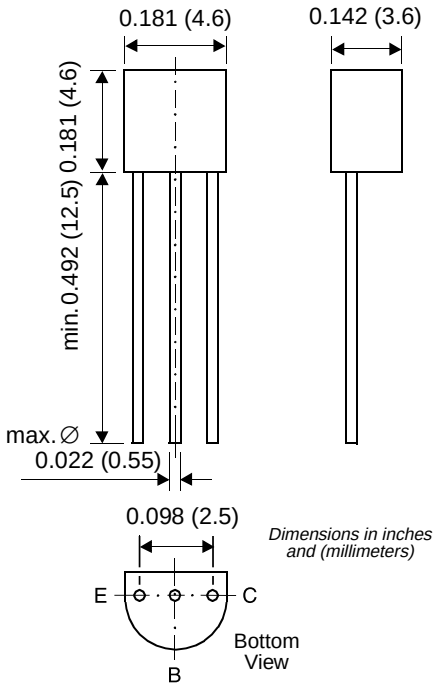
GENERAL SEMICONDUCTOR®

# 2N3904

## Small Signal Transistor (NPN)

New Product

**TO-226AA (TO-92)**




## Features

- NPN Silicon Epitaxial Planar Transistor for switching and amplifier applications.
- As complementary type, the PNP transistor 2N3906 is recommended.
- On special request, this transistor is also manufactured in the pin configuration TO-18.
- This transistor is also available in the SOT-23 case with the type designation MMBT3904.

## Mechanical Data

**Case:** TO-92 Plastic Package

**Weight:** approx. 0.18g

**Packaging Codes/Options:**

E6/Bulk - 5K per container
E7/4K per Ammo tape

## Maximum Ratings & Thermal Characteristics

Ratings at 25°C ambient temperature unless otherwise specified.

| Parameters | Symbols | Value | Units |
|---|---|---|---|
| Collector-Emitter Voltage | $V_{CEO}$ | 40 | V |
| Collector-Base Voltage | $V_{CBO}$ | 60 | V |
| Emitter-Base Voltage | $V_{EBO}$ | 6.0 | V |
| Collector Current | $I_C$ | 200 | mA |
| Power Dissipation $T_A$ = 25°C<br>$T_C$ = 25°C | $P_{tot}$ | 625<br>1.5 | mW<br>W |
| Thermal Resistance Junction to Ambient Air | $R_{\Theta JA}$ | 250(1) | °C/W |
| Junction Temperature | $T_j$ | 150 | °C |
| Storage Temperature Range | $T_S$ | – 65 to +150 | °C |

