



# 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

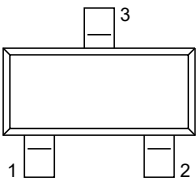
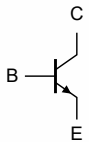
## 4. Quick reference data

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        | <br>SOT23 | <br>aaa-027673 |
| 2   | E      | emitter     |  |   |
| 3   | C      | collector   |  |   |

6. Ordering information

Table 3. Ordering information

| Type number | Package |  |         |
|-------------|---------|--|---------|
|             | Name    | Description  | Version |
| MMBT3904    | 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    | 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 <sub>CBO</sub> | collector-base voltage    | open emitter             |     | -   | 60  | V    |
| V <sub>CEO</sub> | collector-emitter voltage | open base                |     | -   | 40  | V    |
| V <sub>EBO</sub> | emitter-base voltage      | open collector           |     | -   | 6   | V    |
| I <sub>C</sub>   | collector current         |                          |     | -   | 200 | mA   |
| I <sub>CM</sub>  | peak collector current    |                          |     | -   | 200 | mA   |
| I <sub>BM</sub>  | peak base current         |                          |     | -   | 100 | mA   |
| P <sub>tot</sub> | total power dissipation   | T <sub>amb</sub> ≤ 25 °C | [1] | -   | 250 | mW   |
| T <sub>j</sub>   | junction temperature      |                          |     | -   | 150 | °C   |
| T <sub>amb</sub> | ambient temperature       |                          |     | -65 | 150 | °C   |
| T <sub>stg</sub> | 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 <sub>th(j-a)</sub> | 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 <sub>CBO</sub>                              | collector-base cut-off current       | V <sub>CB</sub> = 30 V; I <sub>E</sub> = 0 A; T <sub>amb</sub> = 25 °C   |  | -   | -   | 50  | nA   |
| I <sub>EBO</sub>                              | emitter-base cut-off current         | V <sub>EB</sub> = 6 V; I <sub>C</sub> = 0 A; T <sub>amb</sub> = 25 °C  |  | -   | -   | 50  | nA   |
| h <sub>FE</sub>                               | DC current gain                      | V <sub>CE</sub> = 1 V; I <sub>C</sub> = 0.1 mA; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02; T <sub>amb</sub> = 25 °C            |  | 60  | -   | -   |      |
|   |                                      | V <sub>CE</sub> = 1 V; I <sub>C</sub> = 1 mA; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02; T <sub>amb</sub> = 25 °C              |  | 80  | -   | -   |      |
|   |                                      | V <sub>CE</sub> = 1 V; I <sub>C</sub> = 10 mA; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02; T <sub>amb</sub> = 25 °C             |  | 100 | -   | 300 |      |
|   |                                      | V <sub>CE</sub> = 1 V; I <sub>C</sub> = 50 mA; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02; T <sub>amb</sub> = 25 °C             |  | 60  | -   | -   |      |
|   |                                      | V <sub>CE</sub> = 1 V; I <sub>C</sub> = 100 mA; t <sub>p</sub> ≤ 300 μs; δ ≤ 0.02; T <sub>amb</sub> = 25 °C            |  | 30  | -   | -   |      |
| V <sub>CEsat</sub>                            | collector-emitter saturation voltage | I <sub>C</sub> = 10 mA; I <sub>B</sub> = 1 mA; T <sub>amb</sub> = 25 °C  |  | -   | -   | 200 | mV   |
|   |                                      | I <sub>C</sub> = 50 mA; I <sub>B</sub> = 5 mA; T <sub>amb</sub> = 25 °C  |  | -   | -   | 300 | mV   |
| V <sub>BEsat</sub>                            | base-emitter saturation voltage      | I <sub>C</sub> = 10 mA; I <sub>B</sub> = 1 mA; T <sub>amb</sub> = 25 °C  |  | 650 | -   | 850 | mV   |
|   |                                      | I <sub>C</sub> = 50 mA; I <sub>B</sub> = 5 mA; T <sub>amb</sub> = 25 °C  |  | -   | -   | 950 | mV   |
| C <sub>c</sub>                                | collector capacitance                | V <sub>CB</sub> = 5 V; I <sub>E</sub> = 0 A; i <sub>e</sub> = 0 A; f = 1 MHz; T <sub>amb</sub> = 25 °C                 |  | -   | -   | 4   | pF   |
| C <sub>e</sub>                                | emitter capacitance                  | V <sub>EB</sub> = 500 mV; I <sub>C</sub> = 0 A; i <sub>c</sub> = 0 A; f = 1 MHz; T <sub>amb</sub> = 25 °C              |  | -   | -   | 8   | pF   |
| f <sub>T</sub>                                | transition frequency                 | V <sub>CE</sub> = 20 V; I <sub>C</sub> = 10 mA; f = 100 MHz; T <sub>amb</sub> = 25 °C                                  |  | 300 | -   | -   | MHz  |
| NF  | noise figure                         | V <sub>CE</sub> = 5 V; I <sub>C</sub> = 100 μA; R <sub>S</sub> = 1 kΩ; f = 10 Hz to 15.7 kHz; T <sub>amb</sub> = 25 °C |  | -   | -   | 5   | dB   |
| Switching times (between 10% and 90% levels); |                                      |  |  |     |     |     |      |
| t <sub>d</sub>                                | delay time                           | I <sub>C</sub> = 10 mA; I <sub>Bon</sub> = 1 mA; I <sub>Boff</sub> = -1 mA; T <sub>amb</sub> = 25 °C                   |  | -   | -   | 35  | ns   |
| t <sub>r</sub>                                | rise time                            |  |  | -   | -   | 35  | ns   |
| t <sub>s</sub>                                | storage time                         |  |  | -   | -   | 200 | ns   |
| t <sub>f</sub>                                | fall time                            |  |  | -   | -   | 50  | ns   |

