

## 1.225V MICROPOWER SHUNT VOLTAGE REFERENCE

- 1.225V TYP OUTPUT VOLTAGE
- ULTRA LOW OPERATING CURRENT : 45µA maximum at 25°C
- HIGH PRECISION @ 25°C
  - +/- 2% (Standard version)
  - +/- 1% (A grade)
  - +/- 0.5% (B grade)
- HIGH STABILITY WHEN USED WITH CAPACITIVE LOADS
- INDUSTRIAL TEMPERATURE RANGE: -40 to +85°C
- 120ppm/°C MAXIMUM TEMPERATURE COEFFICIENT

### DESCRIPTION

The TS821 is a low power shunt voltage reference providing a stable 1.225V output voltage over the industrial temperature range (-40 to +85°C). Available in SOT23-3 surface mount package, it can be designed in applications where space saving is a critical issue.

The low operating current is a key advantage for power restricted designs. In addition, the TS821 is very stable and can be used in a broad range of application conditions.

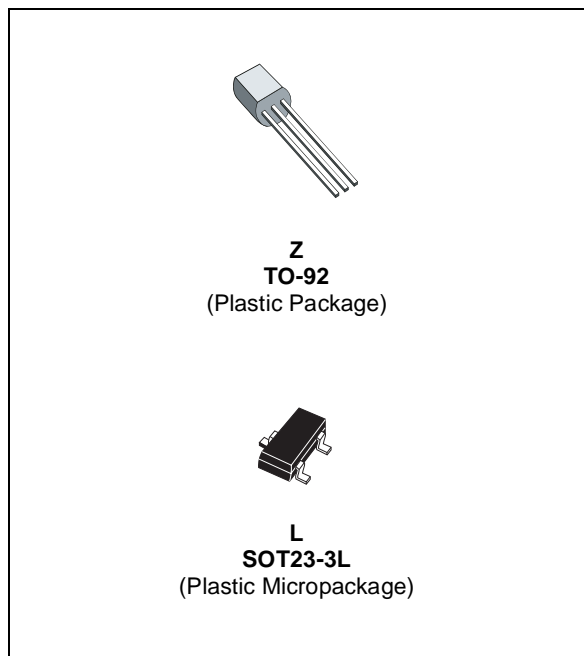
### APPLICATION

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

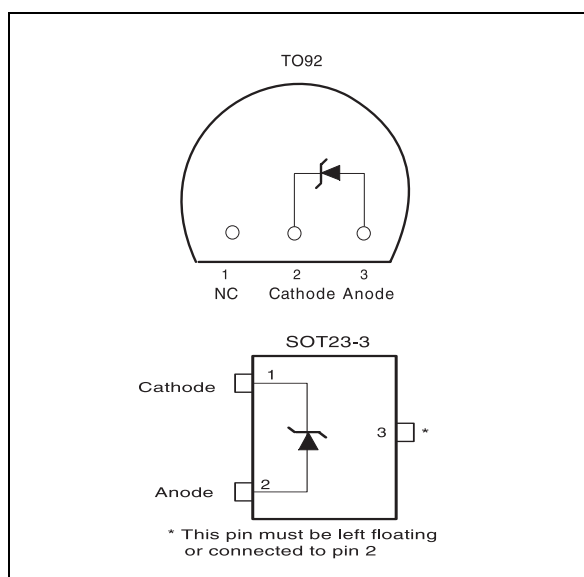
### ORDER CODE

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			

Z = TO92 Plastic package - also available in Bulk (Z), Tape & Reel (ZT) and Ammo Pack (AP)  
 LT = Tiny Package (SOT23-3) - only available in Tape & Reel (LT)



### PIN CONNECTIONS (top view)



**ABSOLUTE MAXIMUM RATINGS**

Symbol	Parameter	Value	Unit
$I_k$	Reverse Breakdown Current	20	mA
$I_f$	Forward Current	10	mA
$P_d$	Power Dissipation <sup>1)</sup> SOT23-3 TO92	360 625	mW
$T_{std}$	Storage Temperature	-65 to +150	°C
ESD	Human Body Model (HBM)	2	kV
	Machine Model (MM)	200	V
$T_{lead}$	Lead Temperature (soldering, 10 seconds)	260	°C

