



# TS821

## 1.225V MICROPOWER VOLTAGE REFERENCE

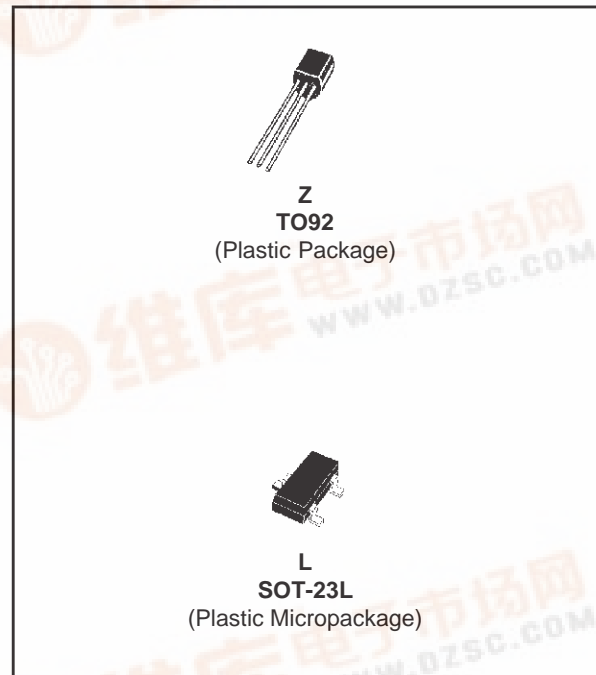
- 1.225V TYP OUTPUT VOLTAGE
- ULTRA LOW OPERATING CURRENT : 40µA typ.
- HIGH PRECISION @ 25°C
  - +/-2% (Standard version)
  - +/-1% (A grade)
  - +/-0.5% (B grade)
- HIGH STABILITY WHEN USED WITH CAPACITIVE LOADS
- WIDE TEMPERATURE RANGE : -40 to +85°C
- T092 & SOT23-3 PACKAGES

### DESCRIPTION

The TS821 is a micropower integrated circuit which is a high stability, two terminals, band gap reference providing a stable output voltage over the industrial temperature range (-40 to +85°C). The minimum operating current is guaranteed at 50µA over the full operating temperature range.

### APPLICATIONS

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

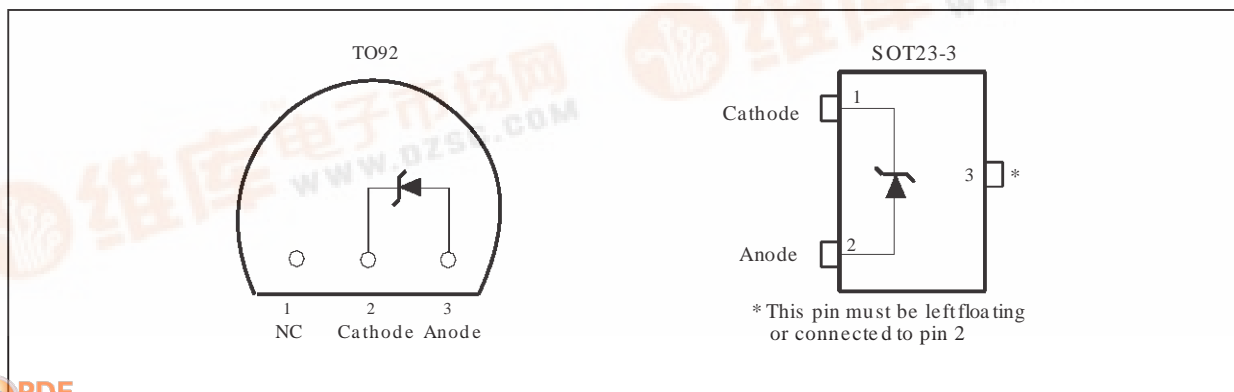


### ORDER CODES

Precision	TO92	SOT23-3	SOT23 Marking
2%	TS821IZ	TS821ILT	L213
1%	TS821AIZ	TS821AILT	L212
0.5%	TS821BIZ	TS821BILT	L211

