# PMBT3904

## 40 V, 200 mA NPN switching transistor

19 April 2023 Product data sheet

## 1. General description

NPN switching transistor in a small SOT23 Surface-Mounted Device (SMD) plastic package.

PNP complement: PMBT3906

## 2. Features and benefits

- Collector current capability $I_C$ = 200 mA
- Collector-emitter voltage $V_{CEO}$ = 40 V
- AEC-Q101 qualified

## 3. Applications

- General switching and amplification

## 4. Quick reference data

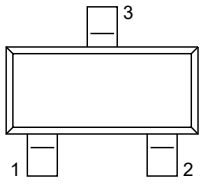
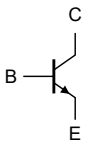
**Table 1. Quick reference data**

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{CEO}$ | collector-emitter voltage | open base | | - | - | 40 | V |
| $I_C$ | collector current | | | - | - | 200 | mA |
| $h_{FE}$ | DC current gain | $V_{CE}$ = 1 V; $I_C$ = 10 mA | [1] | 100 | - | 300 | |

[1] Pulsed test: $t_p \leq 300\ \mu s$; $\delta \leq 0.02$

## 5. Pinning information

**Table 2. Pinning information**

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|---|---|---|---|---|
| 1 | B | base |   SOT23 |   sym021 |
| 2 | E | emitter | | |
| 3 | C | collector | | |

# 6. Ordering information

**Table 3. Ordering information**

| Type number | Package | | |
|---|---|---|---|
| | Name | Description | Version |
| PMBT3904 | SOT23 | plastic, surface-mounted package; 3 terminals; 1.9 mm pitch; 2.9 mm x 1.3 mm x 1 mm body | SOT23 |

# 7. Marking

**Table 4. Marking codes**

| Type number | Marking code[1] |
|---|---|
| PMBT3904 | %1A |

[1] % = placeholder for manufacturing site code

# 8. Limiting values

**Table 5. Limiting values**

*In accordance with the Absolute Maximum Rating System (IEC 60134).*

| Symbol | Parameter | Conditions | | Min | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{CBO}$ | collector-base voltage | open emitter | | - | 60 | V |
| $V_{CEO}$ | collector-emitter voltage | open base | | - | 40 | V |
| $V_{EBO}$ | emitter-base voltage | open collector | | - | 6 | V |
| $I_C$ | collector current | | | - | 200 | mA |
| $I_{CM}$ | peak collector current | single pulse; $t_p \leq 1$ ms | | - | 200 | mA |
| $I_{BM}$ | peak base current | | | - | 100 | mA |
| $P_{tot}$ | total power dissipation | $T_{amb} \leq 25$ °C | [1] | - | 250 | mW |
| $T_j$ | junction temperature | | | - | 150 | °C |
| $T_{amb}$ | ambient temperature | | | -65 | 150 | °C |
| $T_{stg}$ | storage temperature | | | -65 | 150 | °C |

[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and standard footprint.

# 9. Thermal characteristics

**Table 6. Thermal characteristics**

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | | [1] | - | - | 500 | K/W |

[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and standard footprint.

