



# PBL6002D-Q

60 V, 1 A PNP/NPN loadswitch double transistor

26 October 2023

Product data sheet

## 1. General description

PNP low  $V_{CEsat}$  transistor and NPN Resistor-Equipped Transistor (RET) in a SOT457 (SC-74) small Surface Mounted Device (SMD) plastic package.

## 2. Features and benefits

- Low  $V_{CEsat}$  transistor and resistor-equipped transistor in one package
- Low threshold voltage ( $< 1$  V) compared to MOSFET
- Low drive power required
- Space-saving solution
- Reduction of component count
- Qualified according to AEC-Q101 and recommended for use in automotive applications

## 3. Applications

- Supply line switches
- Battery charger switches
- High-side switches for LEDs, drivers and backlights
- Portable equipment

## 4. Quick reference data

Table 1. Quick reference data

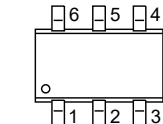
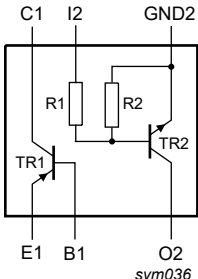
| Symbol                                                | Parameter                               | Conditions                                              |     | Min | Typ | Max | Unit |
|-------------------------------------------------------|-----------------------------------------|---------------------------------------------------------|-----|-----|-----|-----|------|
| <b>TR1; PNP low <math>V_{CEsat}</math> transistor</b> |                                         |                                                         |     |     |     |     |      |
| $V_{CEO}$                                             | collector-emitter voltage               | open base                                               |     | -   | -   | -60 | V    |
| $I_C$                                                 | collector current                       |                                                         | [1] | -   | -   | -1  | A    |
| $R_{CEsat}$                                           | collector-emitter saturation resistance | $I_C = -1000$ mA; $I_B = -100$ mA;<br>$T_{amb} = 25$ °C | [2] | -   | 255 | 340 | mΩ   |
| <b>TR2; NPN resistor-equipped transistor</b>          |                                         |                                                         |     |     |     |     |      |
| $V_{CEO}$                                             | collector-emitter voltage               | open base                                               |     | -   | -   | 50  | V    |
| $I_O$                                                 | output current                          |                                                         |     | -   | -   | 100 | mA   |
| R1                                                    | bias resistor 1 (input)                 |                                                         |     | 3.3 | 4.7 | 6.1 | kΩ   |
| R2/R1                                                 | bias resistor ratio                     |                                                         |     | 0.8 | 1   | 1.2 |      |

[1] Device mounted on a ceramic PCB,  $Al_2O_3$ , standard footprint.

[2] Pulse test:  $t_p \leq 300$  μs;  $\delta \leq 0.02$

5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description            | Simplified outline                                                                                  | Graphic symbol                                                                                |
|-----|--------|------------------------|-----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| 1   | E1     | emitter TR1            | <br>TSOP6 (SOT457) | <br>sym036 |
| 2   | B1     | base TR1               |                                                                                                     |                                                                                               |
| 3   | O2     | output (collector) TR2 |                                                                                                     |                                                                                               |
| 4   | GND2   | GND (emitter) TR2      |                                                                                                     |                                                                                               |
| 5   | I2     | input (base) TR2       |                                                                                                     |                                                                                               |
| 6   | C1     | collector TR1          |                                                                                                     |                                                                                               |

6. Ordering information

Table 3. Ordering information

| Type number | Package |                                                          |         |
|-------------|---------|----------------------------------------------------------|---------|
|             | Name    | Description                                              | Version |
| PBLS6002D-Q | TSOP6   | plastic, surface-mounted package (SC-74; TSOP6); 6 leads | SOT457  |

7. Marking

Table 4. Marking codes

| Type number | Marking code |
|-------------|--------------|
| PBLS6002D-Q | F2           |