Single temperature range : -40 to +85°C

### PIN CONNECTIONS (top view)



## TS821

### ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
$I_k$	Reverse Breakdown Current	20	mA
$I_f$	Forward Current	10	mA
$P_d$	Power Dissipation	SOT23-3 TO92 360 625	mW
$T_{oper}$	Operating Free Air Temperature Range	-40 to +85	°C
$T_{stg}$	Storage Temperature	-65 to +150	°C

Note :  $P_d$  has been calculated with  $T_{amb} = 25^\circ\text{C}$  and  $T_j = 125^\circ\text{C}$  and  
 $R_{thja} = 200^\circ\text{C/W}$  for TO92 package  
 $R_{thja} = 340^\circ\text{C/W}$  for SOT23 package

### OPERATING CONDITIONS

Symbol	Parameter	Value	Unit
$I_{min}$	Minimum Operating Current	45	$\mu\text{A}$
$I_{max}$	Maximum Operating Current	12	mA

### ELECTRICAL CHARACTERISTICS

#### TS821 (2% Precision)

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

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
$V_k$	Reverse Breakdown Voltage	$I_k = 100\mu\text{A} @ T_{amb} = 25^\circ\text{C}$	1.200	1.225	1.250	V
	Reverse Breakdown Voltage Tolerance	$I_k = 100\mu\text{A} @ T_{amb} = 25^\circ\text{C}$ $-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$	-25 -36		+25 +36	mV
$I_{kmin}$	Minimum Operating Current	$T_{amb} = 25^\circ\text{C}$		40	45	$\mu\text{A}$
		$-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$			50	$\mu\text{A}$
$\Delta V_{ref}/\Delta T$	Average Temperature Coefficient	$I_k = 100\mu\text{A}$			150	ppm/°C
$\Delta V_k/\Delta I_k$	Reverse Breakdown Voltage Change with Operating Current Change	$I_{kmin} < I_k < 1\text{mA} @ T_{amb} = 25^\circ\text{C}$ $-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$		0.3	0.7 1	mV
		$1\text{mA} < I_k < 12\text{mA} @ T_{amb} = 25^\circ\text{C}$ $-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$		2.5	5 7	mV
$R_{ka}$	Static Impedance	$\Delta I_k = 45\mu\text{A}$ to 1mA		0.25	0.5	$\Omega$
$K_{vh}$	Long Term Stability	$I_k = 100\mu\text{A}$ , $t = 1000\text{hrs}$ $T_{amb} = 25^\circ\text{C}$		120		ppm
en	Wideband Noise	$I_k = 100\mu\text{A}$ $10\text{Hz} < f < 10\text{kHz}$		200		$\text{nV}\sqrt{\text{Hz}}$

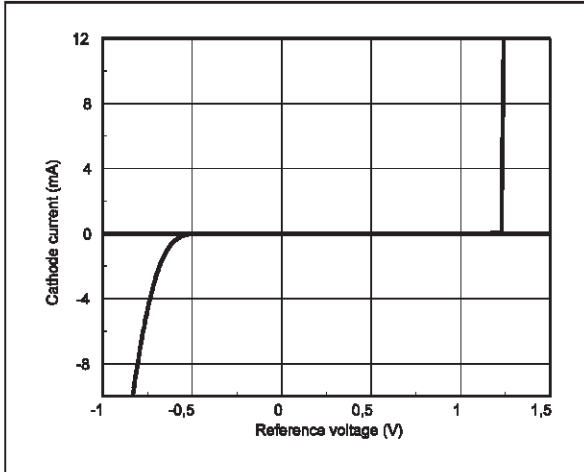
**ELECTRICAL CHARACTERISTICS****TS821A (1% Precision)**T<sub>amb</sub> = 25°C (unless otherwise specified)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V <sub>k</sub>	Reverse Breakdown Voltage	I <sub>k</sub> = 100μA @ T <sub>amb</sub> = 25°C	1.213	1.225	1.237	V
	Reverse Breakdown Voltage Tolerance	I <sub>k</sub> = 100μA @ T <sub>amb</sub> = 25°C -40°C < T <sub>amb</sub> < +85°C	-12 -24		+12 +24	mV
I <sub>kmin</sub>	Minimum Operating Current	T <sub>amb</sub> = 25°C		40	45	μA
		-40°C < T <sub>amb</sub> < +85°C			50	μA
ΔV <sub>ref</sub> /ΔT	Average Temperature Coefficient	I <sub>k</sub> = 100μA			150	ppm/°C
ΔV <sub>k</sub> /ΔI <sub>k</sub>	Reverse Breakdown Voltage Change with Operating Current Change	I <sub>kmin</sub> < I <sub>k</sub> < 1mA @ T <sub>amb</sub> = 25°C -40°C < T <sub>amb</sub> < +85°C		0.3	0.7 1	mV
		1mA < I <sub>k</sub> < 12mA @ T <sub>amb</sub> = 25°C -40°C < T <sub>amb</sub> < +85°C		2.5	5 7	mV
R <sub>ka</sub>	Static Impedance	ΔI <sub>k</sub> = 45μA to 1mA		0.25	0.5	Ω
K <sub>vh</sub>	Long Term Stability	I <sub>k</sub> = 100μA, t = 1000hrs T <sub>amb</sub> = 25°C		120		ppm/kHr
en	Wideband Noise	I <sub>k</sub> = 100μA 10Hz < f < 10kHz		200		nV/√Hz