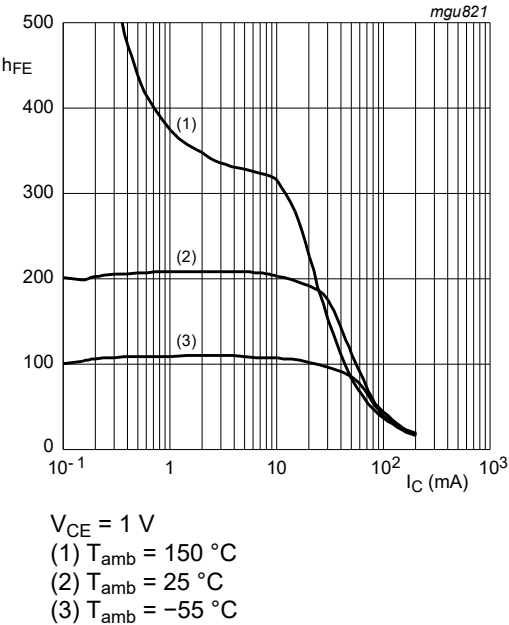


Fig. 1. DC current gain as a function of collector current; typical values

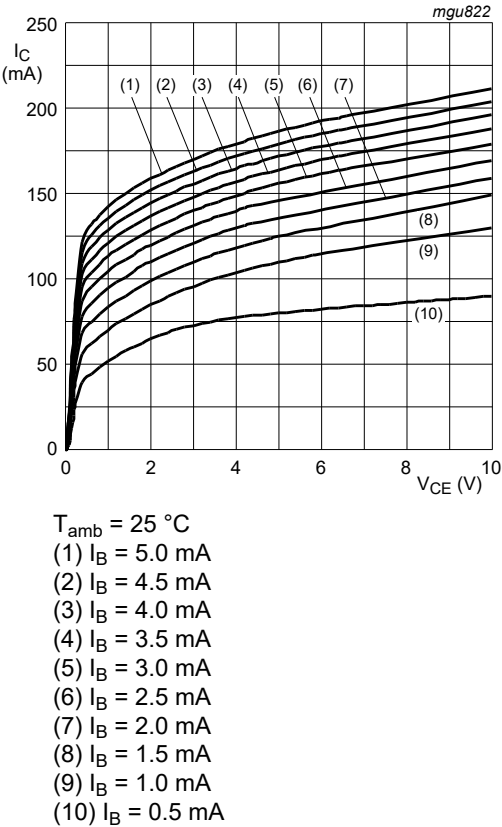


Fig. 2. Collector current as a function of collector-emitter voltage; typical values

