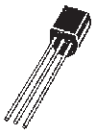
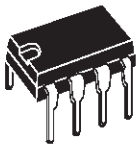
TL431

PROGRAMMABLE VOLTAGE REFERENCE

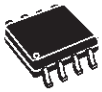
- ADJUSTABLE OUTPUT VOLTAGE : 2.5 to 36V
- SINK CURRENT CAPABILITY : 1 to 100mA
- TYPICAL OUTPUT IMPEDANCE : 0.22Ω
- 1% AND 2% VOLTAGE PRECISION



Z
TO92
(Plastic Package)



N
DIP8
(Plastic Package)



D
SO8
(Batwing Plastic Micropackage)

DESCRIPTION

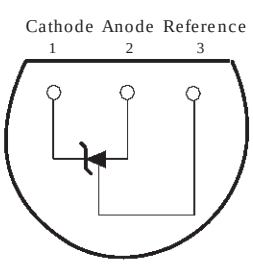
The TL431 is a programmable shunt voltage reference with guaranteed temperature stability over the entire temperature range of operation.
The output voltage may be set to any value between V_{ref} (approximately 2.5V) and 36V with two external resistors.
The TL431 operates with a wide current range from 1 to 100mA with a typical dynamic impedance of 0.22Ω.

ORDER CODES

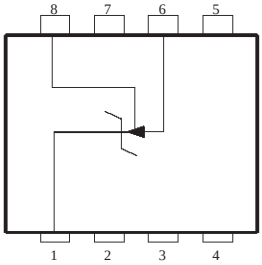
Part number	Temperature Range	Package		
		Z	N	D
TL431C/AC	0°C, +70°C	•	•	•
TL431I/AI	-40°C, +105°C	•	•	•

PIN CONNECTIONS

TO92
(Top view)

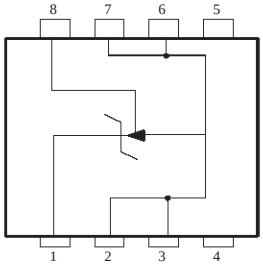


DIP8
(Top view)



1 - Cathode
2 - N.C.
3 - N.C.
4 - N.C.
5 - N.C.
6 - Anode
7 - N.C.
8 - Reference

SO8
(Top view)



1 - Cathode
2 - Anode
3 - Anode
4 - N.C.
5 - N.C.
6 - Anode
7 - Anode
8 - Reference

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

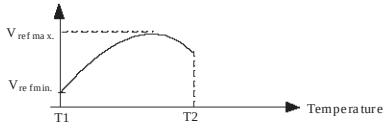
ELECTRICAL CHARACTERISTICS

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 $T_{min.} \le T_{amb} \le T_{max.}$	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, note1) $V_{KA} = V_{ref}$, I_K = 10mA, $T_{min.} \le T_{amb} \le T_{max.}$		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
Iref	Reference Input Current - (figure 2) I_K = 10mA, R_1 = 10kΩ, R_2 = ∞ T_{amb} = 25°C $T_{min.} \le T_{amb} \le T_{max.}$		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 = ∞ $T_{min.} \le T_{amb} \le T_{max.}$		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 $|Z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_K}$