8. Limiting values

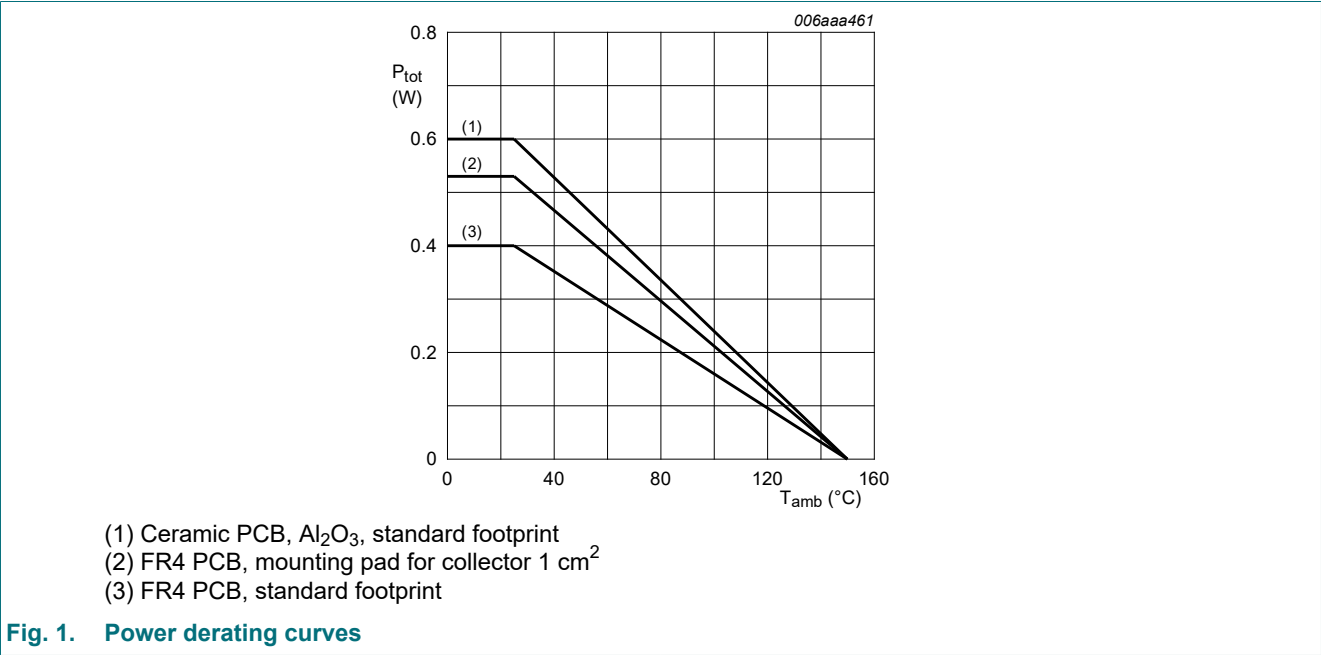
Table 5. Limiting values

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

| Symbol                              | Parameter                 | Conditions                    |     | Min | Max   | Unit |
|-------------------------------------|---------------------------|-------------------------------|-----|-----|-------|------|
| TR1; PNP low $V_{CEsat}$ transistor |                           |                               |     |     |       |      |
| $V_{CBO}$                           | collector-base voltage    | open emitter                  |     | -   | -80   | V    |
| $V_{CEO}$                           | collector-emitter voltage | open base                     |     | -   | -60   | V    |
| $V_{EBO}$                           | emitter-base voltage      | open collector                |     | -   | -5    | V    |
| $I_C$                               | collector current         |                               | [1] | -   | -700  | mA   |
|                                     |                           |                               | [2] | -   | -850  | mA   |
|                                     |                           |                               | [3] | -   | -1    | A    |
| $I_{CM}$                            | peak collector current    | $t_p \leq 1$ ms; single pulse |     | -   | -2    | A    |
| $I_B$                               | base current              |                               |     | -   | -300  | mA   |
| $I_{BM}$                            | peak base current         | single pulse; $t_p \leq 1$ ms |     | -   | -1000 | mA   |
| $P_{tot}$                           | total power dissipation   | $T_{amb} \leq 25$ °C          | [1] | -   | 250   | mW   |
|                                     |                           |                               | [2] | -   | 350   | mW   |
|                                     |                           |                               | [3] | -   | 400   | mW   |

| Symbol                                | Parameter                 | Conditions               |     | Min | Max | Unit |
|---------------------------------------|---------------------------|--------------------------|-----|-----|-----|------|
| TR2; NPN resistor-equipped transistor |                           |                          |     |     |     |      |
| V <sub>CBO</sub>                      | collector-base voltage    | open emitter             |     | -   | 50  | V    |
| V <sub>CEO</sub>                      | collector-emitter voltage | open base                |     | -   | 50  | V    |
| V <sub>EBO</sub>                      | emitter-base voltage      | open collector           |     | -   | 10  | V    |
| V <sub>I</sub>                        | input voltage             |                          |     | -10 | 30  | V    |
| I <sub>O</sub>                        | output current            |                          |     | -   | 100 | mA   |
| I <sub>CM</sub>                       | peak collector current    |                          |     | -   | 100 | mA   |
| P <sub>tot</sub>                      | total power dissipation   |                          | [1] | -   | 200 | mW   |
|                                       |                           |                          | [2] | -   | 200 | mW   |
|                                       |                           |                          | [3] | -   | 200 | mW   |
| Per device                            |                           |                          |     |     |     |      |
| P <sub>tot</sub>                      | total power dissipation   | T <sub>amb</sub> ≤ 25 °C | [1] | -   | 400 | mW   |
|                                       |                           |                          | [2] | -   | 530 | mW   |
|                                       |                           |                          | [3] | -   | 600 | 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.
- [2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for collector 1 cm<sup>2</sup>.
- [3] Device mounted on a ceramic PCB, Al<sub>2</sub>O<sub>3</sub>, standard footprint.



9. Thermal characteristics

Table 6. Thermal characteristics

| Symbol                                     | Parameter                                        | Conditions  |     | Min | Typ | Max | Unit |
|--------------------------------------------|--------------------------------------------------|-------------|-----|-----|-----|-----|------|
| Per device                                 |                                                  |             |     |     |     |     |      |
| R <sub>th(j-a)</sub>                       | thermal resistance from junction to ambient      | in free air | [1] | -   | -   | 312 | K/W  |
|                                            |                                                  |             | [2] | -   | -   | 236 | K/W  |
|                                            |                                                  |             | [3] | -   | -   | 208 | K/W  |
| TR1; PNP low V <sub>CEsat</sub> transistor |                                                  |             |     |     |     |     |      |
| R <sub>th(j-sp)</sub>                      | thermal resistance from junction to solder point |             |     | -   | -   | 105 | K/W  |

- [1] Device mounted on an FR4 PCB, single-sided, copper, tin-plated and standard footprint.
- [2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for collector 1 cm<sup>2</sup>.
- [3] Device mounted on a ceramic PCB, Al<sub>2</sub>O<sub>3</sub>, standard footprint.

