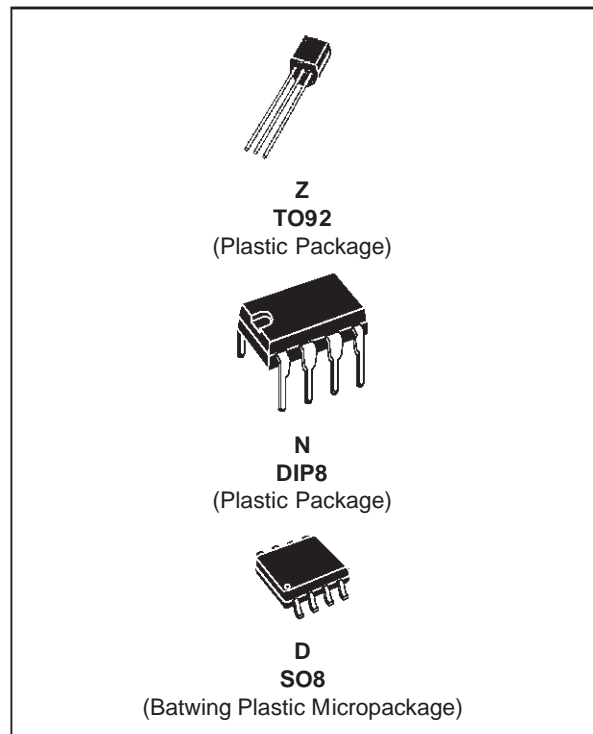


PROGRAMMABLE VOLTAGE REFERENCE

- ADJUSTABLE OUTPUT VOLTAGE :
2.5 to 36V
- SINK CURRENT CAPABILITY : 1 to 100mA
- TYPICAL OUTPUT IMPEDANCE : 0.22Ω
- 1% AND 2% VOLTAGE PRECISION



DESCRIPTION

The TL431 is a programmable shunt voltage reference with guaranteed temperature stability over the entire temperature range of operation.

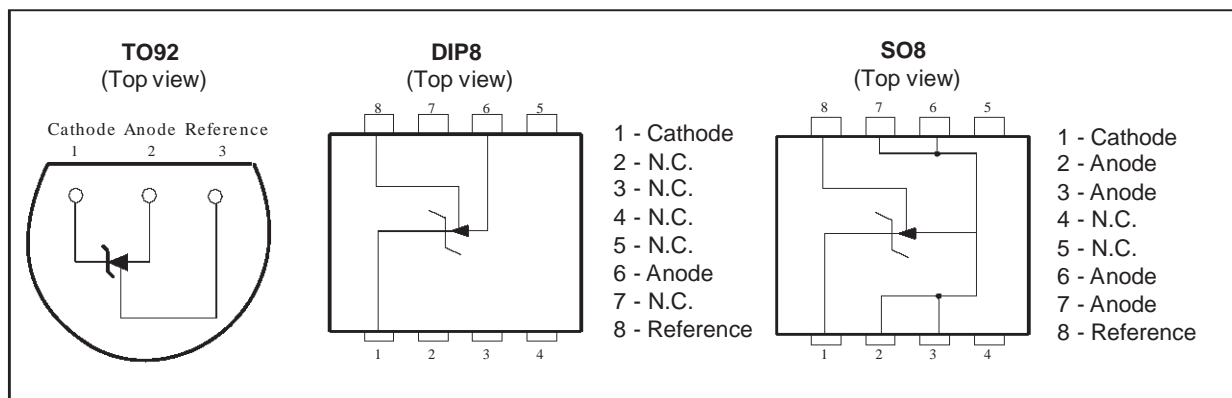
The output voltage may be set to any value between V_{ref} (approximately 2.5V) and 36V with two external resistors.

The TL431 operates with a wide current range from 1 to 100mA with a typical dynamic impedance of 0.22Ω.

