

## 1.24V ADJUSTABLE SHUNT VOLTAGE REFERENCE

- **1.24V TYP OUTPUT VOLTAGE**
- **ULTRA LOW OPERATING CURRENT :**  
60 $\mu$ A maximum at 25°C
- **HIGH PRECISION @ 25°C**  
+/- 1%  
+/- 0.5%
- **HIGH STABILITY WHEN USED WITH CAPACITIVE LOADS**
- **INDUSTRIAL TEMPERATURE RANGE:**  
-40 to +85°C
- **100ppm/°C TEMPERATURE COEFFICIENT**

### DESCRIPTION

The TS432 is an adjustable low power shunt voltage reference providing an output voltage from 1.24V to 10V over the industrial temperature range (-40 to +85°C). Available in SOT23-3 surface mount package, it can be designed in applications where space saving is a critical issue.

The low operating current is a key advantage for power restricted designs. In addition, the TS432 is very stable and can be used in a broad range of application conditions.

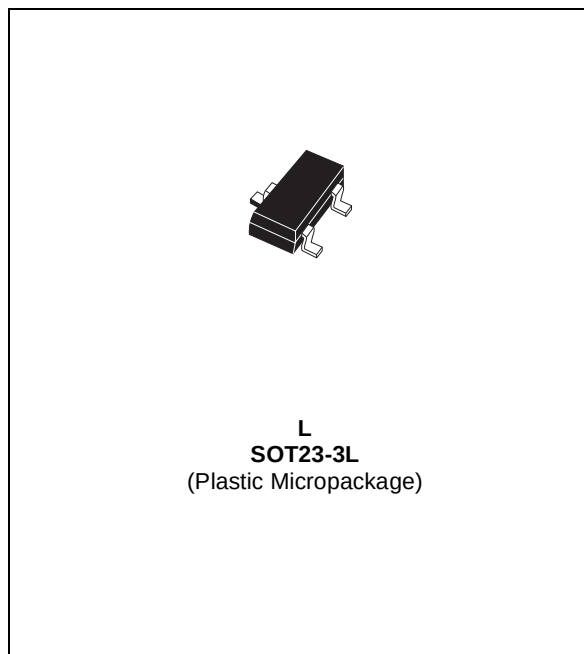
### APPLICATION

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

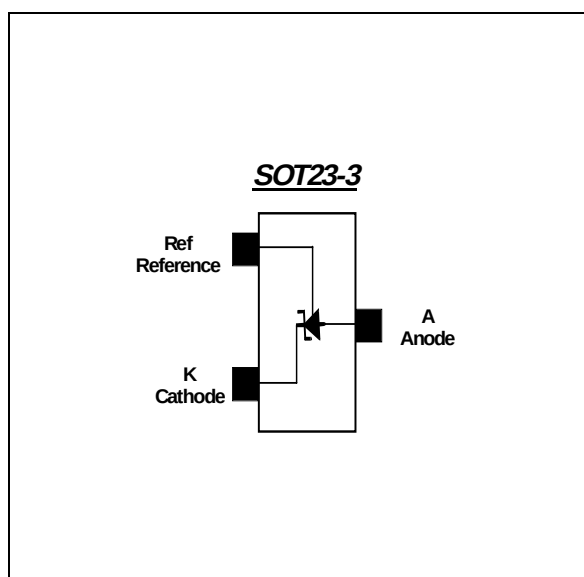
### ORDER CODE

| Precision                              | SOT23-3   | SOT23 Marking |
|----------------------------------------|-----------|---------------|
| 1%                                     | TS432ILT  | L235          |
| 0.5%                                   | TS432AILT | L236          |
| Single temperature range: -40 to +85°C |           |               |