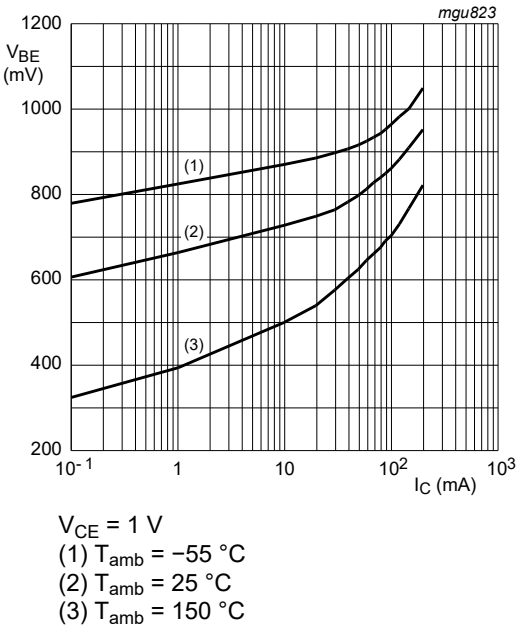


Fig. 3. Base-emitter voltage as a function of collector current; typical values

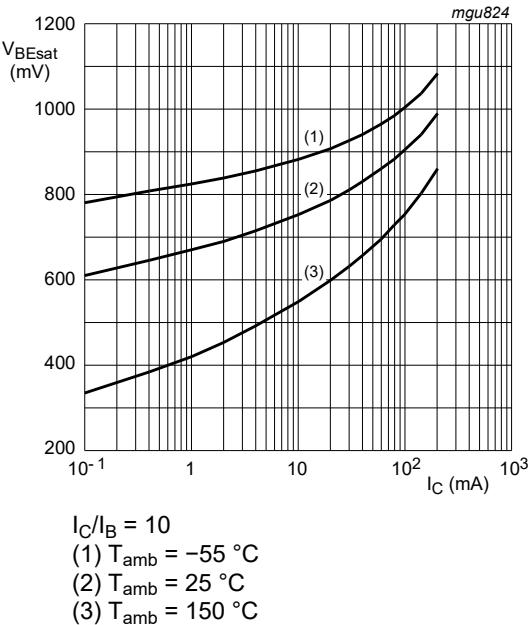
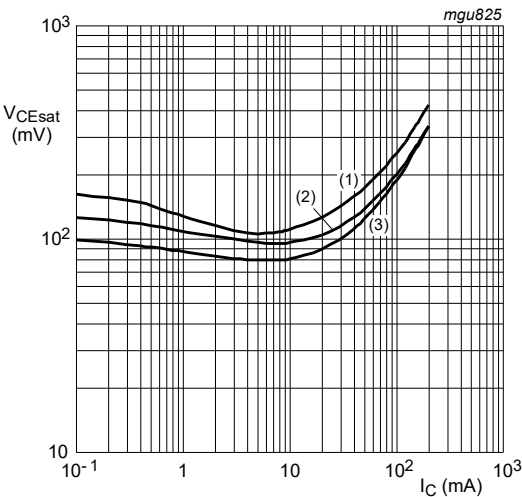


Fig. 4. Base-emitter saturation voltage as a function of collector current; typical values



