



MMBT3904-Q

40 V, 200 mA NPN switching transistor

7 October 2022

Product data sheet

1. General description

NPN switching transistor in a small SOT23 (SC-70) 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
- Qualified according to AEC-Q101 and recommended for use in automotive applications

3. Applications

- General switching and amplification

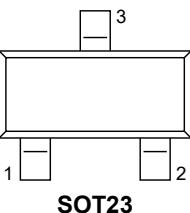
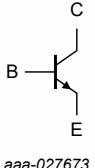
4. Quick reference data

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; $t_p \leq 300$ μ 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		
2	E	emitter		
3	C	collector	 SOT23	 aaa-027673

6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
MMBT3904-Q	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]
MMBT3904-Q	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	$T_{amb} \leq 25^\circ\text{C}$	[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.

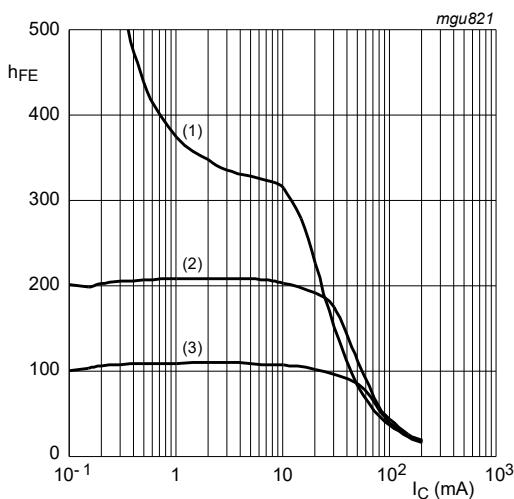
10. Characteristics

Table 7. Characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
I_{CBO}	collector-base cut-off current	$V_{CB} = 30 \text{ V}$; $I_E = 0 \text{ A}$; $T_{amb} = 25 \text{ }^\circ\text{C}$		-	-	50	nA
I_{EBO}	emitter-base cut-off current	$V_{EB} = 6 \text{ V}$; $I_C = 0 \text{ A}$; $T_{amb} = 25 \text{ }^\circ\text{C}$		-	-	50	nA
h_{FE}	DC current gain	$V_{CE} = 1 \text{ V}$; $I_C = 0.1 \text{ mA}$; $t_p \leq 300 \text{ } \mu\text{s}$; $\delta \leq 0.02$; $T_{amb} = 25 \text{ }^\circ\text{C}$		60	-	-	
		$V_{CE} = 1 \text{ V}$; $I_C = 1 \text{ mA}$; $t_p \leq 300 \text{ } \mu\text{s}$; $\delta \leq 0.02$; $T_{amb} = 25 \text{ }^\circ\text{C}$		80	-	-	
		$V_{CE} = 1 \text{ V}$; $I_C = 10 \text{ mA}$; $t_p \leq 300 \text{ } \mu\text{s}$; $\delta \leq 0.02$; $T_{amb} = 25 \text{ }^\circ\text{C}$		100	-	300	
		$V_{CE} = 1 \text{ V}$; $I_C = 50 \text{ mA}$; $t_p \leq 300 \text{ } \mu\text{s}$; $\delta \leq 0.02$; $T_{amb} = 25 \text{ }^\circ\text{C}$		60	-	-	
		$V_{CE} = 1 \text{ V}$; $I_C = 100 \text{ mA}$; $t_p \leq 300 \text{ } \mu\text{s}$; $\delta \leq 0.02$; $T_{amb} = 25 \text{ }^\circ\text{C}$		30	-	-	
V_{CEsat}	collector-emitter saturation voltage	$I_C = 10 \text{ mA}$; $I_B = 1 \text{ mA}$; $T_{amb} = 25 \text{ }^\circ\text{C}$		-	-	200	mV
		$I_C = 50 \text{ mA}$; $I_B = 5 \text{ mA}$; $T_{amb} = 25 \text{ }^\circ\text{C}$		-	-	300	mV
V_{BEsat}	base-emitter saturation voltage	$I_C = 10 \text{ mA}$; $I_B = 1 \text{ mA}$; $T_{amb} = 25 \text{ }^\circ\text{C}$		650	-	850	mV
		$I_C = 50 \text{ mA}$; $I_B = 5 \text{ mA}$; $T_{amb} = 25 \text{ }^\circ\text{C}$		-	-	950	mV
C_c	collector capacitance	$V_{CB} = 5 \text{ V}$; $I_E = 0 \text{ A}$; $i_e = 0 \text{ A}$; $f = 1 \text{ MHz}$; $T_{amb} = 25 \text{ }^\circ\text{C}$		-	-	4	pF
C_e	emitter capacitance	$V_{EB} = 500 \text{ mV}$; $I_C = 0 \text{ A}$; $i_c = 0 \text{ A}$; $f = 1 \text{ MHz}$; $T_{amb} = 25 \text{ }^\circ\text{C}$		-	-	8	pF
f_T	transition frequency	$V_{CE} = 20 \text{ V}$; $I_C = 10 \text{ mA}$; $f = 100 \text{ MHz}$; $T_{amb} = 25 \text{ }^\circ\text{C}$		300	-	-	MHz
NF	noise figure	$V_{CE} = 5 \text{ V}$; $I_C = 100 \mu\text{A}$; $R_S = 1 \text{ k}\Omega$; $f = 10 \text{ Hz to } 15.7 \text{ kHz}$; $T_{amb} = 25 \text{ }^\circ\text{C}$		-	-	5	dB

