



# PBL6024D

60 V, 1.5 A PNP loadswitch

20 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  $V_{CEsat}$  and resistor-equipped transistor in one package
- Low threshold voltage ( $<1$  V) compared to MOSFET
- Space-saving solution
- Reduction of component count
- AEC-Q101 qualified

## 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

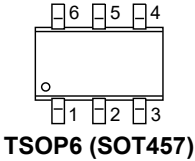
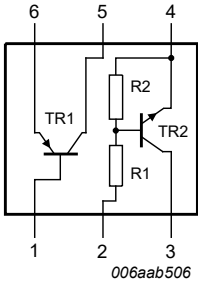
| Symbol                                                | Parameter                               | Conditions                                              | Min | Typ  | Max  | Unit    |
|-------------------------------------------------------|-----------------------------------------|---------------------------------------------------------|-----|------|------|---------|
| <b>TR1; PNP low <math>V_{CEsat}</math> transistor</b> |                                         |                                                         |     |      |      |         |
| $V_{CEO}$                                             | collector-emitter voltage               | open base                                               | -   | -    | -60  | V       |
| $I_C$                                                 | collector current                       |                                                         | -   | -    | -1.5 | A       |
| $I_{CM}$                                              | peak collector current                  | $t_p \leq 1$ ms; single pulse                           | -   | -    | -3   | A       |
| $R_{CEsat}$                                           | collector-emitter saturation resistance | $I_C = -1500$ mA; $I_B = -100$ mA;<br>$T_{amb} = 25$ °C | [1] | 110  | 175  | 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)                 |                                                         | [2] | 15.4 | 22   | 28.6 kΩ |
| R2/R1                                                 | bias resistor ratio                     |                                                         | [2] | 0.8  | 1    | 1.2     |

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

[2] See "Section 11: Test information" for resistor calculation and test conditions.

5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description            | Simplified outline                                                                                  | Graphic symbol                                                                                   |
|-----|--------|------------------------|-----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| 1   | B1     | base TR1               | <br>TSOP6 (SOT457) | <br>006aab506 |
| 2   | I2     | input (base) TR2       |                                                                                                     |                                                                                                  |
| 3   | O2     | output (collector) TR2 |                                                                                                     |                                                                                                  |
| 4   | GND    | GND (emitter) TR2      |                                                                                                     |                                                                                                  |
| 5   | C1     | collector TR1          |                                                                                                     |                                                                                                  |
| 6   | E1     | emitter TR1            |                                                                                                     |                                                                                                  |

6. Ordering information

Table 3. Ordering information

| Type number               | Package |                                                          |                        |
|---------------------------|---------|----------------------------------------------------------|------------------------|
|                           | Name    | Description                                              | Version                |
| <a href="#">PBLS6024D</a> | TSOP6   | plastic, surface-mounted package (SC-74; TSOP6); 6 leads | <a href="#">SOT457</a> |

7. Marking

Table 4. Marking codes

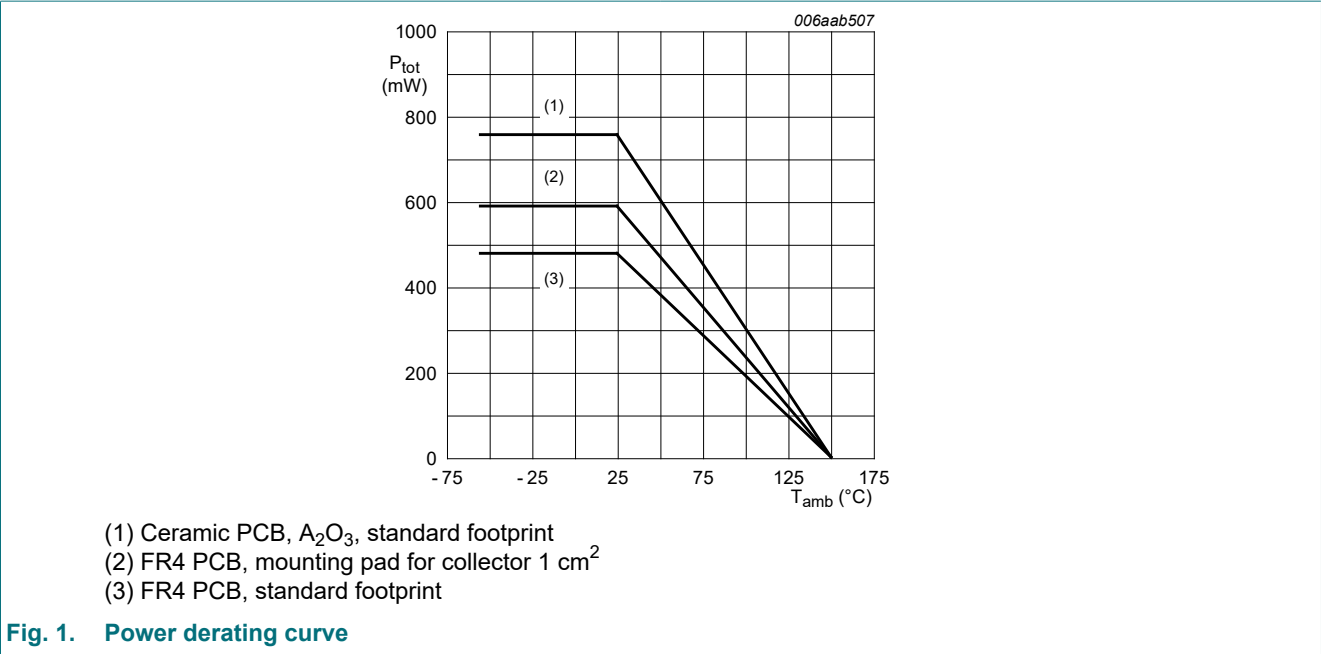
| Type number | Marking code |
|-------------|--------------|
| PBLS6024D   | KH           |

