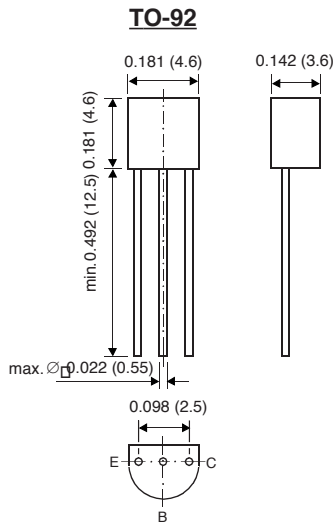


2N3904

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⁾	$^\circ\text{C/W}$
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.

2N3904

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

2N3904

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 $V_{CE} = 5\text{ V}$, $I_C = 100\ \mu\text{A}$, $R_G = 1\text{ k}\Omega$, $f = 10 \dots 15000\text{ Hz}$	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

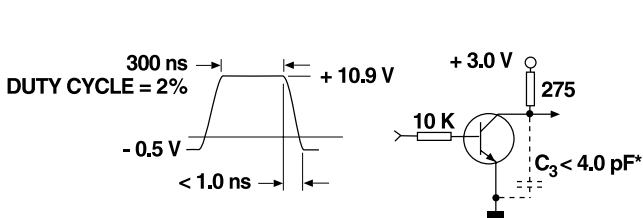


Fig. 1: Test circuit for delay and rise time

* total shunt capacitance of test jig and connectors

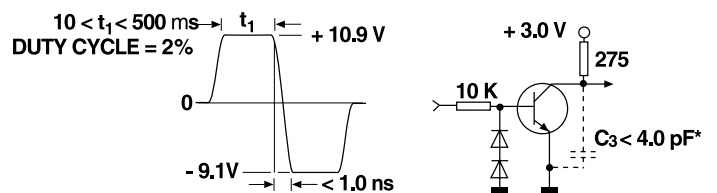


Fig. 2: Test circuit for storage and fall time

* total shunt capacitance of test jig and connectors