ORDER CODES

| Part number | Temperature Range | Package | | |
|-------------|-------------------|---------|---|---|
| | | Z | N | D |
| TL431C/AC | 0°C, +70°C | • | • | • |
| TL431I/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 TL431C/AC TL431I/AI | 0 to +70 -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 |

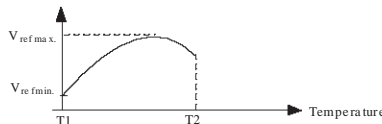
ELECTRICAL CHARACTERISTICS

T_{amb} = 25°C (unless otherwise specified)

| Symbol | Parameter | TL431C | | | TL431AC | | | Unit |
|--|---|---------------|------------|---------------|---------------|------------|---------------|------|
| | | Min. | Typ. | Max. | Min. | Typ. | Max. | |
| V _{ref} | Reference Input Voltage - (figure 1) V _{KA} = V _{ref} , I _K = 10mA T _{amb} = 25°C T _{min.} ≤ T _{amb} ≤ T _{max.} | 2.44 2.423 | 2.495 | 2.55 2.567 | 2.47 2.453 | 2.495 | 2.52 2.537 | V |
| ΔV _{ref} | Reference Input Voltage Deviation Over Temperature Range - (figure 1, note 1) V _{KA} = V _{ref} , I _K = 10mA, T _{min.} ≤ T _{amb} ≤ T _{max.} | | 3 | 17 | | 3 | 15 | mV |
| $\frac{\Delta V_{ref}}{\Delta V_{KA}}$ | Ratio of Change in Reference Input Voltage to Change in Cathode to Anode Voltage - (figure 2) I _K = 10mA ΔV _{KA} = 10V to V _{ref} ΔV _{KA} = 36V to 10V | | -1.4 -1 | -2.7 -2 | | -1.4 -1 | -2.7 -2 | mV/V |
| I _{ref} | Reference Input Current - (figure 2) I _K = 10mA, R ₁ = 10kΩ, R ₂ = ∞ T _{amb} = 25°C T _{min.} ≤ T _{amb} ≤ T _{max.} | | 1.8 | 4 5.2 | | 1.8 | 4 5.2 | μA |
| ΔI _{ref} | Reference Input Current Deviation Over Temperature Range - (figure 2) I _K = 10mA, R ₁ = 10kΩ, R ₂ = ∞ T _{min.} ≤ T _{amb} ≤ T _{max.} | | 0.4 | 1.2 | | 0.4 | 1.2 | μA |
| I _{min} | Minimum Cathode Current for Regulation - (figure 1) V _{KA} = V _{ref} | | 0.5 | 1 | | 0.5 | 0.6 | mA |
| I _{off} | Off-State Cathode Current - (figure 3) | | 2.6 | 1000 | | 2.6 | 1000 | nA |
| Z _{KA} | Dynamic Impedance - (figure 1, note 2) V _{KA} = V _{ref} , ΔI _K = 1 to 100mA, f ≤ 1kHz | | 0.22 | 0.5 | | 0.22 | 0.5 | Ω |

Notes : 1. ΔV_{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 dynamic Impedance is defined as $|Z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_K}$

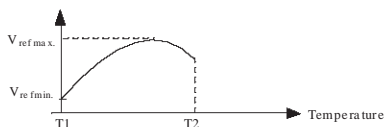
ELECTRICAL CHARACTERISTICS

T_{amb} = 25°C (unless otherwise specified)