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 <sub>CEsat</sub> transistor |                           |                                     |                |     |       |      |
| V <sub>CBO</sub>                           | collector-base voltage    | open emitter                        |                | -   | -60   | V    |
| V <sub>CEO</sub>                           | collector-emitter voltage | open base                           |                | -   | -60   | V    |
| V <sub>EBO</sub>                           | emitter-base voltage      | open collector                      |                | -   | -5    | V    |
| I <sub>C</sub>                             | collector current         |                                     |                | -   | -1.5  | A    |
| I <sub>CM</sub>                            | peak collector current    | t <sub>p</sub> ≤ 1 ms; single pulse |                | -   | -3    | A    |
| I <sub>B</sub>                             | base current              |                                     |                | -   | -300  | mA   |
| I <sub>BM</sub>                            | peak base current         | single pulse; t <sub>p</sub> ≤ 1 ms |                | -   | -1000 | mA   |
| P <sub>tot</sub>                           | total power dissipation   | T <sub>amb</sub> ≤ 25 °C            | [1]            | -   | 370   | mW   |
|                                            |                           |                                     | [2]            | -   | 480   | mW   |
|                                            |                           |                                     | [3]            | -   | 630   | mW   |
| 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             | positive                            |                | -   | 40    | V    |
|                                            |                           | negative                            |                | -   | -10   | V    |
| I <sub>O</sub>                             | output current            |                                     |                | -   | 100   | mA   |
| I <sub>CM</sub>                            | peak collector current    | t <sub>p</sub> ≤ 1 ms; single pulse |                | -   | 100   | mA   |
| P <sub>tot</sub>                           | total power dissipation   | T <sub>amb</sub> ≤ 25 °C            | [1] [2]<br>[3] | -   | 200   | mW   |
| Per device                                 |                           |                                     |                |     |       |      |
| P <sub>tot</sub>                           | total power dissipation   | T <sub>amb</sub> ≤ 25 °C            | [1]            | -   | 480   | mW   |
|                                            |                           |                                     | [2]            | -   | 590   | mW   |
|                                            |                           |                                     | [3]            | -   | 760   | mW   |
| T <sub>j</sub>                             | junction temperature      |                                     |                | -   | 150   | °C   |
| T <sub>amb</sub>                           | ambient temperature       |                                     |                | -55 | 150   | °C   |
| T <sub>stg</sub>                           | storage temperature       |                                     |                | -65 | 150   | °C   |

[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided, 35 µm 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.

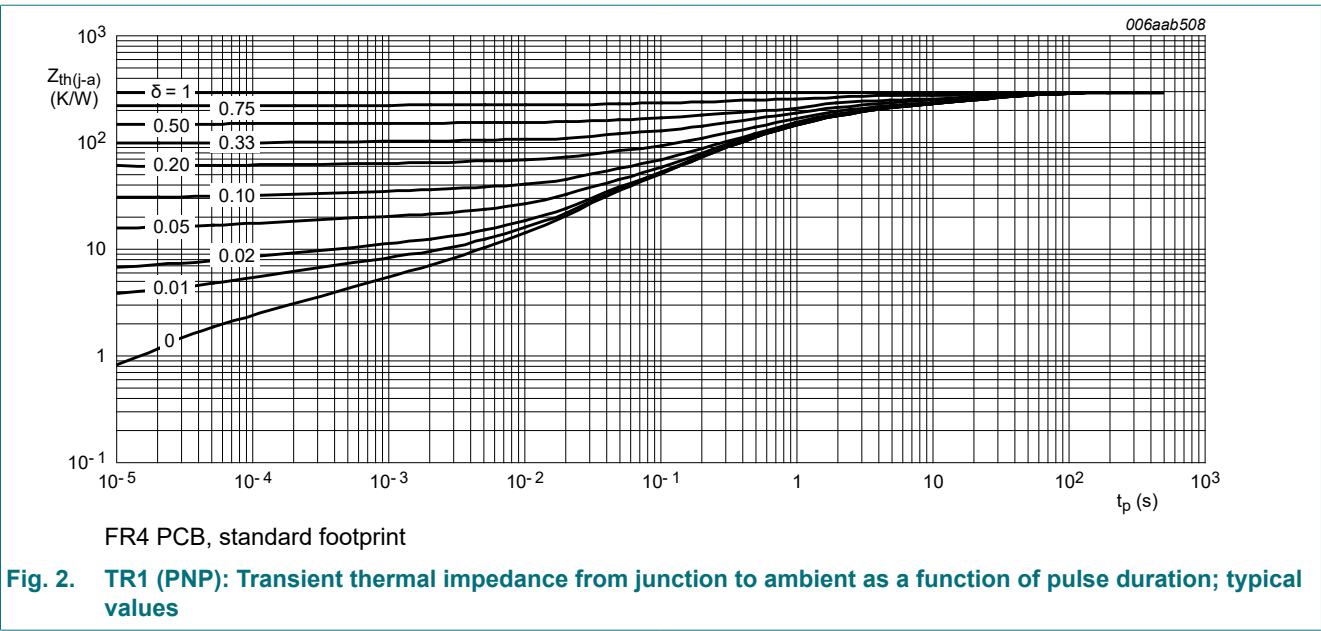


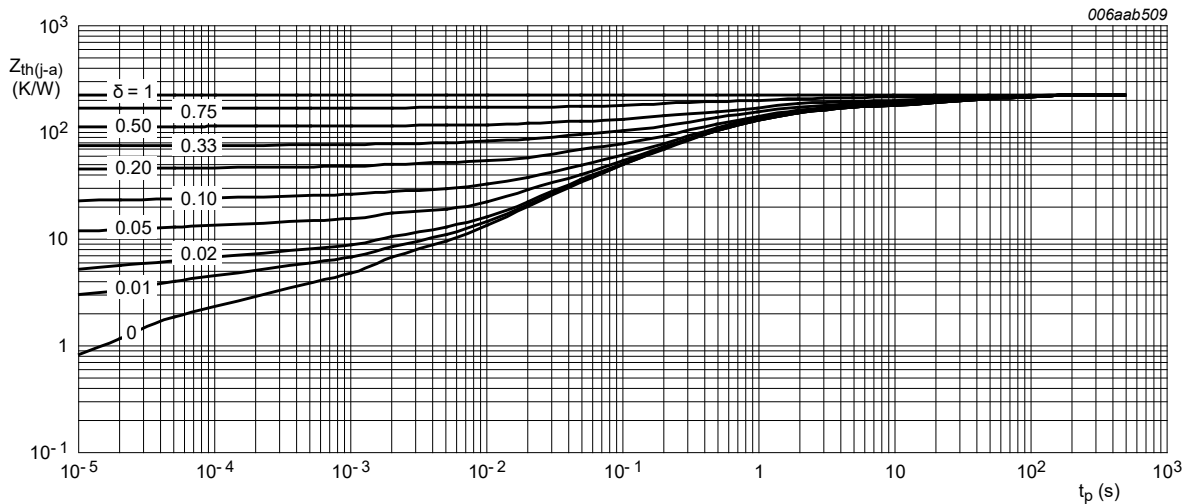
9. Thermal characteristics

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] | -   | -   | 260 | K/W  |
|                       |                                                  |             | [2] | -   | -   | 211 | K/W  |
|                       |                                                  |             | [3] | -   | -   | 165 | K/W  |
| R <sub>th(j-sp)</sub> | thermal resistance from junction to solder point |             |     | -   | -   | 100 | K/W  |

