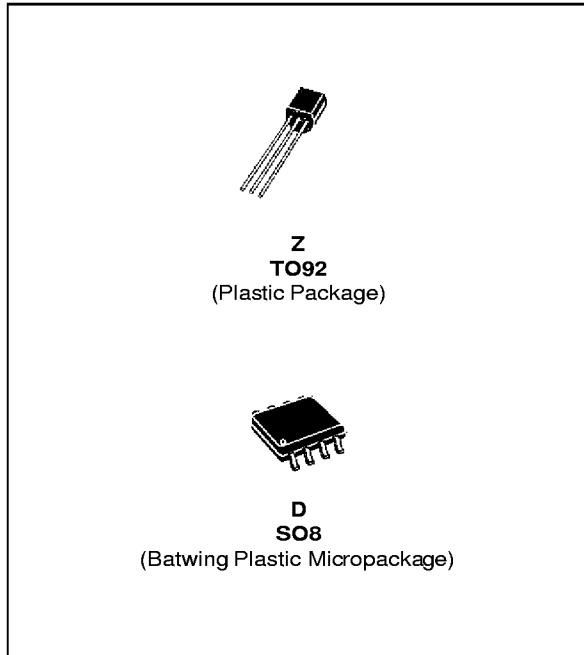


## PROGRAMMABLE VOLTAGE REFERENCE

- ADJUSTABLE OUTPUT VOLTAGE :  
 $V_{ref}$  to 36V
- SINK CURRENT CAPABILITY : 1 to 100mA
- TYPICAL OUTPUT IMPEDANCE :  $0.2\Omega$
- 0.4% AND 0.25% VOLTAGE PRECISION



### DESCRIPTION

The TL1431 is a programmable shunt voltage reference with guaranteed temperature stability over the entire temperature range of operation.

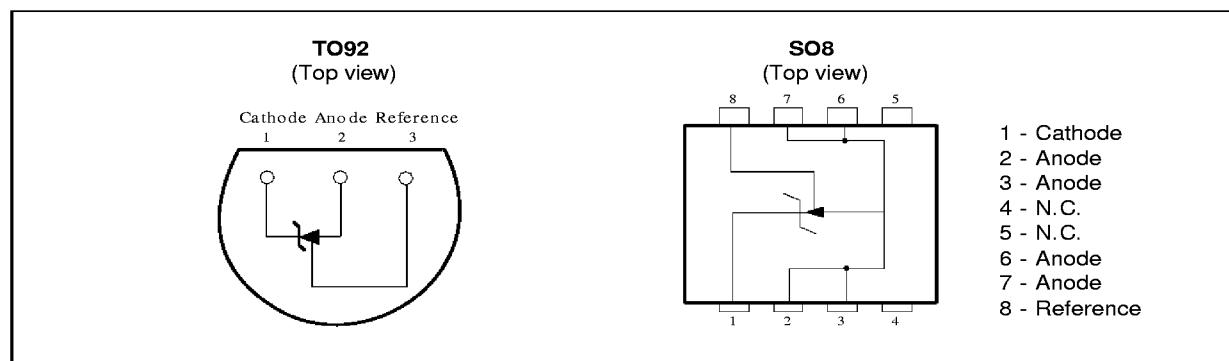
The output voltage may be set to any value between  $V_{ref}$  (approximately 2.5V) and 36V with two external resistors.

The TL1431 operates with a wide current range from 1 to 100mA with a typical dynamic impedance of  $0.2\Omega$ .