1.  $P_d$  has been calculated with  $T_{amb} = 25^\circ\text{C}$  and  $T_j = 150^\circ\text{C}$  and  
 $R_{thja} = 200^\circ\text{C/W}$  for the TO92 package  
 $R_{thja} = 340^\circ\text{C/W}$  for the SOT23-3L package

**OPERATING CONDITIONS**

Symbol	Parameter	Value	Unit
$I_{min}$	Minimum Operating Current	45	$\mu\text{A}$
$I_{max}$	Maximum Operating Current	12	mA
$T_{oper}$	Operating Free Air Temperature Range	-40 to +85	°C

**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	$I_k = 100\mu\text{A}$	1.200	1.225	1.250	V
	Reverse Breakdown Voltage Tolerance	$I_k = 100\mu\text{A}$ $-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$	-25 +34		+25 +34	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	
$\Delta V_{ref}/\Delta T$	Average Temperature Coefficient	$I_k = 100\mu\text{A}$			120	ppm/°C
$\Delta V_k/\Delta I_k$	Reverse Breakdown Voltage Change with Operating Current Range	$I_{kmin} < I_k < 1\text{mA}$ $-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$		0.3	0.7 1	mV
		$1\text{mA} < I_k < 12\text{mA}$ $-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$		2.5	8 10	
$R_{ka}$	Static Impedance	$\Delta I_k = 45\mu\text{A}$ to 1mA		0.25	0.5	$\Omega$
$K_{vh}$	Long Term Stability	$I_k = 100\mu\text{A}$ , $t = 1000\text{hrs}$		120		ppm
$E_n$	Wide Band Noise	$I_k = 100\mu\text{A}$ 10Hz < f < 10kHz		200		nV/√Hz

**Note :** Limits are 100% production tested at 25°C. Limits over temperature are guaranteed through correlation and by design.

**ELECTRICAL CHARACTERISTICS****TS821A (1% Precision)**  $T_{amb} = 25^{\circ}\text{C}$  (unless otherwise specified)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V <sub>k</sub>	Reverse Breakdown Voltage	$I_k = 100\mu\text{A}$	1.213	1.225	1.237	V
	Reverse Breakdown Voltage Tolerance	$I_k = 100\mu\text{A}$ $-40^{\circ}\text{C} < T_{amb} < +85^{\circ}\text{C}$	-12 -22		+12 +22	mV
I <sub>kmin</sub>	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	
$\Delta V_{ref}/\Delta T$	Average Temperature Coefficient	$I_k = 100\mu\text{A}$			120	ppm/ $^{\circ}\text{C}$
$\Delta V_k/\Delta I_k$	Reverse Breakdown Voltage Change with Operating Current Range	$I_{kmin} < I_k < 1\text{mA}$ $-40^{\circ}\text{C} < T_{amb} < +85^{\circ}\text{C}$		0.3	0.7 1	mV
		$1\text{mA} < I_k < 12\text{mA}$ $-40^{\circ}\text{C} < T_{amb} < +85^{\circ}\text{C}$		2.5	5 7	
R <sub>ka</sub>	Static Impedance	$\Delta I_k = 45\mu\text{A}$ to 1mA		0.25	0.5	$\Omega$
K <sub>vh</sub>	Long Term Stability	$I_k = 100\mu\text{A}$ , t = 1000hrs		120		ppm
En	Wide Band Noise	$I_k = 100\mu\text{A}$ 10Hz < f < 10kHz		200		nV/ $\sqrt{\text{Hz}}$

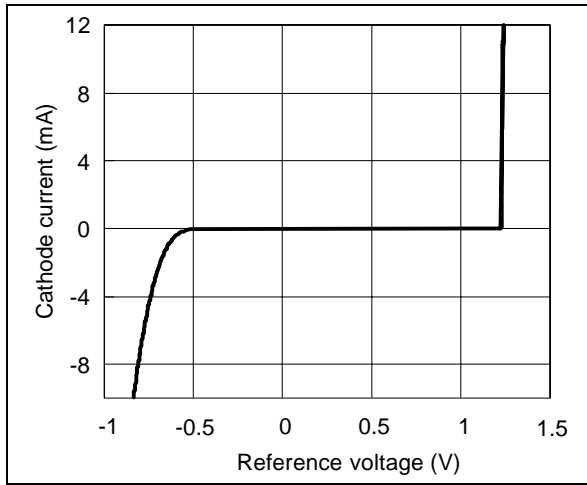
**Note** : Limits are 100% production tested at 25°C. Limits over temperature are guaranteed through correlation and by design.

