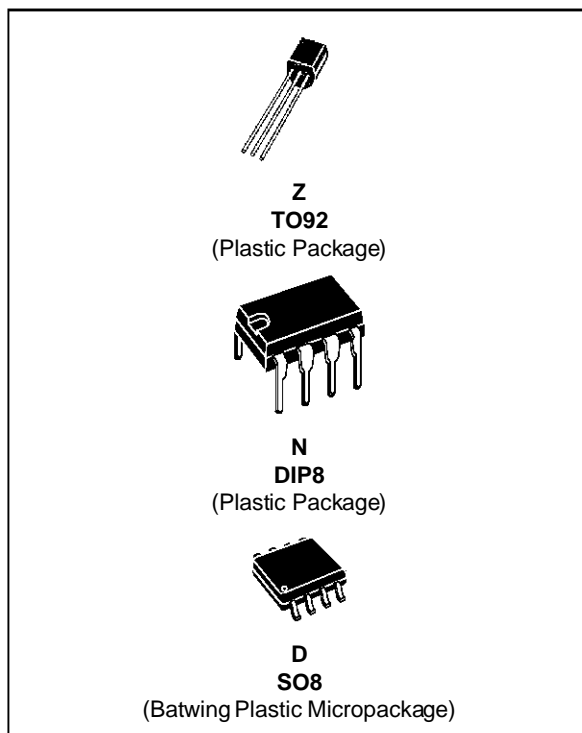


## PROGRAMMABLE VOLTAGE REFERENCE

- ADJUSTABLE OUTPUT VOLTAGE :  
V<sub>ref</sub> 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.

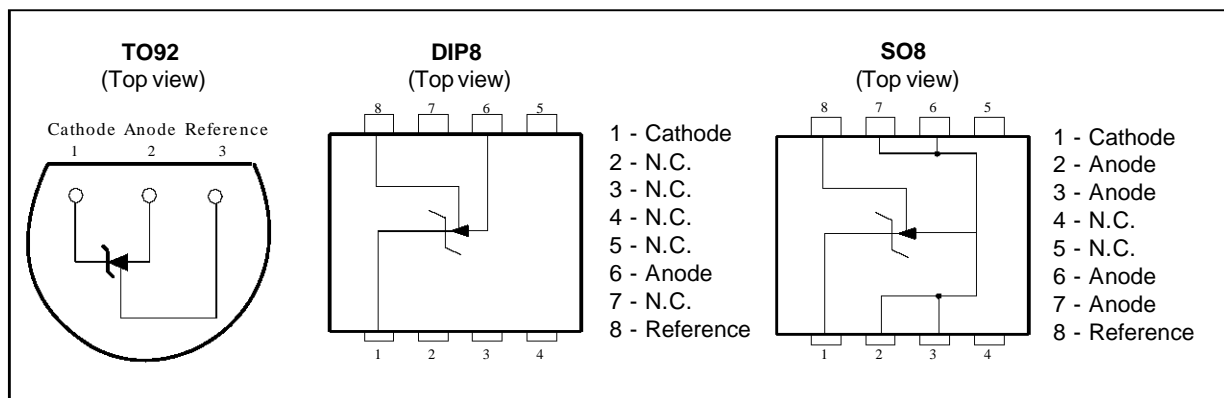
The output voltage may be set to any value between V<sub>ref</sub> (approximately 2.5V) and 36V with two external resistors.

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, +85°C	•	•	•

### PIN CONNECTIONS



**ABSOLUTE MAXIMUM RATINGS**

Symbol	Parameter	Value	Unit
V <sub>KA</sub>	Cathode to Anode Voltage	37	V
I <sub>K</sub>	Continuous Cathode Current Range	-100 to +150	mA
I <sub>ref</sub>	Reference Input Current Range	-0.05 to +10	mA
T <sub>oper</sub>	Operating Free-air Temperature Range	TL431C/AC TL431I/AI 0 to +70 -40 to +85	°C
T <sub>stg</sub>	Storage Temperature Range	-65 to +150	°C

**OPERATING CONDITIONS**

Symbol	Parameter	Value	Unit
V <sub>KA</sub>	Cathode to Anode Voltage	V <sub>ref</sub> to 36	V
I <sub>K</sub>	Cathode Current	1 to 100	mA

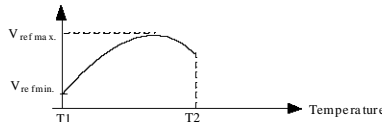
**ELECTRICAL CHARACTERISTICS**

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

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

**Notes :** 1. ΔV<sub>ref</sub> is defined as the difference between the maximum and minimum values obtained over the full temperature range.