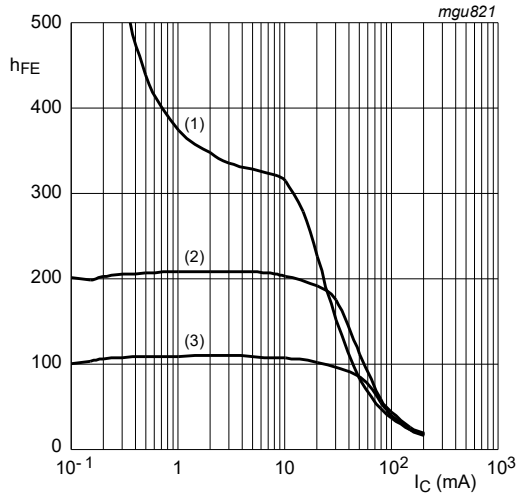
# 10. Characteristics

**Table 7. Characteristics**

*$T_{amb}$ = 25 °C unless otherwise specified.*

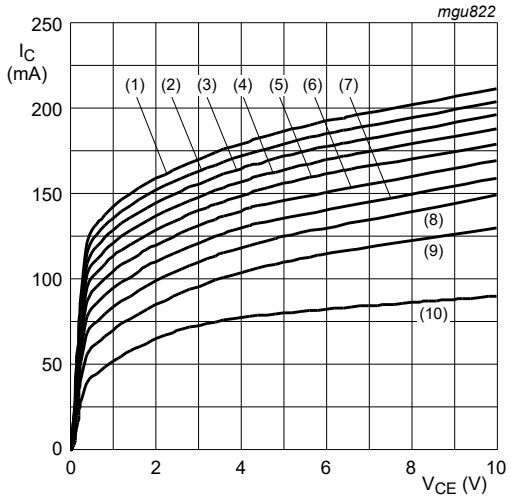
| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $I_{CBO}$ | collector-base cut-off current | $V_{CB}$ = 30 V; $I_E$ = 0 A | | - | - | 50 | nA |
| $I_{EBO}$ | emitter-base cut-off current | $V_{EB}$ = 6 V; $I_C$ = 0 A | | - | - | 50 | nA |
| $h_{FE}$ | DC current gain | $V_{CE}$ = 1 V; $I_C$ = 0.1 mA | [1] | 60 | - | - | |
| | | $V_{CE}$ = 1 V; $I_C$ = 1 mA | [1] | 80 | - | - | |
| | | $V_{CE}$ = 1 V; $I_C$ = 10 mA | [1] | 100 | - | 300 | |
| | | $V_{CE}$ = 1 V; $I_C$ = 50 mA | [1] | 60 | - | - | |
| | | $V_{CE}$ = 1 V; $I_C$ = 100 mA | [1] | 30 | - | - | |
| $V_{CEsat}$ | collector-emitter saturation voltage | $I_C$ = 10 mA; $I_B$ = 1 mA | | - | - | 200 | mV |
| | | $I_C$ = 50 mA; $I_B$ = 5 mA | | - | - | 300 | mV |
| $V_{BEsat}$ | base-emitter saturation voltage | $I_C$ = 10 mA; $I_B$ = 1 mA | | 650 | - | 850 | mV |
| | | $I_C$ = 50 mA; $I_B$ = 5 mA | | - | - | 950 | mV |
| $t_d$ | delay time | $I_C$ = 10 mA; $I_{Bon}$ = 1 mA; $I_{Boff}$ = -1 mA | | - | - | 35 | ns |
| $t_r$ | rise time | | | - | - | 35 | ns |
| $t_s$ | storage time | | | - | - | 200 | ns |
| $t_f$ | fall time | | | - | - | 50 | ns |
| $C_c$ | collector capacitance | $V_{CB}$ = 5 V; $I_E$ = 0 A; $i_e$ = 0 A; f = 1 MHz | | - | - | 4 | pF |
| $C_e$ | emitter capacitance | $V_{EB}$ = 500 mV; $I_C$ = 0 A; $i_c$ = 0 A; f = 1 MHz | | - | - | 8 | pF |
| $f_T$ | transition frequency | $V_{CE}$ = 20 V; $I_C$ = 10 mA; f = 100 MHz | | 300 | - | - | MHz |
| NF | noise figure | $V_{CE}$ = 5 V; $I_C$ = 100 µA; $R_S$ = 1 kΩ; f = 10 Hz to 15.7 kHz | | - | - | 5 | dB |

[1] Pulsed test: $t_p \leq 300$ µs; $\delta \leq 0.02$



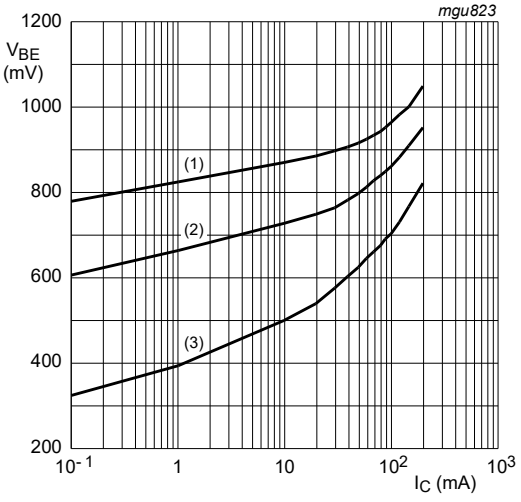

$V_{CE}$ = 1 V
(1) $T_{amb}$ = 150 °C
(2) $T_{amb}$ = 25 °C
(3) $T_{amb}$ = −55 °C