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



### PIN CONNECTIONS (top view)



## ABSOLUTE MAXIMUM RATINGS

| Symbol     | Parameter                                          | Value       | Unit |
|------------|----------------------------------------------------|-------------|------|
| $V_K$      | Cathode voltage                                    | 12          | V    |
| $I_K$      | Cathode current                                    | -10 to +20  | mA   |
| $I_{REF}$  | Reference input current                            | -0.05 to +3 | mA   |
| $P_D$      | Power dissipation <sup>1)</sup> SOT23-3            | 340         | mW   |
| $R_{THJA}$ | Thermal resistance junction to ambient for SOT23-3 | 360         | °C/W |
| $T_{LEAD}$ | Lead temperature (soldering 10 seconds)            | 250         | °C   |
| $T_{STG}$  | Storage temperature                                | -65 to +150 | °C   |
| $T_J$      | Junction temperature                               | 150         | °C   |
| ESD        | Human Body Model (HBM)                             | 1.5         | kV   |
|            | Machine Model (MM)                                 | 150         | V    |

1.  $P_D$  has been calculated with  $T_{amb} = 25^\circ\text{C}$ ,  $T_J = 150^\circ\text{C}$  and  $R_{thja} = 360^\circ\text{C/W}$  for the SOT23-3L package

## OPERATING CONDITIONS

| Symbol    | Parameter           | Value           | Unit |
|-----------|---------------------|-----------------|------|
| $V_K$     | Cathode voltage     | 1.24 to 10      | V    |
| $I_K$     | Cathode current     | 60 $\mu$ to 12m | A    |
| $T_{AMB}$ | Ambient temperature | -40 to +85      | °C   |

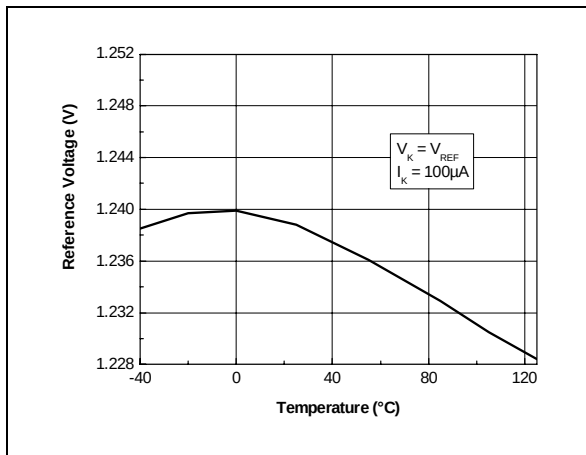
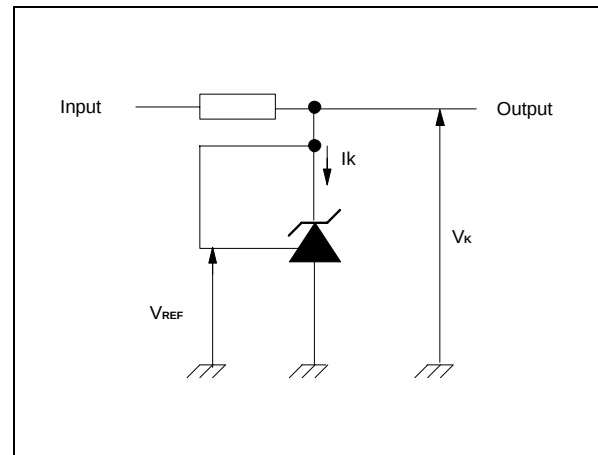
## ELECTRICAL CHARACTERISTICS

$T_{amb} = 25^\circ\text{C}$  (unless otherwise specified)