ΔV<sub>ref</sub> = V<sub>ref max.</sub> - V<sub>ref min.</sub>



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

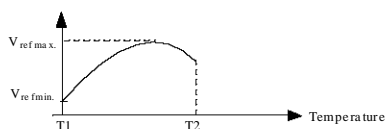
**ELECTRICAL CHARACTERISTICS**

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

Symbol	Parameter	TL431I			TL431AI			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
V <sub>ref</sub>	Reference Input Voltage - (figure 1) V <sub>KA</sub> = V <sub>ref</sub> , I <sub>K</sub> = 10mA T <sub>amb</sub> = 25°C T <sub>min.</sub> ≤ T <sub>amb</sub> ≤ T <sub>max.</sub>	2.44 2.41	2.495	2.55 2.58	2.47 2.44	2.495	2.52 2.55	V
ΔV <sub>ref</sub>	Reference Input Voltage Deviation Over Temperature Range - (figure 1, note1) V <sub>KA</sub> = V <sub>ref</sub> , I <sub>K</sub> = 10mA, T <sub>min.</sub> ≤ T <sub>amb</sub> ≤ T <sub>max.</sub>		7	30		7	17	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 <sub>K</sub> = 10mA ΔV <sub>KA</sub> = 10V to V <sub>ref</sub> ΔV <sub>KA</sub> = 36V to 10V		-1.4 -1	-2.7 -2		-1.4 -1	-2.7 -2	mV/V
I <sub>ref</sub>	Reference Input Current - (figure 2) I <sub>K</sub> = 10mA, R <sub>1</sub> = 10kΩ, R <sub>2</sub> = ∞ T <sub>amb</sub> = 25°C T <sub>min.</sub> ≤ T <sub>amb</sub> ≤ T <sub>max.</sub>		1.8	4 6.5		1.8	4 6.5	μA
ΔI <sub>ref</sub>	Reference Input Current Deviation Over Temperature Range - (figure 2) I <sub>K</sub> = 10mA, R <sub>1</sub> = 10kΩ, R <sub>2</sub> = ∞ T <sub>min.</sub> ≤ T <sub>amb</sub> ≤ T <sub>max.</sub>		0.8	2.5		0.8	1.2	μA
I <sub>min</sub>	Minimum Cathode Current for Regulation - (figure 1) V <sub>KA</sub> = V <sub>ref</sub>		0.5	1		0.5	0.7	mA
I <sub>off</sub>	Off-State Cathode Current - (figure 3)		2.6	1000		2.6	1000	nA
Z <sub>KA</sub>	Dynamic Impedance - (figure 1, note 2) V <sub>KA</sub> = V <sub>ref</sub> , ΔI <sub>K</sub> = 1 to 100mA, f ≤ 1kHz		0.22	0.5		0.22	0.5	Ω

Notes : 1. ΔV<sub>ref</sub> 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  $|Z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_K}$