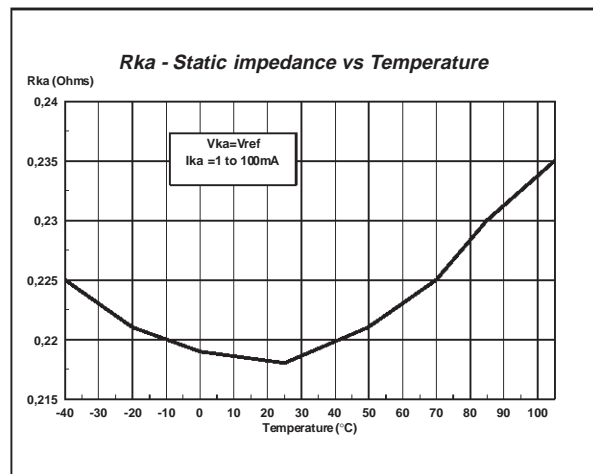
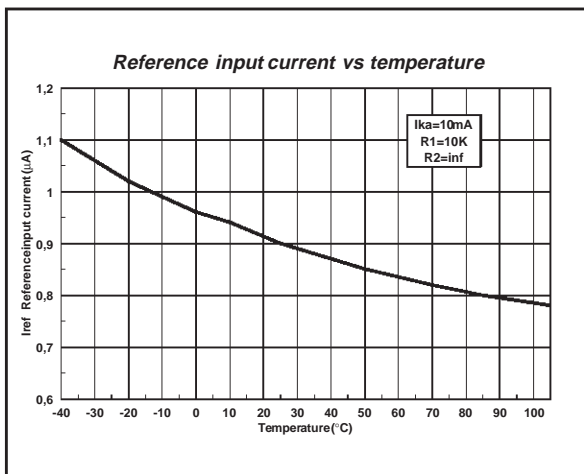
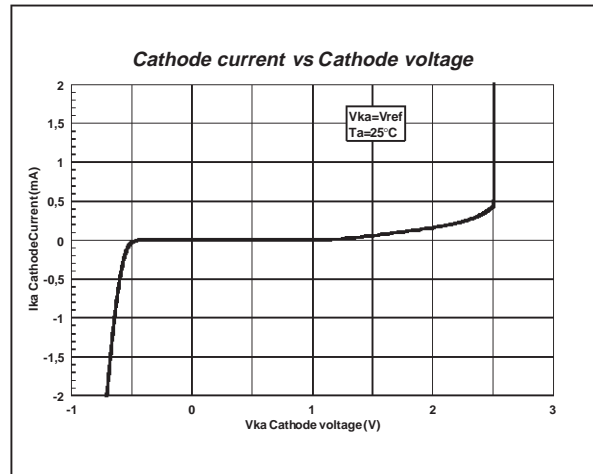
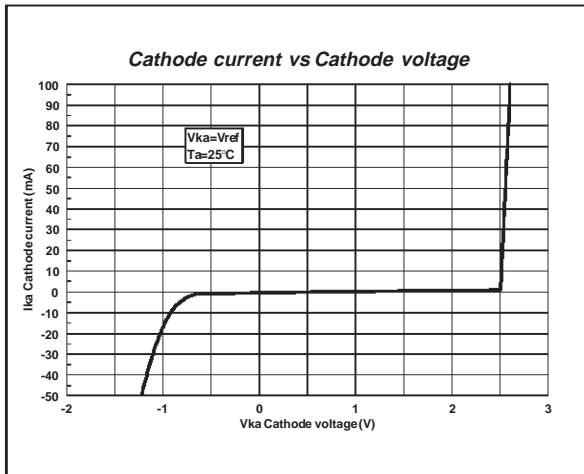
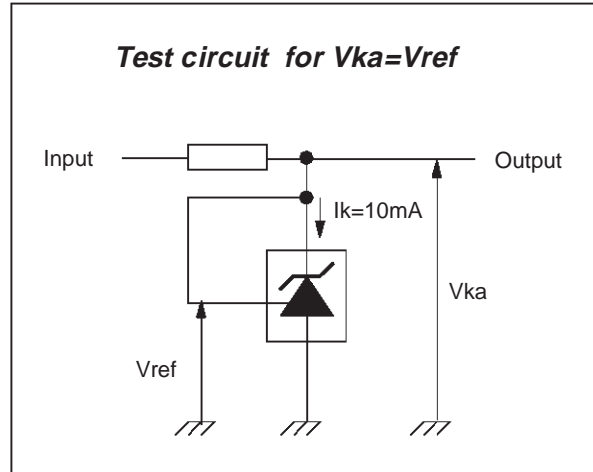
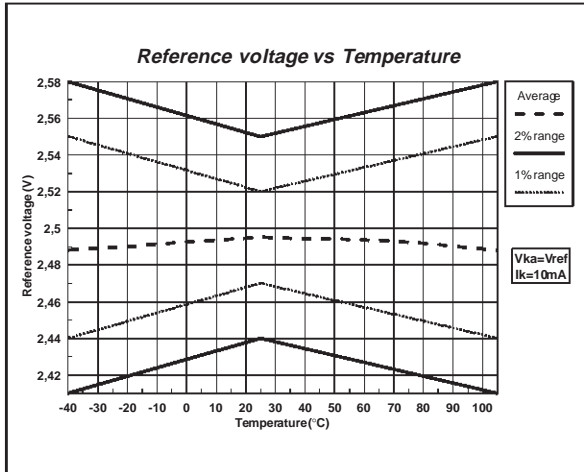
| Symbol | Parameter | TL431I | | | TL431AI | | | Unit |
|--|---|--------------|------------|--------------|--------------|------------|--------------|------|
| | | Min. | Typ. | Max. | Min. | Typ. | Max. | |
| V _{ref} | Reference Input Voltage - (figure 1) V _{KA} = V _{ref} , I _K = 10mA T _{amb} = 25°C T _{min.} ≤ T _{amb} ≤ T _{max.} | 2.44 2.41 | 2.495 | 2.55 2.58 | 2.47 2.44 | 2.495 | 2.52 2.55 | V |
| ΔV _{ref} | Reference Input Voltage Deviation Over Temperature Range - (figure 1, note1) V _{KA} = V _{ref} , I _K = 10mA, T _{min.} ≤ T _{amb} ≤ T _{max.} | | 7 | 30 | | 7 | 30 | mV |