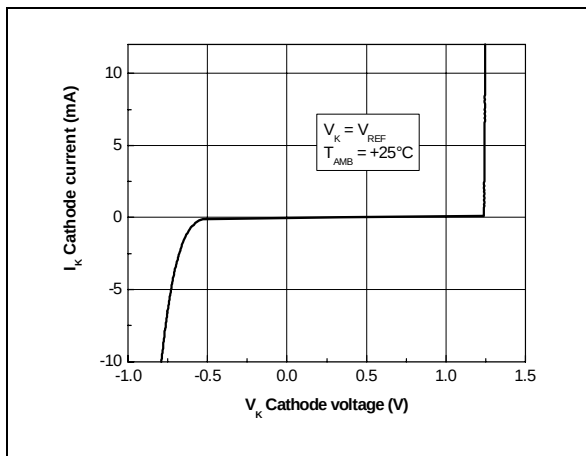
| Symbol                      | Parameter                                                     | Test Condition                                                   | Min.  | Typ. | Max.  | Unit                   |
|-----------------------------|---------------------------------------------------------------|------------------------------------------------------------------|-------|------|-------|------------------------|
| $V_{REF}$                   | Reference voltage                                             | $I_K = 100\mu\text{A}$ , $V_K = V_{REF}$                         |       | 1.24 |       | V                      |
|                             |                                                               | TS432 (1%)                                                       | 1.228 |      | 1.252 |                        |
|                             |                                                               | TS432A (0.5%)                                                    | 1.234 |      | 1.246 |                        |
| $\Delta V_{REF}$            | Reference voltage tolerance over temperature                  | $I_K = 100\mu\text{A}$ , $V_K = V_{REF}$                         |       | 7    | 16    | mV                     |
| $I_{KMIN}$                  | Minimum operating current                                     | $T_{amb} = 25^\circ\text{C}$                                     |       | 40   | 60    | $\mu\text{A}$          |
|                             |                                                               | $-40^\circ\text{C} < T_{AMB} < +85^\circ\text{C}$                |       |      | 65    |                        |
| $\Delta V_{REF}$            | Reverse breakdown voltage change with operating current range | $I_{KMIN} < I_K < 1\text{mA}$                                    |       | 0.7  | 1.5   | mV                     |
|                             |                                                               | $-40^\circ\text{C} < T_{AMB} < +85^\circ\text{C}$                |       |      | 2     |                        |
|                             |                                                               | $1\text{mA} < I_K < 12\text{mA}$                                 |       | 2    | 4     |                        |
|                             |                                                               | $-40^\circ\text{C} < T_{AMB} < +85^\circ\text{C}$                |       |      | 6     |                        |
| $\Delta V_{REF}/\Delta V_K$ | Reference voltage change with output voltage change           | $I_K = 10\text{mA}$ , $V_K = 10\text{V}$ to $V_{REF}$            |       | 1.8  | 2.5   | mV/V                   |
|                             |                                                               | $-40^\circ\text{C} < T_{AMB} < +85^\circ\text{C}$                |       |      | 3     |                        |
| $I_{REF}$                   | Reference input current                                       | $I_K = 10\text{mA}$ , $R_1 = 10\text{K}\Omega$ , $R_2 = +\infty$ |       | 50   | 100   | nA                     |
|                             |                                                               | $-40^\circ\text{C} < T_{AMB} < +85^\circ\text{C}$                |       |      | 200   |                        |
| $I_{OFF}$                   | Off-state cathode current                                     | $V_{REF} = 0$ , $V_K = 10\text{V}$                               |       | 1    | 100   | nA                     |
|                             |                                                               | $-40^\circ\text{C} < T_{AMB} < +85^\circ\text{C}$                |       |      | 150   |                        |
| $R_{KA}$                    | Static impedance                                              | $\Delta I_K = 100\mu\text{A}$ to $12\text{mA}$                   |       | 0.25 | 0.5   | $\Omega$               |
| $K_{VH}$                    | Long term stability                                           | $I_K = 100\mu\text{A}$ , $t = 1000\text{hrs}$                    |       | 120  |       | ppm                    |
| $E_N$                       | Wide band noise                                               | $I_K = 100\mu\text{A}$ 100Hz < F < 10kHz                         |       | 200  |       | nV/ $\sqrt{\text{Hz}}$ |

**Note :** Limits are 100% production tested at  $25^\circ\text{C}$ . Limits over temperature are guaranteed through correlation and by design.

