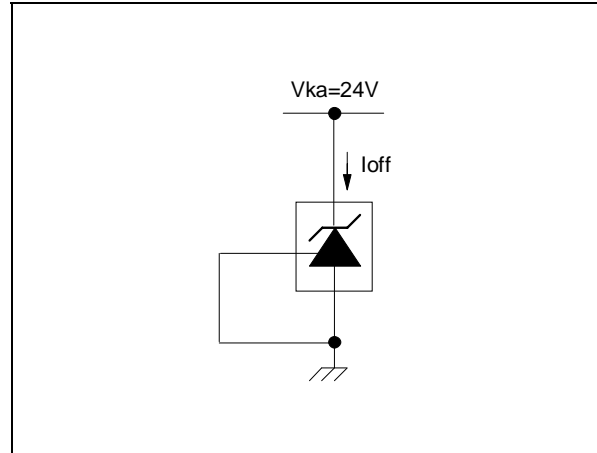
Dynamic impedance vs frequency



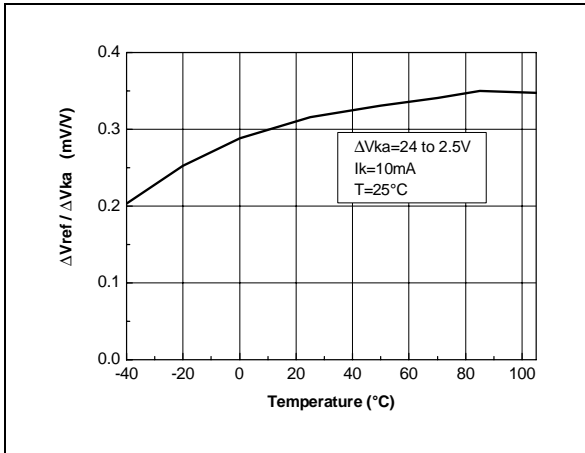
Off-State current vs temperature



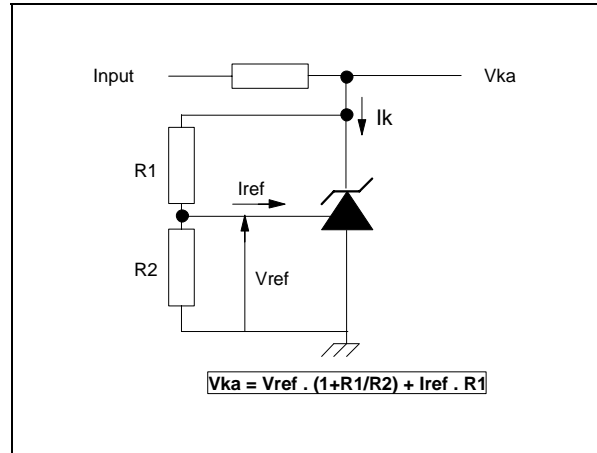
Test circuit for Off-State current measurement



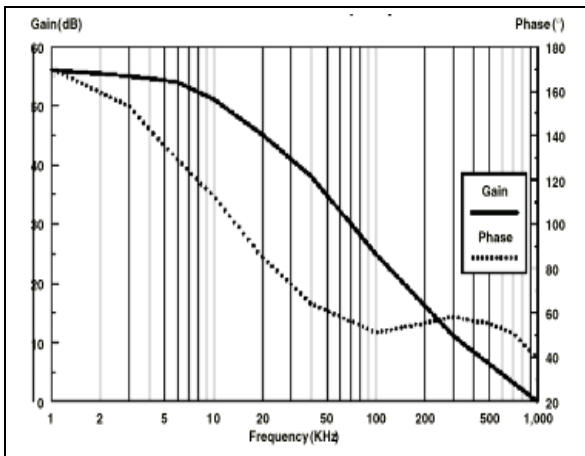
Ratio of change in reference input voltage to change in Vka voltage vs temperature