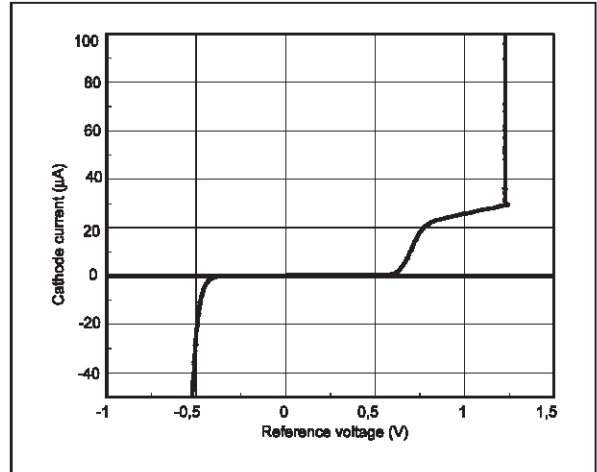
**ELECTRICAL CHARACTERISTICS****TS821B (0.5% Precision)**T<sub>amb</sub> = 25°C (unless otherwise specified)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V <sub>k</sub>	Reverse Breakdown Voltage	I <sub>k</sub> = 100μA @ T <sub>amb</sub> = 25°C	1.219	1.225	1.231	V
	Reverse Breakdown Voltage Tolerance	I <sub>k</sub> = 100μA @ T <sub>amb</sub> = 25°C -40°C < T <sub>amb</sub> < +85°C	-6 -14		+6 +14	mV
I <sub>kmin</sub>	Minimum Operating Current	T <sub>amb</sub> = 25°C		40	45	μA
		-40°C < T <sub>amb</sub> < +85°C			50	μA
ΔV <sub>ref</sub> /ΔT	Average Temperature Coefficient	I <sub>k</sub> = 100μA			120	ppm/°C
ΔV <sub>k</sub> /ΔI <sub>k</sub>	Reverse Breakdown Voltage Change with Operating Current Change	I <sub>kmin</sub> < I <sub>k</sub> < 1mA @ T <sub>amb</sub> = 25°C -40°C < T <sub>amb</sub> < +85°C		0.3	0.7 1	mV
		1mA < I <sub>k</sub> < 12mA @ T <sub>amb</sub> = 25°C -40°C < T <sub>amb</sub> < +85°C		2.5	5 7	mV
R <sub>ka</sub>	Static Impedance	ΔI <sub>k</sub> = 45μA to 1mA		0.25	0.5	Ω
K <sub>vh</sub>	Long Term Stability	I <sub>k</sub> = 100μA, t = 1000hrs T <sub>amb</sub> = 25°C		120		ppm
en	Wideband Noise	I <sub>k</sub> = 100μA 10Hz < f < 10kHz		200		nV/√Hz

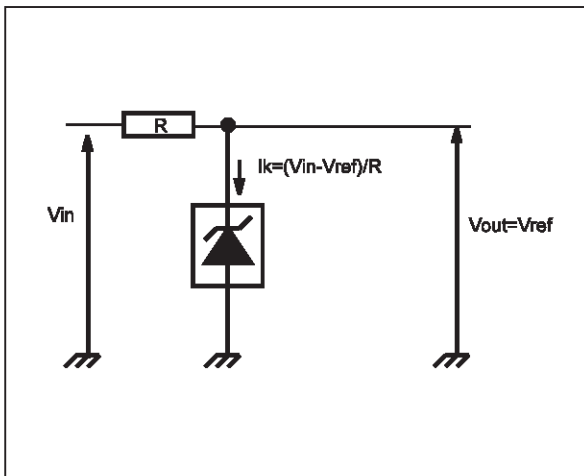
Reference Voltage versus Cathode Current