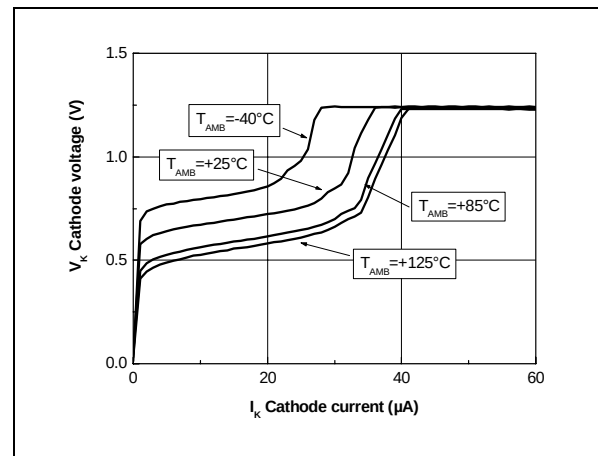
Reference voltage vs temperature

Test circuit for  $V_K = V_{REF}$ 

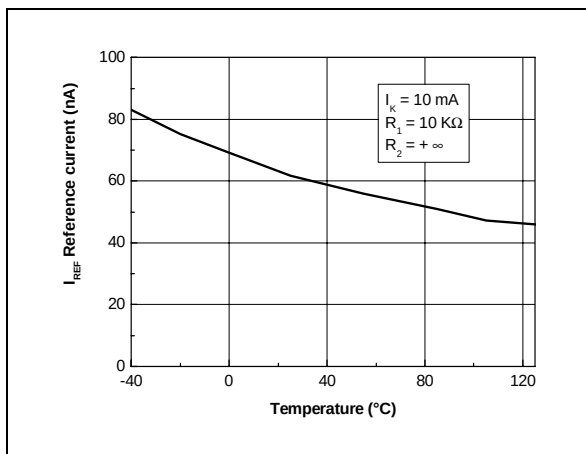
Cathode voltage vs cathode current



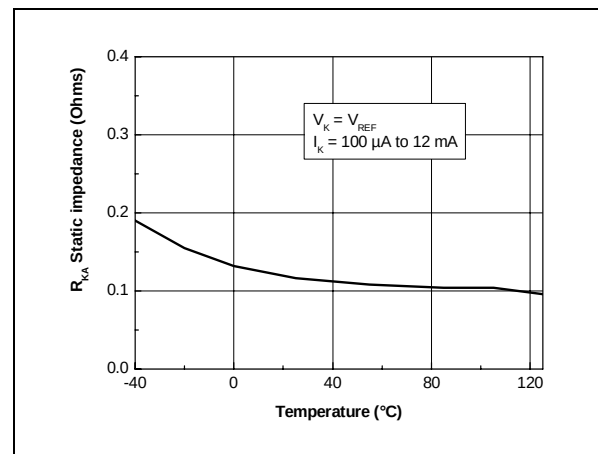
Cathode voltage vs cathode current



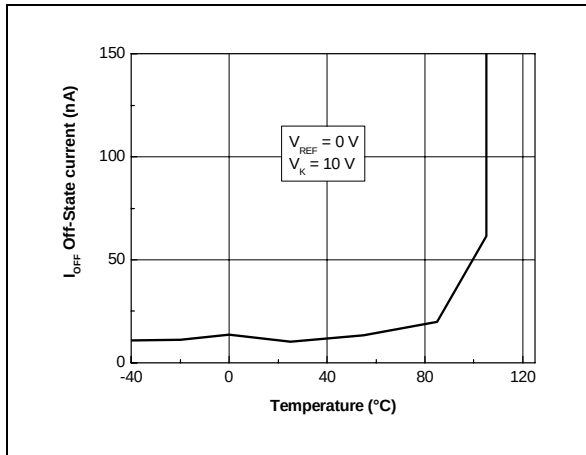
Reference input current vs temperature