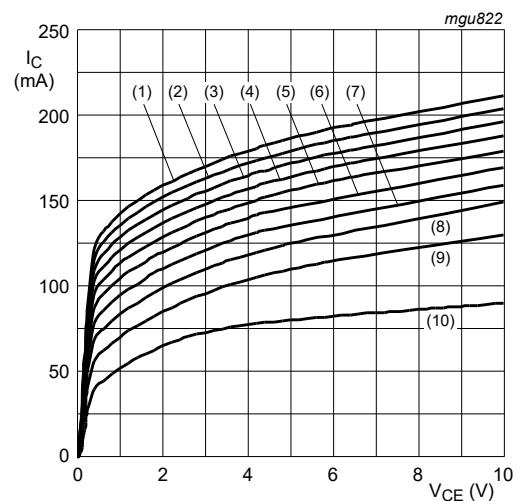
Switching times (between 10% and 90% levels);

t_d	delay time	$I_C = 10 \text{ mA}$; $I_{Bon} = 1 \text{ mA}$; $I_{Boff} = -1 \text{ mA}$; $T_{amb} = 25 \text{ }^\circ\text{C}$		-	-	35	ns
t_r	rise time			-	-	35	ns
t_s	storage time			-	-	200	ns
t_f	fall time			-	-	50	ns



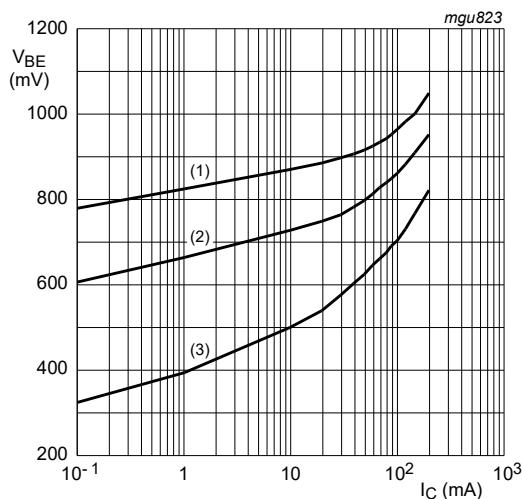
$V_{CE} = 1 \text{ V}$
 (1) $T_{amb} = 150 \text{ }^{\circ}\text{C}$
 (2) $T_{amb} = 25 \text{ }^{\circ}\text{C}$
 (3) $T_{amb} = -55 \text{ }^{\circ}\text{C}$

