

1.225V MICROPOWER SHUNT VOLTAGE REFERENCE

- 1.225V TYP OUTPUT VOLTAGE
- ULTRA LOW OPERATING CURRENT : 65µA maximum at 25°C
- HIGH PRECISION @ 25°C
 - +/- 2%
 - +/- 1%
 - +/- 0.5%
- HIGH STABILITY WHEN USED WITH CAPACITIVE LOADS
- INDUSTRIAL TEMPERATURE RANGE: -40 to +85°C
- 150ppm/°C MAXIMUM TEMPERATURE COEFFICIENT

DESCRIPTION

The TS4041 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 TS4041 is very stable and can be used in a broad range of application conditions.

APPLICATION

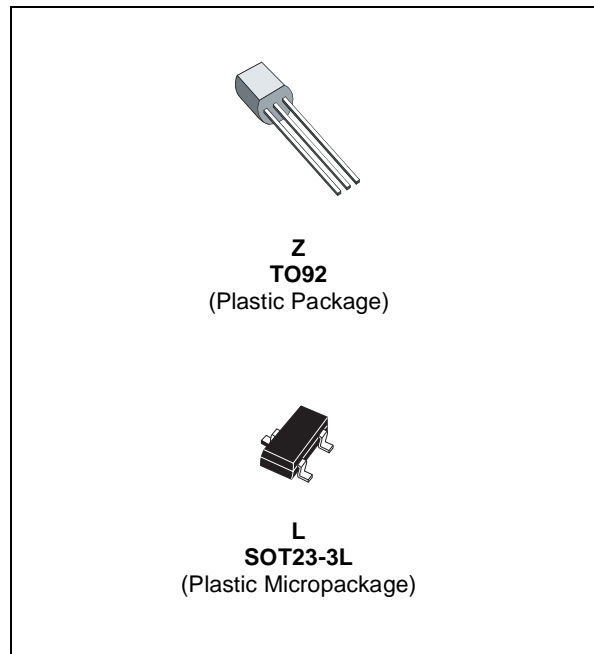
- Computers
- Instrumentation
- Battery chargers
- Switch Mode Power Supply
- Battery operated equipments

ORDER CODE

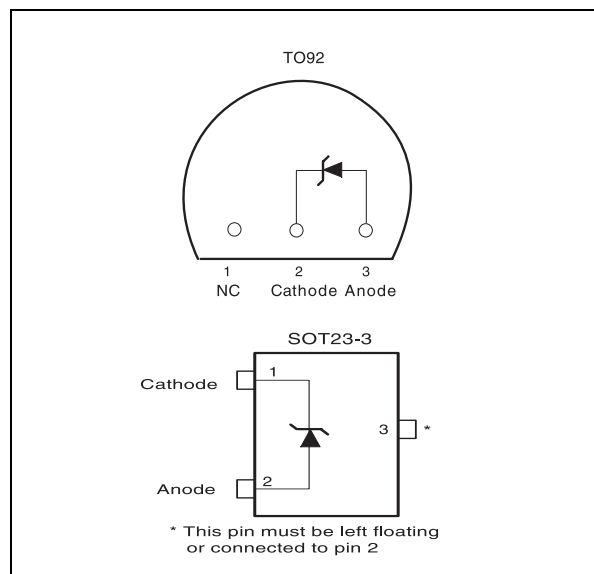
| Precision | TO92 | SOT23-3 | SOT23 Marking |
|--|---------------|----------------|---------------|
| 2% | TS4041EIZ-1.2 | TS4041EILT-1.2 | L233 |
| 1% | TS4041DIZ-1.2 | TS4041DILT-1.2 | L232 |
| 0.5% | TS4041CIZ-1.2 | TS4041CILT-1.2 | L231 |
| Single temperature range: -40 to +85°C | | | |

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 ¹⁾ 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 | 65 | μA |
| I_{max} | Maximum Operating Current | 12 | mA |
| T_{oper} | Operating Free Air Temperature Range | -40 to +85 | °C |