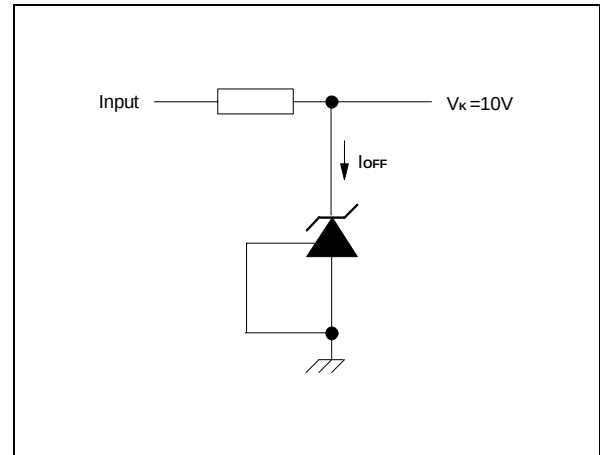
Static impedance vs temperature



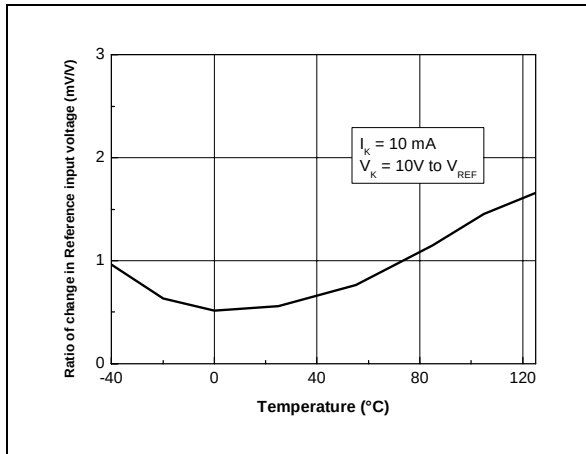
Off-State current vs temperature



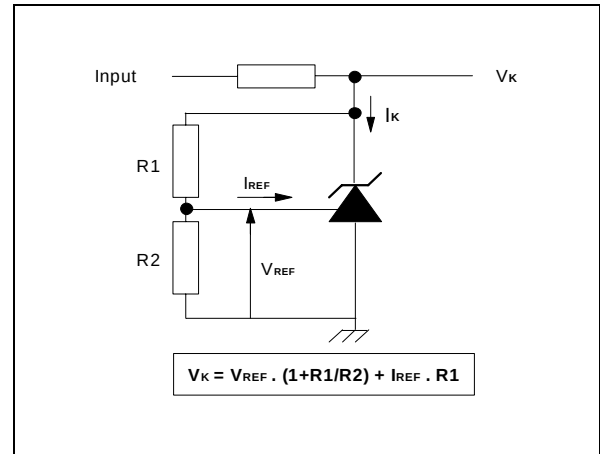
Test circuit for Off-State current measurement



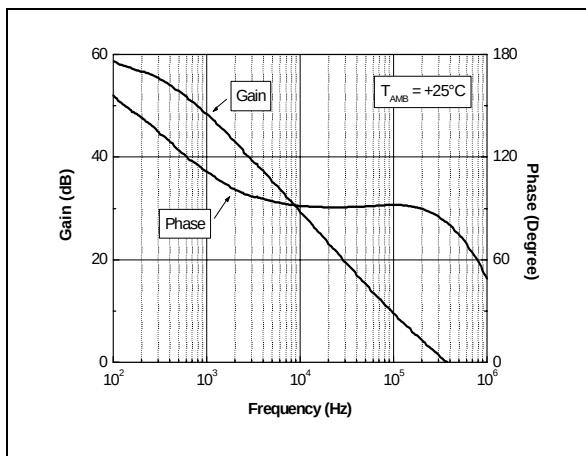
Ratio of change in reference input voltage to change in  $V_K$  voltage vs temperature