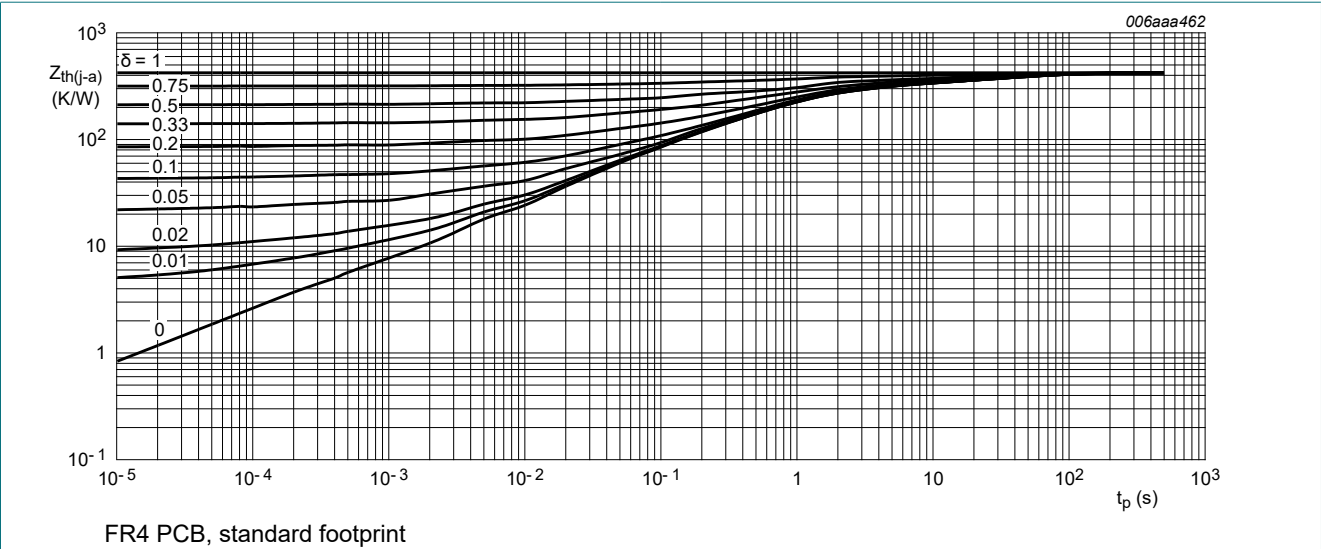


Fig. 2. TR1 (PNP): Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

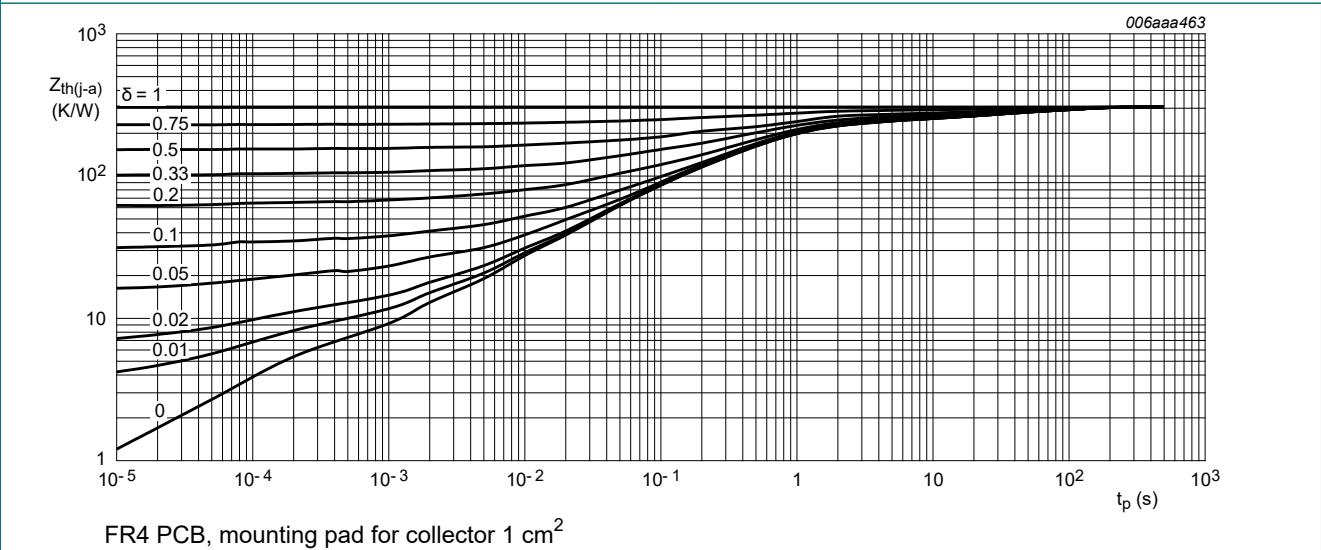
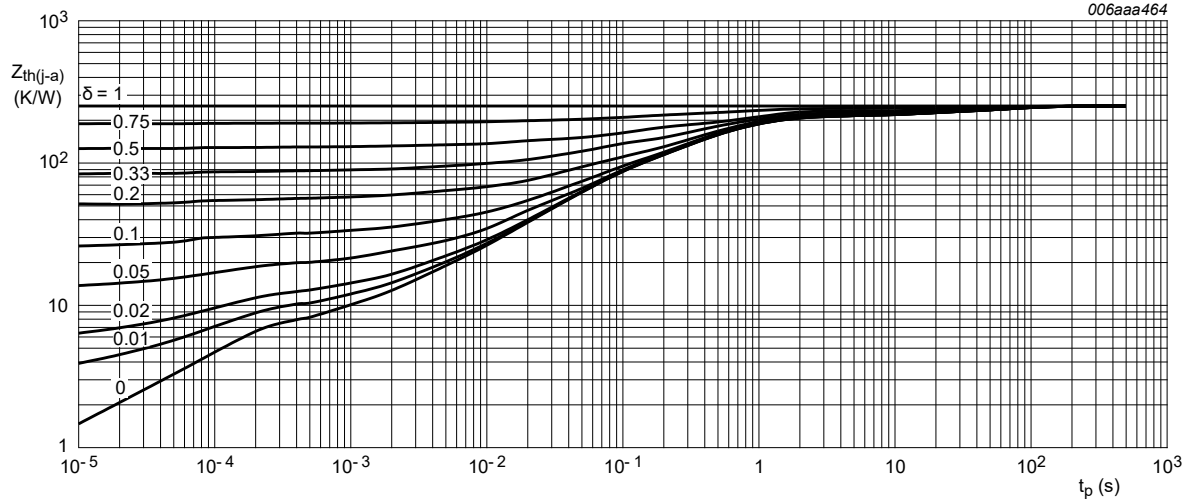


Fig. 3. TR1 (PNP): Transient thermal impedance from junction to ambient as a function of pulse duration; typical values



Ceramic PCB, Al<sub>2</sub>O<sub>3</sub>, standard footprint

**Fig. 4. TR1 (PNP): Transient thermal impedance from junction to ambient as a function of pulse duration; typical values**