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

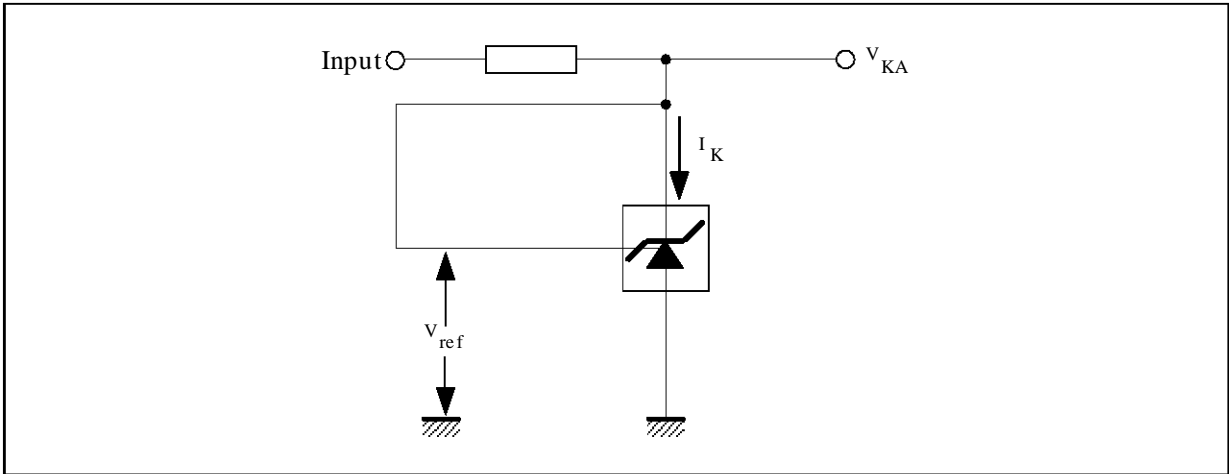


Figure 2 : Test Circuit for  $V_{KA} > V_{ref}$