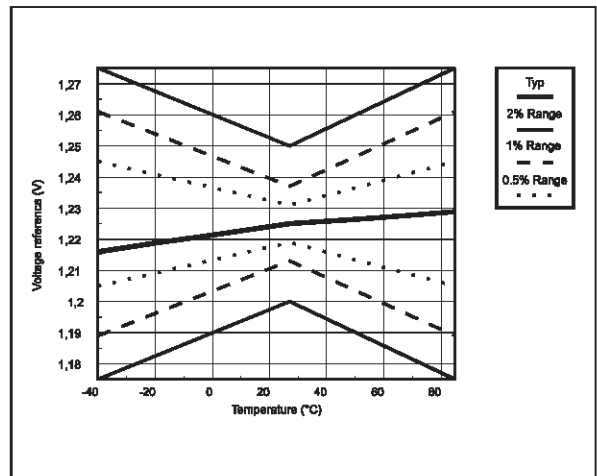
Reference Voltage versus Cathode Current



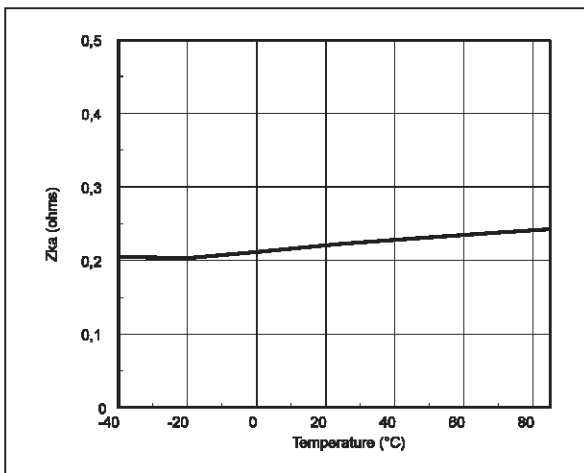
Test Circuit



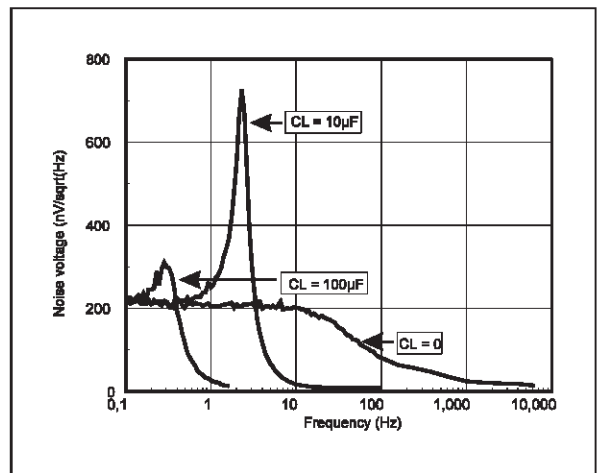
Reference Voltage versus Temperature



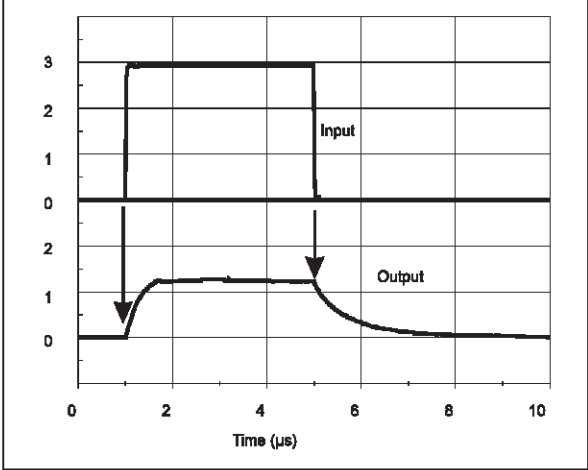
Dynamic Impedance versus Temperature