ELECTRICAL CHARACTERISTICS

TS4041E (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 -36 | | +25 +36 | mV |
| I_{kmin} | Minimum Operating Current | $T_{amb} = 25^\circ\text{C}$ | | 40 | 65 | μA |
| | | $-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$ | | | 70 | |
| $\Delta V_{ref}/\Delta T$ | 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 Range | $I_{kmin} < I_k < 1\text{mA}$ $-40^\circ\text{C} < T_{amb} < +85^\circ\text{C}$ | | 0.3 | 2 2.5 | 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 | Ω |
| 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**TS4041D (1% Precision)** $T_{amb} = 25^{\circ}\text{C}$ (unless otherwise specified)

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|---------------------------|---|---|------------|-------|------------|-------------------------|
| Vk | 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 -25 | | +12 +25 | mV |
| I_{kmin} | Minimum Operating Current | $T_{amb} = 25^{\circ}\text{C}$ | | 40 | 65 | μA |
| | | $-40^{\circ}\text{C} < T_{amb} < +85^{\circ}\text{C}$ | | | 70 | |
| $\Delta V_{ref}/\Delta T$ | Average Temperature Coefficient | $I_k = 100\mu\text{A}$ | | | 150 | 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 | 2 2.5 | 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 | Ω |
| K_{vh} | Long Term Stability | $I_k = 100\mu\text{A}$, $t = 1000\text{hrs}$ | | 120 | | ppm |
| En | Wide Band Noise | $I_k = 100\mu\text{A}$ $10\text{Hz} < f < 10\text{kHz}$ | | 200 | | nV/ $\sqrt{\text{Hz}}$ |

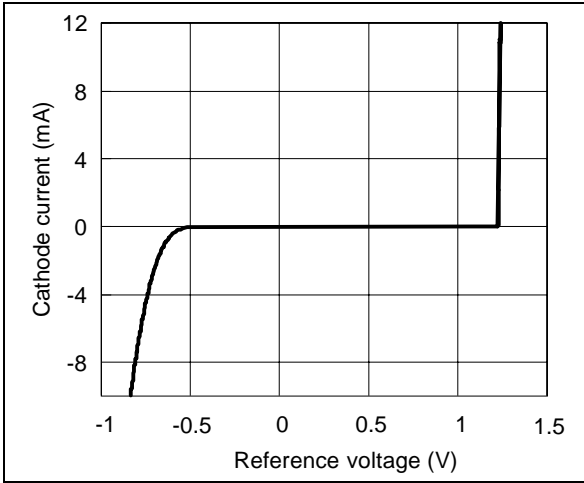
Note : Limits are 100% production tested at 25°C. Limits over temperature are guaranteed through correlation and by design.

ELECTRICAL CHARACTERISTICS**TS4041C (0.5% Precision)** $T_{amb} = 25^{\circ}\text{C}$ (unless otherwise specified)

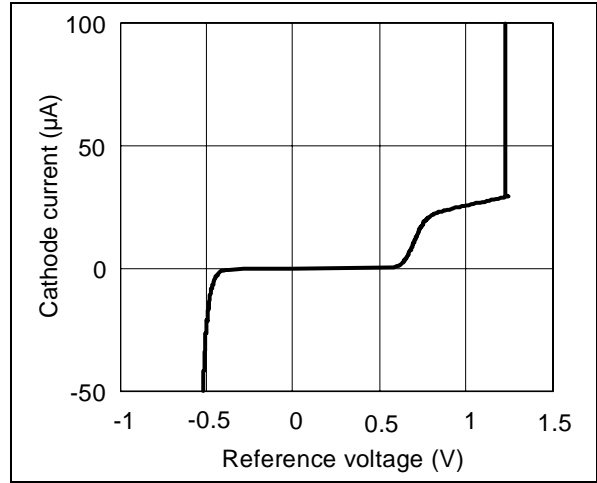
| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|---------------------------|---|---|-----------|-------|-----------|-------------------------|
| Vk | Reverse Breakdown Voltage | $I_k = 100\mu\text{A}$ | 1.219 | 1.225 | 1.231 | V |
| | Reverse Breakdown Voltage Tolerance | $I_k = 100\mu\text{A}$ $-40^{\circ}\text{C} < T_{amb} < +85^{\circ}\text{C}$ | -6 -16 | | +6 +16 | mV |
| I_{kmin} | Minimum Operating Current | $T_{amb} = 25^{\circ}\text{C}$ | | 40 | 60 | μA |
| | | $-40^{\circ}\text{C} < T_{amb} < +85^{\circ}\text{C}$ | | | 65 | |
| $\Delta V_{ref}/\Delta T$ | 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 | 1.5 2 | mV |
| | | $1\text{mA} < I_k < 12\text{mA}$ $-40^{\circ}\text{C} < T_{amb} < +85^{\circ}\text{C}$ | | 2.5 | 6 8 | |
| R_{ka} | Static Impedance | $\Delta I_k = 45\mu\text{A}$ to 1mA | | 0.25 | 0.5 | Ω |
| K_{vh} | Long Term Stability | $I_k = 100\mu\text{A}$, $t = 1000\text{hrs}$ | | 120 | | ppm |
| En | Wide Band Noise | $I_k = 100\mu\text{A}$ $10\text{Hz} < f < 10\text{kHz}$ | | 200 | | nV/ $\sqrt{\text{Hz}}$ |