$I_C/I_B = 10$   
(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

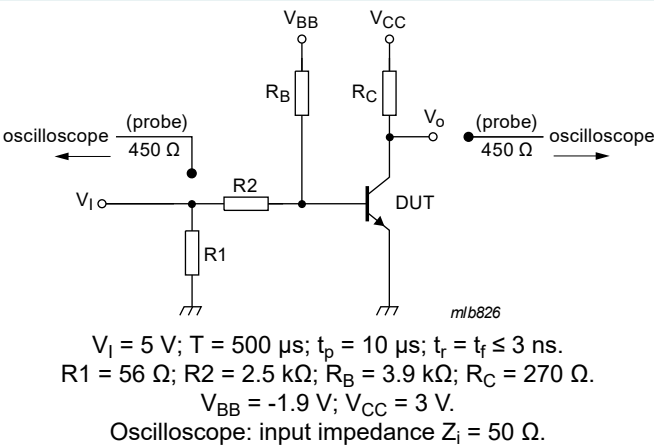
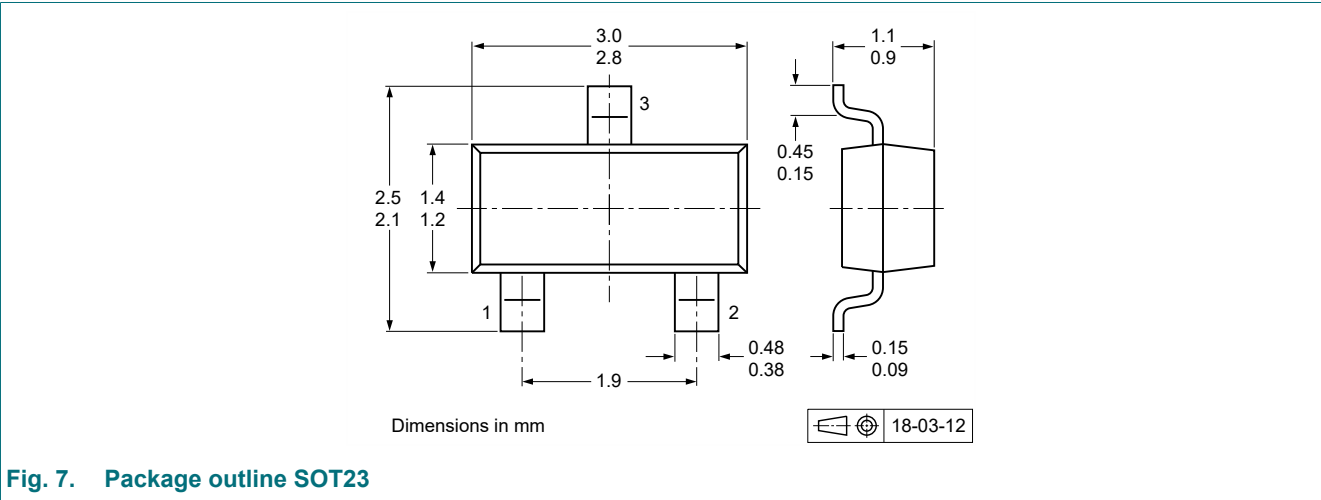