| $\frac{\Delta V_{ref}}{\Delta V_{KA}}$ | Ratio of Change in Reference Input Voltage to Change in Cathode to Anode Voltage - (figure 2) I _K = 10mA ΔV _{KA} = 10V to V _{ref} ΔV _{KA} = 36V to 10V | | -1.4 -1 | -2.7 -2 | | -1.4 -1 | -2.7 -2 | mV/V |
| I _{ref} | Reference Input Current - (figure 2) I _K = 10mA, R ₁ = 10kΩ, R ₂ = ∞ T _{amb} = 25°C T _{min.} ≤ T _{amb} ≤ T _{max.} | | 1.8 | 4 6.5 | | 1.8 | 4 6.5 | μA |
| ΔI _{ref} | Reference Input Current Deviation Over Temperature Range - (figure 2) I _K = 10mA, R ₁ = 10kΩ, R ₂ = ∞ T _{min.} ≤ T _{amb} ≤ T _{max.} | | 0.8 | 2.5 | | 0.8 | 1.2 | μA |
| I _{min} | Minimum Cathode Current for Regulation - (figure 1) V _{KA} = V _{ref} | | 0.5 | 1 | | 0.5 | 0.7 | mA |
| I _{off} | Off-State Cathode Current - (figure 3) | | 2.6 | 1000 | | 2.6 | 1000 | nA |
| Z _{KA} | Dynamic Impedance - (figure 1, note 2) V _{KA} = V _{ref} , ΔI _K = 1 to 100mA, f ≤ 1kHz | | 0.22 | 0.5 | | 0.22 | 0.5 | Ω |