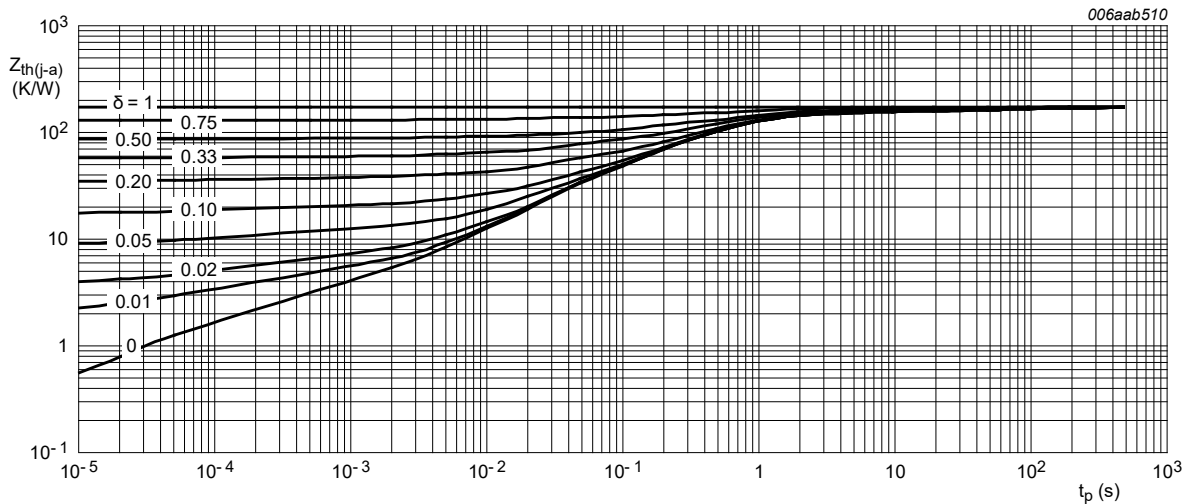
- [1] Device mounted on an FR4 PCB, single-sided, 35 µm copper, tin-plated and standard footprint.  
[2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for collector 1 cm<sup>2</sup>.  
[3] Device mounted on a ceramic PCB, Al<sub>2</sub>O<sub>3</sub>, standard footprint.





FR4 PCB, mounting pad for collector 1 cm<sup>2</sup>

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  | μA   |
| $I_{CES}$                                             | collector-emitter cut-off current       | $V_{CE} = -48\text{ V}; T_{amb} = 25\text{ °C}; V_{BE} = 0\text{ A}$                                                 |     | -   | -     | -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                         | $V_{CE} = -2\text{ V}; I_C = -100\text{ mA}; T_{amb} = 25\text{ °C}$                                                 |     | 180 | 285   | -    |      |
|                                                       |                                         | $V_{CE} = -2\text{ V}; I_C = -500\text{ mA}; T_{amb} = 25\text{ °C}$                                                 | [1] | 150 | 255   | -    |      |
|                                                       |                                         | $V_{CE} = -2\text{ V}; I_C = -1\text{ A}; T_{amb} = 25\text{ °C}$                                                    | [1] | 140 | 210   | -    |      |
|                                                       |                                         | $V_{CE} = -2\text{ V}; I_C = -1.5\text{ A}; T_{amb} = 25\text{ °C}$                                                  | [1] | 120 | 185   | -    |      |
| $V_{CEsat}$                                           | collector-emitter saturation voltage    | $I_B = -50\text{ mA}; T_{amb} = 25\text{ °C}; I_C = -0.5\text{ A}$                                                   | [1] | -   | -65   | -100 | mV   |
|                                                       |                                         | $I_B = -50\text{ mA}; T_{amb} = 25\text{ °C}; I_C = -1\text{ A}$                                                     | [1] | -   | -130  | -200 | mV   |
|                                                       |                                         | $I_B = -100\text{ mA}; T_{amb} = 25\text{ °C}; I_C = -1\text{ A}$                                                    | [1] | -   | -110  | -170 | mV   |
|                                                       |                                         | $I_B = -100\text{ mA}; T_{amb} = 25\text{ °C}; I_C = -1.5\text{ A}$                                                  | [1] | -   | -165  | -260 | mV   |
| $R_{CEsat}$                                           | collector-emitter saturation resistance | $I_C = -1000\text{ mA}; I_B = -100\text{ mA}; T_{amb} = 25\text{ °C}$                                                | [1] | -   | 110   | 170  | mΩ   |
|                                                       |                                         | $I_C = -1500\text{ mA}; I_B = -100\text{ mA}; T_{amb} = 25\text{ °C}$                                                | [1] | -   | 110   | 175  | mΩ   |
| $V_{BEsat}$                                           | base-emitter saturation voltage         | $I_C = -500\text{ mA}; I_B = -50\text{ mA}; T_{amb} = 25\text{ °C}$                                                  | [1] | -   | -0.85 | -1   | V    |
|                                                       |                                         | $I_C = -1500\text{ mA}; I_B = -100\text{ mA}; T_{amb} = 25\text{ °C}$                                                | [1] | -   | -0.93 | -1.1 | V    |
| $V_{BEon}$                                            | base-emitter turn-on voltage            | $V_{CE} = -10\text{ V}; I_C = -1000\text{ mA}; T_{amb} = 25\text{ °C}$                                               | [1] | -   | -0.75 | -1.1 | V    |
| $t_d$                                                 | delay time                              | $V_{CC} = -10\text{ V}; I_C = -1\text{ A}; I_{Bon} = -50\text{ mA}; I_{Boff} = 50\text{ mA}; T_{amb} = 25\text{ °C}$ |     | -   | 17    | -    | ns   |
| $t_r$                                                 | rise time                               |                                                                                                                      |     | -   | 38    | -    | ns   |
| $t_{on}$                                              | turn-on time                            |                                                                                                                      |     | -   | 55    | -    | ns   |
| $t_s$                                                 | storage time                            |                                                                                                                      |     | -   | 350   | -    | ns   |
| $t_f$                                                 | fall time                               |                                                                                                                      |     | -   | 65    | -    | ns   |
| $t_{off}$                                             | turn-off time                           |                                                                                                                      |     | -   | 415   | -    | ns   |
| $C_c$                                                 | collector capacitance                   | $V_{CB} = -10\text{ V}; I_E = 0\text{ A}; I_e = 0\text{ A}; f = 1\text{ MHz}; T_{amb} = 25\text{ °C}$                |     | -   | 30    | -    | pF   |
| $f_T$                                                 | transition frequency                    | $V_{CE} = -10\text{ V}; I_C = -50\text{ mA}; f = 100\text{ MHz}; T_{amb} = 25\text{ °C}$                             |     | -   | 150   | -    | 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    | μA   |
|                                                       |                                         | $V_{CE} = 30\text{ V}; I_B = 0\text{ A}; T_j = 150\text{ °C}$                                                        |     | -   | -     | 50   | μA   |
| $I_{EBO}$                                             | emitter-base cut-off current            | $V_{EB} = 5\text{ V}; I_C = 0\text{ A}; T_{amb} = 25\text{ °C}$                                                      |     | -   | -     | 180  | μA   |
| $h_{FE}$                                              | DC current gain                         | $V_{CE} = 5\text{ V}; I_C = 5\text{ mA}; T_{amb} = 25\text{ °C}$                                                     |     | 60  | -     | -    |      |
| $V_{CEsat}$                                           | collector-emitter saturation voltage    | $I_C = 10\text{ mA}; I_B = 0.5\text{ mA}; T_{amb} = 25\text{ °C}$                                                    |     | -   | -     | 150  | mV   |