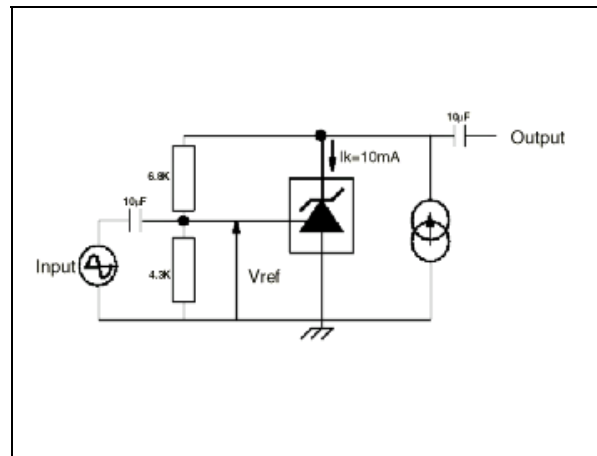
Test circuit for Vka > Vref



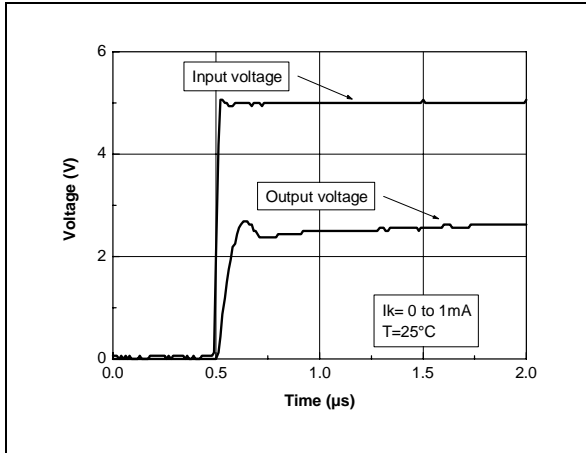
Phase and Gain vs frequency



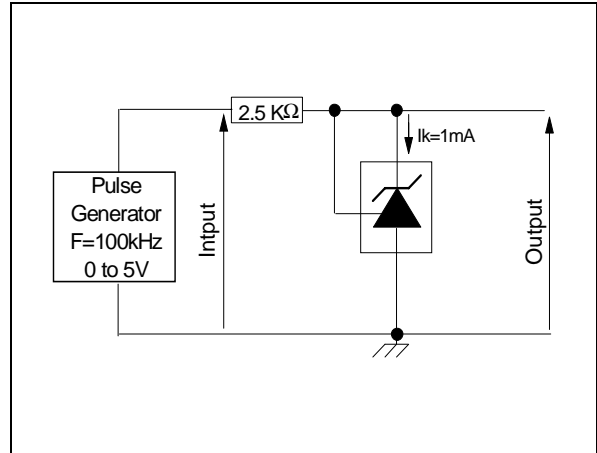
Test circuit for phase and gain measurement



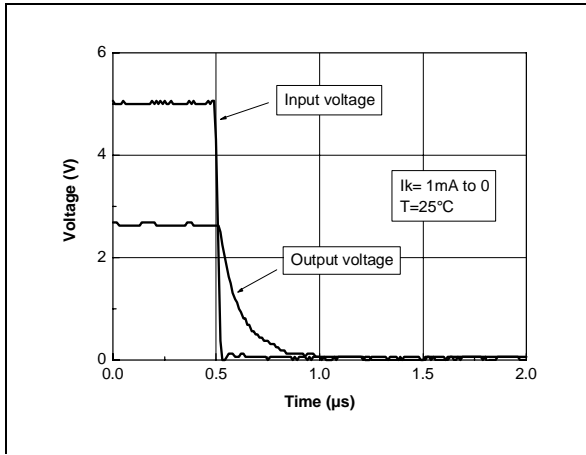
Pulse response at  $I_k=1\text{mA}$



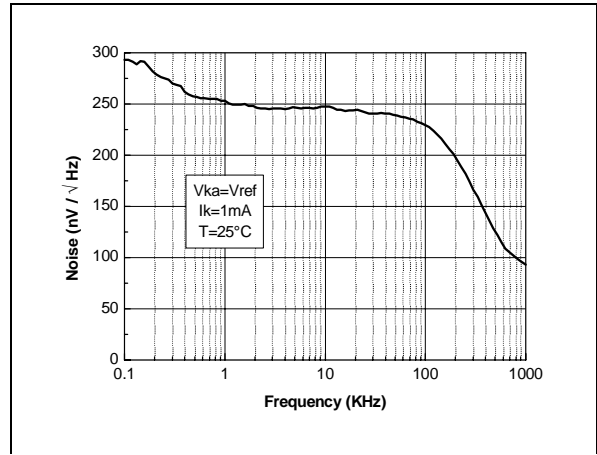
Test circuit for pulse response at  $I_k = 1\text{mA}$