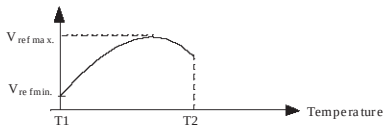
ELECTRICAL CHARACTERISTICS

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

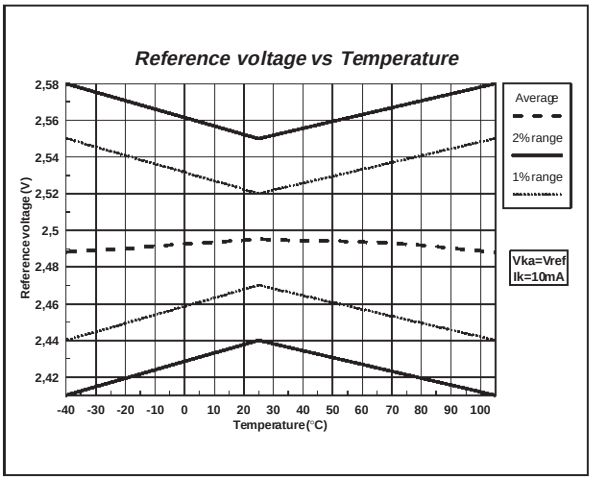
Symbol	Parameter	TL431I			TL431AI			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
V_{ref}	Reference Input Voltage - (figure 1) $V_{KA} = V_{ref}$, I_K = 10mA T_{amb} = 25°C $T_{min.} \le T_{amb} \le T_{max.}$	2.44 2.41	2.495	2.55 2.58	2.47 2.44	2.495	2.52 2.55	V
ΔV_{ref}	Reference Input Voltage Deviation Over Temperature Range - (figure 1, note1) $V_{KA} = V_{ref}$, I_K = 10mA, $T_{min.} \le T_{amb} \le T_{max.}$		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
Iref	Reference Input Current - (figure 2) I_K = 10mA, R_1 = 10kΩ, R_2 = ∞ T_{amb} = 25°C $T_{min.} \le T_{amb} \le T_{max.}$		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 = ∞ $T_{min.} \le T_{amb} \le T_{max.}$		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

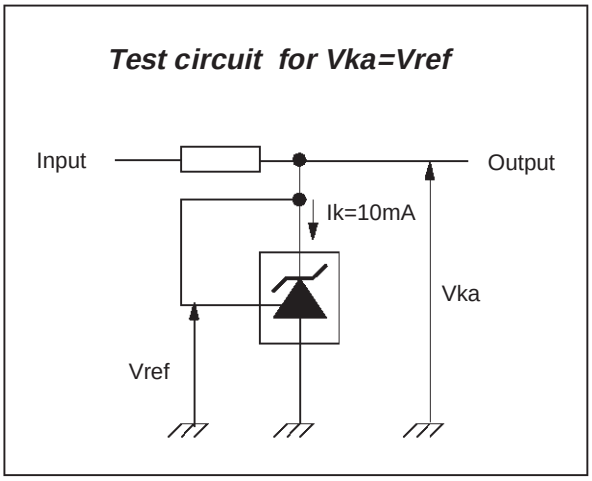
Notes : 1. ΔV_{ref} is defined as the difference between the maximum and minimum values obtained over the full temperature range.

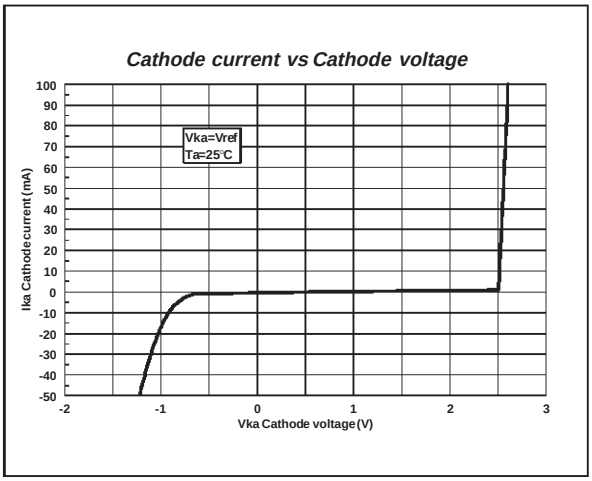
$\Delta V_{ref} = V_{ref\,max.} - V_{ref\,min}$