| Symbol       | Parameter               | Conditions                                                                                                       |     | Min  | Typ | Max  | Unit       |
|--------------|-------------------------|------------------------------------------------------------------------------------------------------------------|-----|------|-----|------|------------|
| $V_{I(off)}$ | off-state input voltage | $V_{CE} = 5\text{ V}; I_C = 100\text{ }\mu\text{A}; T_{amb} = 25\text{ }^\circ\text{C}$                          |     | -    | 1.1 | 0.8  | V          |
| $V_{I(on)}$  | on-state input voltage  | $V_{CE} = 0.3\text{ V}; I_C = 5\text{ mA}; T_{amb} = 25\text{ }^\circ\text{C}$                                   |     | 2.5  | 1.7 | -    | V          |
| R1           | bias resistor 1 (input) |                                                                                                                  | [2] | 15.4 | 22  | 28.6 | k $\Omega$ |
| R2/R1        | bias resistor ratio     |                                                                                                                  | [2] | 0.8  | 1   | 1.2  |            |
| $C_c$        | collector capacitance   | $V_{CB} = 10\text{ V}; I_E = 0\text{ A}; i_e = 0\text{ A}; f = 1\text{ MHz}; T_{amb} = 25\text{ }^\circ\text{C}$ |     | -    | -   | 2.5  | pF         |

[1] Pulse test:  $t_p \leq 300\text{ }\mu\text{s}$ ;  $\delta \leq 0.02$   
[2] See "Section 11: Test information" for resistor calculation and test conditions.

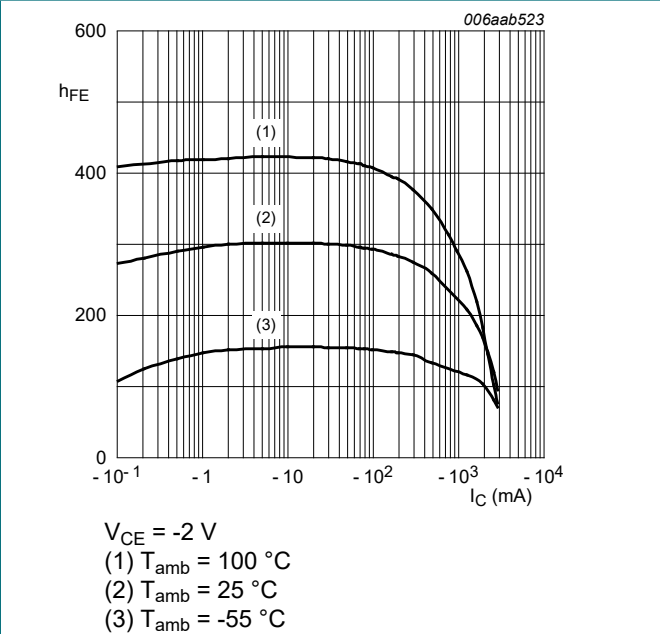


Fig. 5. TR1 (PNP): DC current gain as a function of collector current; typical values

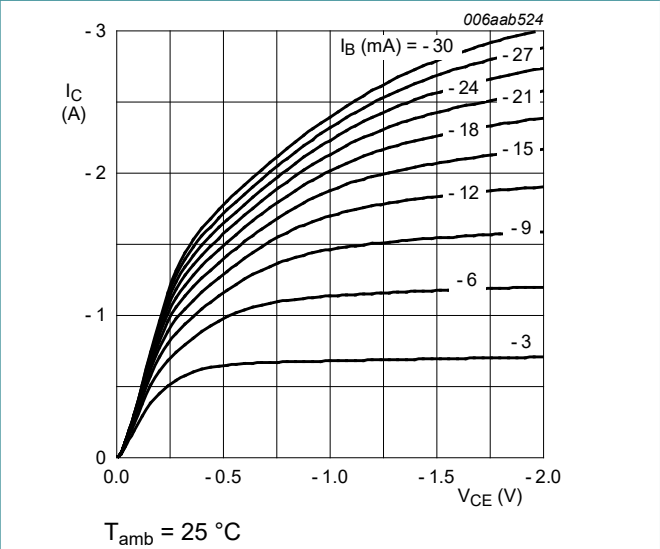


Fig. 6. TR1 (PNP): Collector current as a function of collector-emitter voltage; typical values

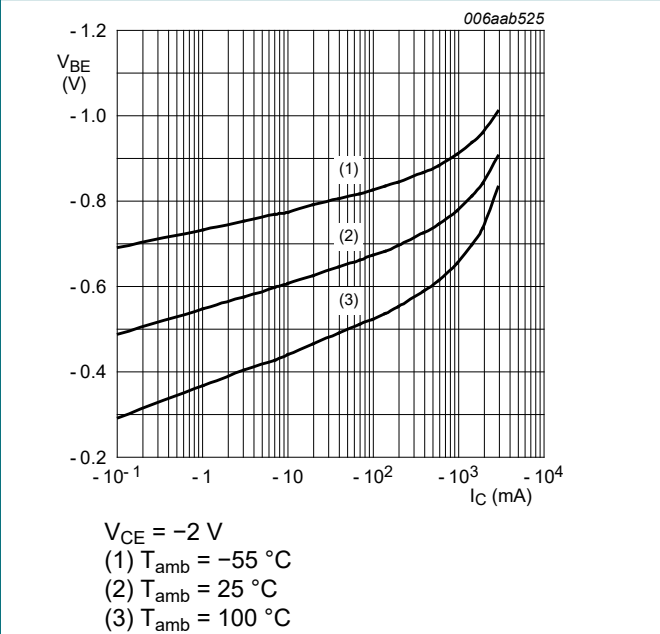


Fig. 7. TR1 (PNP): Base-emitter voltage as a function of collector current; typical values