**ELECTRICAL CHARACTERISTICS****TS821B (0.5% Precision)**  $T_{amb} = 25^{\circ}\text{C}$  (unless otherwise specified)

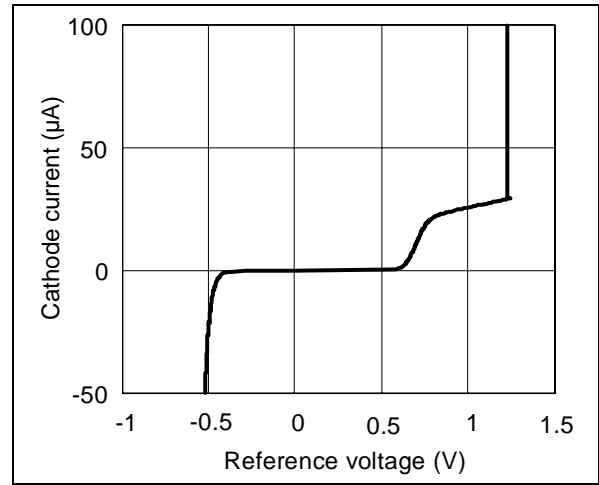
Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V <sub>k</sub>	Reverse Breakdown Voltage	$I_k = 100\mu\text{A}$	1.219	1.225	1.231	V
	Reverse Breakdown Voltage Tolerance	$I_k = 100\mu\text{A}$ $-40^{\circ}\text{C} < T_{amb} < +85^{\circ}\text{C}$	-6 -16		+6 +16	mV
I <sub>kmin</sub>	Minimum Operating Current	$T_{amb} = 25^{\circ}\text{C}$		40	45	$\mu\text{A}$
		$-40^{\circ}\text{C} < T_{amb} < +85^{\circ}\text{C}$			50	
$\Delta V_{ref}/\Delta T$	Average Temperature Coefficient	$I_k = 100\mu\text{A}$			120	ppm/ $^{\circ}\text{C}$
$\Delta V_k/\Delta I_k$	Reverse Breakdown Voltage Change with Operating Current Range	$I_{kmin} < I_k < 1\text{mA}$ $-40^{\circ}\text{C} < T_{amb} < +85^{\circ}\text{C}$		0.3	0.7 1	mV
		$1\text{mA} < I_k < 12\text{mA}$ $-40^{\circ}\text{C} < T_{amb} < +85^{\circ}\text{C}$		2.5	5 7	
R <sub>ka</sub>	Static Impedance	$\Delta I_k = 45\mu\text{A}$ to 1mA		0.25	0.5	$\Omega$
K <sub>vh</sub>	Long Term Stability	$I_k = 100\mu\text{A}$ , t = 1000hrs		120		ppm
En	Wide Band Noise	$I_k = 100\mu\text{A}$ 10Hz < f < 10kHz		200		nV/ $\sqrt{\text{Hz}}$

**Note** : Limits are 100% production tested at 25°C. Limits over temperature are guaranteed through correlation and by design.

