



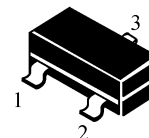
**THE DATASHEET OF  
MMBT3904**



## NPN Switching Transistor

SOT-23

- 1. BASE
- 2. EMITTER
- 3. COLLECTOR



### ■ MAXIMUM RATINGS

| Characteristic               | Symbol    | Rating | Unit |
|------------------------------|-----------|--------|------|
| Collector-Emitter Voltage    | $V_{CEO}$ | 40     | Vdc  |
| Collector-Base Voltage       | $V_{CBO}$ | 60     | Vdc  |
| Emitter-Base Voltage         | $V_{EBO}$ | 6.0    | Vdc  |
| Collector Current-Continuous | $I_c$     | 200    | mAdc |

### ■ THERMAL CHARACTERISTICS

| Characteristic  | Symbol          | Max                | Unit  |
|---|-----------------|--------------------|-------|
| Total Device Dissipation<br>FR-5 Board(1)<br>Derate above 25°C      | $P_D$           | 225                | mW    |
|   |                 | 1.8                | mW/°C |
| Total Device Dissipation<br>Alumina Substrate,<br>Derate above 25°C | $P_D$           | 300                | mW    |
|   |                 | 2.4                | mW/°C |
| Thermal Resistance Junction to Ambient                              | $R_{\theta JA}$ | 417                | °C/W  |
| Solder Temperature/Solder Time                                      | T/t             | 260/10             | °C/S  |
| Junction and Storage Temperature                                    | $T_J, T_{stg}$  | 150°C, -55to+150°C |       |

**■ ELECTRICAL CHARACTERISTICS**
**( $T_A=25^{\circ}\text{C}$  unless otherwise noted)**
**■ OFF CHARACTERISTICS**

| Characteristic   | Symbol        | Min | Max | Unit |
|--|---------------|-----|-----|------|
| Collector-Emitter Breakdown Voltage(3)<br>( $I_C=1.0\text{mA}$ , $I_B=0$ )     | $V_{(BR)CEO}$ | 40  | —   | Vdc  |
| Collector-Base Breakdown Voltage<br>( $I_C=10\ \mu\text{A}$ , $I_E=0$ )        | $V_{(BR)CBO}$ | 60  | —   | Vdc  |
| Emitter-Base Breakdown Voltage<br>( $I_E=10\ \mu\text{A}$ , $I_C=0$ )          | $V_{(BR)EBO}$ | 6.0 | —   | Vdc  |
| Base Cutoff Current<br>( $V_{CE}=30\text{Vdc}$ , $V_{EB}=3.0\text{Vdc}$ )      | $I_{BEX}$     | —   | 50  | nAdc |
| Collector Cutoff Current<br>( $V_{CE}=30\text{Vdc}$ , $V_{EB}=3.0\text{Vdc}$ ) | $I_{CEX}$     | —   | 50  | nAdc |

**■ ON CHARCTERISTICS(2)**

| Characteristic   | Symbol        | Min       | Max          | Unit |
|--|---------------|-----------|--------------|------|
| DC Current Gain  | $h_{FE}$      |           |              | —    |
| ( $I_C=0.1\text{mA}$ , $V_{CE}=1.0\text{Vdc}$ )  |               | 40        | —            |      |
| ( $I_C=1.0\text{mA}$ , $V_{CE}=1.0\text{Vdc}$ )  |               | 70        | —            |      |
| ( $I_C=10\text{mA}$ , $V_{CE}=1.0\text{Vdc}$ )   |               | 100       | 300          |      |
| ( $I_C=50\text{mA}$ , $V_{CE}=1.0\text{Vdc}$ )   |               | 60        | —            |      |
| ( $I_C=100\text{mA}$ , $V_{CE}=1.0\text{Vdc}$ )  |               | 30        | —            |      |
| Collector-Emitter Saturation Voltage<br>( $I_C=10\text{mA}$ , $I_B=1.0\text{mA}$ )<br>( $I_C=50\text{mA}$ , $I_B=5.0\text{mA}$ ) | $V_{CE(sat)}$ | —<br>—    | 0.25<br>0.4  | Vdc  |
| Base-Emitter Saturation Voltage<br>( $I_C=10\text{mA}$ , $I_B=1.0\text{mA}$ )<br>( $I_C=50\text{mA}$ , $I_B=5.0\text{mA}$ )      | $V_{BE(sat)}$ | 0.65<br>— | 0.85<br>0.95 | Vdc  |