## 10. Characteristics

**Table 7. Characteristics**

| Symbol                                                | Parameter                               | Conditions                                                                                               | Min | Typ   | Max  | Unit          |
|-------------------------------------------------------|-----------------------------------------|----------------------------------------------------------------------------------------------------------|-----|-------|------|---------------|
| <b>TR1; PNP low <math>V_{CEsat}</math> transistor</b> |                                         |                                                                                                          |     |       |      |               |
| $I_{CBO}$                                             | collector-base cut-off current          | $V_{CB} = -60\text{ V}$ ; $I_E = 0\text{ A}$ ; $T_{amb} = 25\text{ °C}$                                  | -   | -     | -100 | nA            |
|                                                       |                                         | $V_{CB} = -60\text{ V}$ ; $I_E = 0\text{ A}$ ; $T_j = 150\text{ °C}$                                     | -   | -     | -50  | $\mu\text{A}$ |
| $I_{CES}$                                             | collector-emitter cut-off current       | $V_{CE} = -60\text{ V}$ ; $V_{BE} = 0\text{ V}$ ; $T_{amb} = 25\text{ °C}$                               | -   | -     | -100 | nA            |
| $I_{EBO}$                                             | emitter-base cut-off current            | $V_{EB} = -5\text{ V}$ ; $I_C = 0\text{ A}$ ; $T_{amb} = 25\text{ °C}$                                   | -   | -     | -100 | nA            |
| $h_{FE}$                                              | DC current gain                         | $V_{CE} = -5\text{ V}$ ; $I_C = -1\text{ mA}$ ; $T_{amb} = 25\text{ °C}$                                 | 200 | 350   | -    |               |
|                                                       |                                         | $V_{CE} = -5\text{ V}$ ; $I_C = -500\text{ mA}$ ; $T_{amb} = 25\text{ °C}$ [1]                           | 150 | 230   | -    |               |
|                                                       |                                         | $V_{CE} = -5\text{ V}$ ; $I_C = -1000\text{ mA}$ ; $T_{amb} = 25\text{ °C}$ [1]                          | 100 | 160   | -    |               |
| $V_{CEsat}$                                           | collector-emitter saturation voltage    | $I_C = -100\text{ mA}$ ; $I_B = -1\text{ mA}$ ; $T_{amb} = 25\text{ °C}$                                 | -   | -110  | -175 | mV            |
|                                                       |                                         | $I_C = -500\text{ mA}$ ; $I_B = -50\text{ mA}$ ; $T_{amb} = 25\text{ °C}$ [1]                            | -   | -135  | -180 | mV            |
|                                                       |                                         | $I_C = -1000\text{ mA}$ ; $I_B = -100\text{ mA}$ ; $T_{amb} = 25\text{ °C}$ [1]                          | -   | -255  | -340 | mV            |
| $R_{CEsat}$                                           | collector-emitter saturation resistance | $T_{amb} = 25\text{ °C}$ [1]                                                                             | -   | 255   | 340  | m $\Omega$    |
| $V_{BEsat}$                                           | base-emitter saturation voltage         | $I_C = -1000\text{ mA}$ ; $I_B = -50\text{ mA}$ ; $T_{amb} = 25\text{ °C}$ [1]                           | -   | -0.95 | -1.1 | V             |
| $V_{BEon}$                                            | base-emitter turn-on voltage            | $V_{CE} = -5\text{ V}$ ; $I_C = -1000\text{ mA}$ ; $T_{amb} = 25\text{ °C}$ [1]                          | -   | -0.82 | -0.9 | V             |
| $t_d$                                                 | delay time                              | $I_C = -0.5\text{ A}$ ; $I_{Bon} = -25\text{ mA}$ ; $I_{Boff} = 25\text{ mA}$ ; $T_{amb} = 25\text{ °C}$ | -   | 11    | -    | ns            |
| $t_r$                                                 | rise time                               |                                                                                                          | -   | 30    | -    | ns            |
| $t_{on}$                                              | turn-on time                            |                                                                                                          | -   | 41    | -    | ns            |
| $t_s$                                                 | storage time                            |                                                                                                          | -   | 205   | -    | ns            |
| $t_f$                                                 | fall time                               |                                                                                                          | -   | 55    | -    | ns            |
| $t_{off}$                                             | turn-off time                           | $I_C = -0.5\text{ A}$ ; $I_{Bon} = 25\text{ mA}$ ; $I_{Boff} = 25\text{ A}$ ; $T_{amb} = 25\text{ °C}$   | -   | 260   | -    | ns            |

| Symbol                                       | Parameter                            | Conditions                                                                                                           | Min | Typ | Max | Unit          |
|----------------------------------------------|--------------------------------------|----------------------------------------------------------------------------------------------------------------------|-----|-----|-----|---------------|
| $C_c$                                        | collector capacitance                | $V_{CB} = -10\text{ V}$ ; $I_E = 0\text{ A}$ ; $i_e = 0\text{ A}$ ;<br>$f = 1\text{ MHz}$ ; $T_{amb} = 25\text{ °C}$ | -   | 9   | 15  | pF            |
| $f_T$                                        | transition frequency                 | $V_{CE} = -10\text{ V}$ ; $I_C = -50\text{ mA}$ ; $f = 100\text{ MHz}$ ;<br>$T_{amb} = 25\text{ °C}$                 | 150 | 185 | -   | MHz           |
| <b>TR2; NPN resistor-equipped transistor</b> |                                      |                                                                                                                      |     |     |     |               |
| $I_{CBO}$                                    | collector-base cut-off current       | $V_{CB} = 50\text{ V}$ ; $I_E = 0\text{ A}$ ; $T_{amb} = 25\text{ °C}$                                               | -   | -   | 100 | nA            |
| $I_{CEO}$                                    | collector-emitter cut-off current    | $V_{CE} = 30\text{ V}$ ; $I_B = 0\text{ A}$ ; $T_{amb} = 25\text{ °C}$                                               | -   | -   | 1   | $\mu\text{A}$ |
|                                              |                                      | $V_{CE} = 30\text{ V}$ ; $I_B = 0\text{ A}$ ; $T_j = 150\text{ °C}$                                                  | -   | -   | 50  | $\mu\text{A}$ |
| $I_{EBO}$                                    | emitter-base cut-off current         | $V_{EB} = 5\text{ V}$ ; $I_C = 0\text{ A}$ ; $T_{amb} = 25\text{ °C}$                                                | -   | -   | 900 | $\mu\text{A}$ |
| $h_{FE}$                                     | DC current gain                      | $V_{CE} = 5\text{ V}$ ; $I_C = 20\text{ mA}$ ; $T_{amb} = 25\text{ °C}$                                              | 30  | -   | -   |               |
| $V_{CEsat}$                                  | collector-emitter saturation voltage | $I_C = 10\text{ mA}$ ; $I_B = 0.5\text{ mA}$ ; $T_{amb} = 25\text{ °C}$ [1]                                          | -   | -   | 150 | mV            |
| $V_{I(off)}$                                 | off-state input voltage              | $V_{CE} = 5\text{ V}$ ; $I_C = 100\text{ }\mu\text{A}$ ; $T_{amb} = 25\text{ °C}$                                    | -   | 1.1 | 0.5 | V             |
| $V_{I(on)}$                                  | on-state input voltage               | $V_{CE} = 0.3\text{ V}$ ; $I_C = 20\text{ mA}$ ; $T_{amb} = 25\text{ °C}$                                            | 2.5 | 1.9 | -   | V             |
| R1                                           | bias resistor 1 (input)              |                                                                                                                      | 3.3 | 4.7 | 6.1 | k $\Omega$    |
| R2/R1                                        | bias resistor ratio                  |                                                                                                                      | 0.8 | 1   | 1.2 |               |
| $C_c$                                        | collector capacitance                | $V_{CB} = 10\text{ V}$ ; $I_E = 0\text{ A}$ ; $i_e = 0\text{ A}$ ; $f = 1\text{ MHz}$ ;<br>$T_{amb} = 25\text{ °C}$  | -   | -   | 2.5 | pF            |