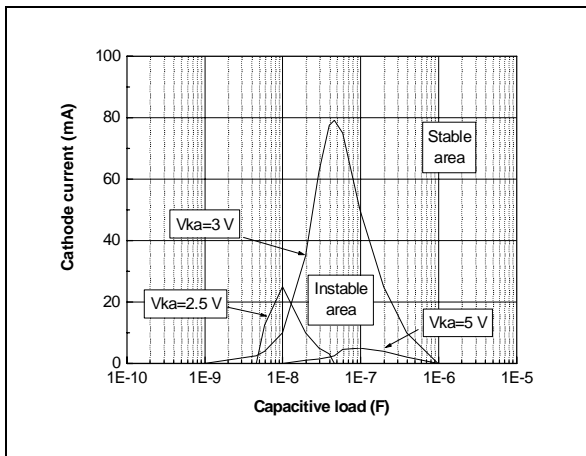
Pulse response at  $I_k = 1\text{mA}$



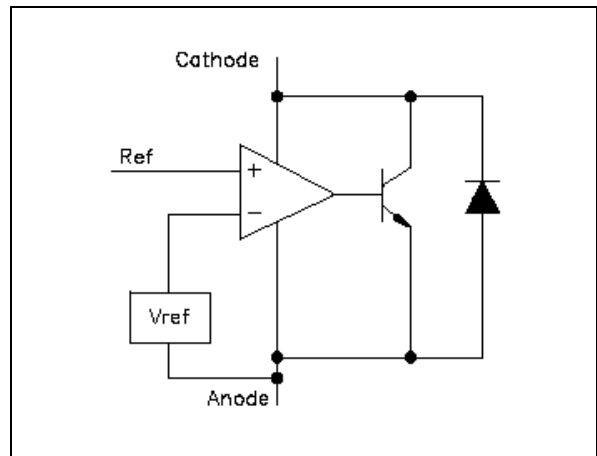
Equivalent input noise vs frequency



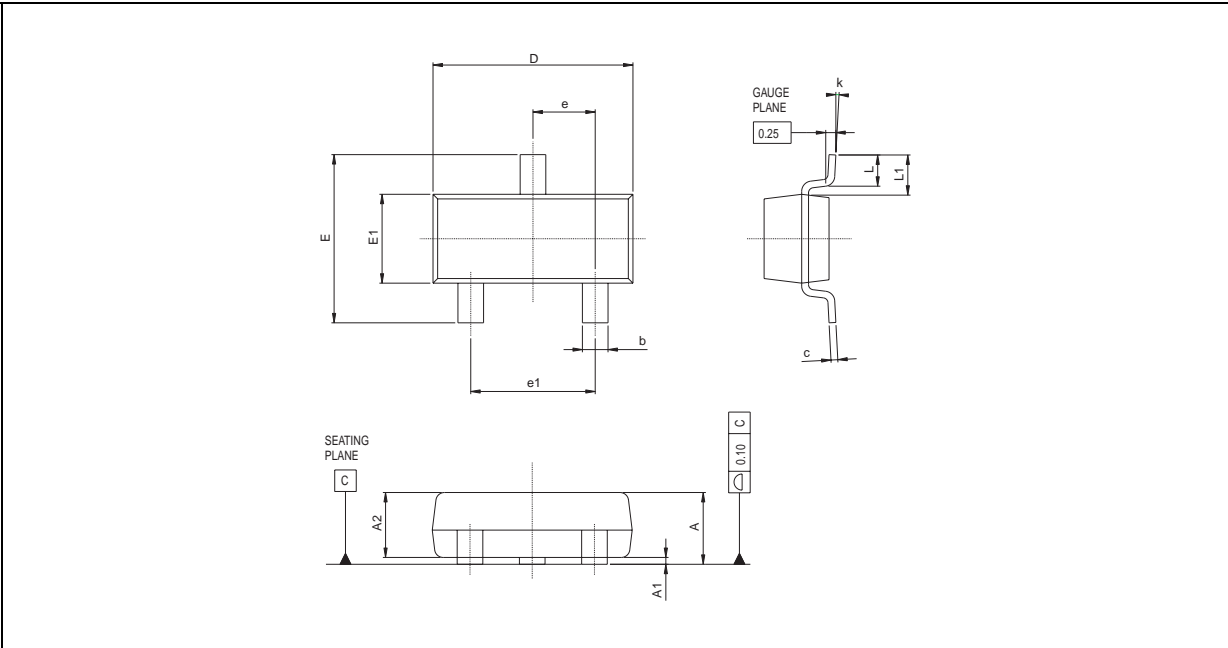
Stability boundary conditions



Block Diagram



**PACKAGE MECHANICAL DATA**  
**3 PINS - TINY PACKAGE (SOT-23)**



| Dimensions | Millimeters |       |       | Inches |       |       |
|------------|-------------|-------|-------|--------|-------|-------|
|            | Min.        | Typ.  | Max.  | Min.   | Typ.  | Max.  |
| A          | 0.890       |       | 1.120 | 0.035  |       | 0.044 |
| A1         | 0.010       |       | 0.100 | 0.0004 |       | 0.004 |
| A2         | 0.880       | 0.950 | 1.020 |        | 0.037 | 0.040 |
| b          | 0.300       |       | 0.500 | 0.012  |       | 0.020 |
| c          | 0.080       |       | 0.200 | 0.003  |       | 0.008 |
| D          | 2.800       | 2.900 | 3.040 | 0.110  | 0.114 | 0.120 |
| E          | 2.100       |       | 2.640 | 0.083  |       | 0.104 |
| E1         | 1.200       | 1.300 | 1.400 | 0.047  | 0.051 | 0.055 |
| e          |             | 0.950 |       |        | 0.037 |       |
| e1         |             | 1.900 |       |        | 0.075 |       |
| L          | 0.400       | 0.500 | 0.600 | 0.016  | 0.020 | 0.024 |
| L1         |             | 0.540 |       |        | 0.021 |       |
| k          | 0°          |       | 8°    |        |       |       |

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