



# MMBT3904

40 V, 200 mA NPN switching transistor

11 April 2024

Product data sheet

## 1. General description

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

PNP complement: MMBT3906

## 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

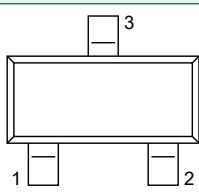
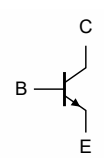
## 4. Quick reference data

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; $t_p \leq 300$ $\mu$ s; $\delta \leq 0.02$ ; $T_{amb} = 25$ °C	100	-	300	

## 5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	B	base	 SOT23	 aaa-027673
2	E	emitter		
3	C	collector		

## 6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
<a href="#">MMBT3904</a>	SOT23	plastic, surface-mounted package; 3 terminals; 1.9 mm pitch; 2.9 mm x 1.3 mm x 1 mm body	<a href="#">SOT23</a>

## 7. Marking

Table 4. Marking codes

Type number	Marking code[1]
MMBT3904	7A%

[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		-	200	mA
$I_{BM}$	peak base current		-	100	mA
$P_{tot}$	total power dissipation	$T_{amb} \leq 25\text{ °C}$	[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

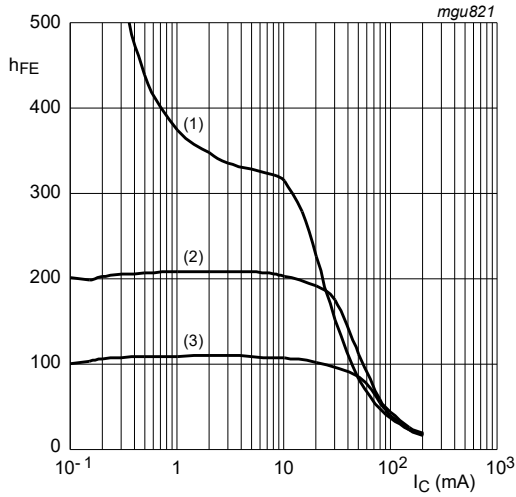
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient		[1]	-	500	K/W