### ORDER CODES

| Part number | Temperature Range | Package |   |
|-------------|-------------------|---------|---|
|             |                   | Z       | D |
| TL1431C/AC  | -20°C, +70°C      | •       | • |
| TL1431I/AI  | -40°C, +105°C     | •       | • |

### PIN CONNECTIONS



## ABSOLUTE MAXIMUM RATINGS

| Symbol     | Parameter  | Value                     | Unit |
|------------|--|---------------------------|------|
| $V_{KA}$   | Cathode to Anode Voltage   | 37                        | V    |
| $I_K$      | Continuous Cathode Current Range                                 | -100 to +150              | mA   |
| $I_{ref}$  | Reference Input Current Range                                    | -0.05 to +10              | mA   |
| $T_{oper}$ | Operating Free-air Temperature Range<br>TL1431C/AC<br>TL1431I/AI | -20 to +70<br>-40 to +105 | °C   |
| $T_{stg}$  | Storage Temperature Range  | -65 to +150               | °C   |

## OPERATING CONDITIONS

| Symbol   | Parameter                | Value           | Unit |
|----------|--------------------------|-----------------|------|
| $V_{KA}$ | Cathode to Anode Voltage | $V_{ref}$ to 36 | V    |
| $I_K$    | Cathode Current          | 1 to 100        | mA   |

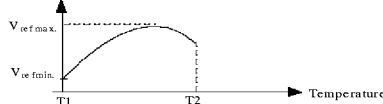
## ELECTRICAL CHARACTERISTICS

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

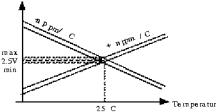
| Symbol                                 | Parameter   | TL1431C |          |          | TL1431AC |          |          | Unit          |
|--|---|---------|----------|----------|----------|----------|----------|---------------|
|  |   | Min.    | Typ.     | Max.     | Min.     | Typ.     | Max.     |               |
| $V_{ref}$                              | Reference Input Voltage - (figure 1)<br>$V_{KA} = V_{ref}$ , $I_K = 10\text{mA}$ , $T_{amb} = 25^\circ\text{C}$   | 2.490   | 2.500    | 2.510    | 2.493    | 2.500    | 2.507    | V             |
| $\Delta V_{ref}$                       | Reference Input Voltage Deviation Over Temperature Range - (figure 1, note 1)<br>$V_{KA} = V_{ref}$ , $I_K = 10\text{mA}$ , $T_{min.} \leq T_{amb} \leq T_{max.}$                 |         | 3        | 20       |          | 3        | 20       | mV            |
| $\frac{\Delta V_{ref}}{\Delta T}$      | Temperature Coefficient of Reference Input Voltage - (note 2)<br>$V_{KA} = V_{ref}$ , $I_K = 10\text{mA}$ , $T_{min.} \leq T_{amb} \leq T_{max.}$                                 |         | $\pm 13$ | $\pm 90$ |          | $\pm 13$ | $\pm 90$ | ppm/°C        |
| $\frac{\Delta V_{ref}}{\Delta V_{KA}}$ | Ratio of Change in Reference Input Voltage to Change in Cathode to Anode Voltage - (figure 2)<br>$I_K = 10\text{mA}$ , $\Delta V_{KA} = 36\text{V}$ to $3\text{V}$                | -2      | -1.1     |          | -2       | -1.1     |          | mV/V          |
| $I_{ref}$                              | Reference Input Current - (figure 2)<br>$I_K = 10\text{mA}$ , $R_1 = 10\text{k}\Omega$ , $R_2 = \infty$<br>$T_{amb} = 25^\circ\text{C}$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$  |         | 1.5<br>3 | 2.5      |          | 1.5<br>3 | 2.5<br>3 | $\mu\text{A}$ |
| $\Delta I_{ref}$                       | Reference Input Current Deviation Over Temperature Range - (figure 2)<br>$I_K = 10\text{mA}$ , $R_1 = 10\text{k}\Omega$ , $R_2 = \infty$<br>$T_{min.} \leq T_{amb} \leq T_{max.}$ |         | 0.2      | 1.2      |          | 0.2      | 1.2      | $\mu\text{A}$ |
| $I_{min}$                              | Minimum Cathode Current for Regulation - (figure 1)<br>$V_{KA} = V_{ref}$   |         | 0.5      | 1        |          | 0.5      | 0.6      | mA            |
| $I_{off}$                              | Off-State Cathode Current - (figure 3)  |         | 180      | 500      |          | 180      | 500      | nA            |
| $ Z_{KA} $                             | Dynamic Impedance - (figure 1, note 3)<br>$V_{KA} = V_{ref}$ , $\Delta I_K = 1$ to $100\text{mA}$ , $f \leq 1\text{kHz}$  |         | 0.2      | 0.5      |          | 0.2      | 0.5      | $\Omega$      |

Notes : 1.  $\Delta V_{ref}$  is defined as the difference between the maximum and minimum values obtained over the full temperature range.

$$\Delta V_{ref} = V_{ref\ max.} - V_{ref\ min}$$



2. The temperature coefficient is defined as the slopes (positive and negative) of the voltage vs temperature limits within which the reference voltage is guaranteed.