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

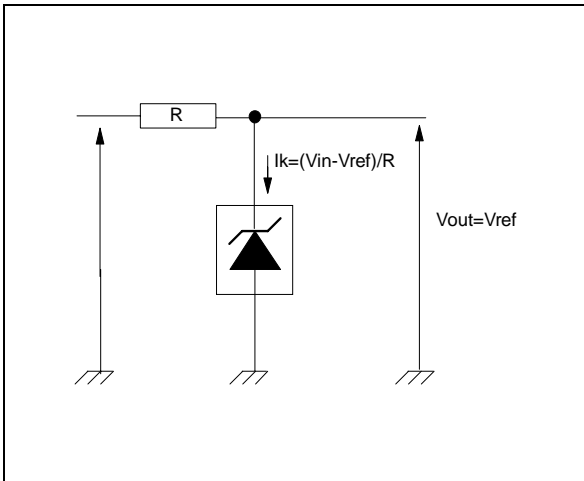
Reference voltage versus cathode current



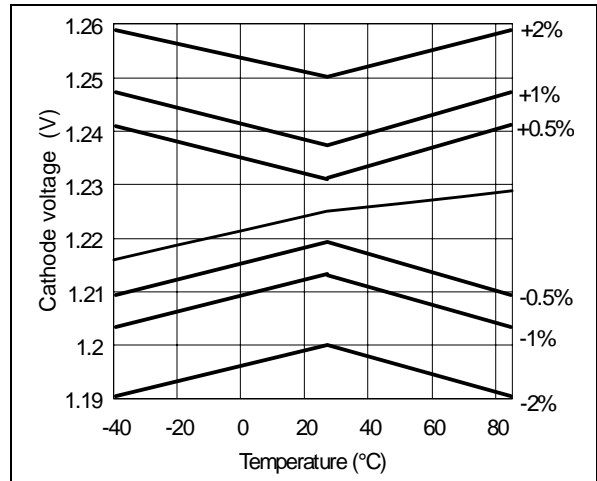
Reference voltage versus cathode current