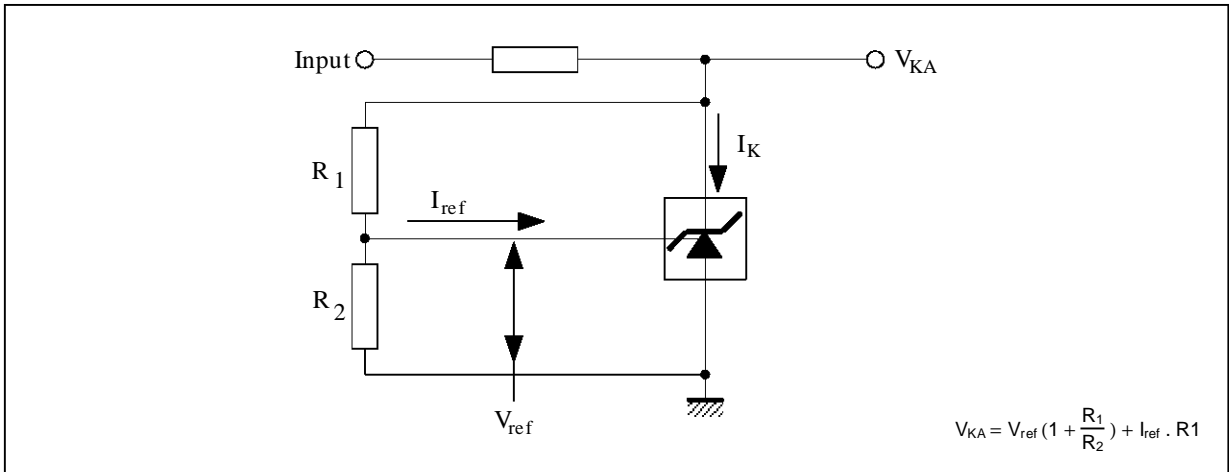
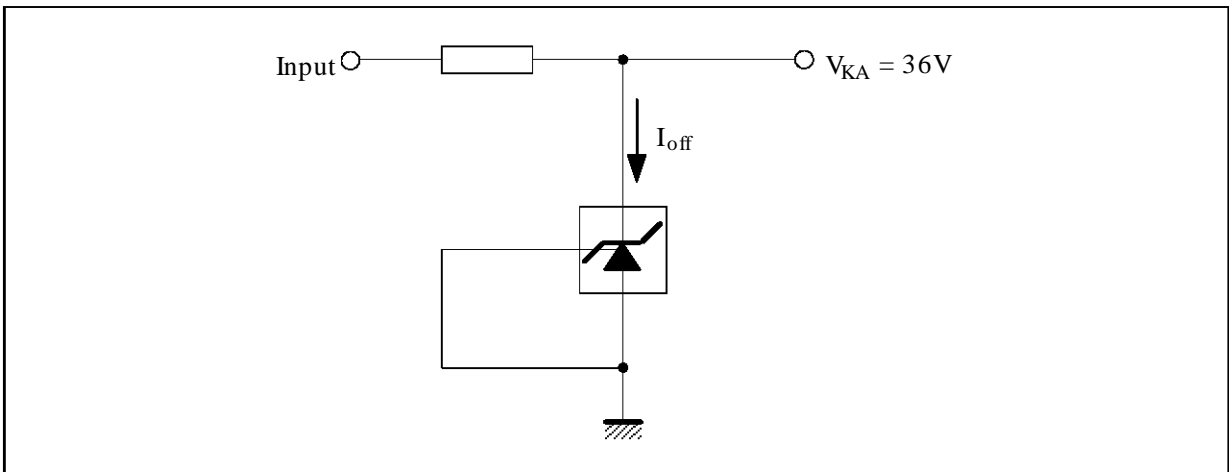
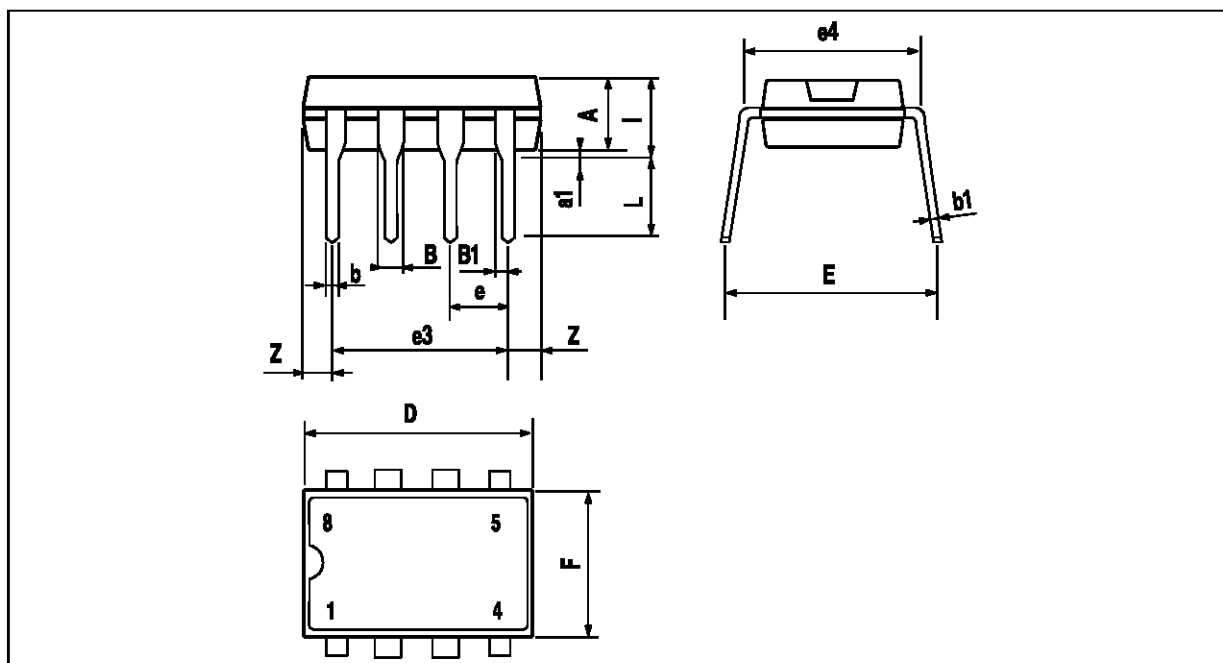


