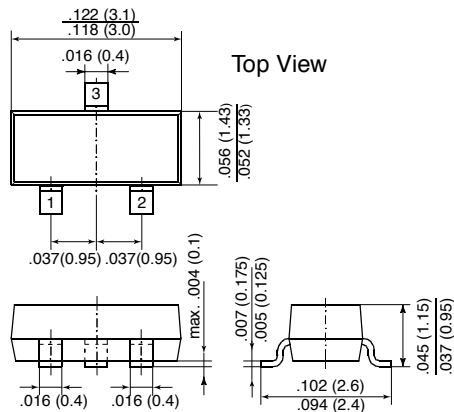


# MMBT3904

## Small Signal Transistors (NPN)

### SOT-23



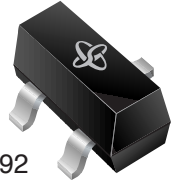
Dimensions in inches and (millimeters)

Pin configuration

1 = Base, 2 = Emitter, 3 = Collector.

### FEATURES

- ◆ NPN Silicon Epitaxial Planar Transistor for switching and amplifier applications.
- ◆ As complementary type, the PNP transistor MMBT3906 is recommended.
- ◆ This transistor is also available in the TO-92 case with the type designation 2N3904.



### MECHANICAL DATA

**Case:** SOT-23 Plastic Package

**Weight:** approx. 0.008g

**Marking code:** 1AM

## MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified

	SYMBOL	VALUE	UNIT
Collector-Base Voltage	$V_{CBO}$	60	V
Collector-Emitter Voltage	$V_{CEO}$	40	V
Emitter-Base Voltage	$V_{EBO}$	6.0	V
Collector Current	$I_C$	200	mA
Power Dissipation at $T_A = 25^\circ\text{C}$	$P_{tot}$	225 <sup>(1)</sup> 300 <sup>(2)</sup>	mW
Thermal Resistance Junction to Substrate Backside	$R_{\theta SB}$	320 <sup>(1)</sup>	$^\circ\text{C/W}$
Thermal Resistance Junction to Ambient Air	$R_{\theta JA}$	450 <sup>(1)</sup>	$^\circ\text{C/W}$
Junction Temperature	$T_j$	150	$^\circ\text{C}$
Storage Temperature Range	$T_S$	-65 to +150	$^\circ\text{C}$

#### NOTES:

(1) Device on fiberglass substrate, see layout.

(2) Device on alumina substrate.

# MMBT3904

## 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 $I_E = 10 \mu\text{A}$ , $I_C = 0$	$V_{(BR)EBO}$	6.0	–	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 $\Omega$
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

# MMBT3904

## ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified

	SYMBOL	MIN.	MAX.	UNIT
Voltage Feedback Ratio at $V_{CE} = 10\text{ V}$ , $I_C = 1\text{ mA}$ , $f = 1\text{ kHz}$	$h_{re}$	$0.5 \cdot 10^{-4}$	$8 \cdot 10^{-4}$	–
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	$\mu\text{S}$
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

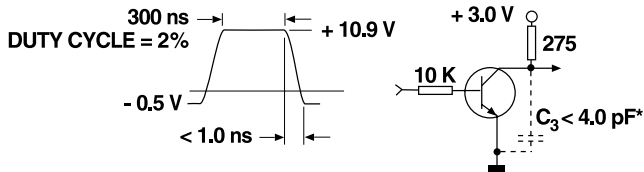


Fig. 1: Test circuit for delay and rise time

\* total shunt capacitance of test jig and connectors

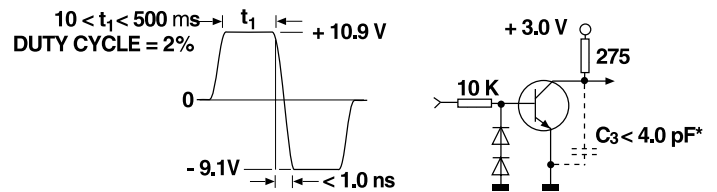
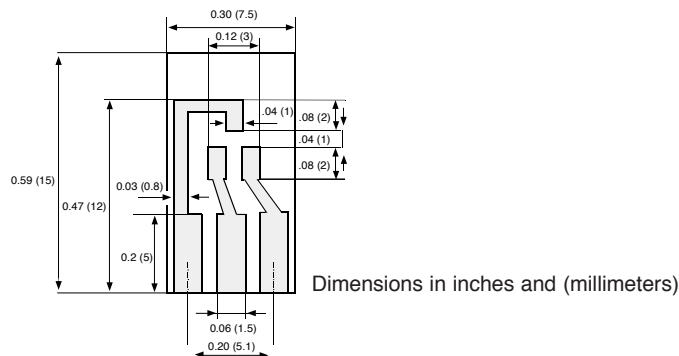


Fig. 2: Test circuit for storage and fall time

\* total shunt capacitance of test jig and connectors



### Layout for $R_{thJA}$ test

Thickness: Fiberglass 0.059 in (1.5 mm)

Copper leads 0.012 in (0.3 mm)