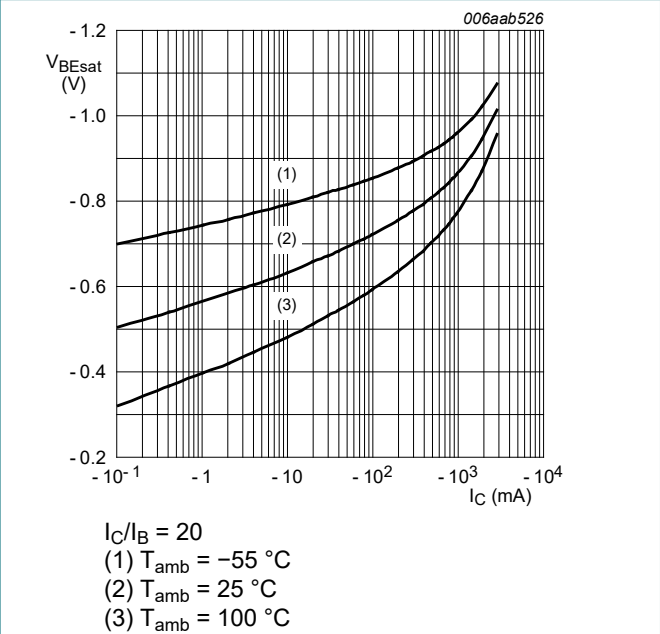


Fig. 8. TR1 (PNP): Base-emitter saturation voltage as a function of collector current; typical values

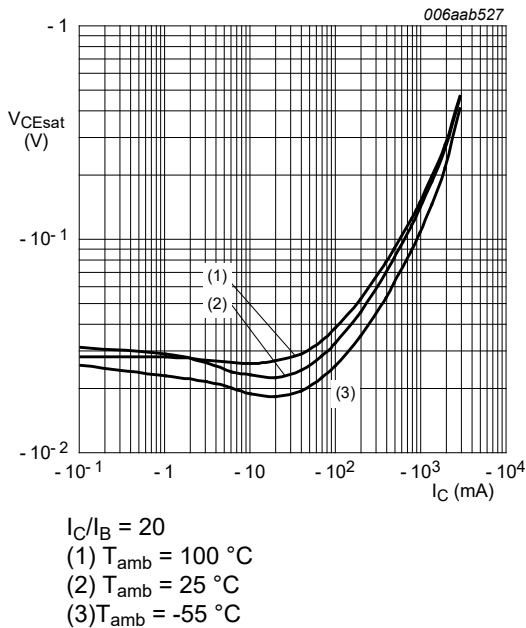


Fig. 9. TR1 (PNP): Collector-emitter saturation voltage as a function of collector current; typical values

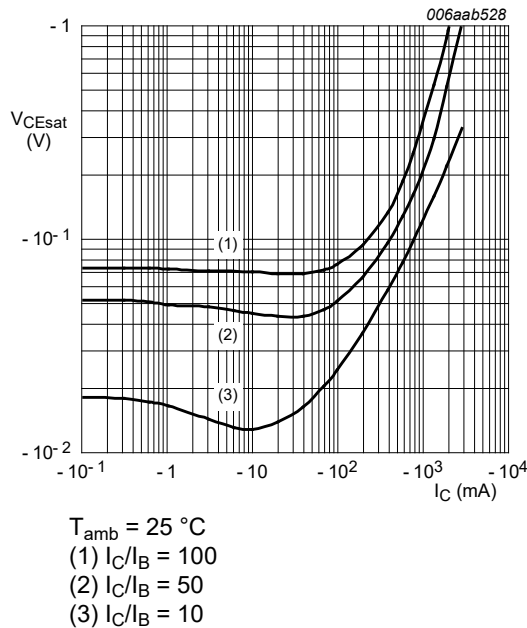


Fig. 10. TR1 (PNP): Collector-emitter saturation voltage as a function of collector current; typical values

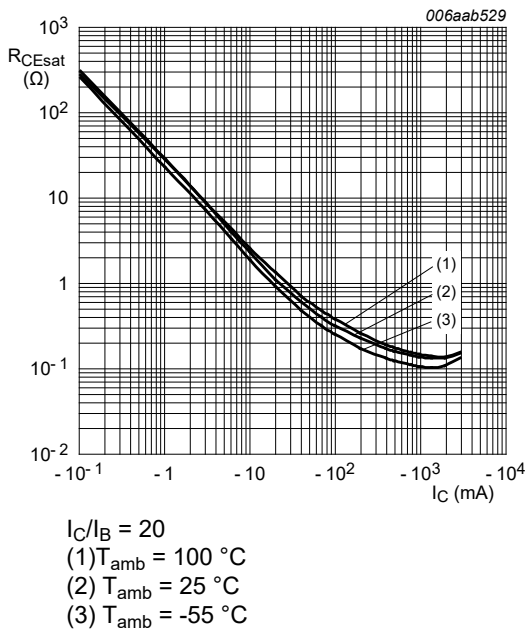


Fig. 11. TR1 (PNP): Collector-emitter saturation resistance as a function of collector current; typical values

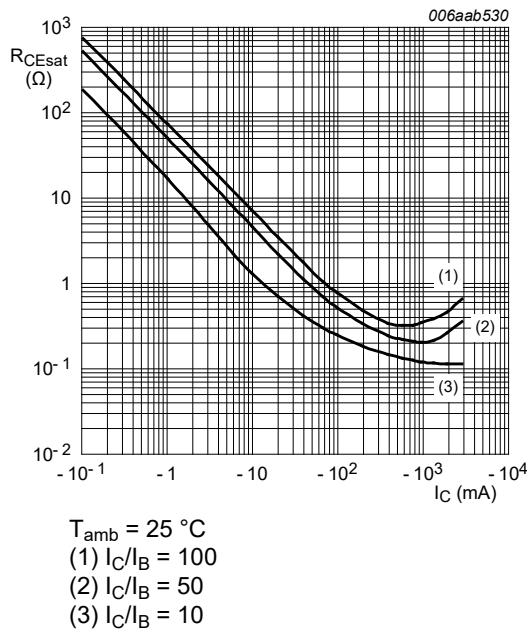


Fig. 12. TR1 (PNP): Collector-emitter saturation resistance as a function of collector current; typical values