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

## 10. Characteristics

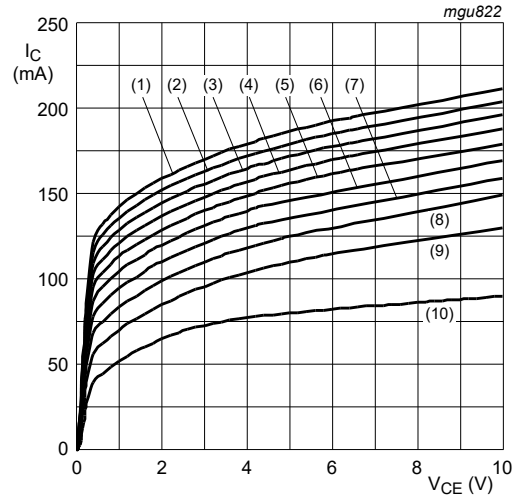
Table 7. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$I_{CBO}$	collector-base cut-off current	$V_{CB} = 30\text{ V}; I_E = 0\text{ A}; T_{amb} = 25\text{ °C}$	-	-	50	nA
$I_{EBO}$	emitter-base cut-off current	$V_{EB} = 6\text{ V}; I_C = 0\text{ A}; T_{amb} = 25\text{ °C}$	-	-	50	nA
$h_{FE}$	DC current gain	$V_{CE} = 1\text{ V}; I_C = 0.1\text{ mA}; t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.02; T_{amb} = 25\text{ °C}$	60	-	-	
		$V_{CE} = 1\text{ V}; I_C = 1\text{ mA}; t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.02; T_{amb} = 25\text{ °C}$	80	-	-	
		$V_{CE} = 1\text{ V}; I_C = 10\text{ mA}; t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.02; T_{amb} = 25\text{ °C}$	100	-	300	
		$V_{CE} = 1\text{ V}; I_C = 50\text{ mA}; t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.02; T_{amb} = 25\text{ °C}$	60	-	-	
		$V_{CE} = 1\text{ V}; I_C = 100\text{ mA}; t_p \leq 300\text{ }\mu\text{s}; \delta \leq 0.02; T_{amb} = 25\text{ °C}$	30	-	-	
$V_{CEsat}$	collector-emitter saturation voltage	$I_C = 10\text{ mA}; I_B = 1\text{ mA}; T_{amb} = 25\text{ °C}$	-	-	200	mV
		$I_C = 50\text{ mA}; I_B = 5\text{ mA}; T_{amb} = 25\text{ °C}$	-	-	300	mV
$V_{BEsat}$	base-emitter saturation voltage	$I_C = 10\text{ mA}; I_B = 1\text{ mA}; T_{amb} = 25\text{ °C}$	650	-	850	mV
		$I_C = 50\text{ mA}; I_B = 5\text{ mA}; T_{amb} = 25\text{ °C}$	-	-	950	mV
$C_c$	collector capacitance	$V_{CB} = 5\text{ V}; I_E = 0\text{ A}; i_e = 0\text{ A}; f = 1\text{ MHz}; T_{amb} = 25\text{ °C}$	-	-	4	pF
$C_e$	emitter capacitance	$V_{EB} = 500\text{ mV}; I_C = 0\text{ A}; i_c = 0\text{ A}; f = 1\text{ MHz}; T_{amb} = 25\text{ °C}$	-	-	8	pF
$f_T$	transition frequency	$V_{CE} = 20\text{ V}; I_C = 10\text{ mA}; f = 100\text{ MHz}; T_{amb} = 25\text{ °C}$	300	-	-	MHz
NF	noise figure	$V_{CE} = 5\text{ V}; I_C = 100\text{ }\mu\text{A}; R_S = 1\text{ k}\Omega; f = 10\text{ Hz to }15.7\text{ kHz}; T_{amb} = 25\text{ °C}$	-	-	5	dB
<b>Switching times (between 10% and 90% levels);</b>						
$t_d$	delay time	$I_C = 10\text{ mA}; I_{Bon} = 1\text{ mA}; I_{Boff} = -1\text{ mA}; T_{amb} = 25\text{ °C}$	-	-	35	ns
$t_r$	rise time		-	-	35	ns
$t_s$	storage time		-	-	200	ns
$t_f$	fall time		-	-	50	ns



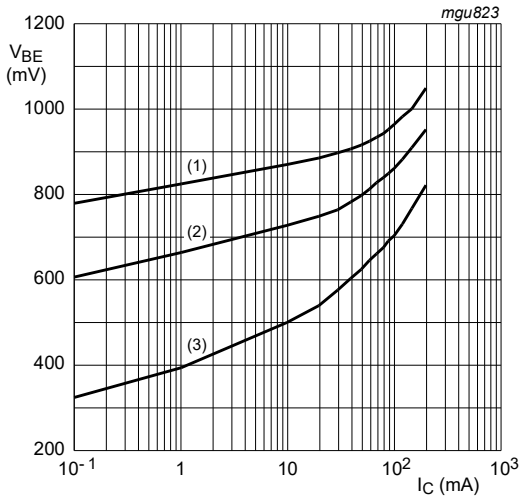
$V_{CE} = 1\text{ V}$   
 (1)  $T_{amb} = 150\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -55\text{ °C}$

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



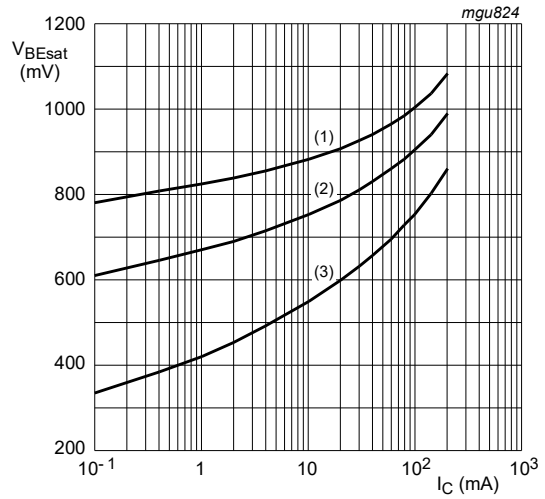
$T_{amb} = 25\text{ °C}$   
 (1)  $I_B = 5.0\text{ mA}$   
 (2)  $I_B = 4.5\text{ mA}$   
 (3)  $I_B = 4.0\text{ mA}$   
 (4)  $I_B = 3.5\text{ mA}$   
 (5)  $I_B = 3.0\text{ mA}$   
 (6)  $I_B = 2.5\text{ mA}$   
 (7)  $I_B = 2.0\text{ mA}$   
 (8)  $I_B = 1.5\text{ mA}$   
 (9)  $I_B = 1.0\text{ mA}$   
 (10)  $I_B = 0.5\text{ mA}$