[1] Pulse test:  $t_p \leq 300\text{ }\mu\text{s}$ ;  $\delta \leq 0.02$

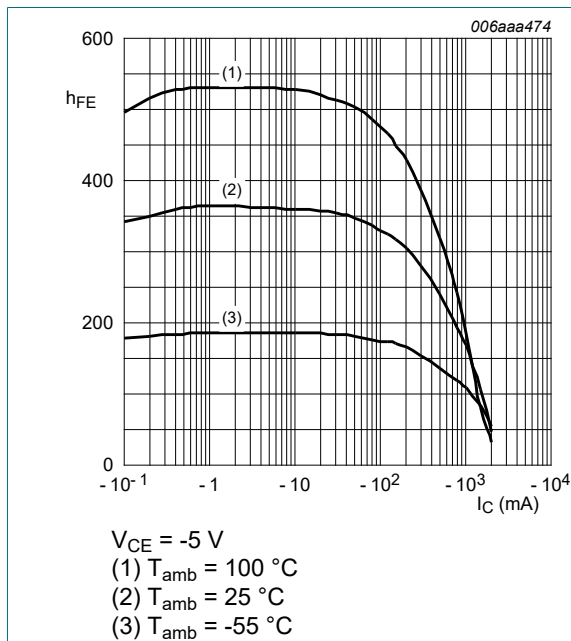


**Fig. 5. TR1 (PNP): DC current gain as a function of collector current; typical values**

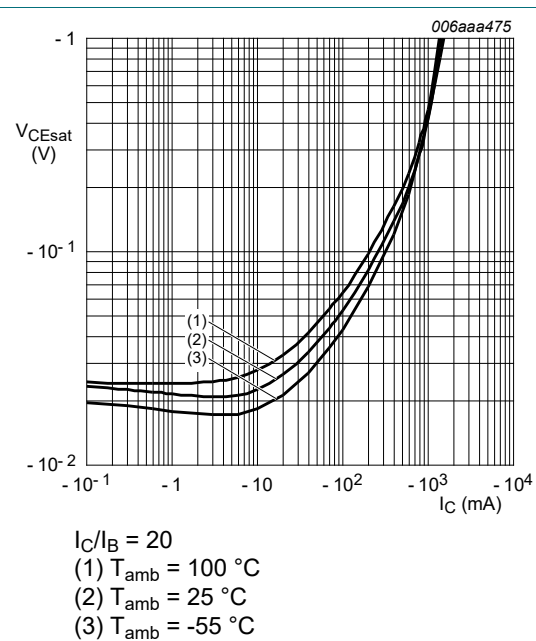


**Fig. 6. TR1 (PNP): Collector-emitter saturation voltage as a function of collector current; typical values**

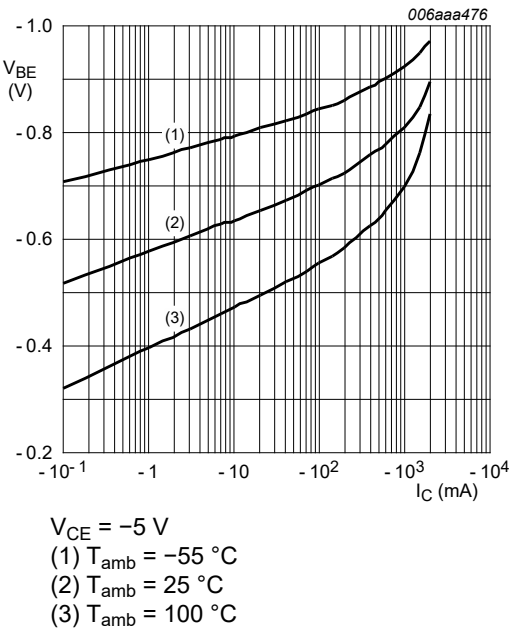


Fig. 7. TR1 (PNP): Base-emitter voltage as a function of collector current; typical values

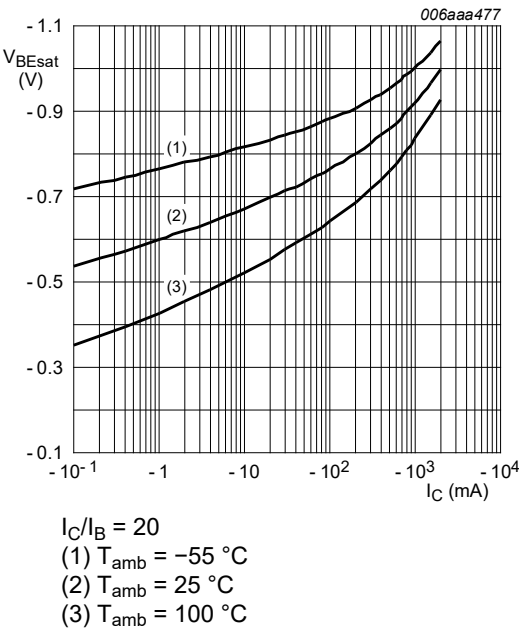


Fig. 8. TR1 (PNP): Base-emitter saturation voltage as a function of collector current; typical values