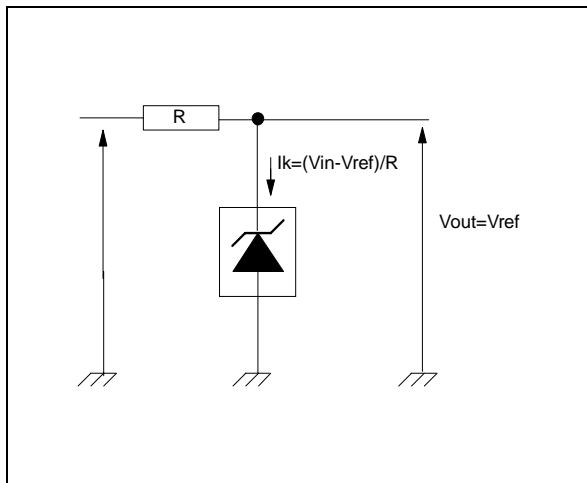
Reference voltage versus cathode current



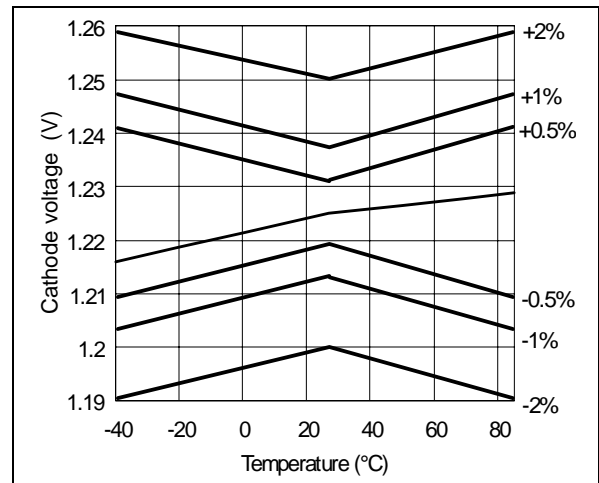
Reference voltage versus cathode current