3. The dynamic Impedance is defined as  $|Z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_K}$

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

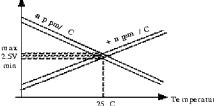
| Symbol                                 | Parameter   | TL1431I |          |           | TL1431AI |          |           | Unit            |
|--|---|---------|----------|-----------|----------|----------|-----------|-----------------|
|  |   | Min.    | Typ.     | Max.      | Min.     | Typ.     | Max.      |                 |
| $V_{ref}$                              | Reference Input Voltage - (figure 1)<br>$V_{KA} = V_{ref}$ , $I_k = 10mA$ $T_{amb} = 25^\circ C$  | 2.490   | 2.500    | 2.510     | 2.493    | 2.500    | 2.507     | V               |
| $\Delta V_{ref}$                       | Reference Input Voltage Deviation Over Temperature Range - (figure 1, note1)<br>$V_{KA} = V_{ref}$ , $I_k = 10mA$ , $T_{min} \leq T_{amb} \leq T_{max}$ .           |         | 7        | 30        |          | 7        | 30        | mV              |
| $\frac{\Delta V_{ref}}{\Delta T}$      | Temperature Coefficient of Reference Input Voltage - (note 2)<br>$V_{KA} = V_{ref}$ , $I_k = 10mA$ , $T_{min} \leq T_{amb} \leq T_{max}$ .                          |         | $\pm 22$ | $\pm 100$ |          | $\pm 22$ | $\pm 100$ | ppm/ $^\circ C$ |
| $\frac{\Delta V_{ref}}{\Delta V_{KA}}$ | Ratio of Change in Reference Input Voltage to Change in Cathode to Anode Voltage - (figure 2)<br>$I_k = 10mA$ , $\Delta V_{KA} = 36$ to 3V                          |         | -1.1     | -2        |          | -1.1     | -2        | mV/V            |
| $I_{ref}$                              | Reference Input Current - (figure 2)<br>$I_k = 10mA$ , $R_1 = 10k\Omega$ , $R_2 = \infty$<br>$T_{amb} = 25^\circ C$<br>$T_{min} \leq T_{amb} \leq T_{max}$ .        |         | 1.5      | 2.5<br>3  |          | 1.5      | 2.5<br>3  | $\mu A$         |
| $\Delta I_{ref}$                       | Reference Input Current Deviation Over Temperature Range - (figure 2)<br>$I_k = 10mA$ , $R_1 = 10k\Omega$ , $R_2 = \infty$<br>$T_{min} \leq T_{amb} \leq T_{max}$ . |         | 0.5      | 1         |          | 0.8      | 1.2       | $\mu A$         |
| $I_{min}$                              | Minimum Cathode Current for Regulation - (figure 1)<br>$V_{KA} = V_{ref}$   |         | 0.5      | 1         |          | 0.5      | 0.7       | mA              |
| $I_{off}$                              | Off-State Cathode Current - (figure 3)  |         | 180      | 500       |          | 180      | 500       | nA              |
| $ Z_{KA} $                             | Dynamic Impedance - (figure 1, note 3)<br>$V_{KA} = V_{ref}$ , $\Delta I_k = 1$ to 100mA, $f \leq 1kHz$   |         | 0.2      | 0.5       |          | 0.2      | 0.5       | $\Omega$        |

- Notes :** 1.  $\Delta V_{ref}$  is defined as the difference between the maximum and minimum values obtained over the full temperature range.