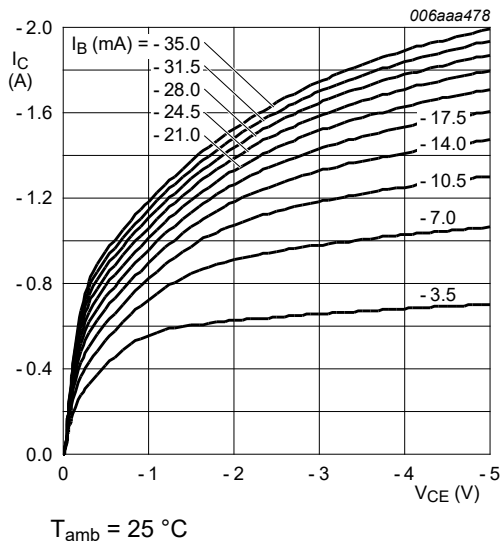


Fig. 9. TR1 (PNP): Collector current as a function of collector-emitter voltage; typical values

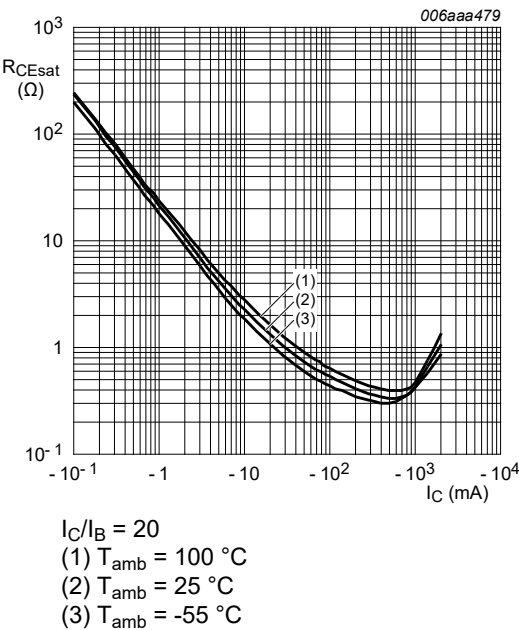


Fig. 10. TR1 (PNP): Collector-emitter saturation resistance as a function of collector current; typical values

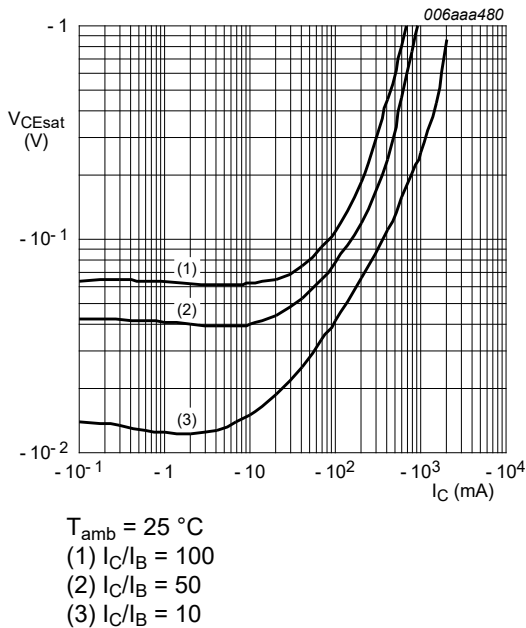


Fig. 11. TR1 (PNP): Collector-emitter saturation voltage as a function of collector current; typical values

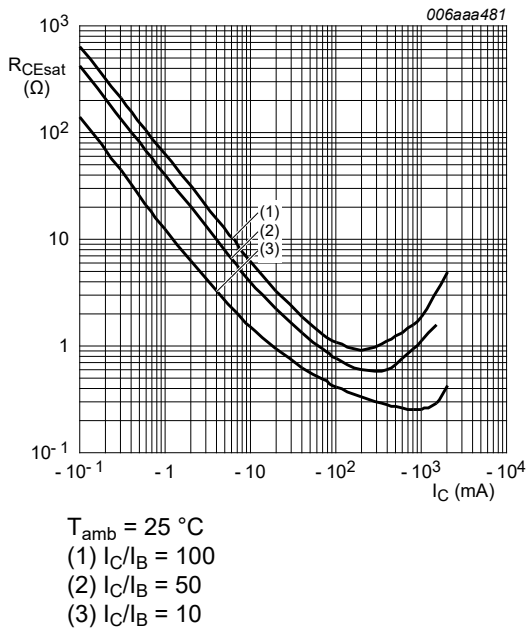


Fig. 12. TR1 (PNP): Collector-emitter saturation resistance as a function of collector current; typical values

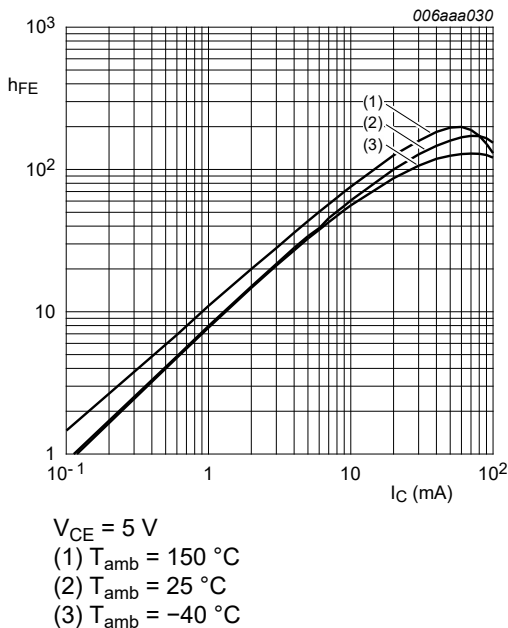


Fig. 13. TR2 (NPN): DC current gain as a function of collector current; typical values