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



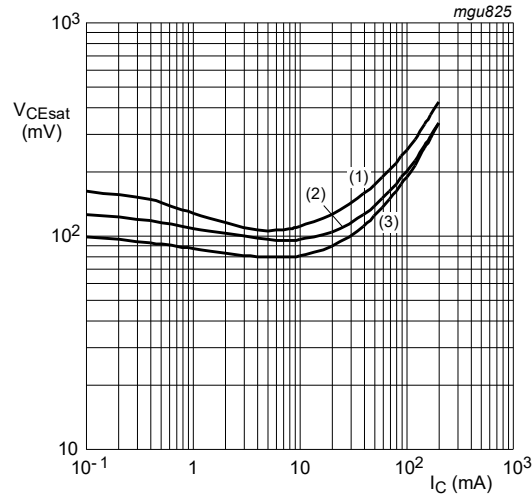
$V_{CE} = 1\text{ V}$   
 (1)  $T_{amb} = -55\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = 150\text{ °C}$

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



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

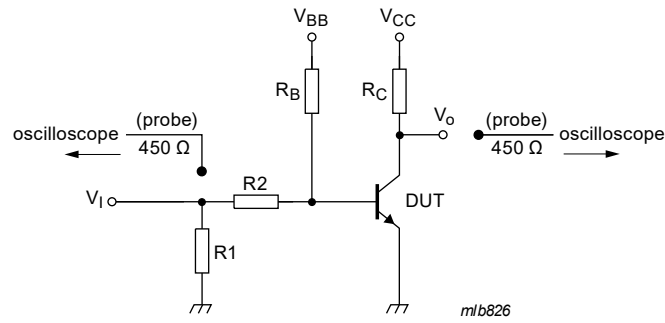
**Fig. 4. Base-emitter saturation voltage as a function of collector current; typical values**



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

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

## 11. Test information



$V_1 = 5\text{ V}$ ;  $T = 500\text{ }\mu\text{s}$ ;  $t_p = 10\text{ }\mu\text{s}$ ;  $t_r = t_f \leq 3\text{ ns}$ .  
 $R_1 = 56\text{ }\Omega$ ;  $R_2 = 2.5\text{ k}\Omega$ ;  $R_B = 3.9\text{ k}\Omega$ ;  $R_C = 270\text{ }\Omega$ .  
 $V_{BB} = -1.9\text{ V}$ ;  $V_{CC} = 3\text{ V}$ .  
 Oscilloscope: input impedance  $Z_i = 50\text{ }\Omega$ .