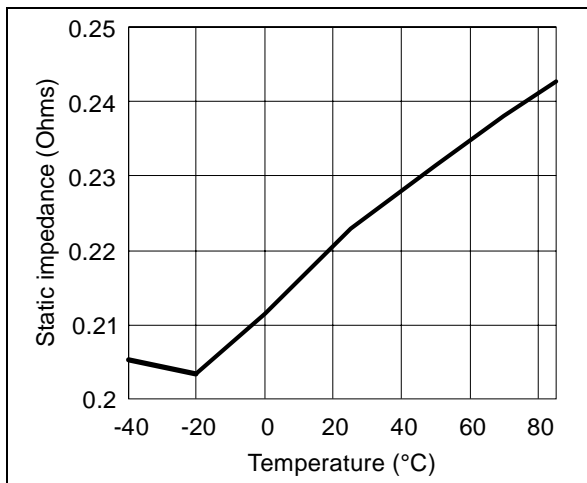
Test circuit



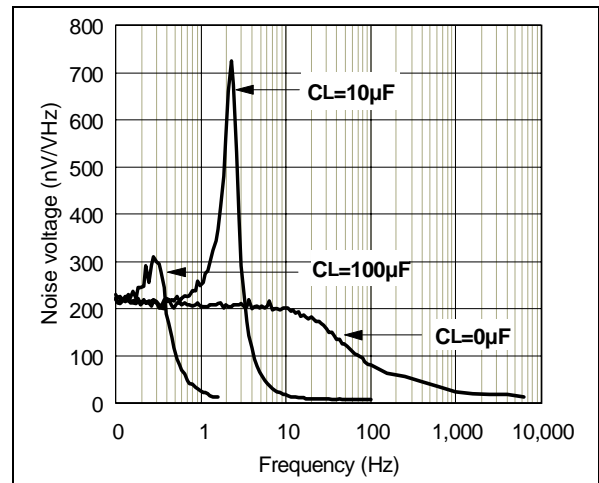
Reference voltage versus Temperature



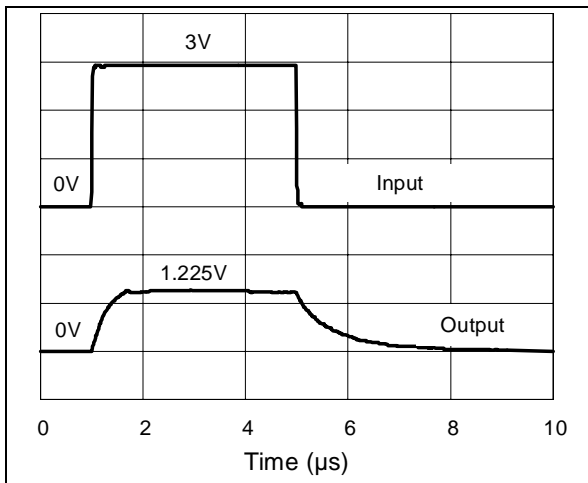
Static impedance versus temperature



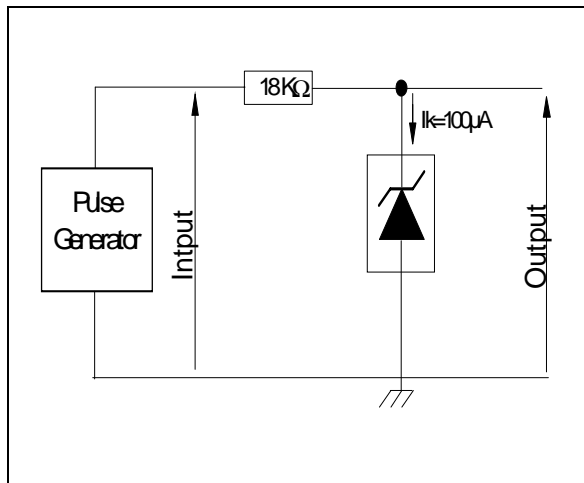
Noise voltage versus frequency



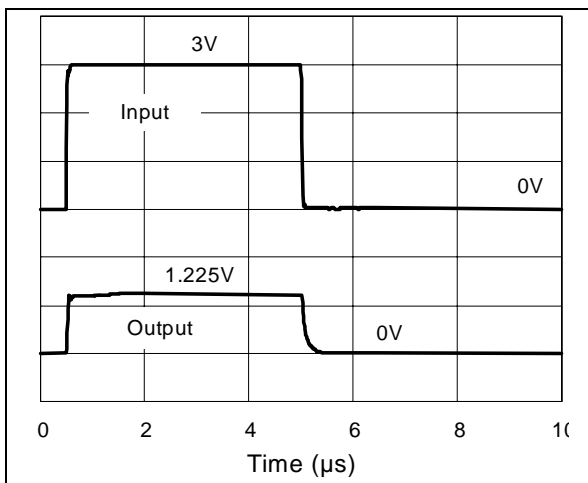
Pulse response for  $I_k=100\mu\text{A}$



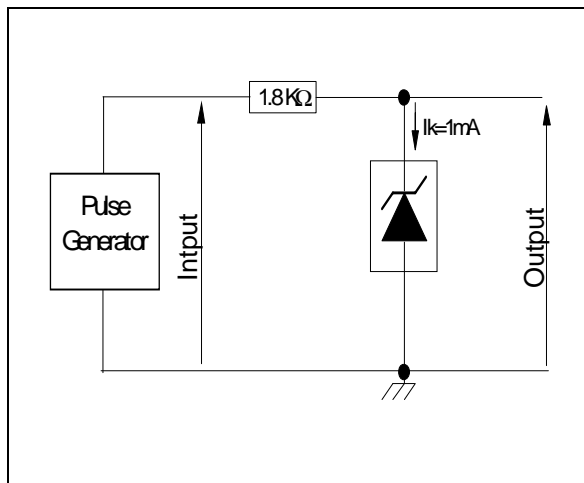
Test circuit for pulse response at  $I_k=100\mu\text{A}$