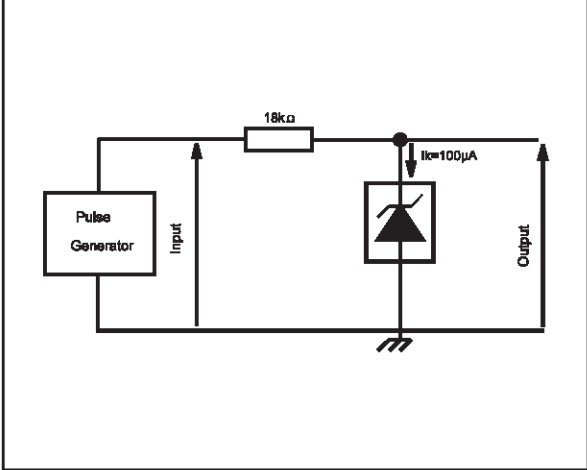
Noise Voltage versus Frequency



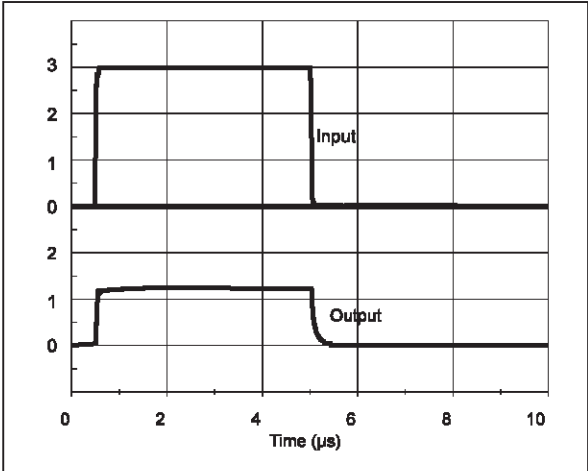
Pulse Response for  $I_k = 100\mu\text{A}$



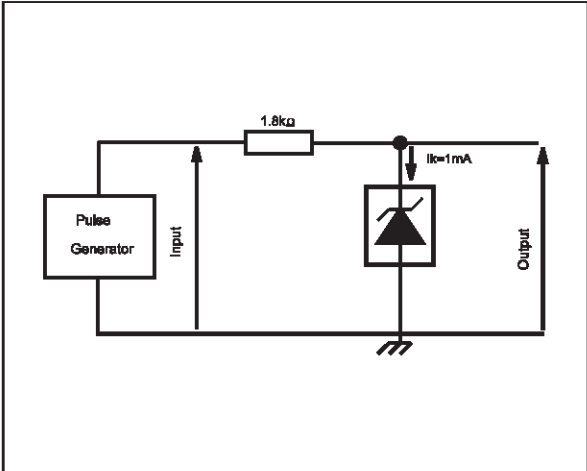
Test Circuit for Pulse Response at  $I_k = 100\mu\text{A}$