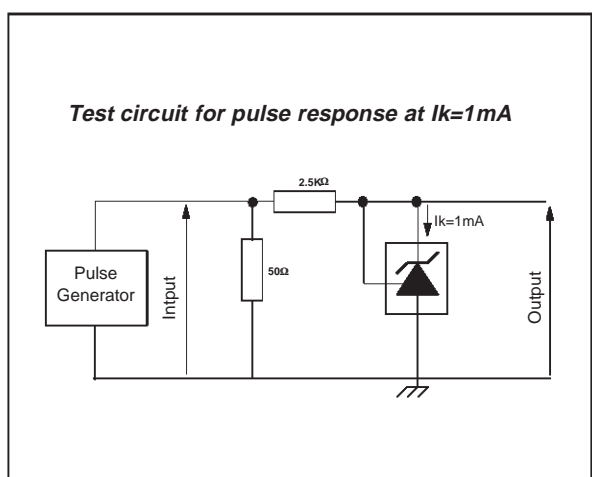
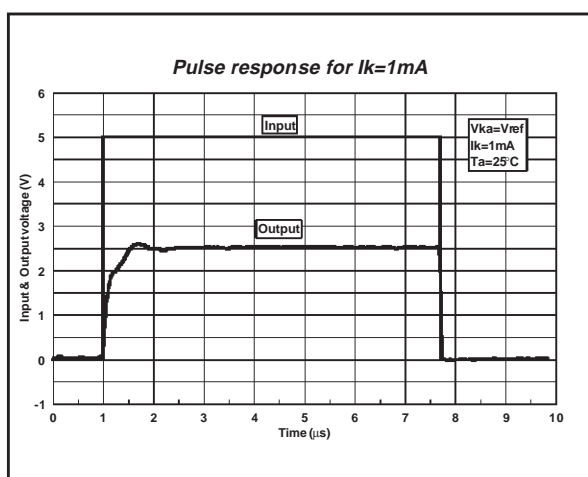
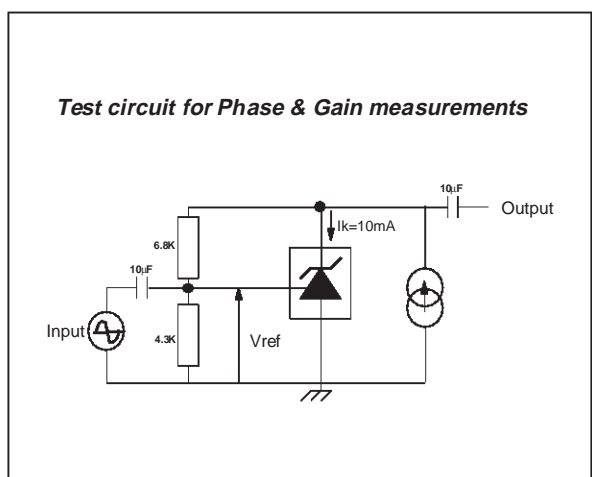
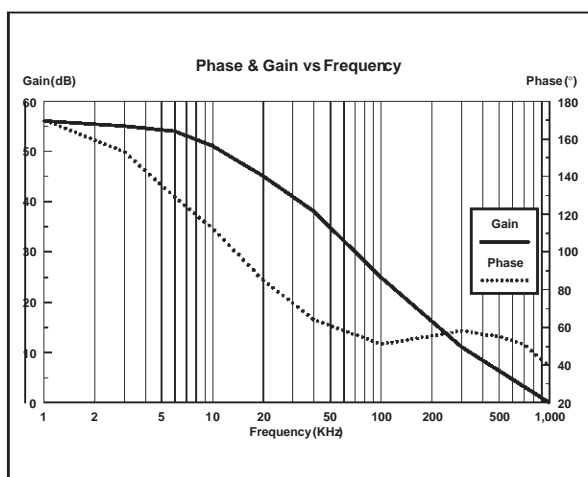
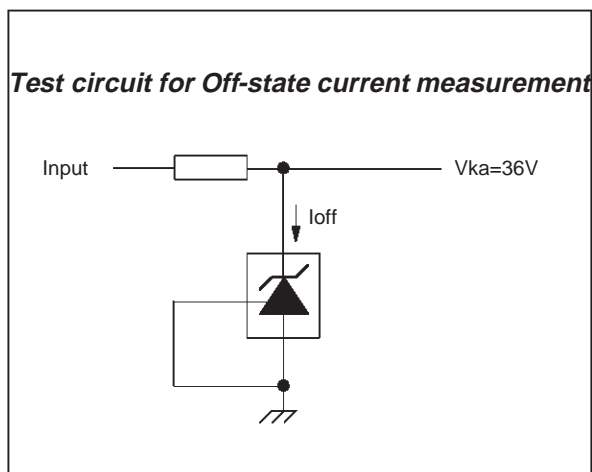
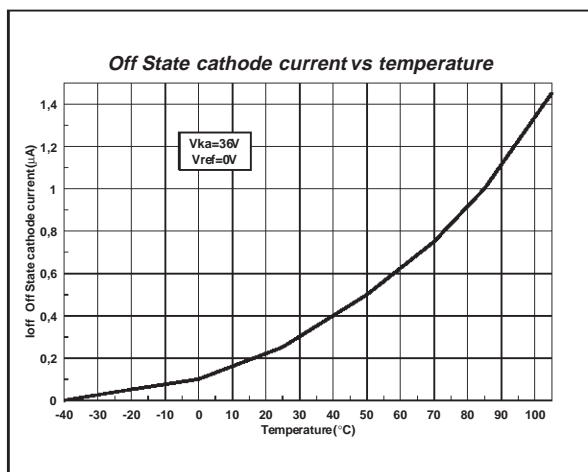
Notes : 1. ΔV_{ref} is defined as the difference between the maximum and minimum values obtained over the full temperature range.