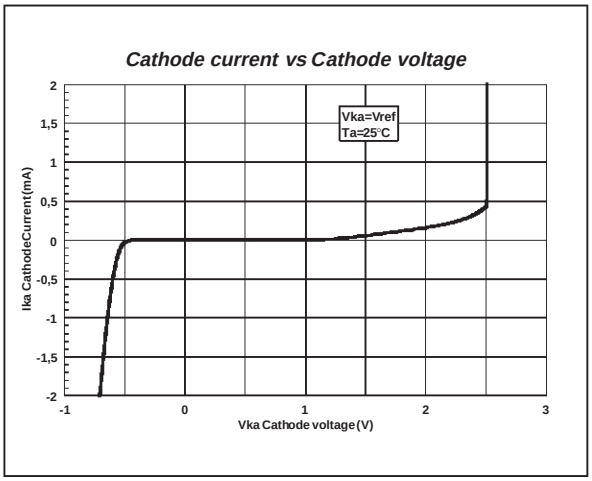


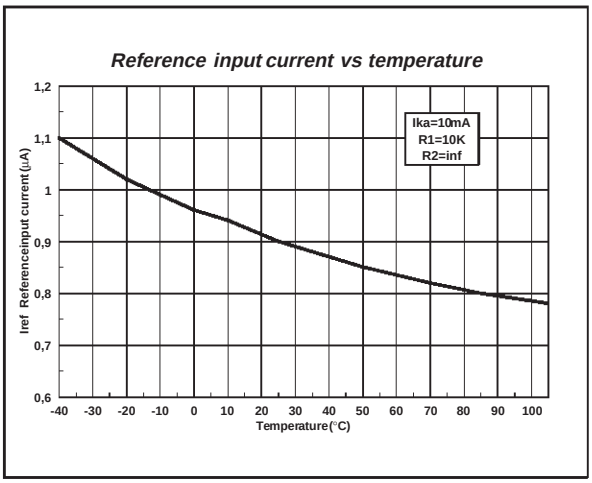
2. The dynamic Impedance is defined as $|Z_{KA}| = \frac{\Delta V_{KA}}{\Delta I_K}$

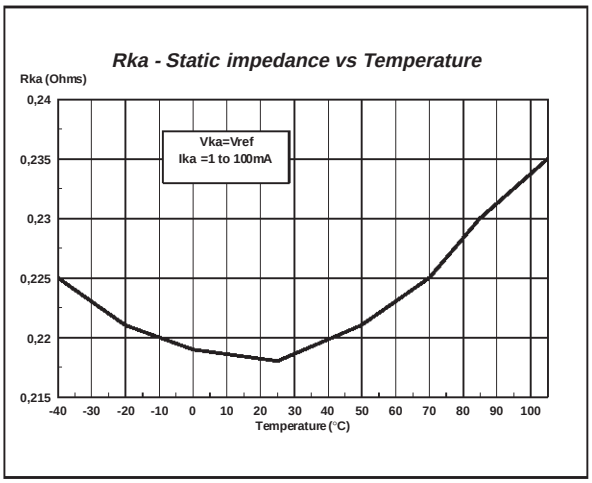

Reference voltage vs Temperature
Reference voltage (V)
Temperature (°C)
Average
2% range
1% range
Vka=Vref
Ik=10mA


Test circuit for Vka=Vref
Input
Output
Ik=10mA
Vka
Vref

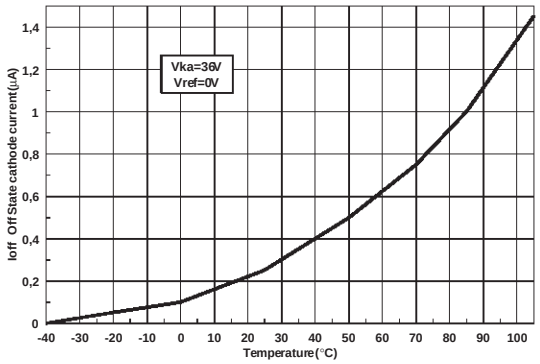

Cathode current vs Cathode voltage
Ika Cathode current (mA)
Vka Cathode voltage (V)
Vka=Vref
Ta=25°C


Cathode current vs Cathode voltage
Ika CathodeCurrent (mA)
Vka Cathode voltage (V)
Vka=Vref
Ta=25°C

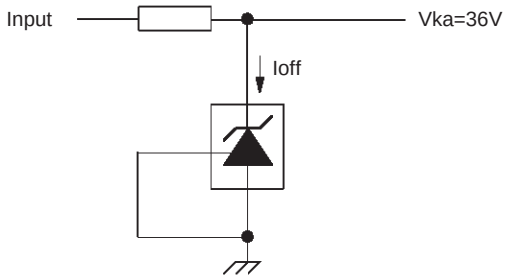

Reference input current vs temperature
Iref Referenceinput current (µA)
Temperature (°C)
Ika=10mA
R1=10K
R2=inf


Rka - Static impedance vs Temperature
Rka (Ohms)
Temperature (°C)
Vka=Vref
Ika =1 to 100mA

