



# TO-92 Plastic-Encapsulate Transistors

Tonghua Electronics

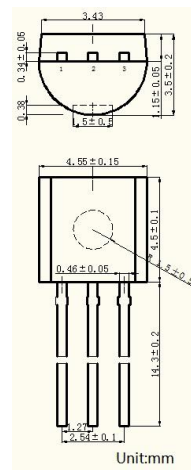
## 2N3904 TRANSISTOR (NPN)

### Features:

- NPN silicon epitaxial planar transistor for switching and Amplifier applications
- As complementary type, the PNP transistor 2N3906 is Recommended
- This transistor is also available in the SOT-23 case with the type designation MMBT3904

### MAXIMUM RATINGS ( $T_a=25^{\circ}\text{C}$ unless otherwise noted)

| Symbol    | Parameter                   | Value      | Unit               |
|-----------|-----------------------------|------------|--------------------|
| VCBO      | Collector-Base Voltage      | 60         | V                  |
| VCEO      | Collector-Emitter Voltage   | 40         | V                  |
| VEBO      | Emitter-Base Voltage        | 6          | V                  |
| $I_C$     | Collector Current           | 200        | mA                 |
| PC        | Collector Power Dissipation | 0.625      | W                  |
| $T_J$     | Junction Temperature        | 150        | $^{\circ}\text{C}$ |
| $T_{stg}$ | Storage Temperature         | -55 ~ +150 | $^{\circ}\text{C}$ |



1. EMITTER
2. BASE
3. COLLECTOR

### ELECTRICAL CHARACTERISTICS ( $T_a=25^{\circ}\text{C}$ unless otherwise specified)

| Parameter                            | Symbol        | Test conditions                                             | Min  | Typ | Max  | Unit          |
|--------------------------------------|---------------|-------------------------------------------------------------|------|-----|------|---------------|
| Collector-base breakdown voltage     | $V_{(BR)CBO}$ | $I_C=10\mu\text{A}$ , $I_E=0$                               | 60   |     |      | V             |
| Collector-emitter breakdown voltage  | $V_{(BR)CEO}$ | $I_C=1\text{mA}$ , $I_B=0$                                  | 40   |     |      | V             |
| Emitter-base breakdown voltage       | $V_{(BR)EBO}$ | $I_E=10\mu\text{A}$ , $I_C=0$                               | 6    |     |      | V             |
| Collector cut-off current            | $I_{CBO}$     | $V_{CB}=60\text{V}$ , $I_E=0$                               |      |     | 0.1  | $\mu\text{A}$ |
| Emitter cut-off current              | $I_{CEO}$     | $V_{CE}=40\text{V}$ , $I_E=0$                               |      |     | 0.1  | $\mu\text{A}$ |
| Emitter cut-off current              | $I_{EBO}$     | $V_{EB}=5\text{V}$ , $I_C=0$                                |      |     | 0.1  | $\mu\text{A}$ |
| DC current gain                      | $h_{FE(1)}$   | $V_{CE}=1\text{V}$ , $I_C=0.1\text{mA}$                     | 40   |     |      |               |
|                                      | $h_{FE(2)}$   | $V_{CE}=1\text{V}$ , $I_C=1\text{mA}$                       | 70   |     |      |               |
|                                      | $h_{FE(3)}$   | $V_{CE}=1\text{V}$ , $I_C=10\text{mA}$                      | 100  |     | 400  |               |
|                                      | $h_{FE(4)}$   | $V_{CE}=1\text{V}$ , $I_C=50\text{mA}$                      | 60   |     |      |               |
|                                      | $h_{FE(5)}$   | $V_{CE}=1\text{V}$ , $I_C=100\text{mA}$                     | 30   |     |      |               |
| Collector-emitter saturation voltage | $V_{CE(sat)}$ | $I_C=10\text{mA}$ , $I_B=1\text{mA}$                        |      |     | 0.2  | V             |
|                                      |               | $I_C=50\text{mA}$ , $I_B=5\text{mA}$                        |      |     | 0.3  | V             |
| Base-emitter saturation voltage      | $V_{BE(sat)}$ | $I_C=10\text{mA}$ , $I_B=1\text{mA}$                        | 0.65 |     | 0.85 | V             |
|                                      |               | $I_C=50\text{mA}$ , $I_B=5\text{mA}$                        |      |     | 0.95 | V             |
| Transition frequency                 | $f_T$         | $V_{CE}=20\text{V}$ , $I_C=10\text{mA}$ , $f=100\text{MHz}$ | 300  |     |      | MHz           |
| Delay Time                           | $t_d$         | $V_{CC}=3\text{V}$ , $V_{BE}=0.5\text{V}$                   |      |     | 35   | ns            |
| Rise Time                            | $t_r$         | $I_C=10\text{mA}$ , $I_{B1}=1\text{mA}$                     |      |     | 35   | ns            |
| Storage Time                         | $t_s$         | $V_{CC}=3\text{V}$ , $I_C=10\text{mA}$                      |      |     | 200  | ns            |
| Fall Time                            | $t_f$         | $I_{B1}=I_{B2}=1\text{mA}$                                  |      |     | 50   | ns            |

### CLASSIFICATION OF $h_{FE}$

| RANK  | O       | Y       | G       |
|-------|---------|---------|---------|
| RANGE | 100-200 | 200-300 | 300-400 |

# Typical Characteristics

# 2N3904