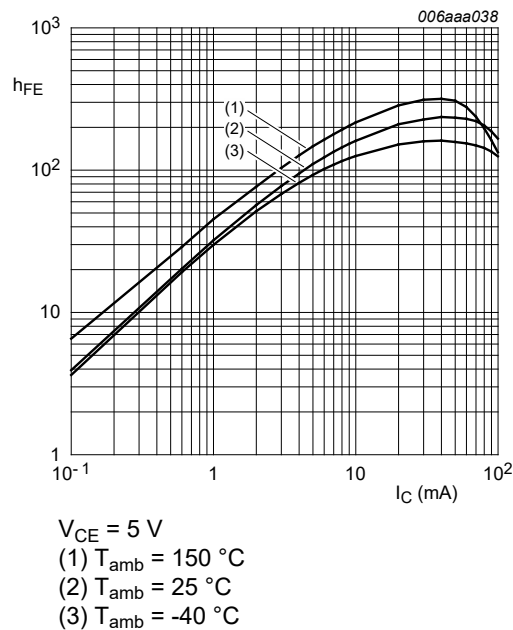


Fig. 13. TR2 (NPN): DC current gain as a function of collector current; typical values

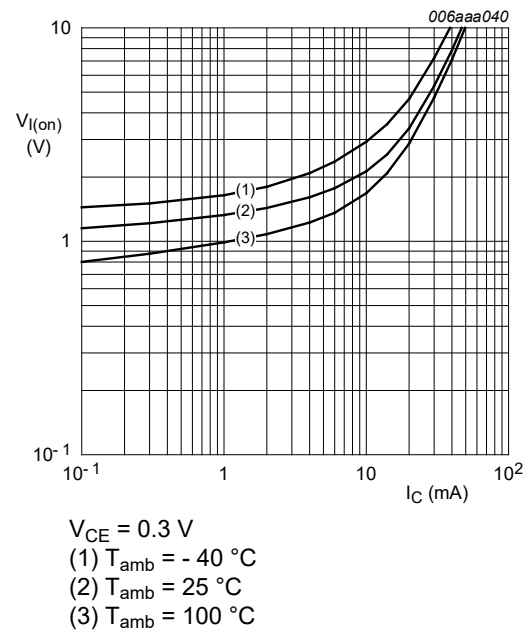


Fig. 14. TR2 (NPN): On-state input voltage as a function of collector current; typical values

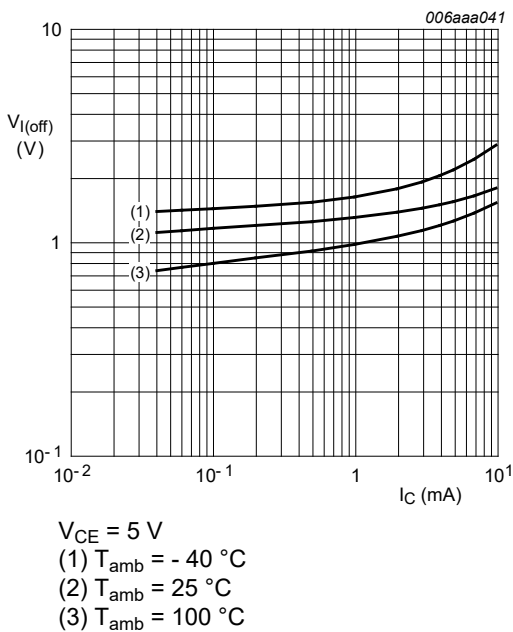


Fig. 15. TR2 (NPN): Off-state input voltage as a function of collector current; typical values

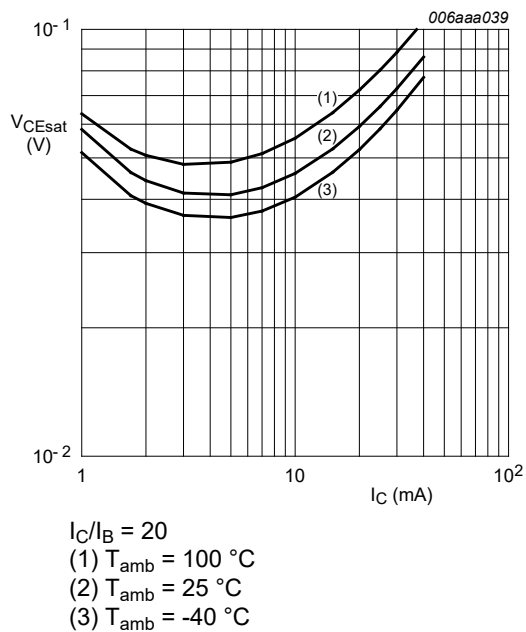
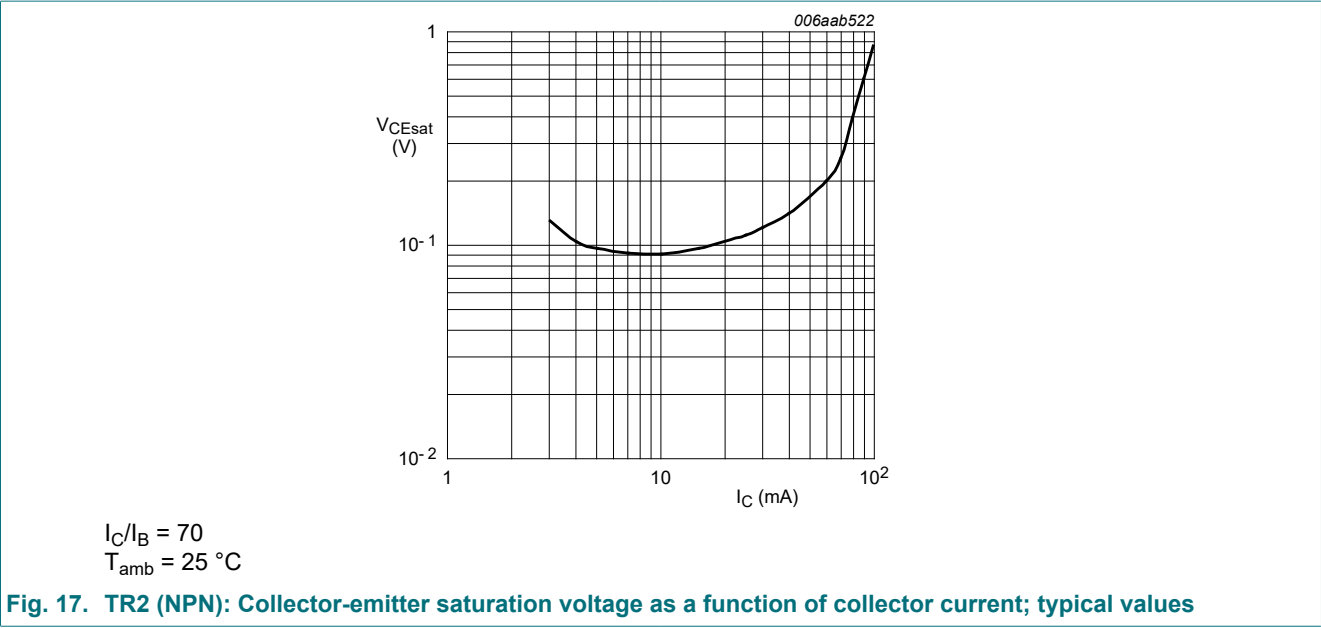