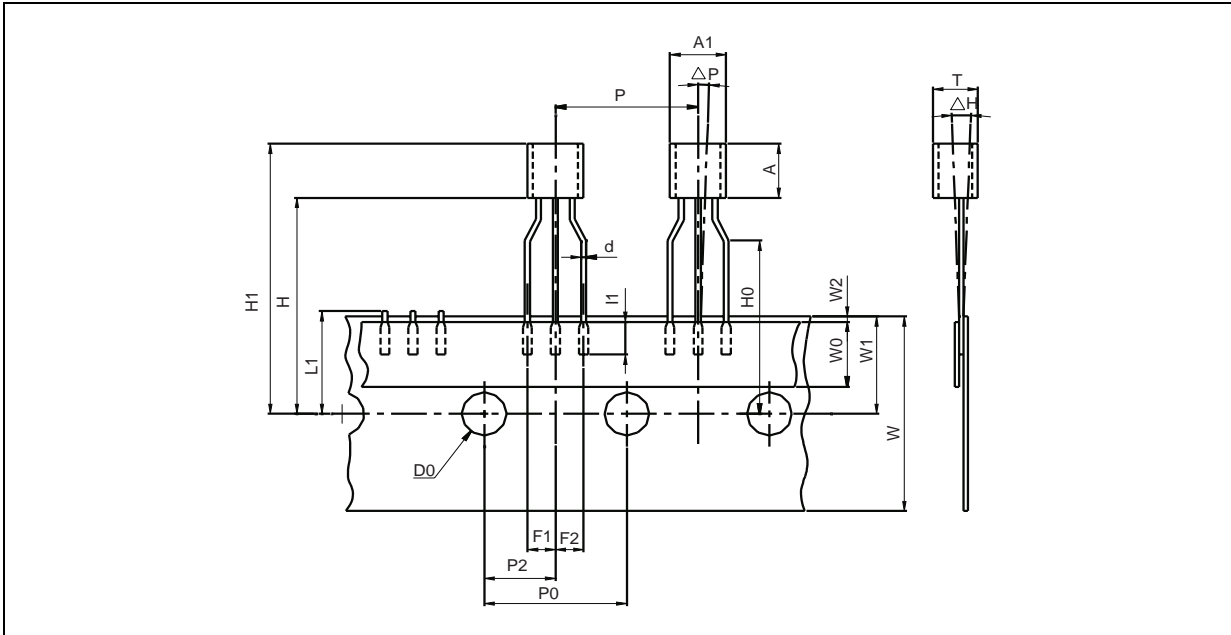
Pulse response for  $I_k=1\text{mA}$



Test circuit for pulse response at  $I_k=1\text{mA}$

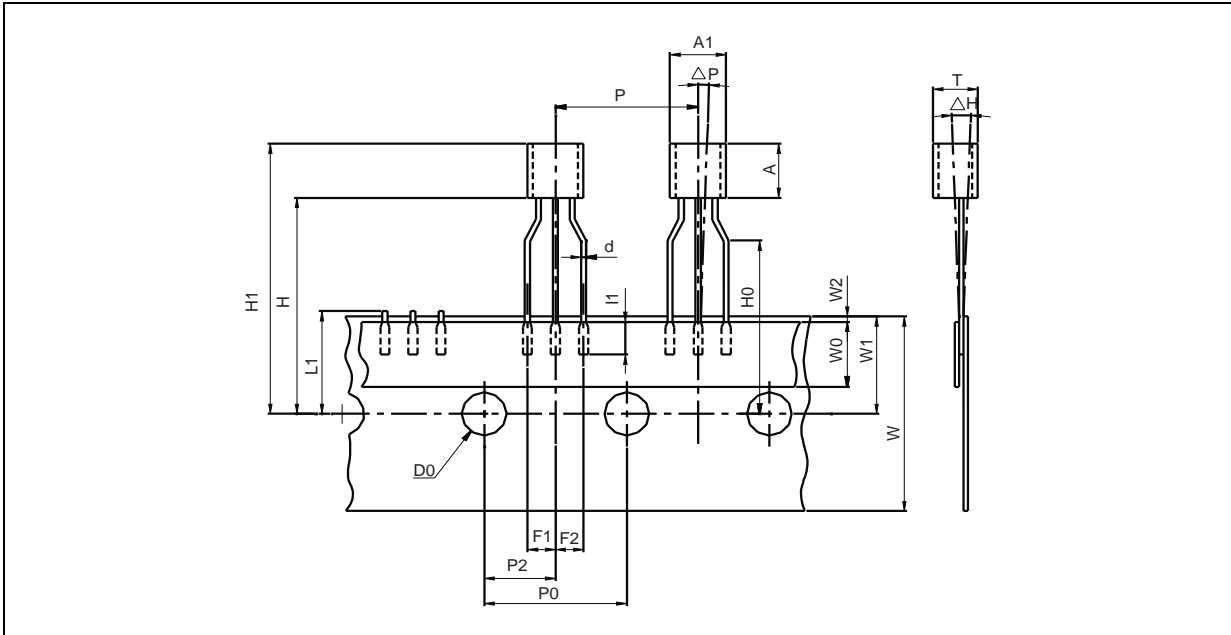


**PACKAGE MECHANICAL DATA**  
**3 PINS - PLASTIC PACKAGE TO92 (TAPE & REEL)**



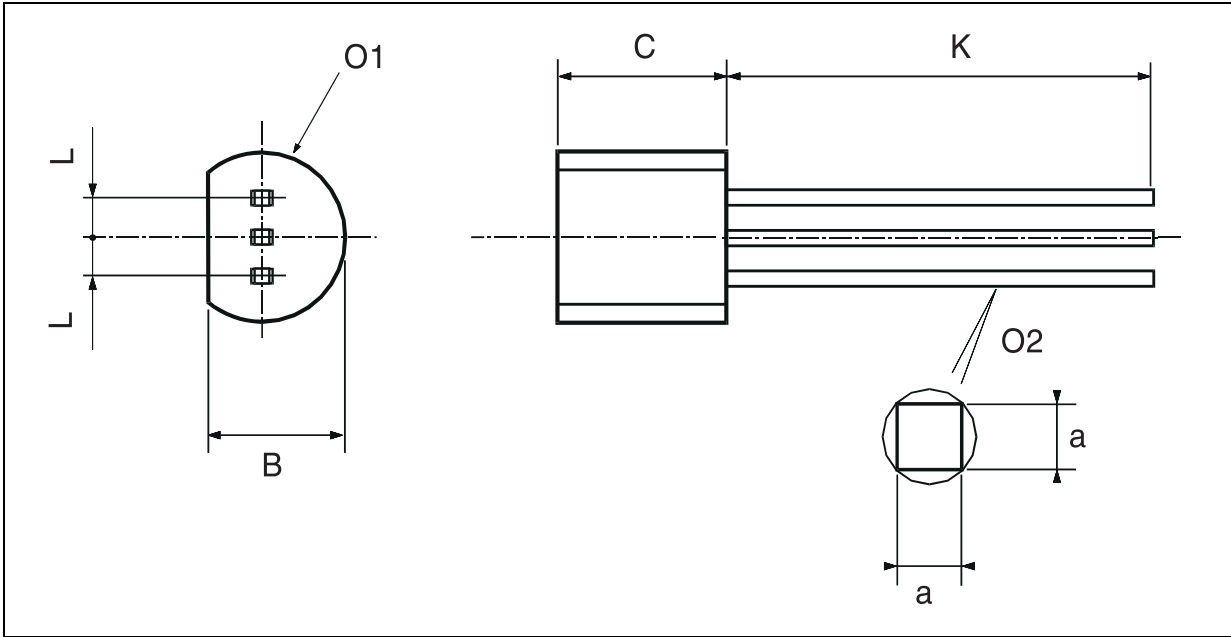
Dim.	Millimeters			Inches		
	Min	Typ.	Max.	Min.	Typ.	Max.
AL			5.0			0.197
A			5.0			0.197
T			4.0			0.157
d		0.45			0.018	
I1	2.5			0.098		
P	11.7	12.7	13.7	0.461	0.500	0.539
PO	12.4	12.7	13	0.488	0.500	0.512
P2	5.95	6.35	6.75	0.234	0.250	0.266
F1/F2	2.4	2.5	2.8	0.094	0.098	0.110
Δh	-1	0	1	-0.039	0	0.039
ΔP	-1	0	1	-0.039	0	0.039
W	17.5	18.0	19.0	0.689	0.709	0.748
W0	5.7	6	6.3	0.224	0.236	0.248
W1	8.5	9	9.75	0.335	0.354	0.384
W2			0.5			0.020
H			20			0.787
H0	15.5	16	16.5	0.610	0.630	0.650
H1			25			0.984
DO	3.8	4.0	4.2	0.150	0.157	0.165
L1			11			0.433