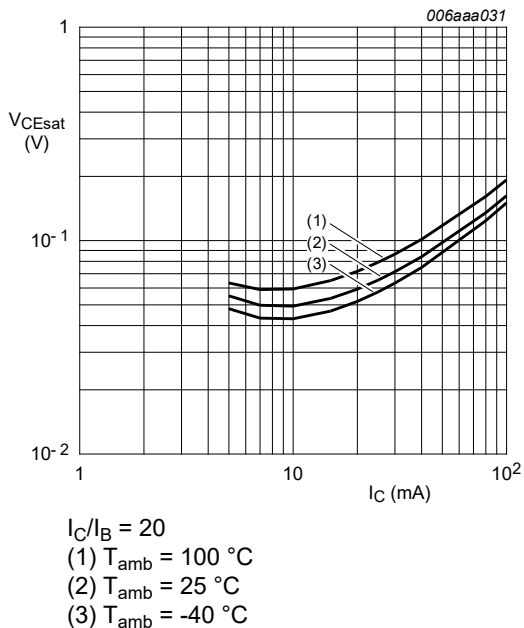


Fig. 14. TR2 (NPN): Collector-emitter saturation voltage as a function of collector current; typical values

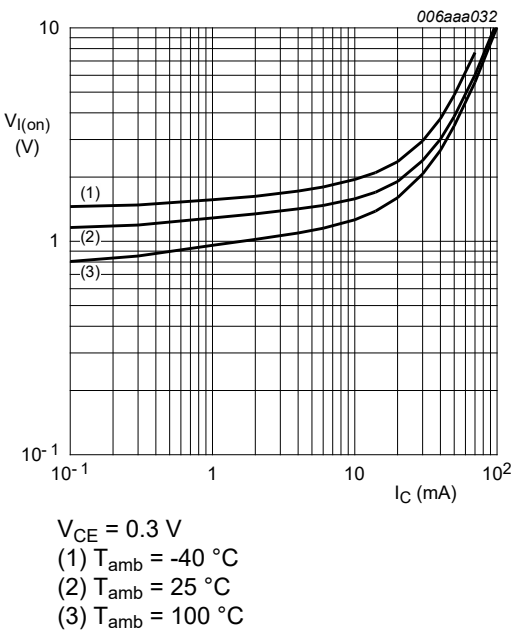


Fig. 15. TR2 (NPN): On-state input voltage as a function of collector current; typical values

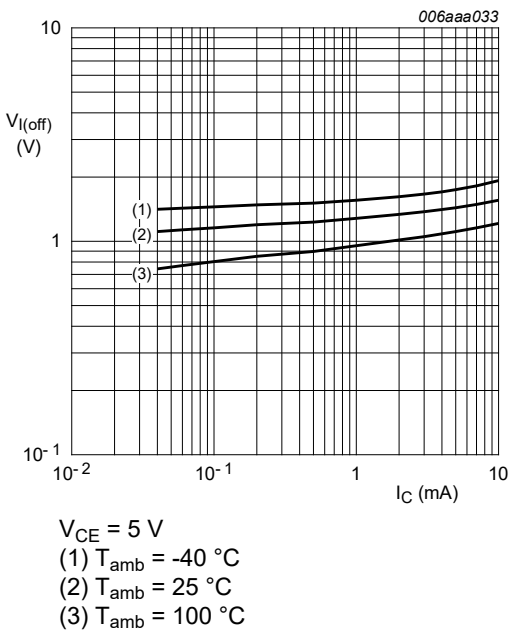


Fig. 16. TR2 (NPN): Off-state input voltage as a function of collector current; typical values

11. Test information

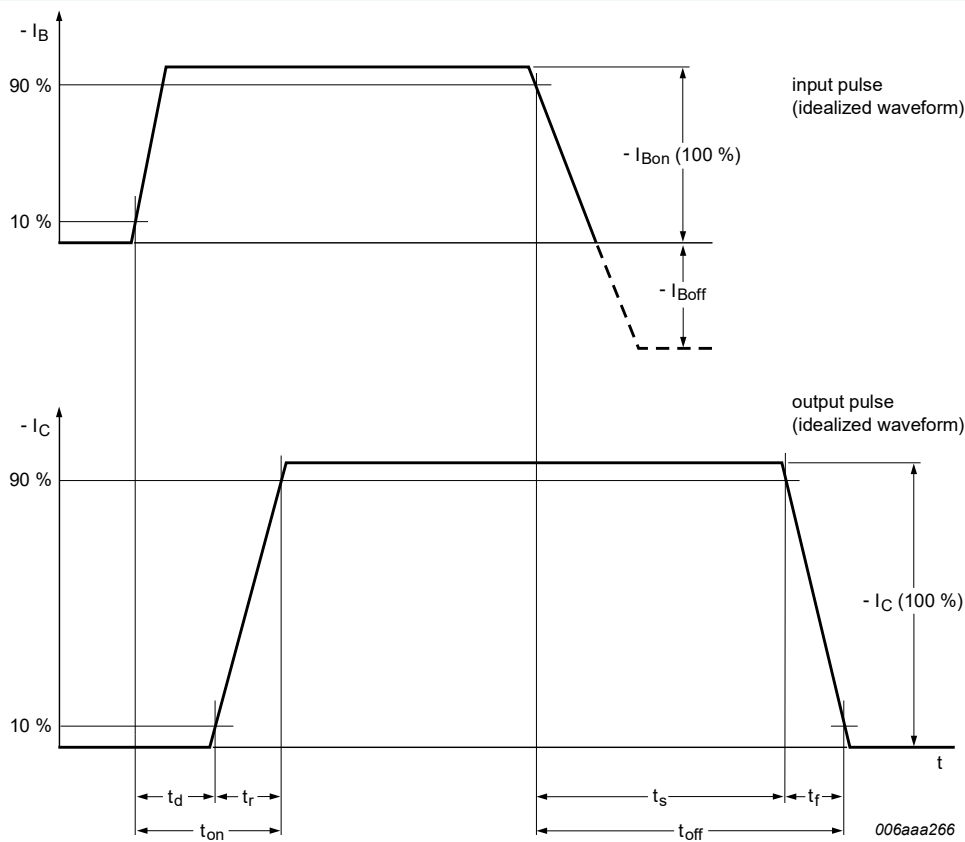
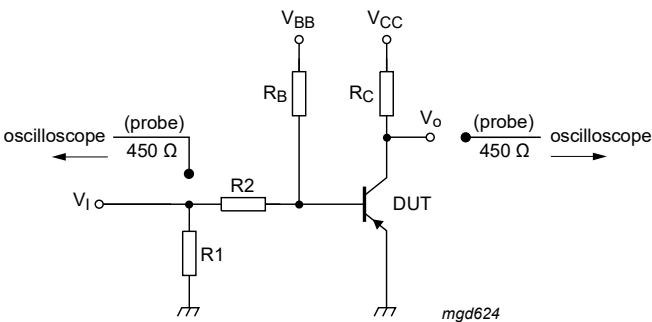