**■ SMALL-SIGNAL CHARACTERISTICS**

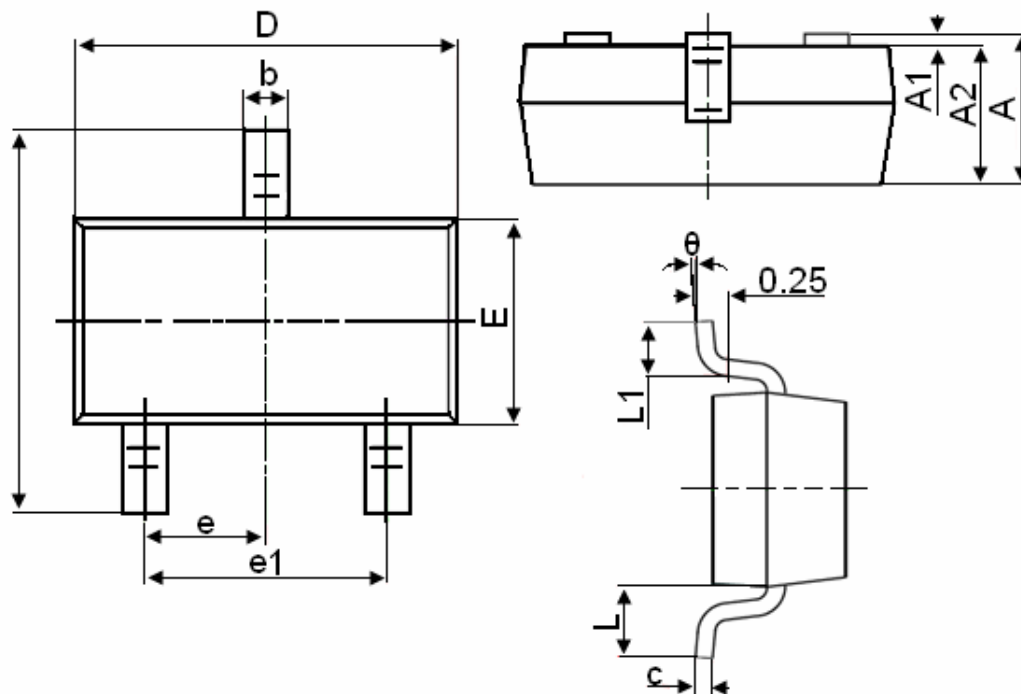
| Characteristic   | Symbol    | Min | Max | Unit              |
|--|-----------|-----|-----|-------------------|
| Current-Gain-Bandwidth Product<br>( $I_C=10\text{mA dc}$ , $V_{CE}=-20\text{V dc}$ , $f=100\text{MHz}$ )             | $f_T$     | 300 | —   | MHz               |
| Output Capacitance<br>( $V_{CB}=5.0\text{V dc}$ , $I_E=0$ , $f=1.0\text{MHz}$ )                                      | $C_{obo}$ | —   | 4.0 | pF                |
| Input Capacitance<br>( $V_{EB}=0.5\text{V dc}$ , $I_C=0$ , $f=1.0\text{MHz}$ )                                       | $C_{ibo}$ | —   | 8.0 | pF                |
| Input Impedance<br>( $V_{CE}=10\text{V dc}$ , $I_C=1.0\text{mA dc}$ , $f=1.0\text{KHz}$ )                            | $h_{ie}$  | 1.0 | 10  | $k\Omega$         |
| Voltage Feedback Ratio<br>( $V_{CE}=10\text{V dc}$ , $I_C=1.0\text{mA dc}$ , $f=1.0\text{KHz}$ )                     | $h_{re}$  | 0.5 | 8.0 | $\times 10^{-4}$  |
| Small-Signal Current Gain<br>( $V_{CE}=10\text{V dc}$ , $I_C=1.0\text{mA dc}$ , $f=1.0\text{KHz}$ )                  | $h_{fe}$  | 100 | 400 | —                 |
| Output Admittance<br>( $V_{CE}=10\text{V dc}$ , $I_C=1.0\text{mA dc}$ , $f=1.0\text{KHz}$ )                          | $h_{oe}$  | 1.0 | 40  | $\mu\text{ mhos}$ |
| Noise Figure<br>( $V_{CE}=5.0\text{V dc}$ , $I_C=100\mu\text{A dc}$ , $R_s=1.0\text{ k}\Omega$ , $f=1.0\text{KHz}$ ) | NF        | —   | 5.0 | dB                |

**■ SWITCHING CHARACTERISTICS**

| Characteristic | Symbol | Min | Max | Unit |
|----------------|--------|-----|-----|------|
| Delay Time     | $t_d$  | —   | 35  | ns   |
| Rise Time      |        |     |     |      |
| Storage Time   | $t_s$  | —   | 225 | ns   |
| Fall Time      |        |     |     |      |

$(V_{CC}=3.0\text{V dc}, V_{BE}=0.5\text{V dc}, I_C=10\text{mA dc}, I_{B1}=1.0\text{mA dc})$   
 $(V_{CC}=3.0\text{V dc}, I_C=10\text{mA dc}, I_{B1}=I_{B2}=1.0\text{mA dc})$

- FR-5=1.0×0.75×0.062in.
- Alumina=0.4×0.3×0.024in.99.5%alumina.
- Pulse Width≤300us;Duty Cycle≤2.0%.
- Pulse Test: Pulse Width≤300us;Duty Cycle≤2.0%.

**SOT-23 Package Information**


| Symbol   | Dimensions in Millimeters |       |
|----------|---------------------------|-------|
|          | MIN.                      | MAX.  |
| A        | 0.900                     | 1.150 |
| A1       | 0.000                     | 0.100 |
| A2       | 0.900                     | 1.050 |
| b        | 0.300                     | 0.500 |
| c        | 0.080                     | 0.150 |
| D        | 2.800                     | 3.000 |
| E        | 1.200                     | 1.400 |
| E1       | 2.250                     | 2.550 |
| e        | 0.950TYP                  |       |
| e1       | 1.800                     | 2.000 |
| L        | 0.550REF                  |       |
| L1       | 0.300                     | 0.500 |
| $\theta$ | 0°                        | 8°    |

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