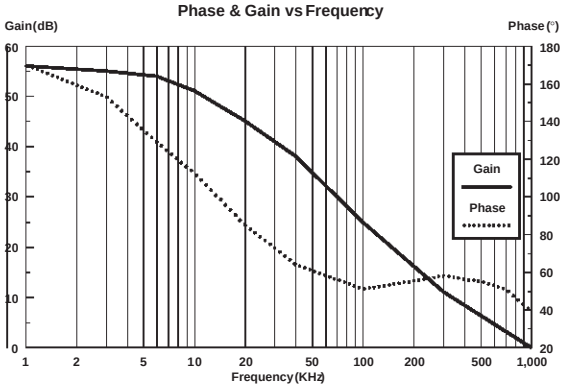
Off State cathode current vs temperature



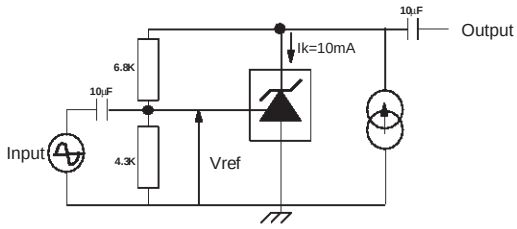
Test circuit for Off-state current measurement



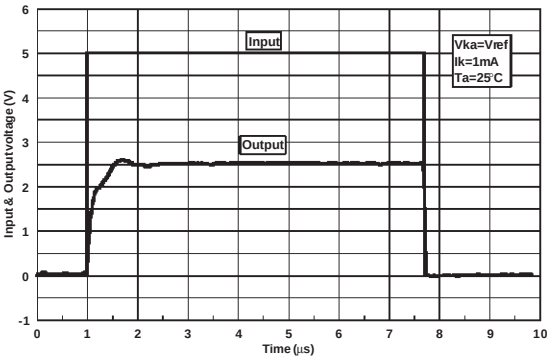
Phase & Gain vs Frequency



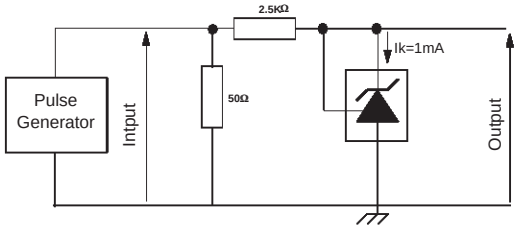
Test circuit for Phase & Gain measurements



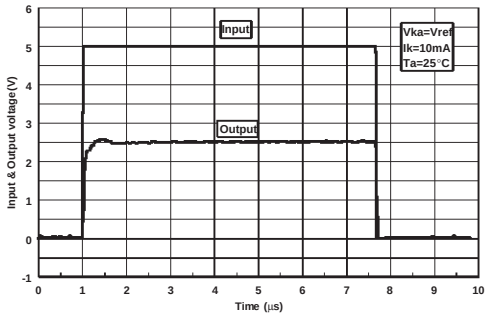
Pulse response for Ik=1mA



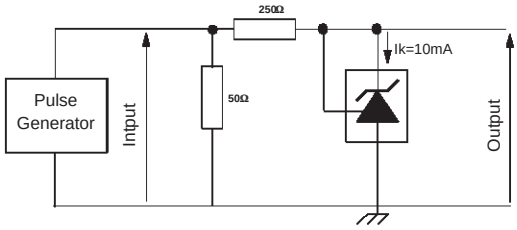
Test circuit for pulse response at Ik=1mA



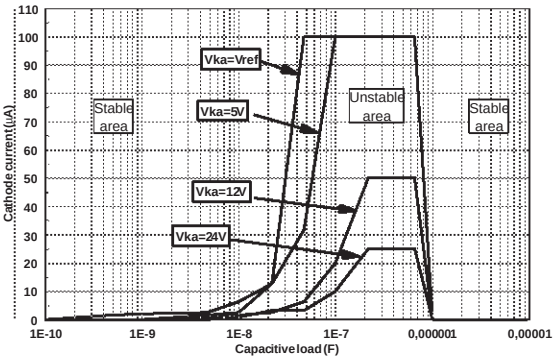
Pulse response for Ik=10mA



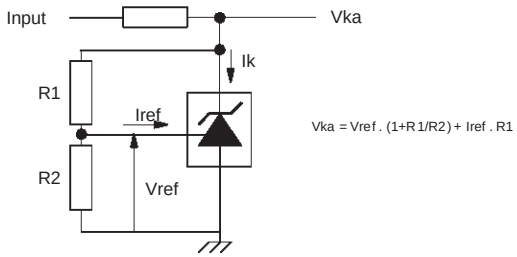
Test circuit for pulse response at Ik=10mA