Fig. 17. Transistor switching time definition



$I_I = -0.5\text{ A}$ ;  $I_{B\text{on}} = 25\text{ mA}$ ;  $I_{B\text{off}} = 25\text{ mA}$ ;  $R_1 = \text{open}$ ;  $R_2 = 100\text{ }\Omega$ ;  $R_B = 300\text{ }\Omega$ ;  $R_C = 20\text{ }\Omega$

Fig. 18. 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

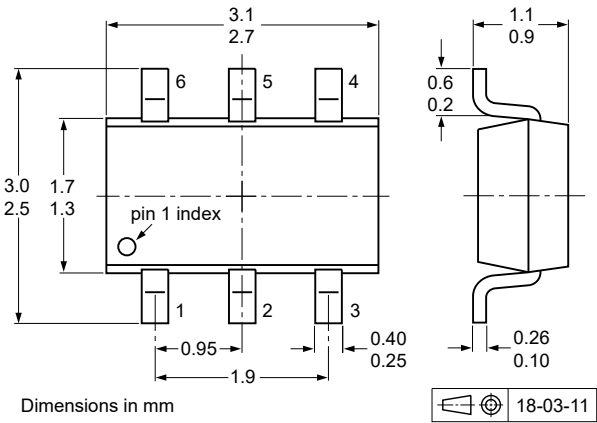
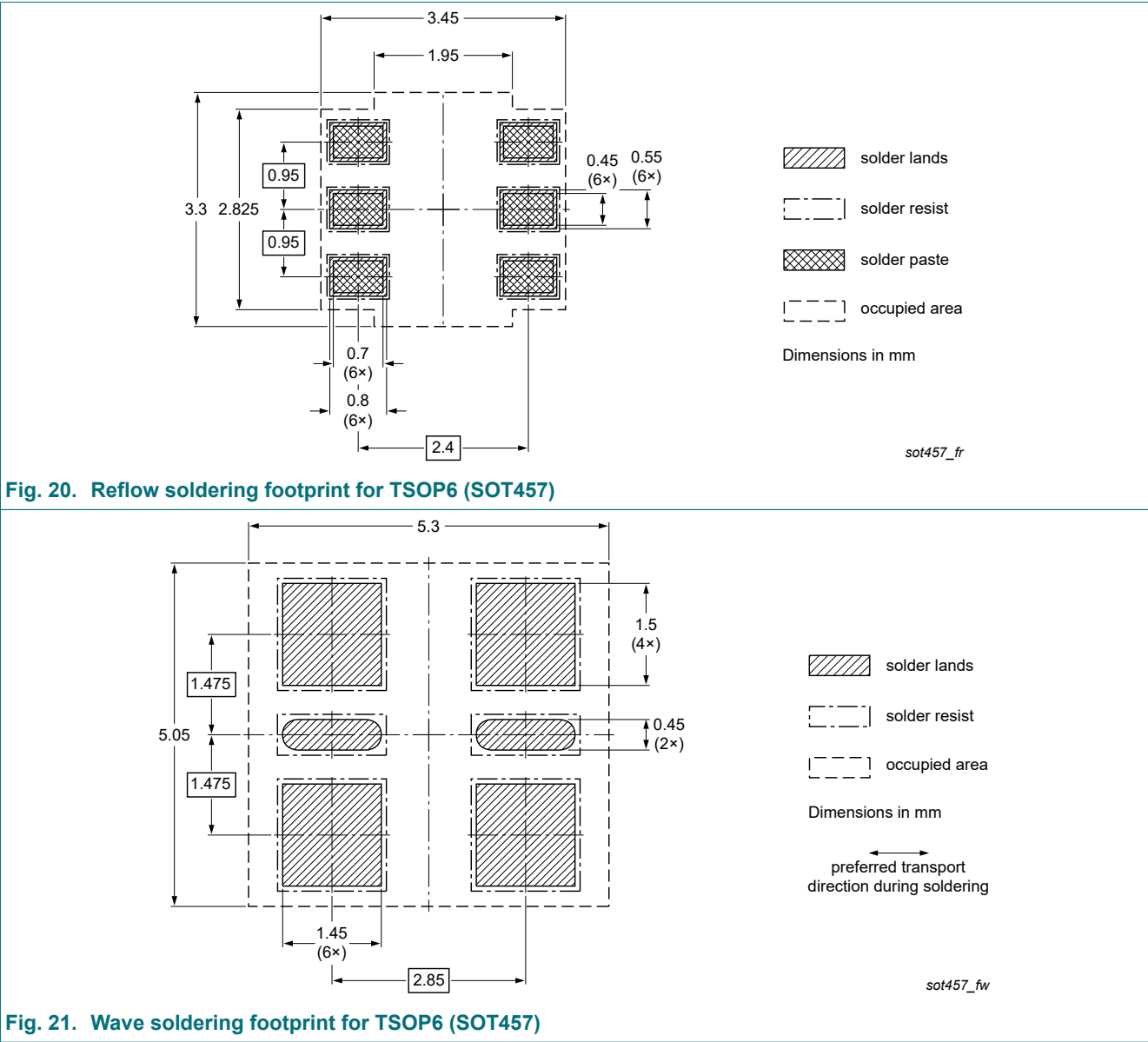


Fig. 19. Package outline TSOP6 (SOT457)

13. Soldering



## 14. Revision history

Table 8. Revision history

| Data sheet ID   | Release date | Data sheet status  | Change notice | Supersedes |
|-----------------|--------------|--------------------|---------------|------------|
| PBLS6002D-Q v.1 | 20231026     | 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".
- [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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