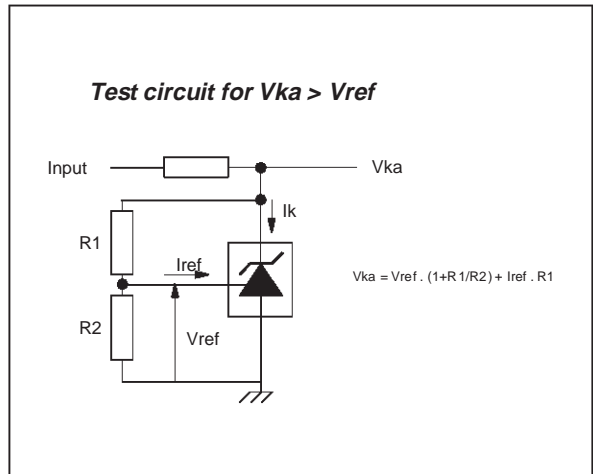
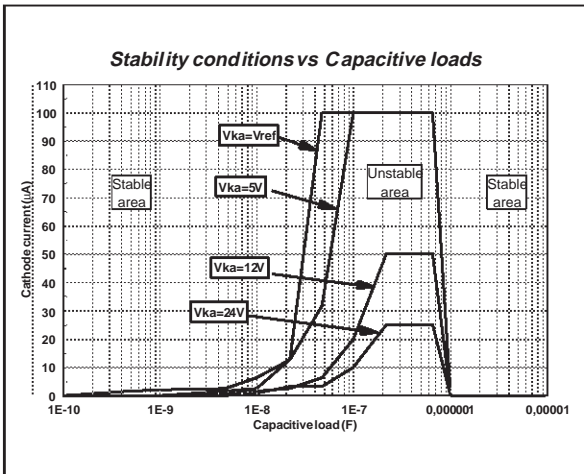
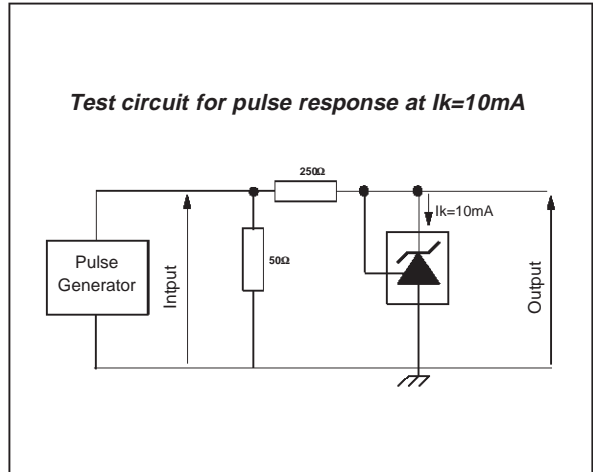
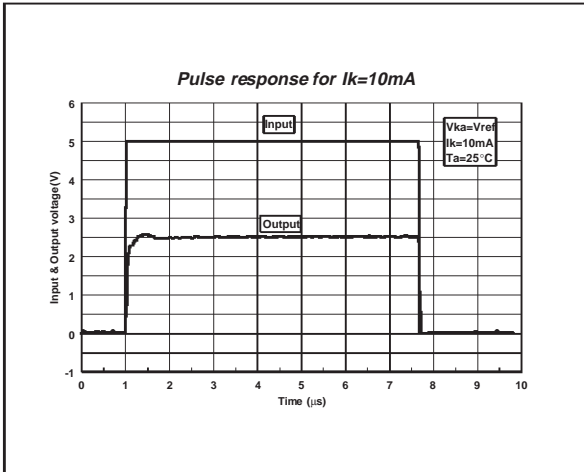
$$\Delta V_{ref} = V_{refmax.} - V_{refmin.}$$