**Fig. 1. DC current gain as a function of collector current; typical values**



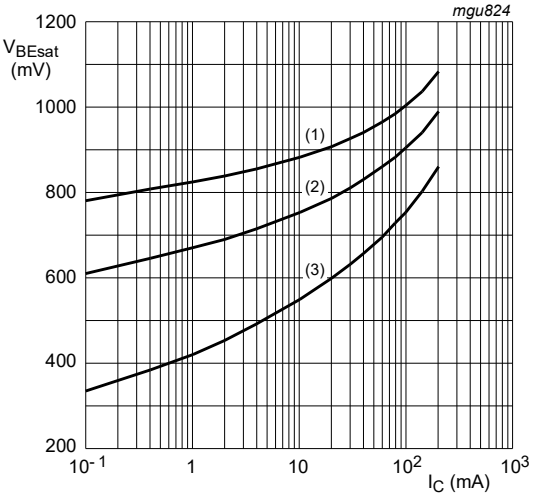

$T_{amb}$ = 25 °C
(1) $I_B$ = 5.5 mA
(2) $I_B$ = 5.0 mA
(3) $I_B$ = 4.5 mA
(4) $I_B$ = 3.5 mA
(5) $I_B$ = 3.0 mA
(6) $I_B$ = 2.5 mA
(7) $I_B$ = 2.0 mA
(8) $I_B$ = 1.5 mA
(9) $I_B$ = 1.0 mA
(10) $I_B$ = 0.5 mA

**Fig. 2. Collector current as a function of collector-emitter voltage; typical values**



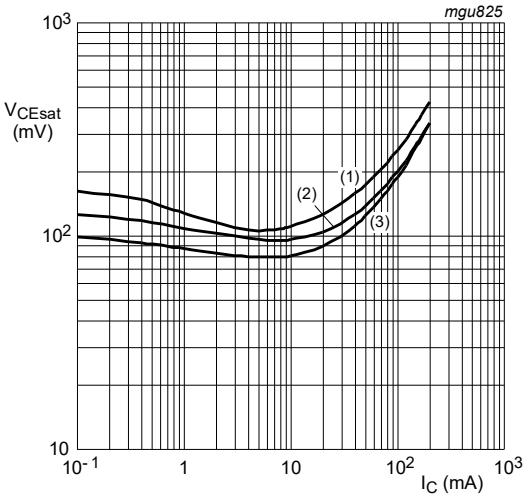

$V_{CE}$ = 1 V
(1) $T_{amb}$ = −55 °C
(2) $T_{amb}$ = 25 °C
(3) $T_{amb}$ = 150 °C

**Fig. 3. Base-emitter voltage as a function of collector current; typical values**




$I_C/I_B$ = 10
(1) $T_{amb}$ = −55 °C
(2) $T_{amb}$ = 25 °C
(3) $T_{amb}$ = 150 °C

**Fig. 4. Base-emitter saturation voltage as a function of collector current; typical values**




$I_C/I_B$ = 10
(1) $T_{amb}$ = 150 °C
(2) $T_{amb}$ = 25 °C
(3) $T_{amb}$ = −55 °C

