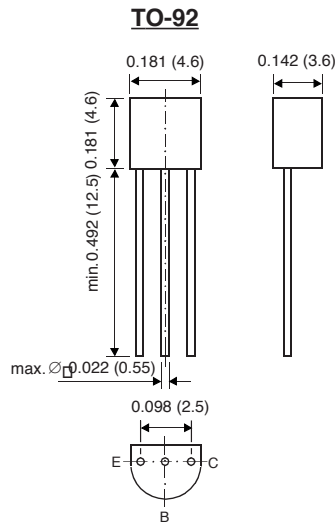


2N3904

SMALL SIGNAL TRANSISTORS (NPN)



Dimensions in inches and (millimeters)

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

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified

| | SYMBOL | VALUE | UNIT |
|--|-----------------|--------------------|---------------------------|
| Collector-Base Voltage | V_{CB0} | 60 | V |
| Collector-Emitter Voltage | V_{CE0} | 40 | V |
| Emitter-Base Voltage | V_{EB0} | 6.0 | V |
| Collector Current | I_C | 200 | mA |
| Power Dissipation at $T_A = 25^\circ\text{C}$ at $T_C = 25^\circ\text{C}$ | P_{tot} | 625 1.5 | mW W |
| Thermal Resistance Junction to Ambient Air | $R_{\theta JA}$ | 250 ⁽¹⁾ | $^\circ\text{C}/\text{W}$ |
| Junction Temperature | T_j | 150 | $^\circ\text{C}$ |
| Storage Temperature Range | T_S | - 65 to +150 | $^\circ\text{C}$ |

NOTES:

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

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ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified

| | SYMBOL | MIN. | MAX. | UNIT |
|---|--|-----------------------------|-------------------------|-----------------------|
| Collector-Base Breakdown Voltage at $I_C = 10 \mu\text{A}$, $I_E = 0$ | $V_{(BR)CBO}$ | 60 | – | V |
| Collector-Emitter Breakdown Voltage at $I_C = 1 \text{ mA}$, $I_B = 0$ | $V_{(BR)CEO}$ | 40 | – | V |
| Emitter-Base Breakdown Voltage at $I_E = 10 \mu\text{A}$, $I_C = 0$ | $V_{(BR)EBO}$ | 6 | – | V |
| Collector Saturation Voltage at $I_C = 10 \text{ mA}$, $I_B = 1 \text{ mA}$ at $I_C = 50 \text{ mA}$, $I_B = 5 \text{ mA}$ | V_{CEsat} V_{CEsat} | – – | 0.2 0.3 | V V |
| Base Saturation Voltage at $I_C = 10 \text{ mA}$, $I_B = 1 \text{ mA}$ at $I_C = 50 \text{ mA}$, $I_B = 5 \text{ mA}$ | V_{BEsat} V_{BEsat} | – – | 0.85 0.95 | V V |
| Collector-Emitter Cutoff Current $V_{EB} = 3 \text{ V}$, $V_{CE} = 30 \text{ V}$ | I_{CEV} | – | 50 | nA |
| Emitter-Base Cutoff Current $V_{EB} = 3 \text{ V}$, $V_{CE} = 30 \text{ V}$ | I_{EBV} | – | 50 | nA |
| DC Current Gain at $V_{CE} = 1 \text{ V}$, $I_C = 0.1 \text{ mA}$ at $V_{CE} = 1 \text{ V}$, $I_C = 1 \text{ mA}$ at $V_{CE} = 1 \text{ V}$, $I_C = 10 \text{ mA}$ at $V_{CE} = 1 \text{ V}$, $I_C = 50 \text{ mA}$ at $V_{CE} = 1 \text{ V}$, $I_C = 100 \text{ mA}$ | h_{FE} h_{FE} h_{FE} h_{FE} h_{FE} | 40 70 100 60 30 | – – 300 – – | – – – – – |
| Input Impedance at $V_{CE} = 10 \text{ V}$, $I_C = 1 \text{ mA}$, $f = 1 \text{ kHz}$ | h_{ie} | 1 | 10 | k Ω |
| Voltage Feedback Ratio at $V_{CE} = 10 \text{ V}$, $I_C = 1 \text{ mA}$, $f = 1 \text{ kHz}$ | h_{re} | $0.5 \cdot 10^{-4}$ | $8 \cdot 10^{-4}$ | – |
| Gain-Bandwidth Product at $V_{CE} = 20 \text{ V}$, $I_C = 10 \text{ mA}$, $f = 100 \text{ MHz}$ | f_T | 300 | – | MHz |
| Collector-Base Capacitance at $V_{CB} = 5 \text{ V}$, $f = 100 \text{ kHz}$ | C_{CBO} | – | 4 | pF |
| Emitter-Base Capacitance at $V_{EB} = 0.5 \text{ V}$, $f = 100 \text{ kHz}$ | C_{EBO} | – | 8 | pF |

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ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified

| | SYMBOL | MIN. | MAX. | UNIT |
|--|----------|------|------|---------------|
| Small Signal Current Gain at $V_{CE} = 10\text{ V}$, $I_C = 1\text{ mA}$, $f = 1\text{ kHz}$ | h_{fe} | 100 | 400 | – |
| Output Admittance at $V_{CE} = 1\text{ V}$, $I_C = 1\text{ mA}$, $f = 1\text{ kHz}$ | h_{oe} | 1 | 40 | μS |
| Noise Figure at $V_{CE} = 5\text{ V}$, $I_C = 100\text{ }\mu\text{A}$, $R_G = 1\text{ k}\Omega$, $f = 10 \dots 15000\text{ Hz}$ | NF | – | 5 | dB |
| Delay Time (see Fig. 1) at $I_{B1} = 1\text{ mA}$, $I_C = 10\text{ mA}$ | t_d | – | 35 | ns |
| Rise Time (see Fig. 1) at $I_{B1} = 1\text{ mA}$, $I_C = 10\text{ mA}$ | t_r | – | 35 | ns |
| Storage Time (see Fig. 2) at $-I_{B1} = I_{B2} = 1\text{ mA}$, $I_C = 10\text{ mA}$ | t_s | – | 200 | ns |
| Fall Time (see Fig. 2) at $-I_{B1} = I_{B2} = 1\text{ mA}$, $I_C = 10\text{ mA}$ | t_f | – | 50 | ns |

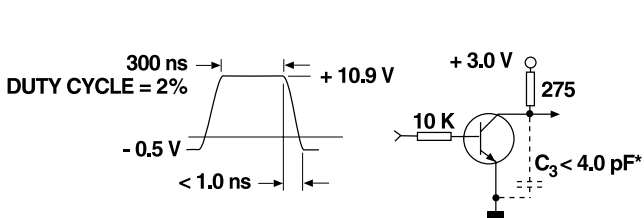


Fig. 1: Test circuit for delay and rise time

* total shunt capacitance of test jig and connectors

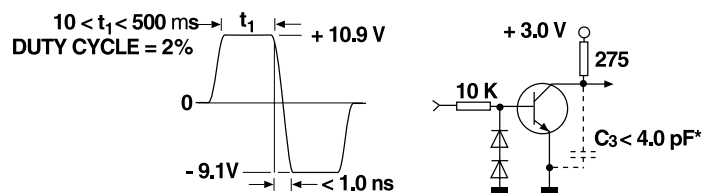


Fig. 2: Test circuit for storage and fall time

* total shunt capacitance of test jig and connectors