Fig. 6. 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

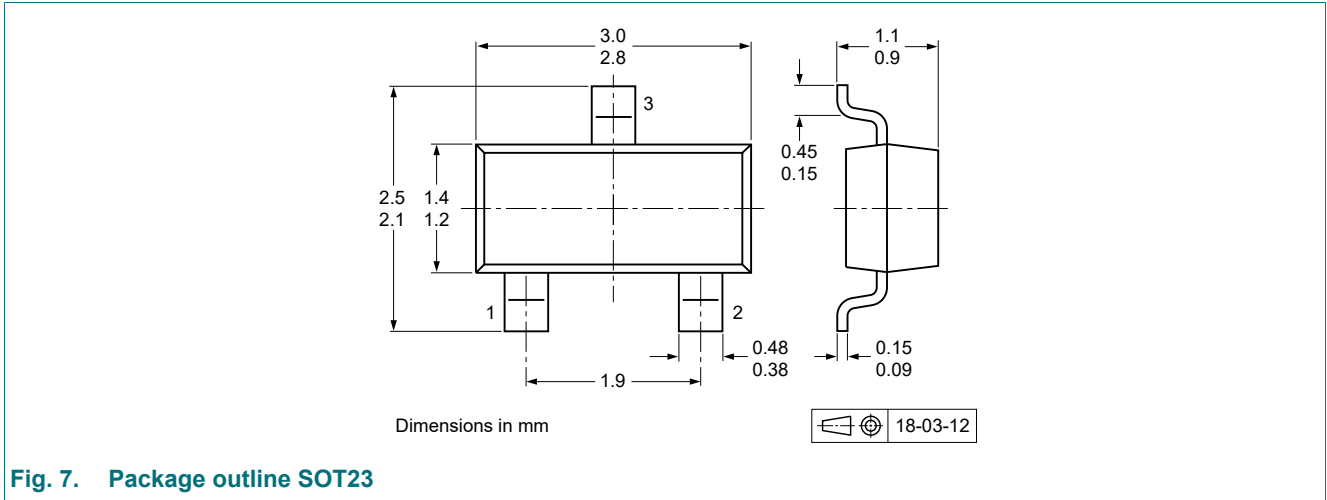


Fig. 7. Package outline SOT23

## 13. Soldering

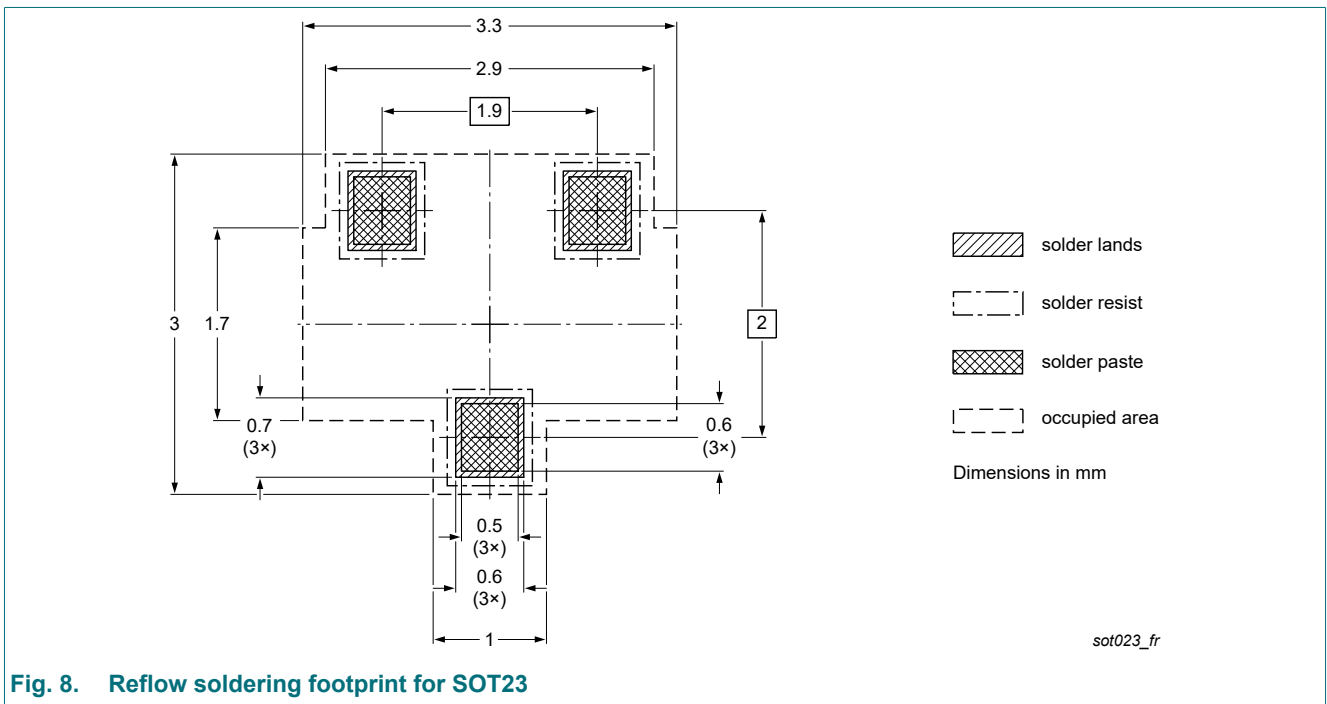


Fig. 8. Reflow soldering footprint for SOT23

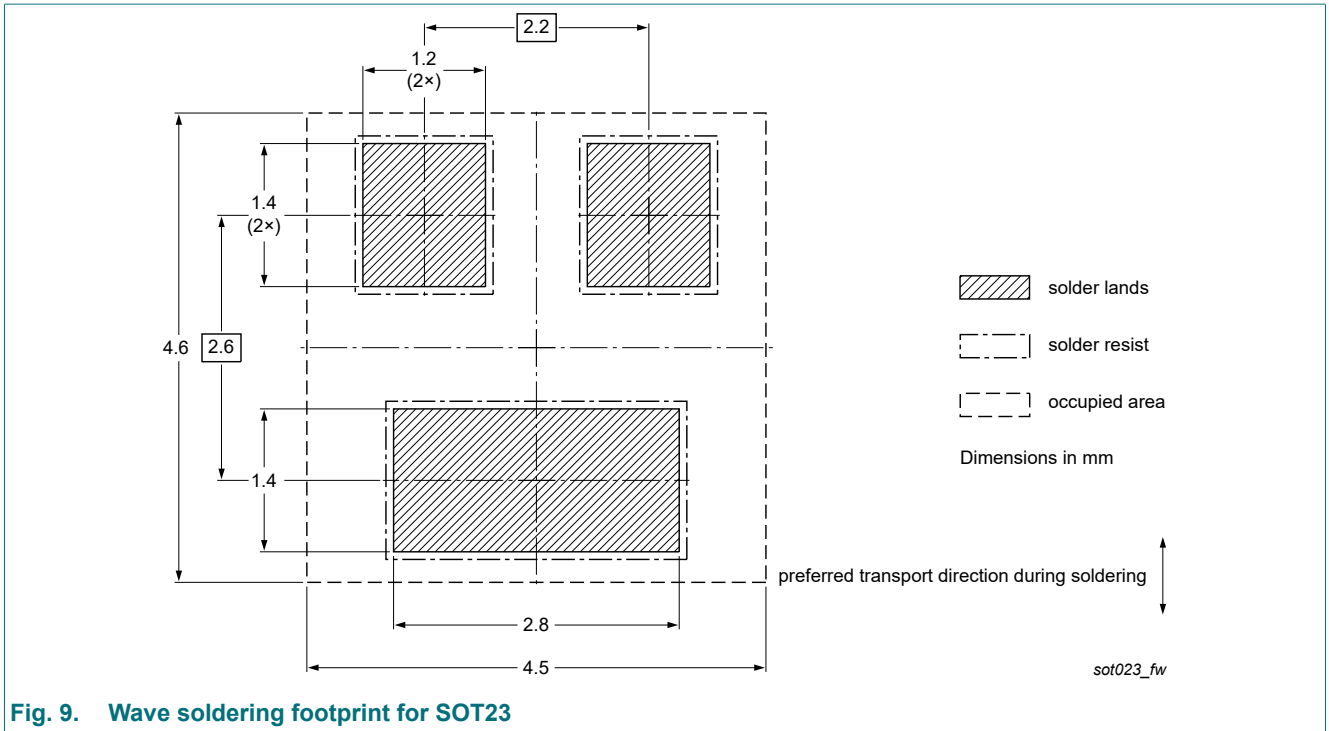


Fig. 9. Wave soldering footprint for SOT23

## 14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
MMBT3904 v.3	20240411	Product data sheet	-	MMBT3904 v.2
Modifications:	<ul style="list-style-type: none"><li>The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia.</li><li>Legal texts have been adapted to the new company name where appropriate.</li></ul>			
MMBT3904 v.2	20040203	Product data sheet	-	MMBT3904 v.1
MMBT3904 v.1	20021004	Product specification	-	-



## 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".
- [3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the internet at <https://www.nexperia.com>.

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