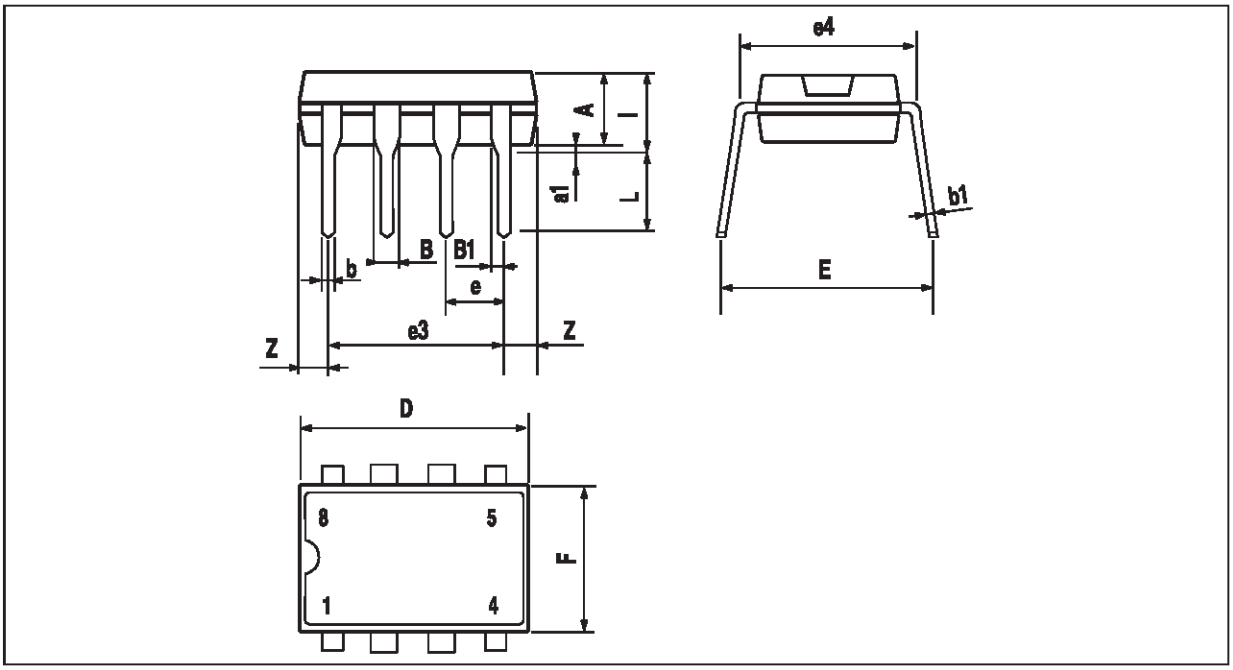
Stability conditions vs Capacitive loads



Test circuit for Vka > Vref



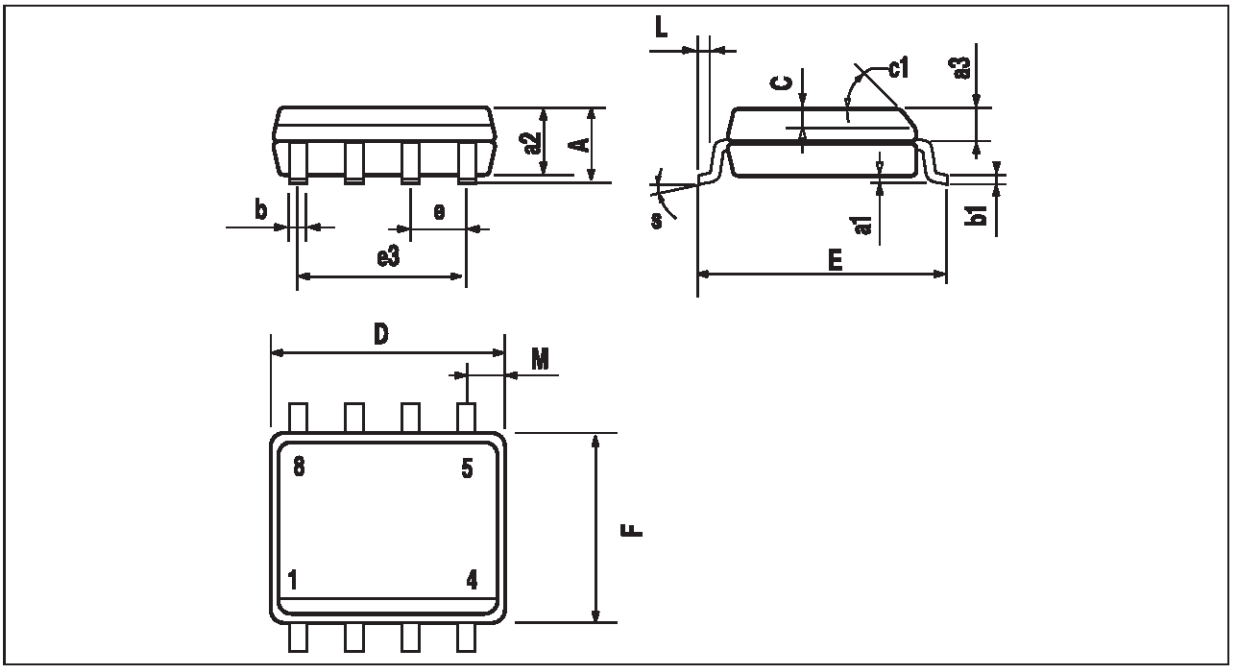
PACKAGE MECHANICAL DATA
8 PINS - PLASTIC DIP