$$\Delta V_{ref} = V_{ref\ max.} - V_{ref\ min.}$$

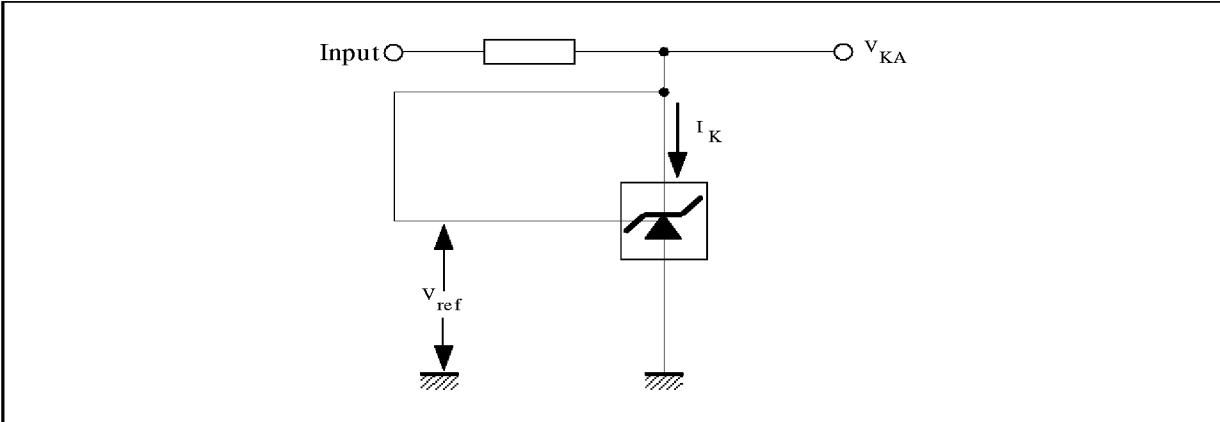


2. The temperature coefficient is defined as the slopes (positive and negative) of the voltage vs temperature limits within which the reference voltage is guaranteed.