Fig. 16. TR2 (NPN): Collector-emitter saturation voltage as a function of collector current; typical values



11. Test information

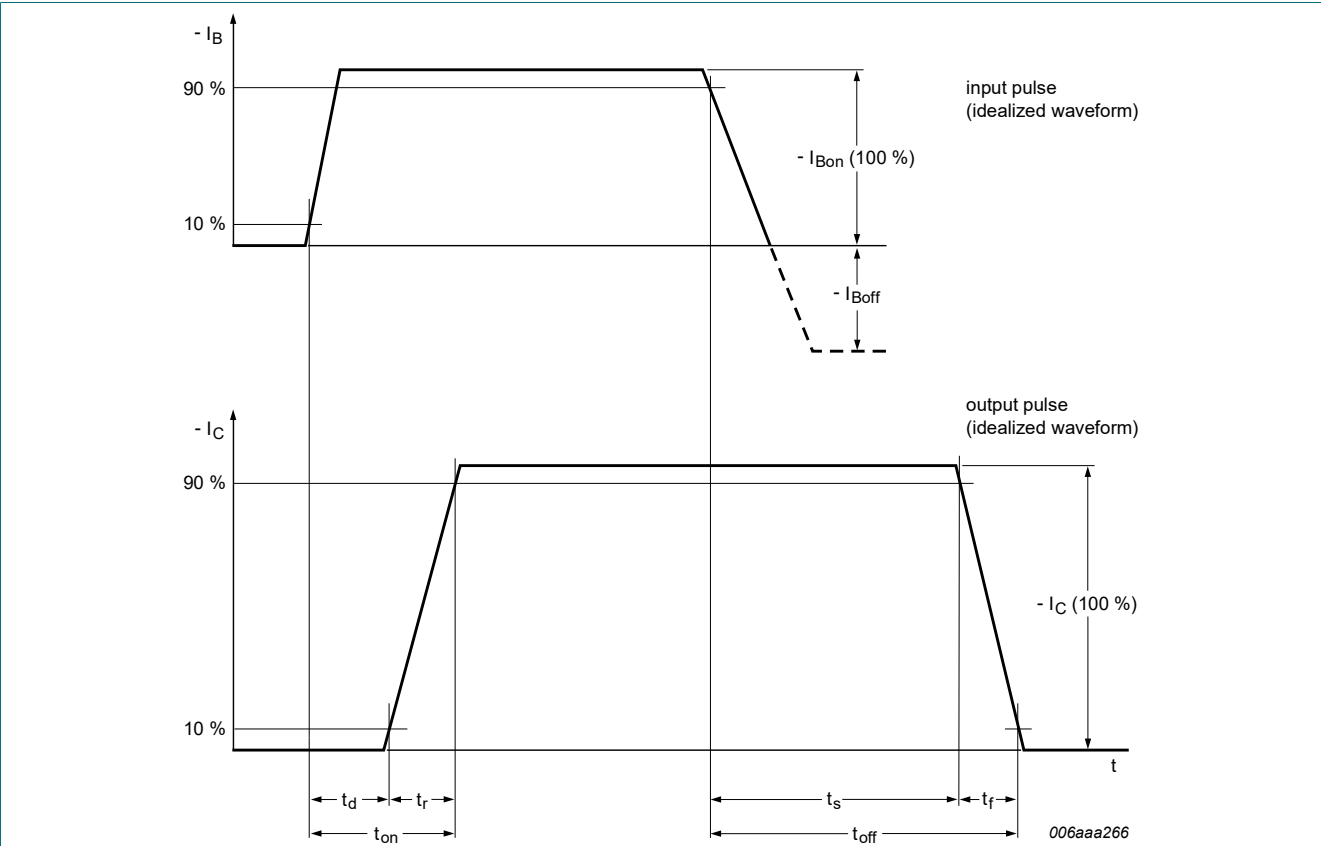


Fig. 18. TR1: Transistor switching time definition