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



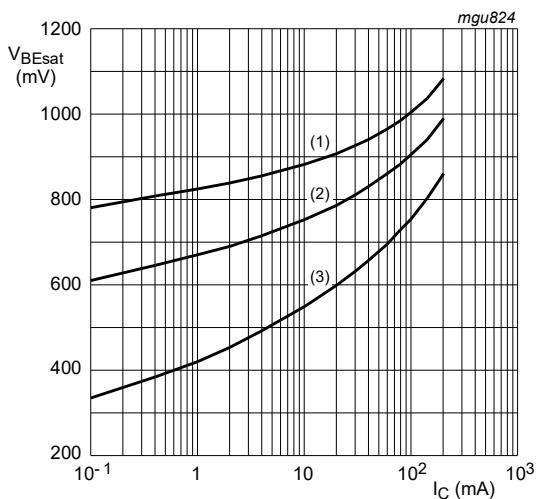
$T_{amb} = 25 \text{ }^{\circ}\text{C}$
 (1) $I_B = 5.5 \text{ mA}$
 (2) $I_B = 5.0 \text{ mA}$
 (3) $I_B = 4.5 \text{ mA}$
 (4) $I_B = 3.5 \text{ mA}$
 (5) $I_B = 3.0 \text{ mA}$
 (6) $I_B = 2.5 \text{ mA}$
 (7) $I_B = 2.0 \text{ mA}$
 (8) $I_B = 1.5 \text{ mA}$
 (9) $I_B = 1.0 \text{ mA}$
 (10) $I_B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

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



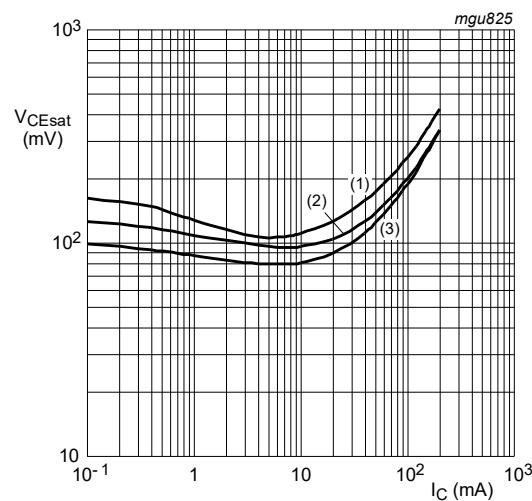
$V_{CE} = 1 \text{ V}$
 (1) $T_{amb} = -55 \text{ }^{\circ}\text{C}$
 (2) $T_{amb} = 25 \text{ }^{\circ}\text{C}$
 (3) $T_{amb} = 150 \text{ }^{\circ}\text{C}$