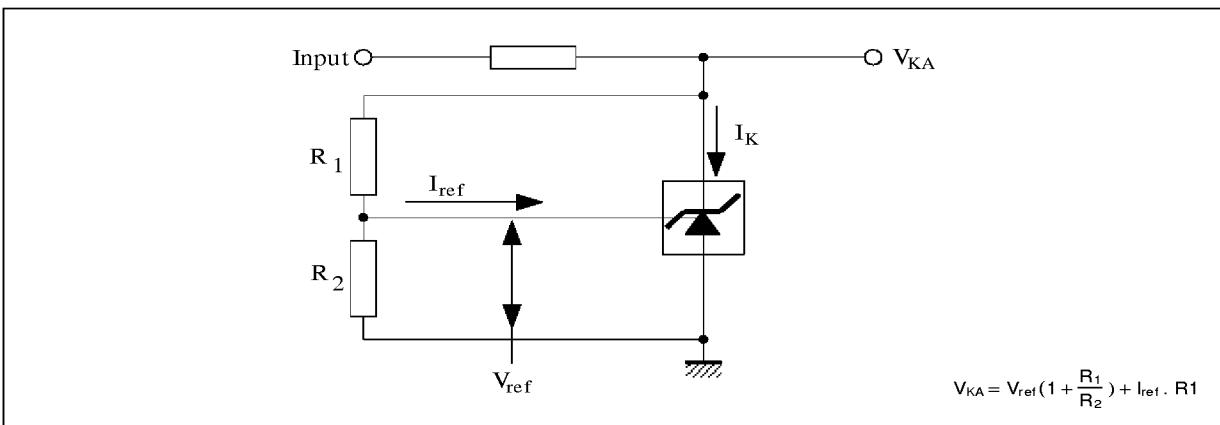


3. The dynamic Impedance is defined as  $|Z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_k}$

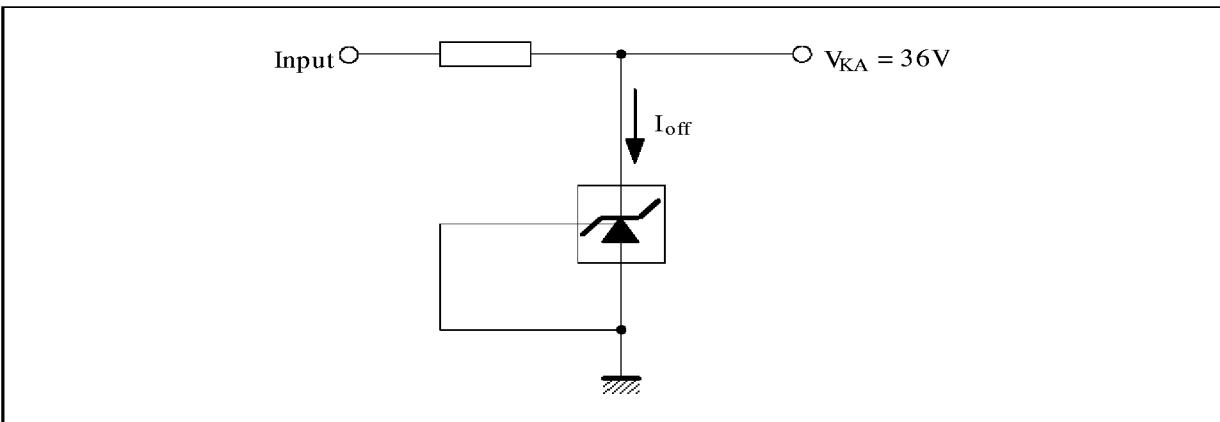
**Figure 1 : Test Circuit for  $V_{KA} = V_{ref}$**



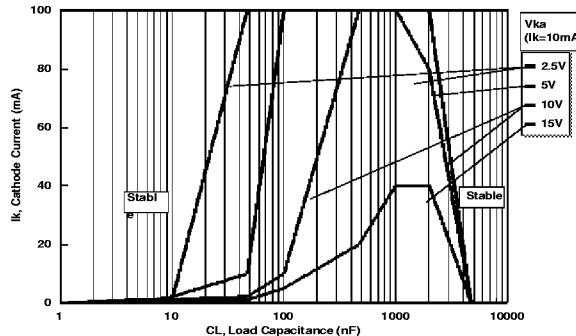
**Figure 2 : Test Circuit for  $V_{KA} > V_{ref}$**



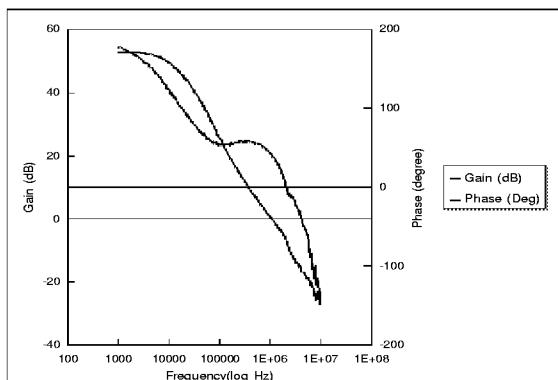
**Figure 3 : Test Circuit for  $I_{off}$**