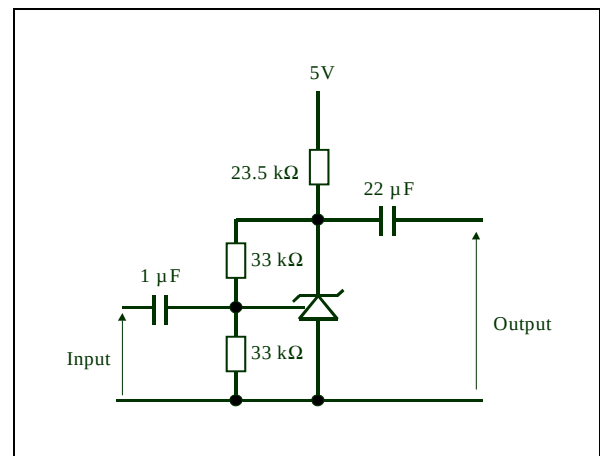
Test circuit for  $V_{KA} > V_{REF}$

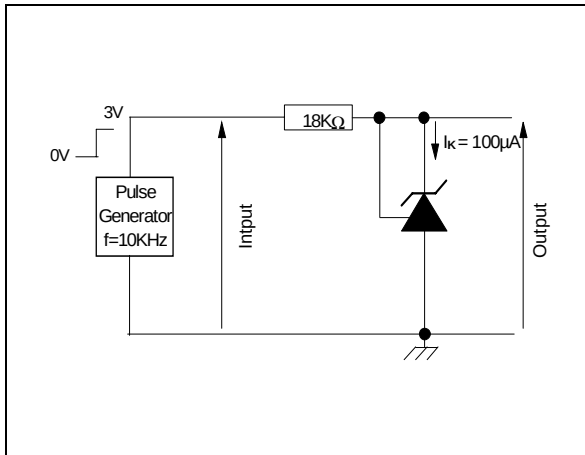
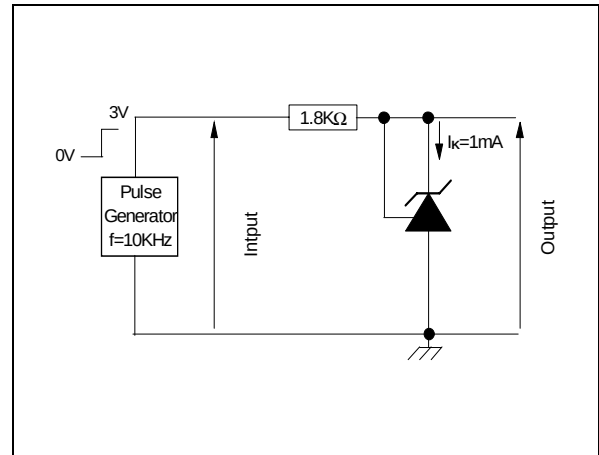