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			0260
i			5.08			0.200
L	3.18		3.81	0.125		0.150
Z			1.52			0.060

PACKAGE MECHANICAL DATA

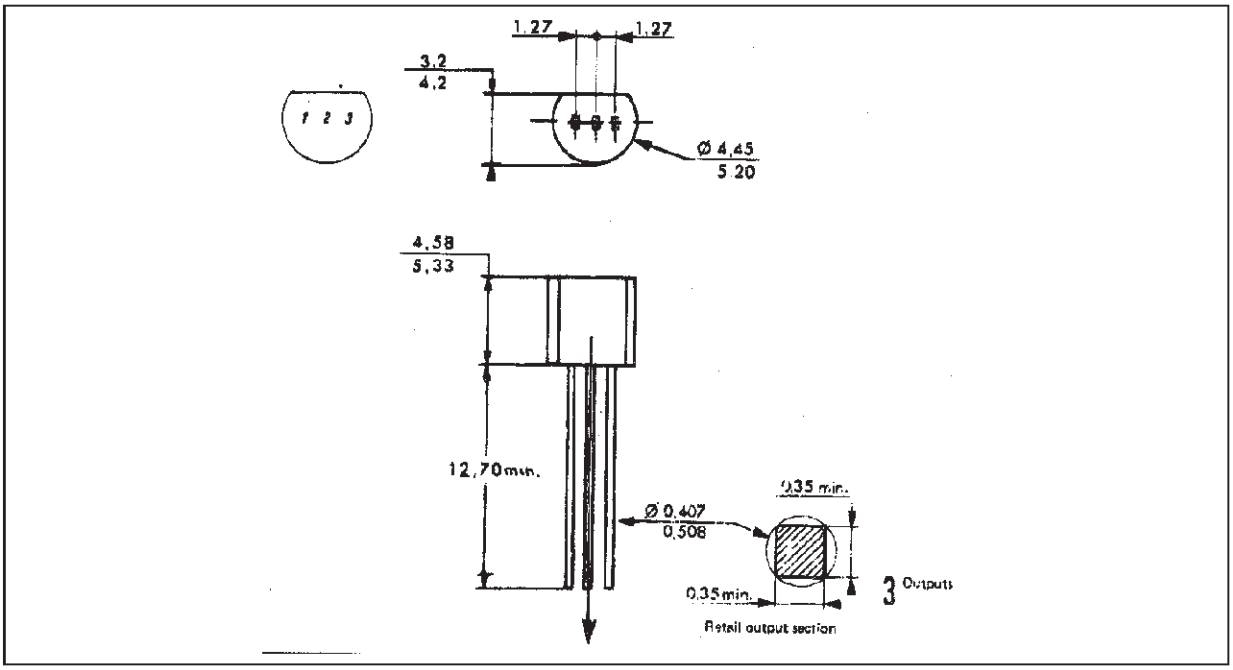
8 PINS - BATWING PLASTIC MICROPACKAGE (SO)



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		