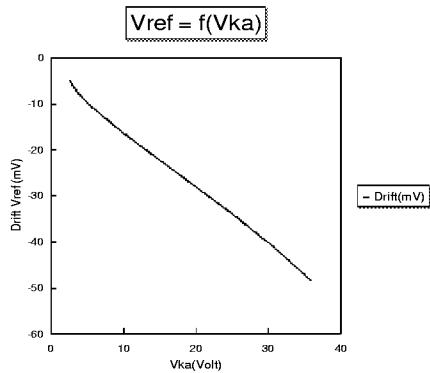
## STABILITY BOUNDARY CONDITIONS



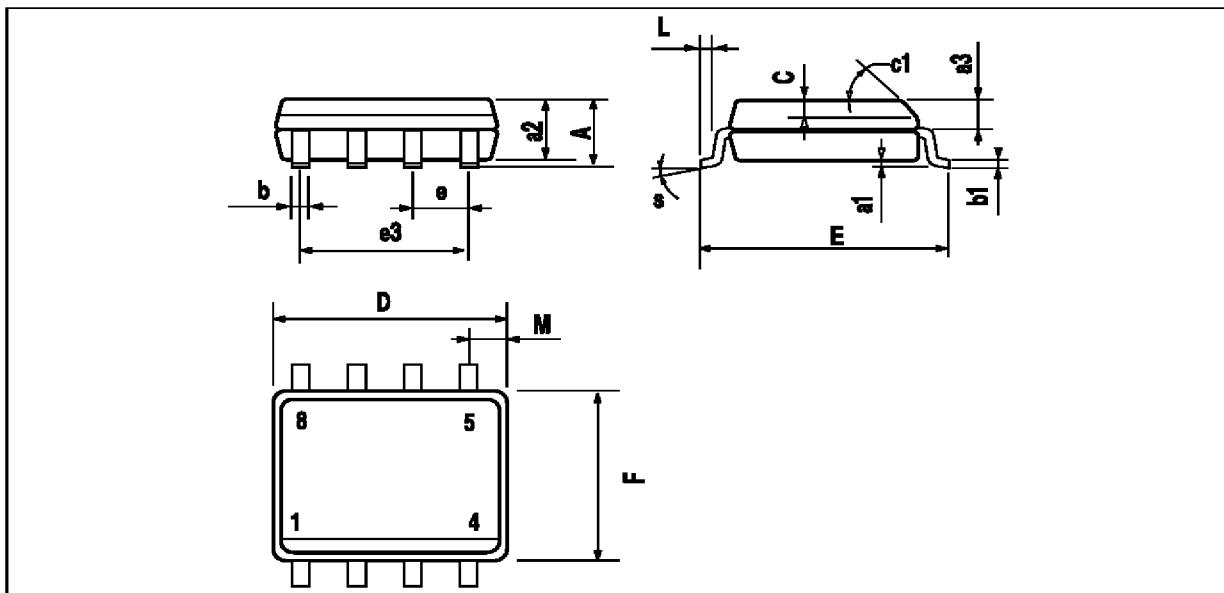
## OPEN LOOP VOLTAGE GAIN VERSUS FREQUENCY



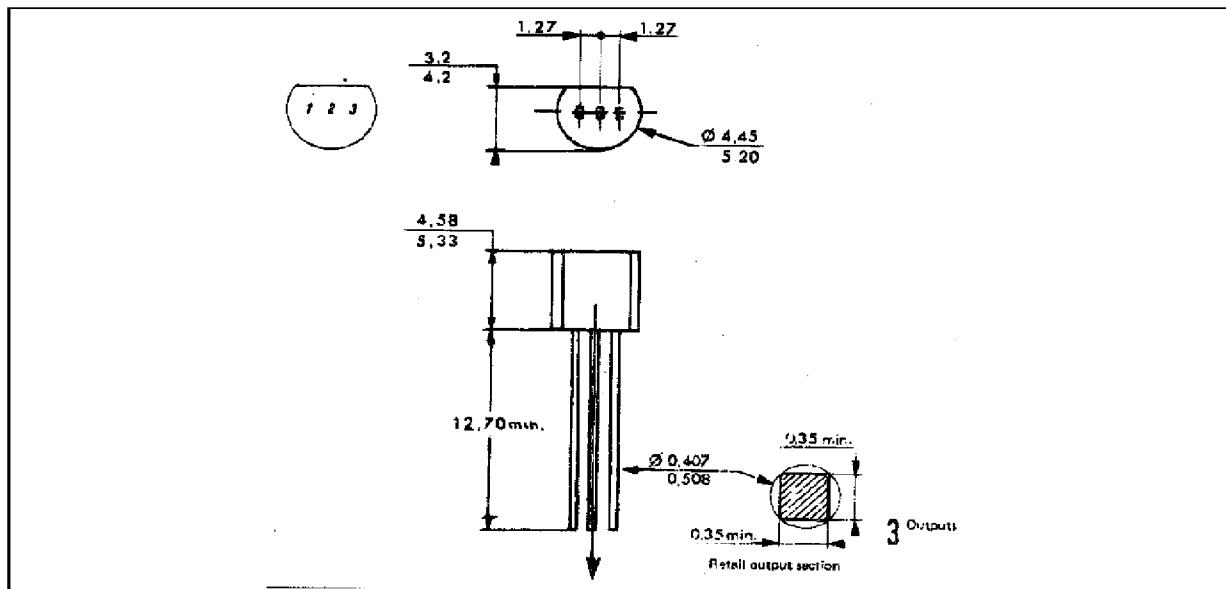
## REFERENCE INPUT VOLTAGE VERSUS CATHODE VOLTAGE