Figure 3 : Test Circuit for  $I_{off}$

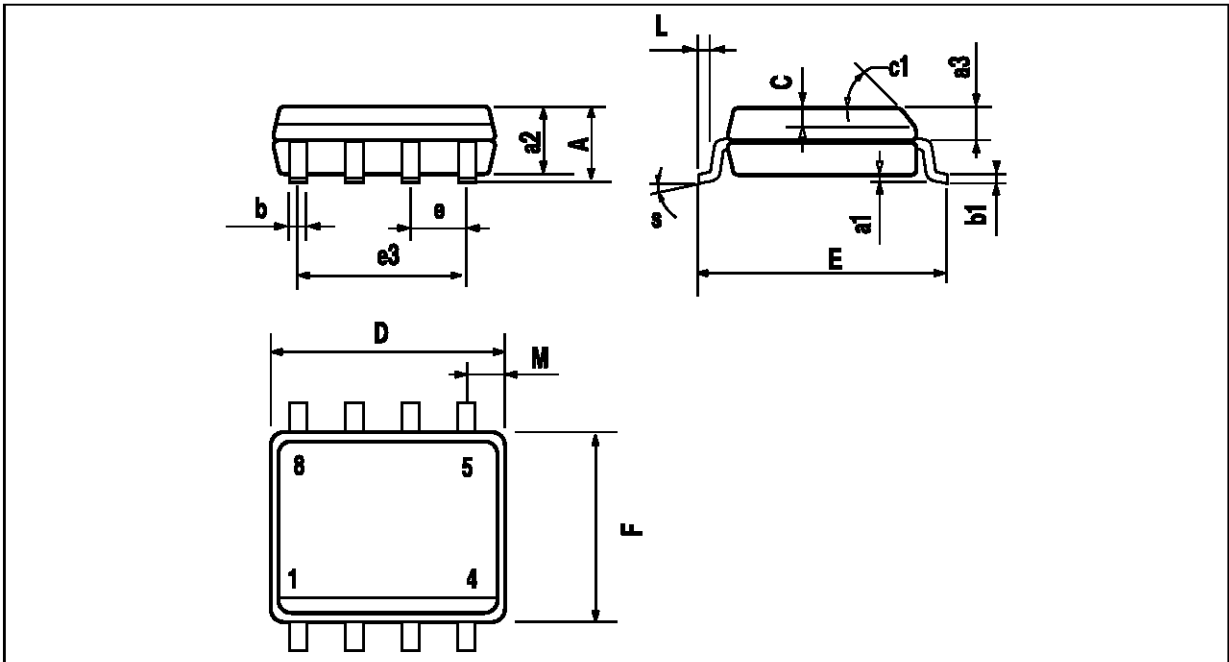


**PACKAGE MECHANICAL DATA**  
8 PINS - PLASTIC DIP



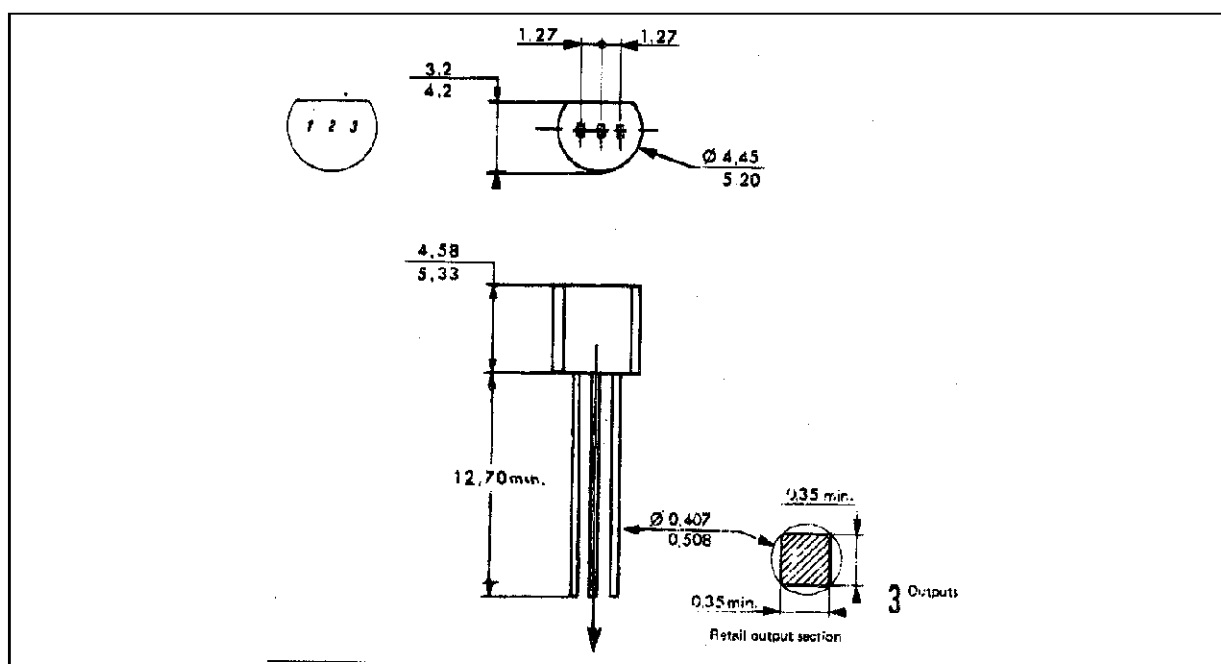
Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A		3.32			0.131	
a1	0.51			0.020		
B	1.15		1.65	0.045		0.065
b	0.356		0.55	0.014		0.022
b1	0.204		0.304	0.008		0.012
D			10.92			0.430
E	7.95		9.75	0.313		0.384
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			6.6			0.260
i			5.08			0.200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

**PACKAGE MECHANICAL DATA**  
**8 PINS - BATWING PLASTIC MICROPACKAGE (SO8)**



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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