**Notes:**
(1) Valid provided that leads are kept at ambient temperature.

GENERAL SEMICONDUCTOR®

# 2N3904

## Small Signal Transistor (NPN)

### Electrical Characteristics ($T_J$ = 25°C unless otherwise noted)

| Parameter | Symbol | Test Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Collector-Base Breakdown Voltage | $V_{(BR)CBO}$ | $I_C$ = 10 µA, $I_E$ = 0 | 60 | — | — | V |
| Collector-Emitter Breakdown Voltage[1] | $V_{(BR)CEO}$ | $I_C$ = 1 mA, $I_B$ = 0 | 40 | — | — | V |
| Emitter-Base Breakdown Voltage | $V_{(BR)EBO}$ | $I_E$ = 10 µA, $I_C$ = 0 | 6 | — | — | V |
| Collector Saturation Voltage | $V_{CEsat}$ | $I_C$ = 10 mA, $I_B$ = 1 mA<br>$I_C$ = 50 mA, $I_B$ = 5 mA | —<br>— | —<br>— | 0.2<br>0.3 | V |
| Base Saturation Voltage | $V_{BEsat}$ | $I_C$ = 10 mA, $I_B$ = 1 mA<br>$I_C$ = 50 mA, $I_B$ = 5 mA | —<br>— | —<br>— | 0.85<br>0.95 | V |
| Collector-Emitter Cutoff Current | $I_{CEV}$ | $V_{EB}$ = 3 V, $V_{CE}$ = 30 V | — | — | 50 | nA |
| Emitter-Base Cutoff Current | $I_{EBV}$ | $V_{EB}$ = 3 V, $V_{CE}$ = 30 V | — | — | 50 | nA |
| DC Current Gain | $h_{FE}$ | $V_{CE}$ = 1 V, $I_C$ = 0.1 mA<br>$V_{CE}$ = 1 V, $I_C$ = 1 mA<br>$V_{CE}$ = 1 V, $I_C$ = 10 mA<br>$V_{CE}$ = 1 V, $I_C$ = 50 mA<br>$V_{CE}$ = 1 V, $I_C$ = 100 mA | 40<br>70<br>100<br>60<br>30 | —<br>—<br>300<br>—<br>— | —<br>—<br>—<br>—<br>— | — |
| Input Impedance | $h_{ie}$ | $V_{CE}$ = 10 V, $I_C$ = 1 mA<br>f = 1 kHz | 1 | — | 10 | kΩ |
| Voltage Feedback Ratio | $h_{re}$ | $V_{CE}$ = 10 V, $I_C$ = 1 mA<br>f = 1 kHz | $0.5 \cdot 10^{-4}$ | — | $8 \cdot 10^{-4}$ | — |
| Gain-Bandwidth Product | $f_T$ | $V_{CE}$ = 20 V, $I_C$ = 10 mA<br>f = 100 MHz | 300 | — | — | MHz |
| Collector-Base Capacitance | $C_{CBO}$ | $V_{CB}$ = 5 V, f = 100 kHz | — | — | 4 | pF |
| Emitter-Base Capacitance | $C_{EBO}$ | $V_{CB}$ = 0.5 V, f = 100 kHz | — | — | 8 | pF |
| Small Signal Current Gain | $h_{fe}$ | $V_{CE}$ = 10 V, $I_C$ = 1 mA,<br>f = 1 kHz | 100 | — | 400 | — |
| Output Admittance | $h_{oe}$ | $V_{CE}$ = 1 V, $I_C$ = 1 mA,<br>f = 1 kHz | 1 | — | 40 | µS |
| Noise Figure | NF | $V_{CE}$ = 5 V, $I_C$ = 100 µA,<br>$R_G$ = 1 kΩ, f = 10...15000 kHz | — | — | 5 | dB |
| Delay Time (see fig. 1) | $t_d$ | $I_{B1}$ = 1 mA, $I_C$ = 10 mA | — | — | 35 | ns |
| Rise Time (see fig. 1) | $t_r$ | $I_{B1}$ = 1 mA, $I_C$ = 10 mA | — | — | 35 | ns |
| Storage Time (see fig. 2) | $t_s$ | $-I_{B1} = I_{B2}$ = 1 mA<br>$I_C$ = 10 mA | — | — | 200 | ns |
| Fall Time (see fig. 2) | $t_f$ | $-I_{B1} = I_{B2}$ = 1 mA<br>$I_C$ = 10 mA | — | — | 50 | ns |

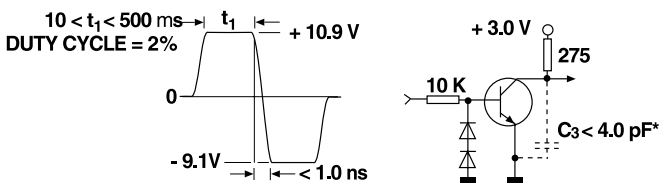



**Fig. 1:** Test circuit for delay and rise time
* total shunt capacitance of test jig and connectors

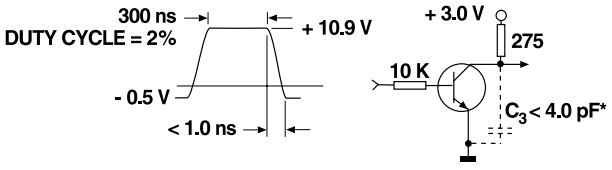



**Fig. 2:** Test circuit for storage and fall time
* total shunt capacitance of test jig and connectors