**PACKAGE MECHANICAL DATA**  
**3 PINS - PLASTIC PACKAGE TO92 (TAPE AMMO PACK)**



Dim.	Millimeters			Inches		
	Min	Typ.	Max.	Min.	Typ.	Max.
AL			5.0			0.197
A			5.0			0.197
T			4.0			0.157
d		0.45			0.018	
l1	2.5			0.098		
P	11.7	12.7	13.7	0.461	0.500	0.539
PO	12.4	12.7	13	0.488	0.500	0.512
P2	5.95	6.35	6.75	0.234	0.250	0.266
F1/F2	2.4	2.5	2.8	0.094	0.098	0.110
Δh	-1	0	1	-0.039	0	0.039
ΔP	-1	0	1	-0.039	0	0.039
W	17.5	18.0	19.0	0.689	0.709	0.748
W0	5.7	6	6.3	0.224	0.236	0.248
W1	8.5	9	9.75	0.335	0.354	0.384
W2			0.5			0.020
H			20			0.787
H0	15.5	16	16.5	0.610	0.630	0.650
H1			25			0.984
DO	3.8	4.0	4.2	0.150	0.157	0.165
L1			11			0.433

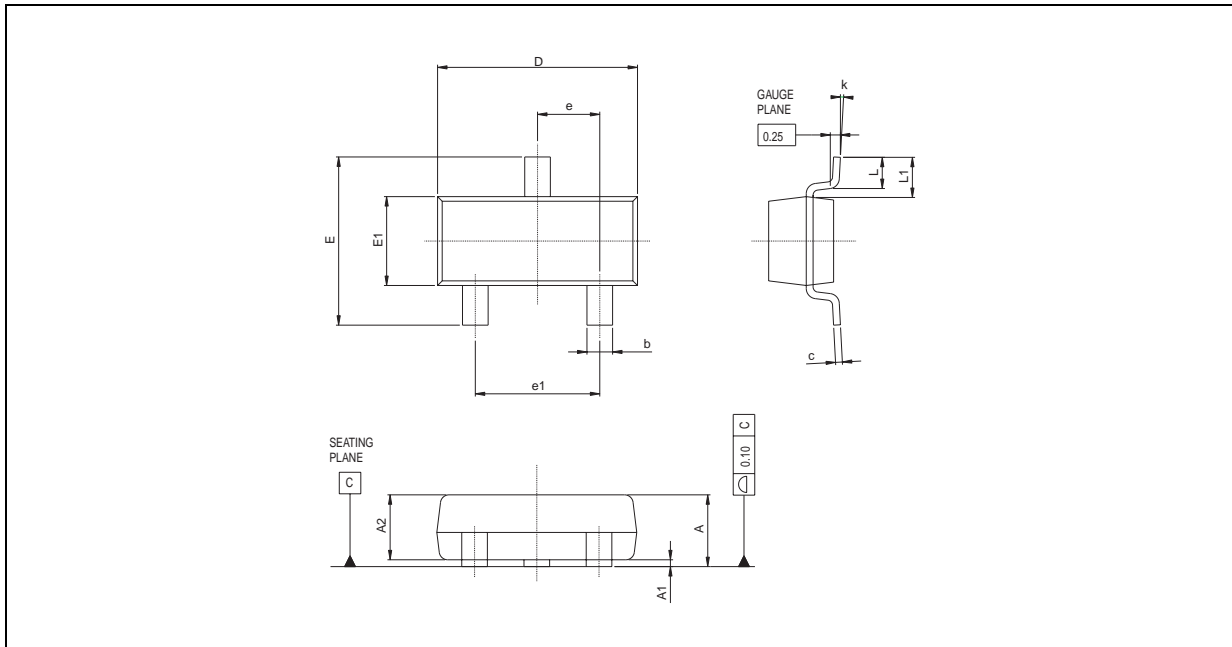
**PACKAGE MECHANICAL DATA**  
 3 PINS - PLASTIC PACKAGE TO92 (BULK)



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 (SOT23-3)**



Dimensions	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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