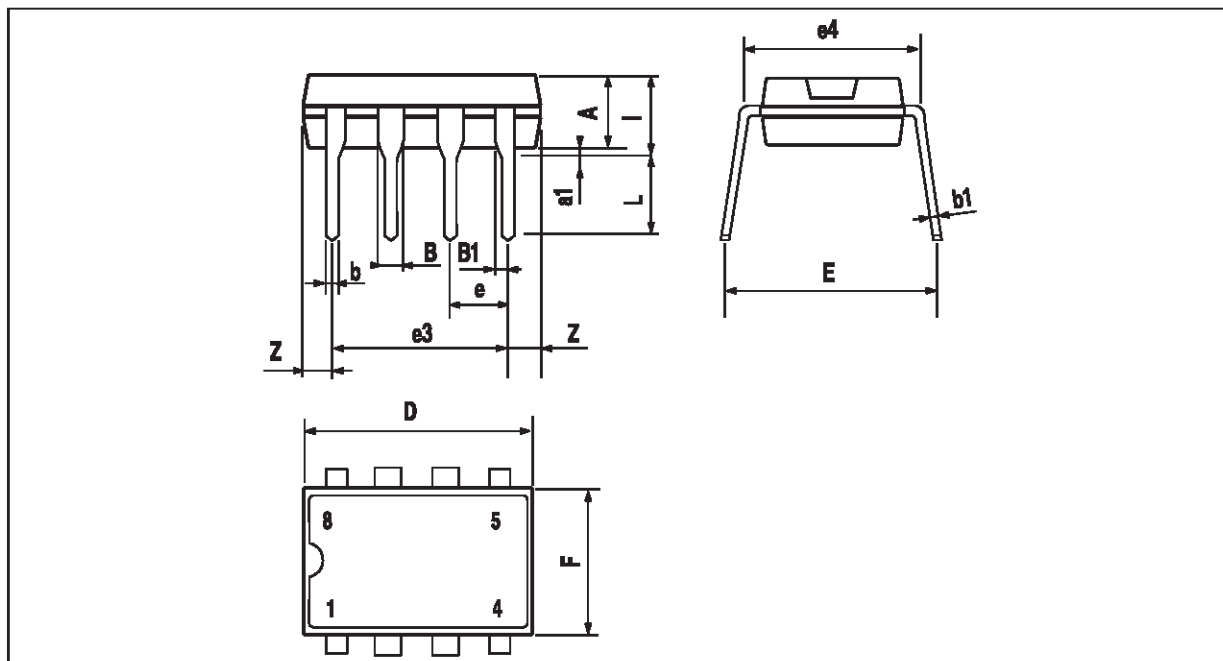
2. The dynamic Impedance is defined as $|Z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_K}$