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



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

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



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

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

11. Test information

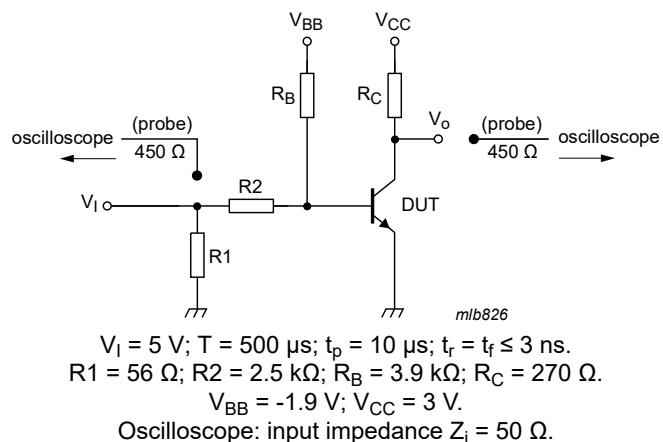


Fig. 6. Test circuit for switching times

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

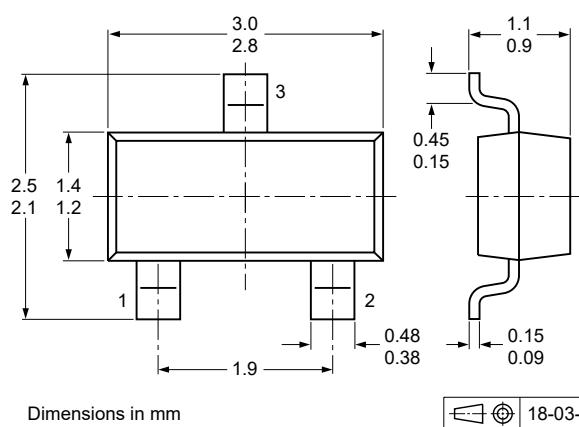


Fig. 7. Package outline SOT23

13. Soldering

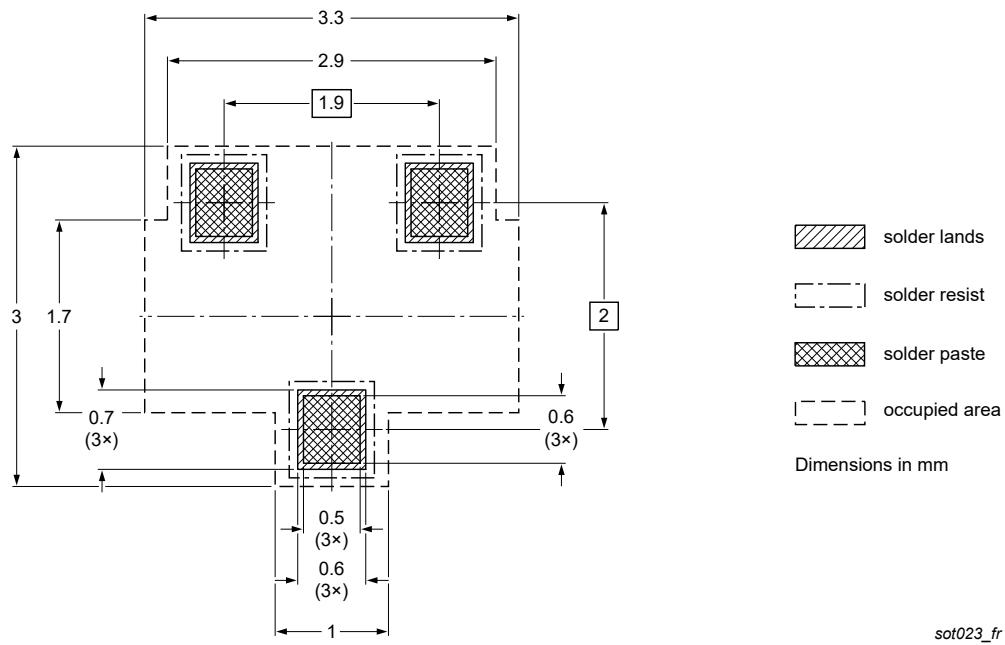


Fig. 8. Reflow soldering footprint for SOT23

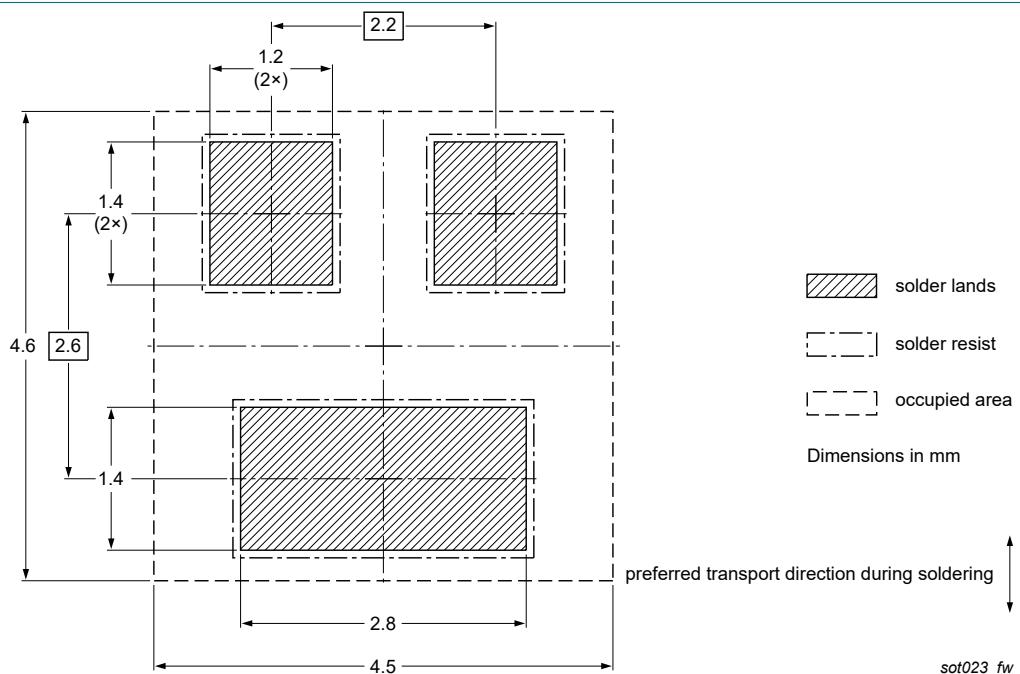


Fig. 9. Wave soldering footprint for SOT23

14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
MMBT3904-Q v.1	20221007	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.

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- [2] The term 'short data sheet' is explained in section "Definitions".
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