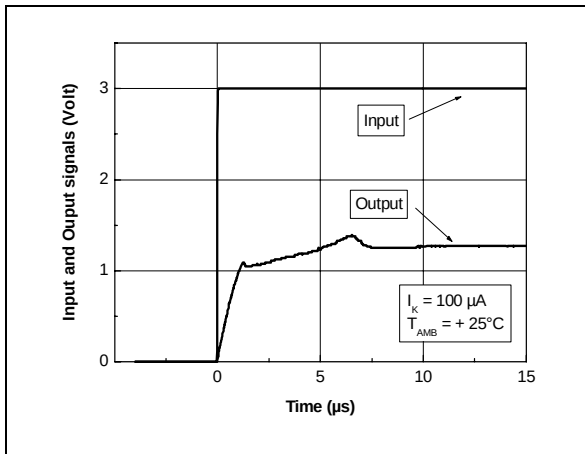
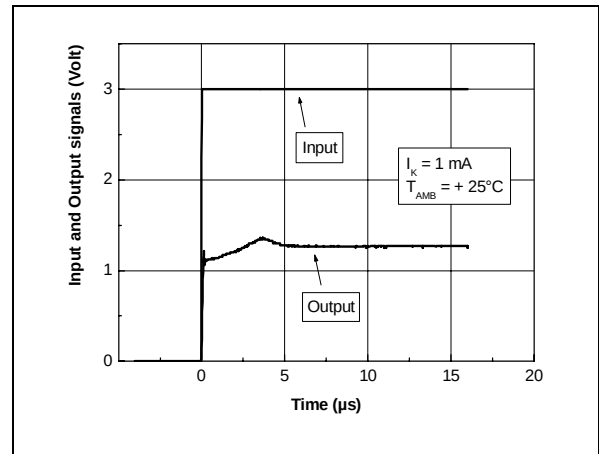
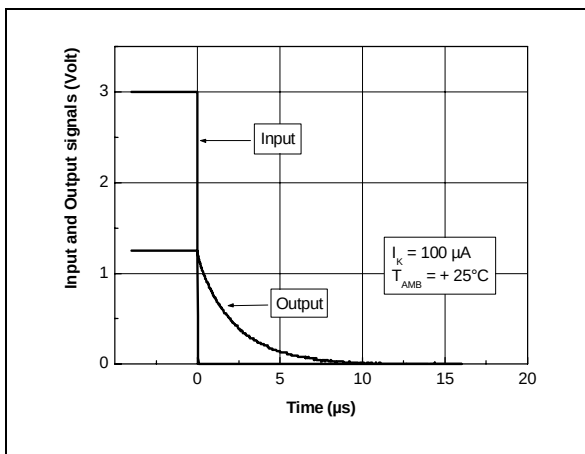
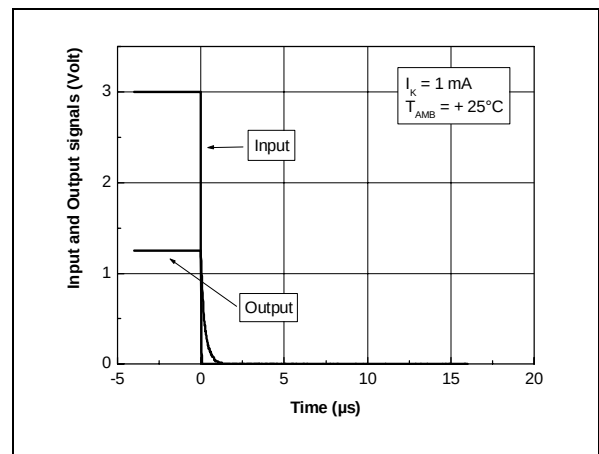