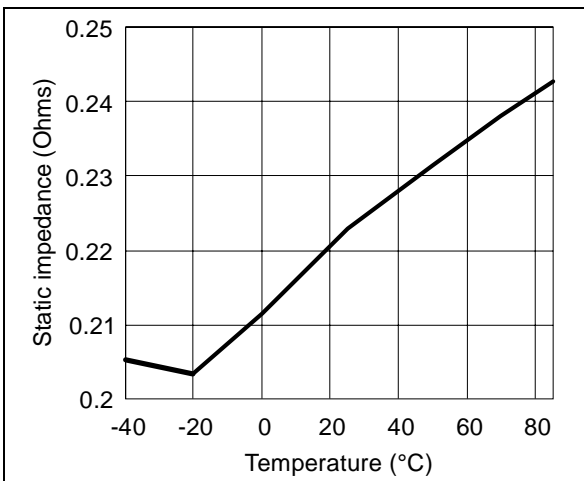
Test circuit



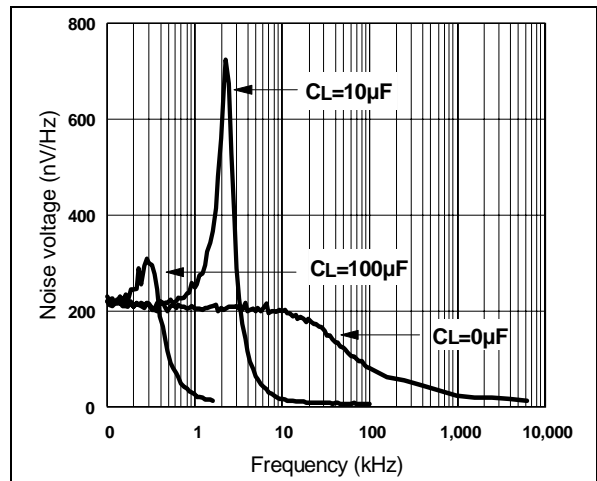
Reference voltage versus Temperature



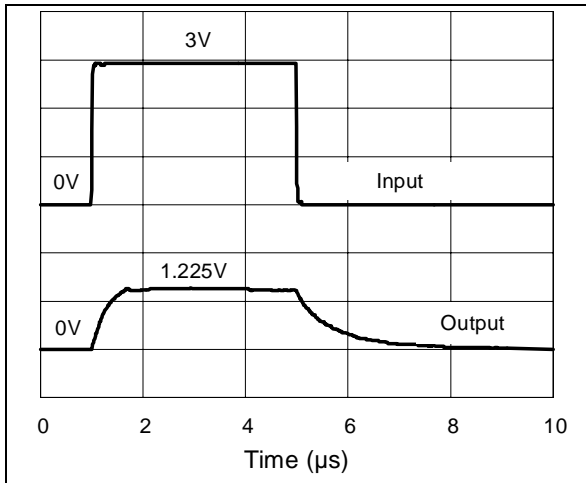
Static impedance versus temperature



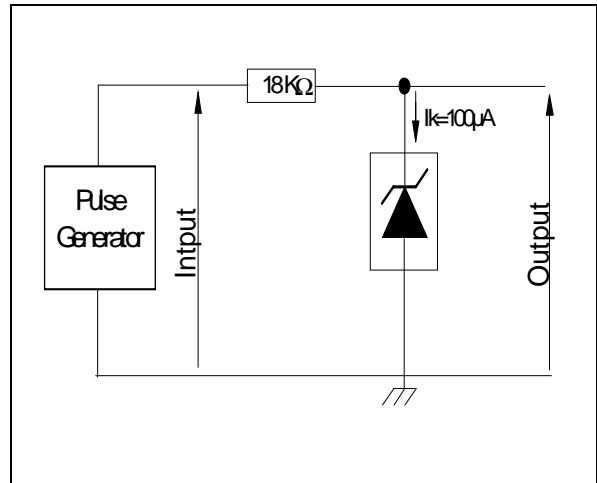
Noise voltage versus frequency



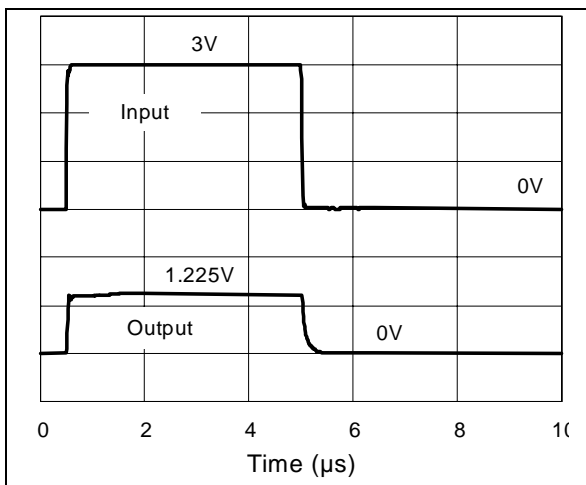
Pulse response for $I_k=100\mu\text{A}$



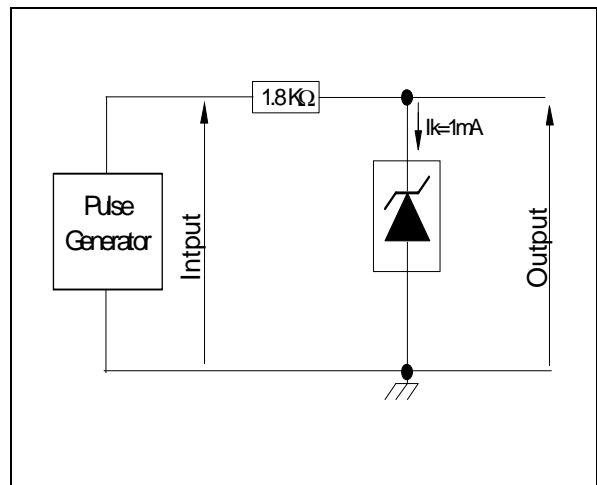
Test circuit for pulse response at $I_k=100\mu\text{A}$