**Fig. 5. Collector-emitter saturation voltage as a function of collector current; typical values**

## 11. Test information

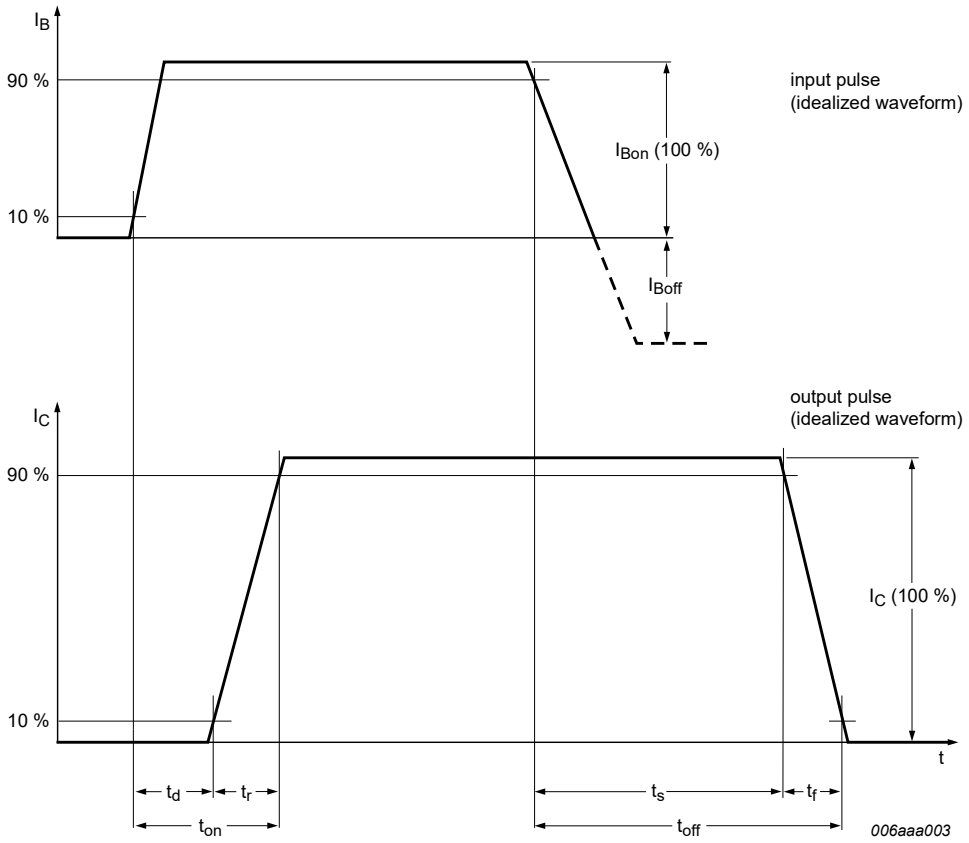



**Fig. 6. Switching time definition**

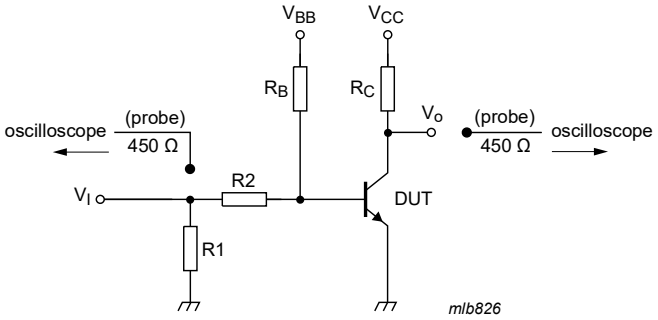



**Fig. 7. Test circuit for switching times**

### Quality information

This product has been qualified in accordance with the Automotive Electronics Council (AEC) standard *Q101 - Stress test qualification for discrete semiconductors*, and is suitable for use in automotive applications.