Phase and Gain vs frequency

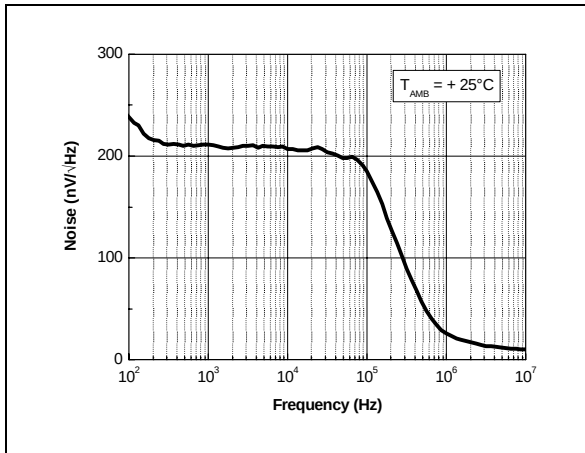


Test circuit for phase and gain measurement

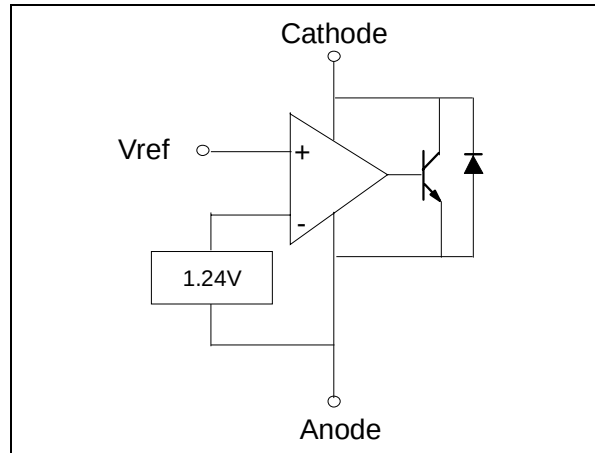


Test circuit for pulse response at  $I_K = 100 \mu\text{A}$ Test circuit for pulse response at  $I_K = 1 \text{ mA}$ Pulse response at  $I_K = 100 \mu\text{A}$ Pulse response at  $I_K = 1 \text{ mA}$ Pulse response at  $I_K = 100 \mu\text{A}$ Pulse response at  $I_K = 1 \text{ mA}$ 

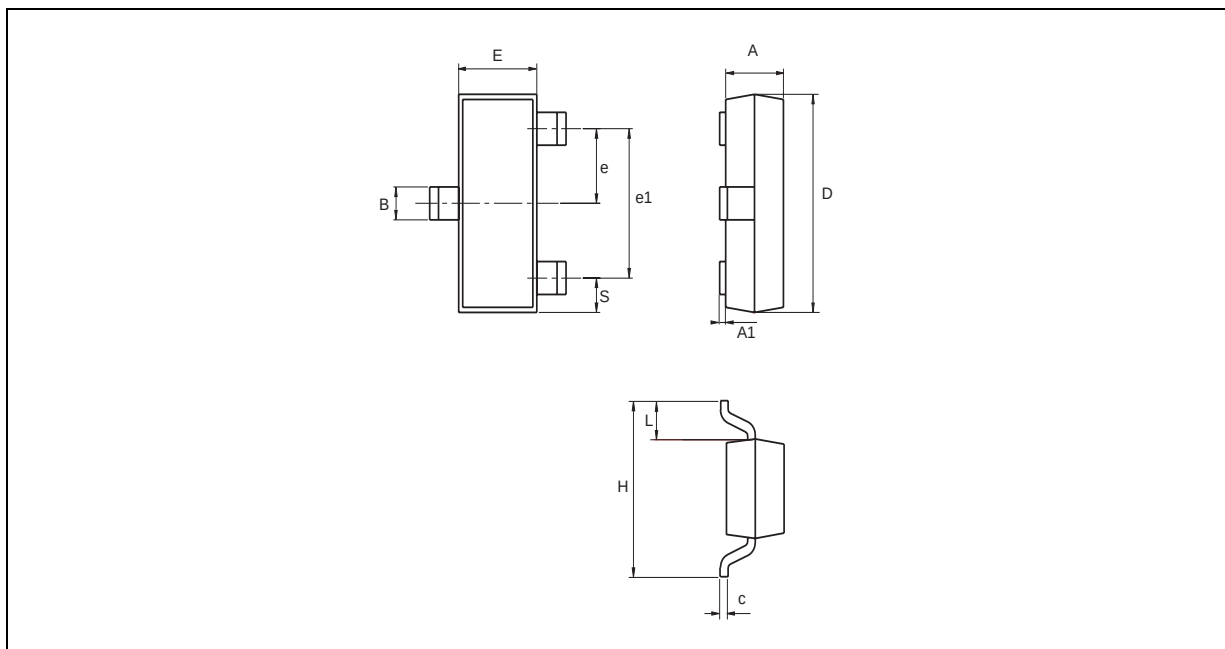
Equivalent input noise vs frequency



Block diagram



# **PACKAGE MECHANICAL DATA** **3 PINS - TINY PACKAGE (SOT23)**



| Dim. | 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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