Pulse Response for  $I_k = 1\text{mA}$

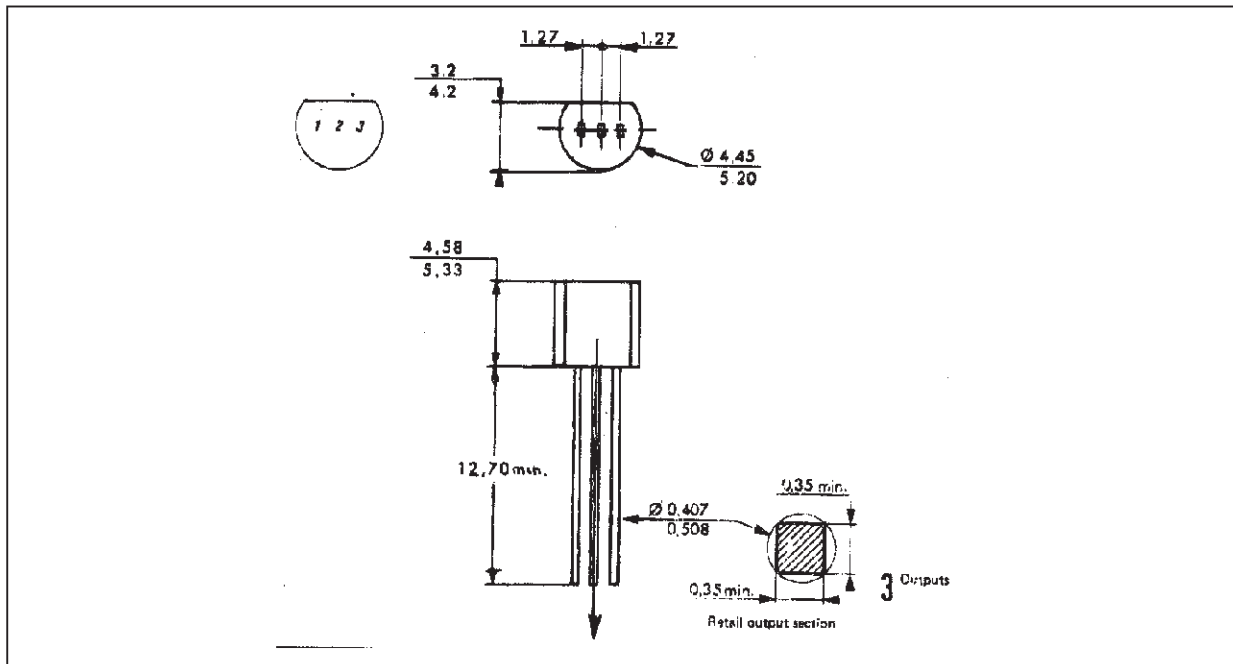


Test Circuit for Pulse Response at  $I_k = 1\text{mA}$



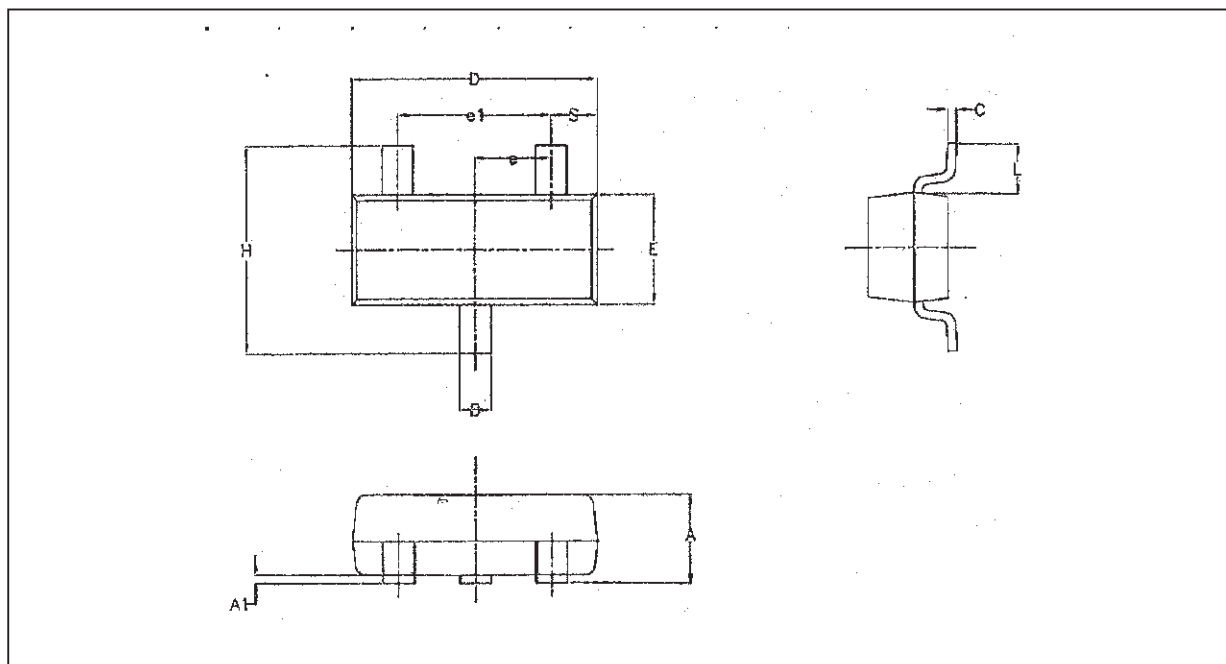
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## PACKAGE MECHANICAL DATA 3 PINS - PLASTIC PACKAGE TO92



Dim.	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		

**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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