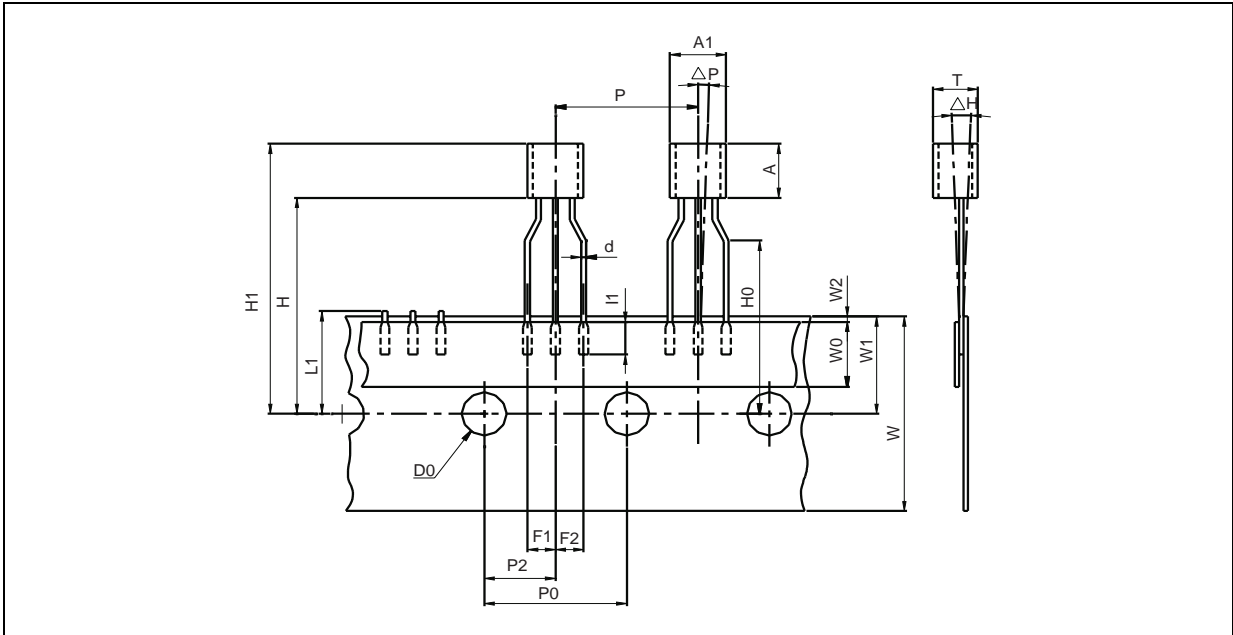
Pulse response for $I_k=1\text{mA}$



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

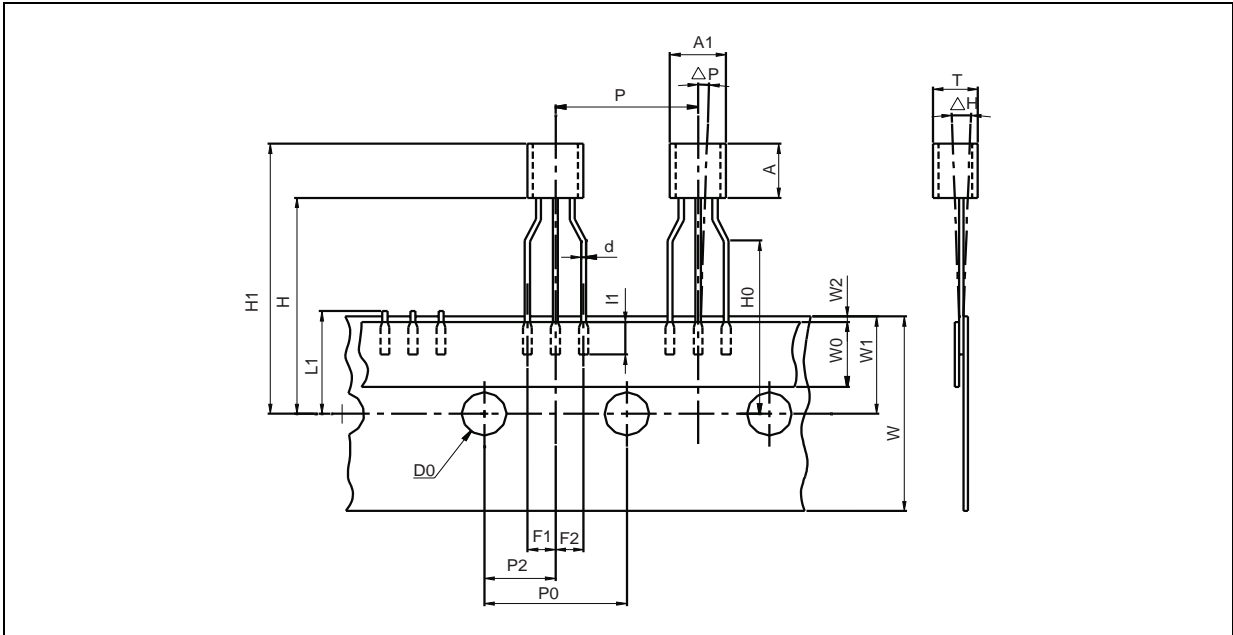


PACKAGE MECHANICAL DATA
3 PINS - PLASTIC PACKAGE TO92 (TAPE & REEL)



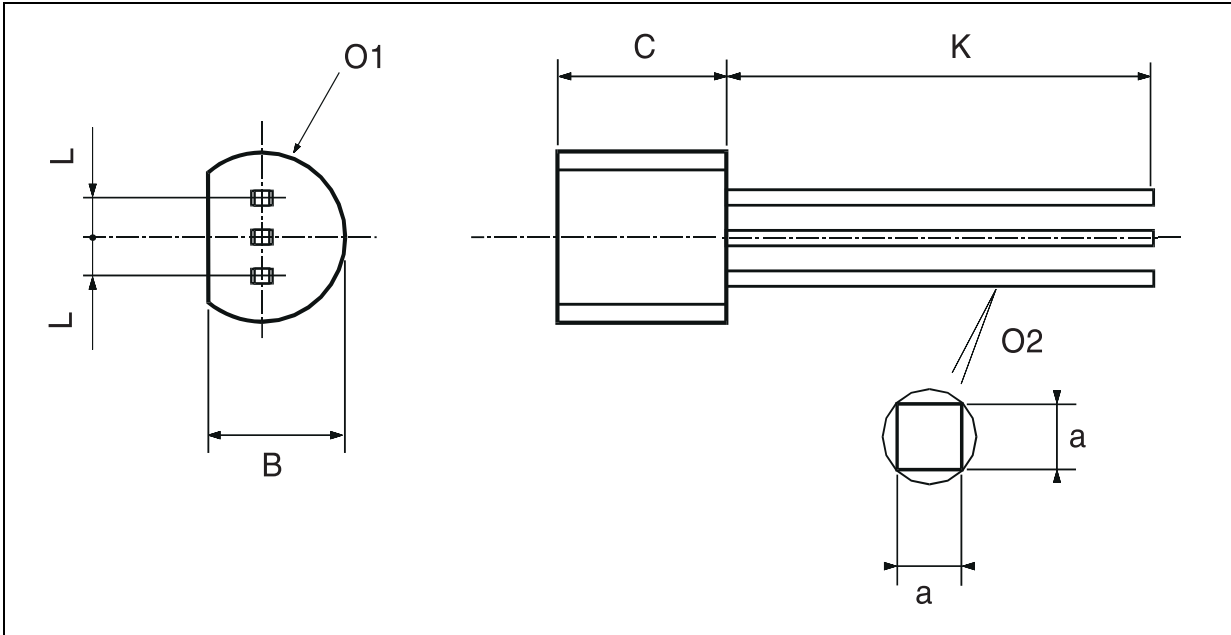
| Dim. | Millimeters | | | Inches | | |
|-------|-------------|------|------|--------|-------|-------|
| | Min | Typ. | Max. | Min. | Typ. | Max. |
| AL | | | 5.0 | | | 0.197 |
| A | | | 5.0 | | | 0.197 |
| T | | | 4.0 | | | 0.157 |
| d | | 0.45 | | | 0.018 | |
| I1 | 2.5 | | | 0.098 | | |
| P | 11.7 | 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)