Fig. 6. Test circuit for switching times

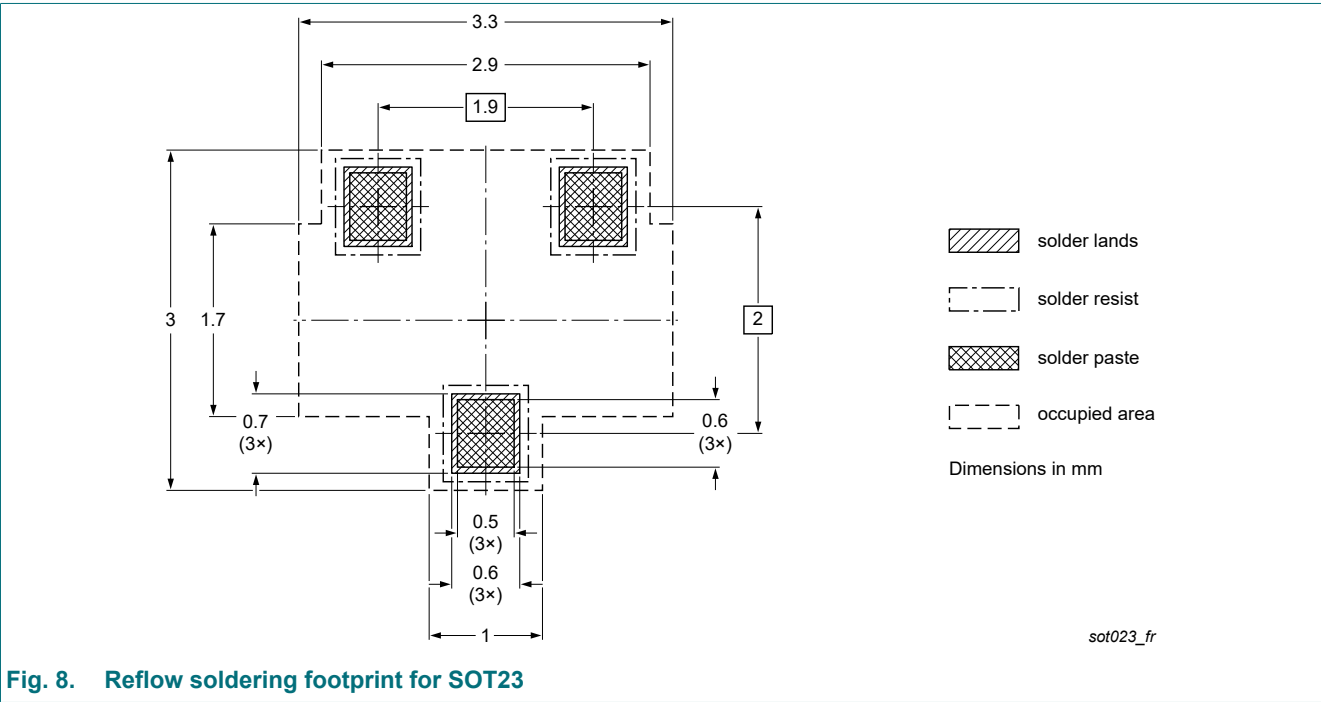
Quality information

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



13. Soldering



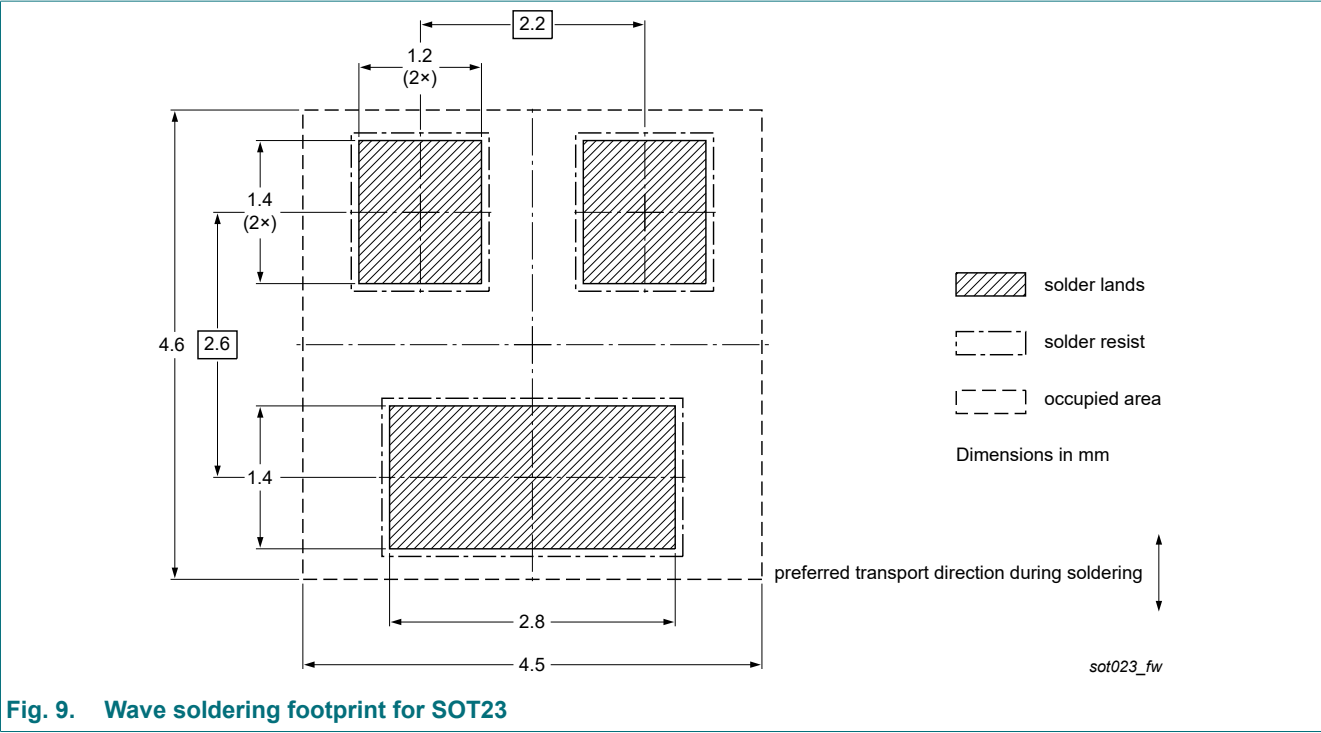


Fig. 9. Wave soldering footprint for SOT23

## 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".
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