## 12. Package outline

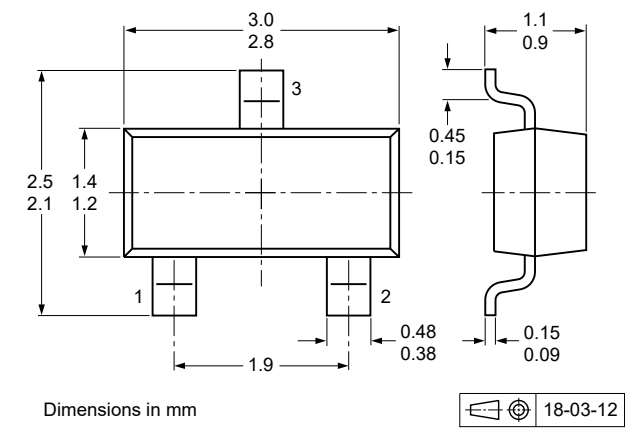



**Fig. 8. Package outline SOT23**

## 13. Soldering

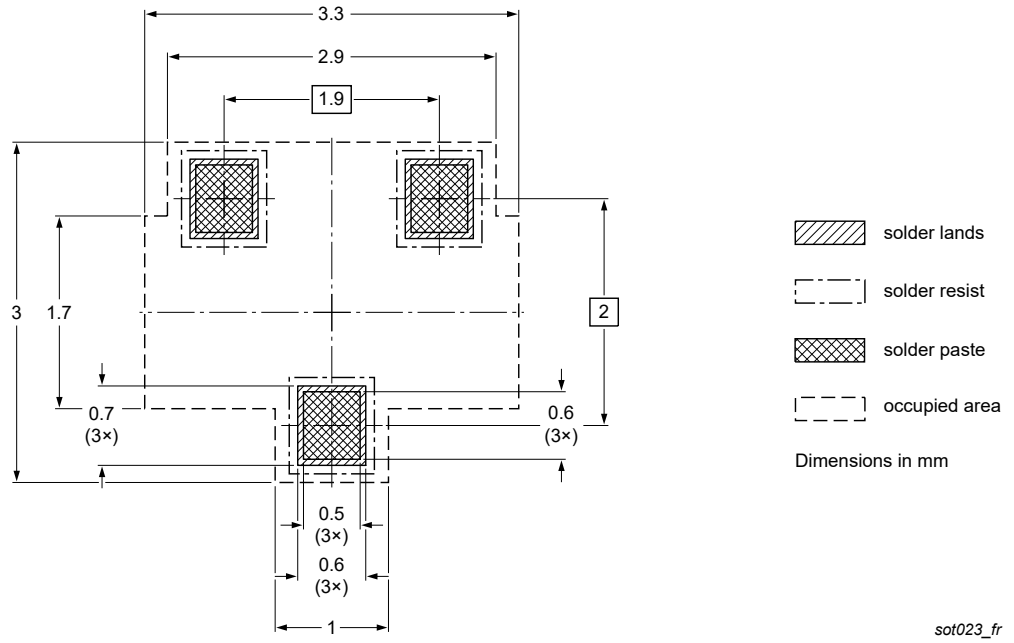



**Fig. 9. Reflow soldering footprint for SOT23**

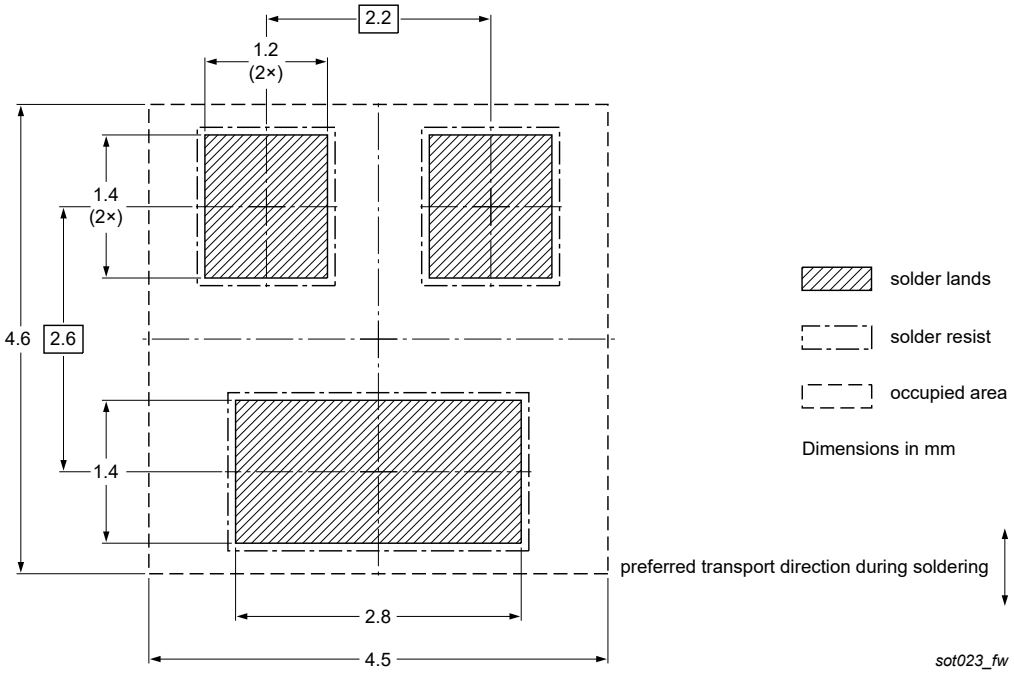



**Fig. 10. Wave soldering footprint for SOT23**

# 14. Revision history

**Table 8. Revision history**

| Data sheet ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| PMBT3904 v.4 | 20230419 | Product data sheet | - | PMBT3904 v.3 |
| Modifications: | • Data sheet changed to automotive qualification in sections Features and benefits, Test information and Legal informations. | | | |
| PMBT3904 v.3 | 20201105 | Product data sheet | - | PMBT3904 v.2 |
| PMBT3904 v.2 | 20040112 | Product data sheet | - | PMBT3904 v.1 |
| PMBT3904 v.1 | 19990427 | Product data sheet | - | - |

# 15. Legal information

## Data sheet status

| Document status [1][2] | Product status [3] | Definition |
|---|---|---|
| Objective [short] data sheet | Development | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet | Qualification | This document contains data from the preliminary specification. |
| Product [short] data sheet | Production | This document contains the product specification. |

[1] Please consult the most recently issued document before initiating or completing a design.
[2] The term 'short data sheet' is explained in section "Definitions".
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**Date of release: 19 April 2023**