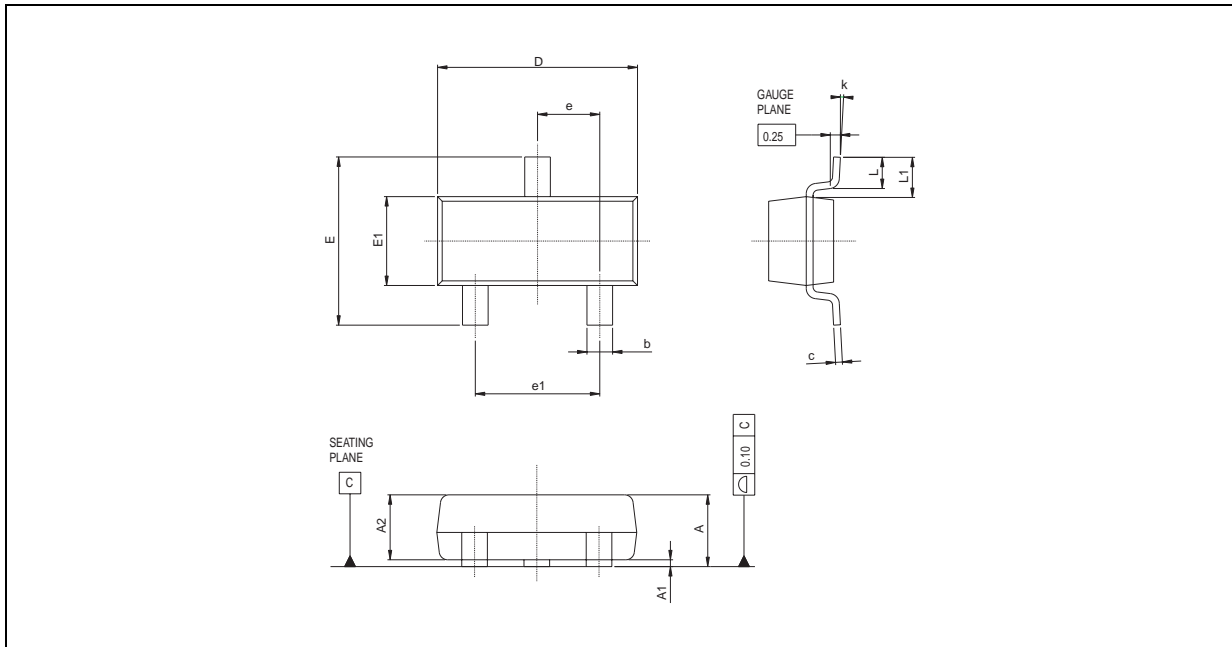
| Dim. | Millimeters | | | Inches | | |
|-------|-------------|------|------|--------|-------|-------|
| | Min | Typ. | Max. | Min. | Typ. | Max. |
| AL | | | 5.0 | | | 0.197 |
| A | | | 5.0 | | | 0.197 |
| T | | | 4.0 | | | 0.157 |
| d | | 0.45 | | | 0.018 | |
| I1 | 2.5 | | | 0.098 | | |
| P | 11.7 | 12.7 | 13.7 | 0.461 | 0.500 | 0.539 |
| P0 | 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)



| 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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