**PACKAGE MECHANICAL DATA**  
8 PINS - BATWING PLASTIC MICROPACKAGE (SO)



| Dimensions | Millimeters |      |      | Inches |       |       |
|------------|-------------|------|------|--------|-------|-------|
|            | Min.        | Typ. | Max. | Min.   | Typ.  | Max.  |
| A          |             |      | 1.75 |        |       | 0.069 |
| a1         | 0.1         |      | 0.25 | 0.004  |       | 0.010 |
| a2         |             |      | 1.65 |        |       | 0.065 |
| a3         | 0.65        |      | 0.85 | 0.026  |       | 0.033 |
| b          | 0.35        |      | 0.48 | 0.014  |       | 0.019 |
| b1         | 0.19        |      | 0.25 | 0.007  |       | 0.010 |
| C          | 0.25        |      | 0.5  | 0.010  |       | 0.020 |
| c1         | 45° (typ.)  |      |      |        |       |       |
| D          | 4.8         |      | 5.0  | 0.189  |       | 0.197 |
| E          | 5.8         |      | 6.2  | 0.228  |       | 0.244 |
| e          |             | 1.27 |      |        | 0.050 |       |
| e3         |             | 3.81 |      |        | 0.150 |       |
| F          | 3.8         |      | 4.0  | 0.150  |       | 0.157 |
| L          | 0.4         |      | 1.27 | 0.016  |       | 0.050 |
| M          |             |      | 0.6  |        |       | 0.024 |
| S          | 8° (max.)   |      |      |        |       |       |

**PACKAGE MECHANICAL DATA**  
 3 PINS - PLASTIC PACKAGE TO92


| Dimensions | Millimeters |      |       | Inches |        |        |
|------------|-------------|------|-------|--------|--------|--------|
|            | Min.        | Typ. | Max.  | Min.   | Typ.   | Max.   |
| L          |             | 1.27 |       |        | 0.05   |        |
| B          | 3.2         | 3.7  | 4.2   | 0.126  | 0.1457 | 0.1654 |
| O1         | 4.45        | 5.00 | 5.2   | 0.1752 | 0.1969 | 0.2047 |
| C          | 4.58        | 5.03 | 5.33  | 0.1803 | 0.198  | 0.2098 |
| K          | 12.7        |      |       | 0.5    |        |        |
| O2         | 0.407       | 0.5  | 0.508 | 0.016  | 0.0197 | 0.02   |
| a          | 0.35        |      |       | 0.0138 |        |        |

Information furnished is believed to be accurate and reliable. However, SGS-THOMSON Microelectronics assumes no responsibility for the consequences of use of such information nor for any infringement of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of SGS-THOMSON Microelectronics. Specification mentioned in this publication are subject to change without notice. This publication supersedes and replaces all information previously supplied. SGS-THOMSON Microelectronics products are not authorized for use as critical components in life support devices or systems without express written approval of SGS-THOMSON Microelectronics.

© 1997 SGS-THOMSON Microelectronics – Printed in Italy – All Rights Reserved

SGS-THOMSON Microelectronics GROUP OF COMPANIES

Australia - Brazil - Canada - China - France - Germany - Hong Kong - Italy - Japan - Korea - Malaysia - Malta - Morocco  
 The Netherlands - Singapore - Spain - Sweden - Switzerland - Taiwan - Thailand - United Kingdom - U.S.A.