# 2N3904

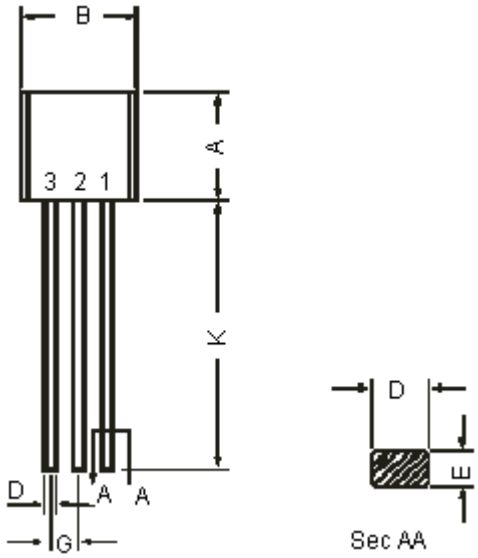
## General Purpose Transistors NPN TO-92

### High Speed Switching

### Features:

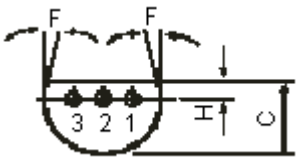
- NPN silicon planar switching transistors.
- Fast switching devices exhibiting short turn-off and low saturation voltage characteristics.
- General purpose switching and amplifier applications.

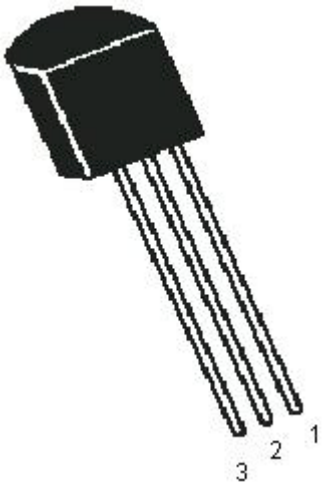
### TO-92 Plastic Package




| Dimensions | Minimum | Maximum |
|---|---|---|
| A | 4.32 | 5.33 |
| B | 4.45 | 5.20 |
| C | 3.18 | 4.19 |
| D | 0.41 | 0.55 |
| E | 0.35 | 0.50 |
| F | 5° | |
| G | 1.14 | 1.40 |
| H | | 1.53 |
| K | 12.70 | - |

Dimensions : Millimetres




**Pin Configuration:**

1. Collector
2. Base
3. Emitter

## Absolute Maximum Ratings

| Description | Symbol | Value | Unit |
|---|---|---|---|
| Collector-Emitter Voltage | $V_{CEO}$ | 40 | V |
| Collector-Base Voltage | $V_{CBO}$ | 60 | |
| Emitter-Base Voltage | $V_{EBO}$ | 6.0 | |
| Collector Current Continuous | $I_C$ | 200 | mA |
| Power Dissipation at $T_a$ = 25°C<br>Derate above 25°C | $P_D$ | 625<br>5.0 | mW<br>mW/°C |
| Power Dissipation at $T_c$= 25°C<br>Derate above 25°C | | 1.5<br>12 | W<br>mW/°C |
| Operating and Storage JunctionTemperature Range | $T_j$, $T_{stg}$ | -55 to +150 | °C |
| **Thermal Resistance** | | | |
| Junction to Case | $R_{th\ (j-c)}$ | 83.3 | °C/W |
| Junction to Ambient | $R_{th\ (j-a)}$ | 200 | |

## Electrical Characteristics ($T_a$ = 25°C unless otherwise specified)

| Description | Symbol | Test Condition | 2N3904 | Unit |
|---|---|---|---|---|
| Collector-Emitter Voltage | *$V_{CEO}$ | $I_C$ = 10mA, $I_B$ = 0 | >40 | V |
| Collector-Base Voltage | $V_{CBO}$ | $I_C$ = 10µA, $I_E$ = 0 | >60 | |
| Emitter-Base Voltage | $V_{EBO}$ | $I_E$ = 10µA, $I_C$ = 0 | >6.0 | |
| Collector-Cut off Current | $I_{CEX}$ | $V_{CE}$ = 30V, $V_{EB}$ = 3V | <50 | nA |
| Base Current | $I_{BL}$ | | | |
| DC Current Gain | *$h_{FE}$ | $I_C$ = 0.1mA, $V_{CE}$ = 1V<br>$I_C$ = 1mA, $V_{CE}$ = 1V<br>$I_C$ = 10mA, $V_{CE}$ = 1V<br>$I_C$ = 50mA, $V_{CE}$ = 1V<br>$I_C$ = 100mA, $V_{CE}$ = 1V | >40<br>>70<br>100 - 300<br>>60<br>>30 | - |
| Collector Emitter Saturation Voltage | *$V_{CE\ (sat)}$ | $I_C$ = 10mA, $I_B$ = 1mA | <0.20<br><0.30 | V |
| Base Emitter Saturation Voltage | *$V_{BE\ (sat)}$ | $I_C$ = 50mA, $I_B$ = 5mA | 0.65 - 0.85<br><0.95 | V |

## Electrical Characteristics ($T_a$ = 25°C unless otherwise specified)

| Description | Symbol | Test Condition | 2N3904 | Units |
|---|---|---|---|---|
| **Small Signal Characteristic** | | | | |
| Transistors Frequency | $f_T$ | $I_C$ = 10mA, $V_{CE}$ = 20V, f = 100MHz | >300 | MHz |
| Output Capacitance | $C_{ob}$ | $V_{CB}$ = 5V, $I_E$ = 0, f = 1MHz | <4.0 | pF |
| Input Capacitance | $C_{ib}$ | $V_{BE}$ = 0.5V, $I_C$ = 0, f = 1MHz All f = kHz | <8.0 | |
| Small Signal Current Gain | $h_{fe}$ | $I_C$ = 1mA, $V_{CE}$ = 10V | 100 - 400 | - |
| Input Impedance | $h_{ie}$ | | 1.0 - 10 | kΩ |
| Output Admittance | $h_{oe}$ | | 1.0 - 40 | umhos |
| Voltage Feedback Ratio | $h_{re}$ | | 0.5 - 0.8 | x $10^{-4}$ |
| Noise Figure | NF | $I_C$ = 100µA, $V_{CE}$ = 5V | <5.0 | dB |
| **Switching Time** | | | | |
| Delay Time | $t_d$ | $V_{CC}$ = 3V, $V_{BE}$ = 0.5V | <35 | ns |
| Rise Time | $t_r$ | $I_C$ = 10mA, $I_{B1}$ = 1mA | | |
| Storage Time | $t_s$ | $V_{CC}$ = 3V, $I_C$ = 10mA $I_{B1}$ = $I_{B2}$ = 1mA | <200 | |
| Fall Time | $t_f$ | - | <50 | |

*Pulse Condition: = 300µs, Duty Cycle = 2%

## Specifications

| $V_{CEO}$ Maximum (V) | $I_C$ Maximum (A) | $V_{CE\ (sat)}$ Maximum (V) at $I_C$ = 10mA | $t_{off}$ Maximum (ns) at $I_C$ = 10mA | $h_{FE}$ Minimum at $I_C$ = 10mA | $P_{tot}$ at 25°C (mW) | Package and Pin Out | Part Number |
|---|---|---|---|---|---|---|---|
| 40 | 0.2 | 0.2 | 250 | 100 | 500 | TO-92 | 2N3904 |