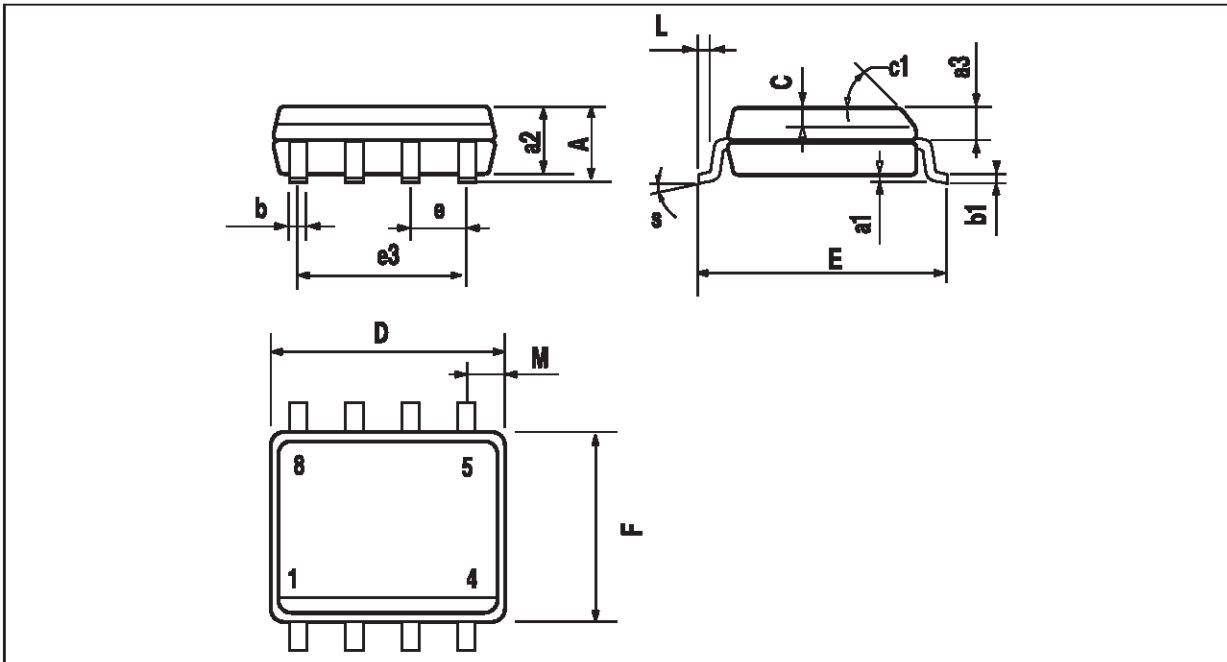


PACKAGE MECHANICAL DATA
8 PINS - PLASTIC DIP



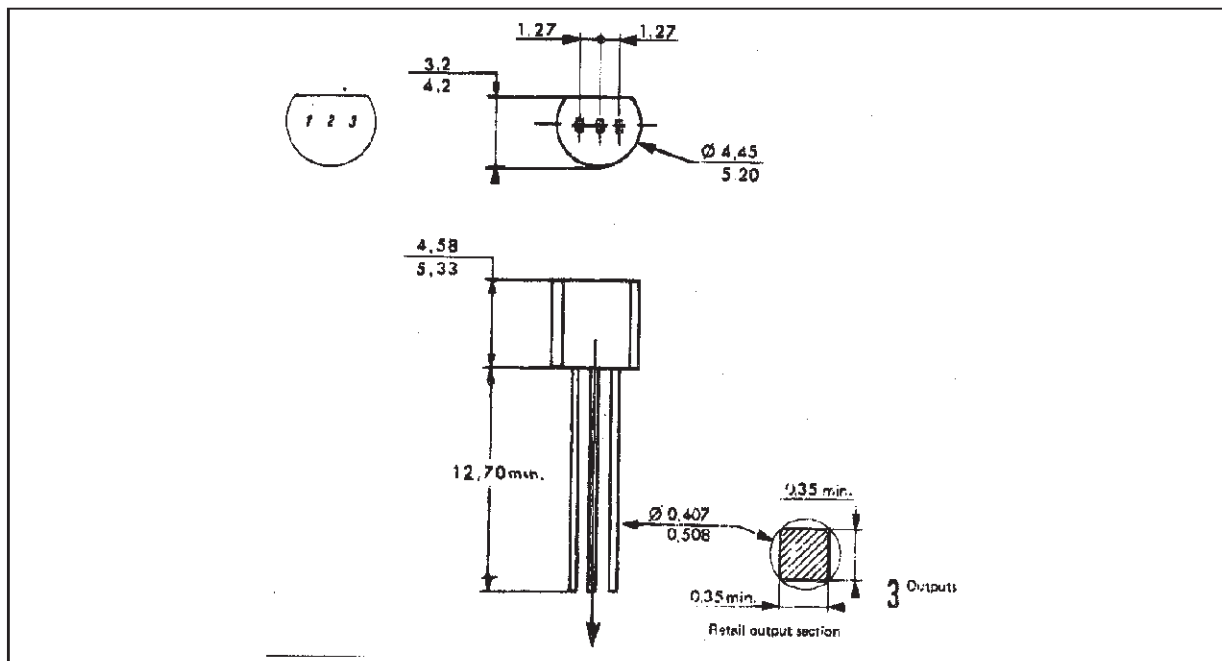
| Dim. | Millimeters | | | Inches | | |
|------|-------------|------|-------|--------|-------|-------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | 3.32 | | | 0.131 | |
| a1 | 0.51 | | | 0.020 | | |
| B | 1.15 | | 1.65 | 0.045 | | 0.065 |
| b | 0.356 | | 0.55 | 0.014 | | 0.022 |
| b1 | 0.204 | | 0.304 | 0.008 | | 0.012 |
| D | | | 10.92 | | | 0.430 |
| E | 7.95 | | 9.75 | 0.313 | | 0.384 |
| e | | 2.54 | | | 0.100 | |
| e3 | | 7.62 | | | 0.300 | |
| e4 | | 7.62 | | | 0.300 | |
| F | | | 6.6 | | | 0.260 |
| i | | | 5.08 | | | 0.200 |
| L | 3.18 | | 3.81 | 0.125 | | 0.150 |
| Z | | | 1.52 | | | 0.060 |

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 | | |

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