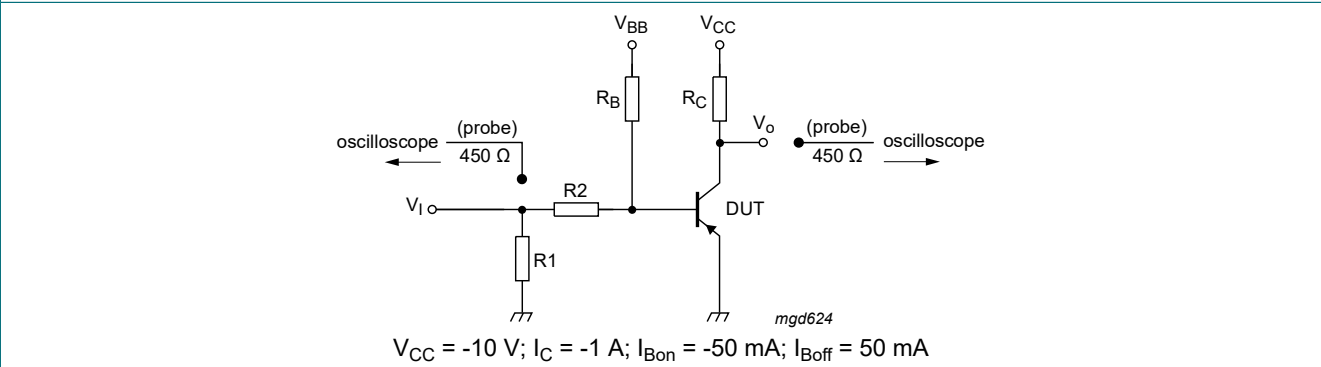
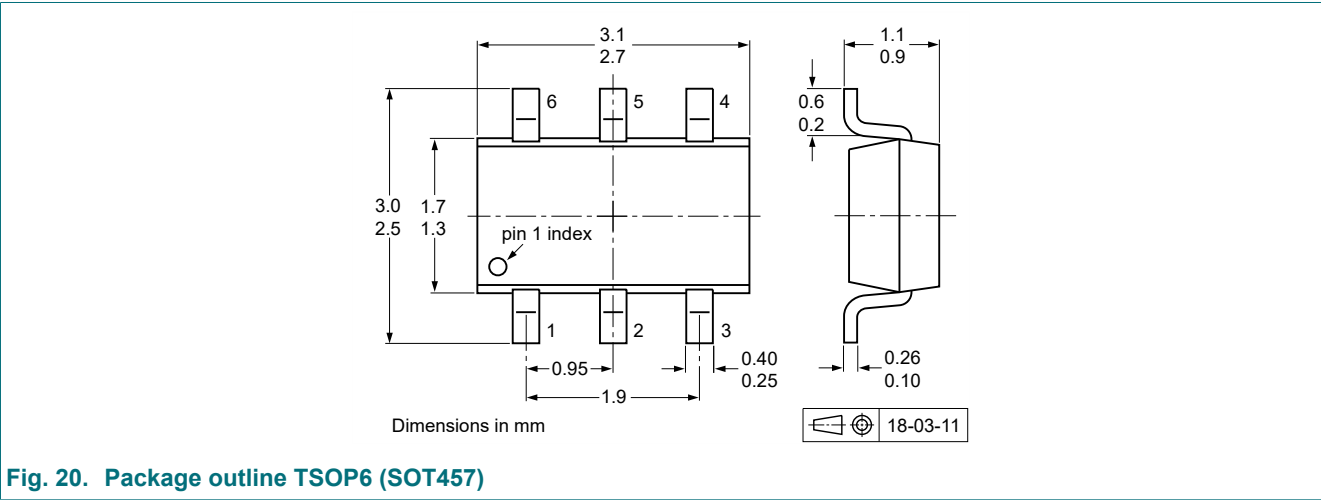


Fig. 19. TR1: Test circuit for switching times

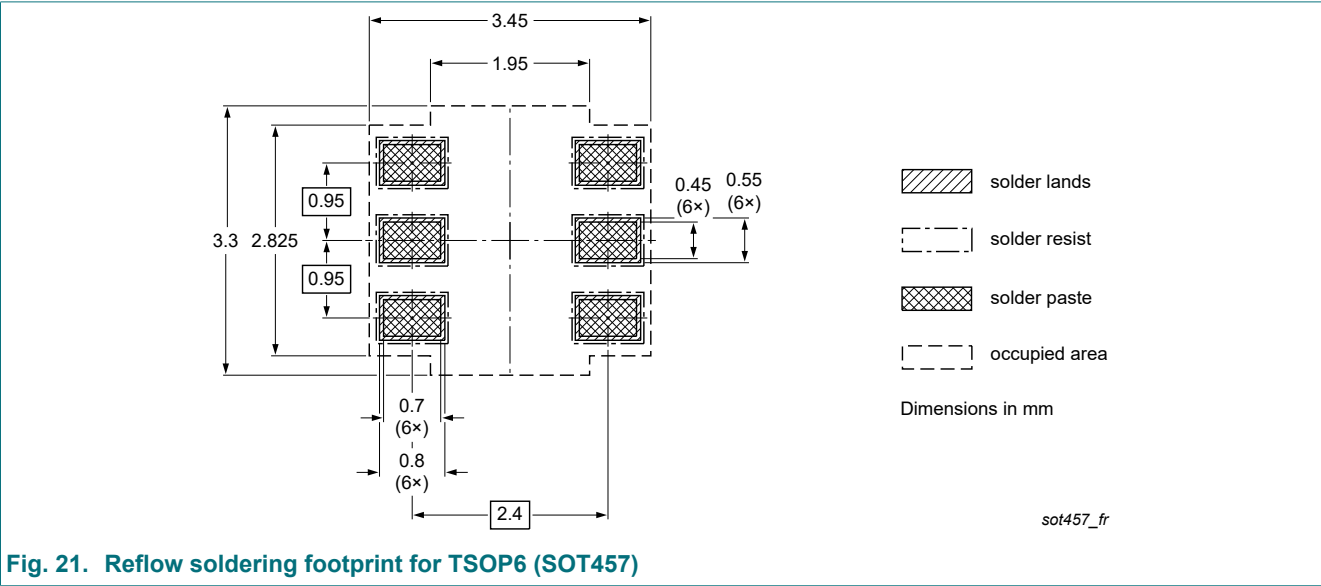
Quality information

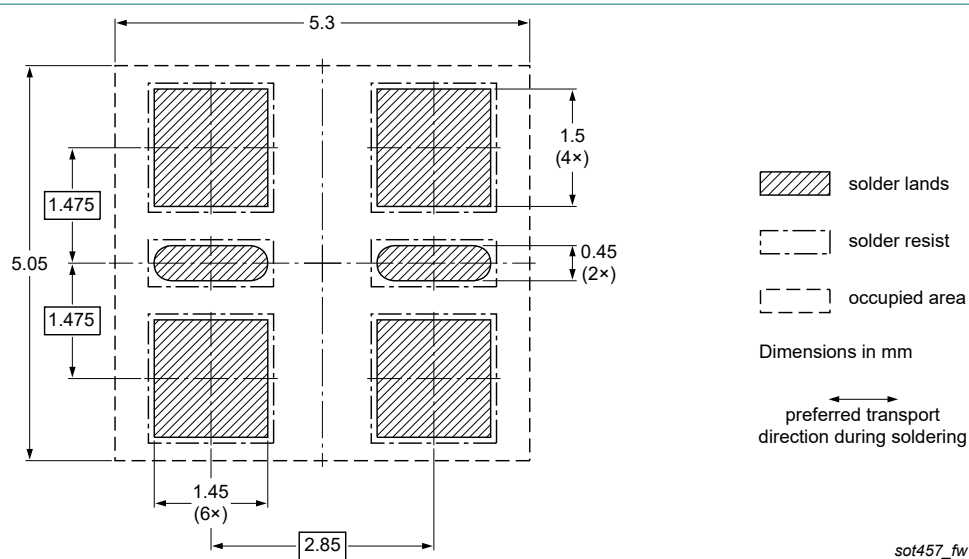
This product has been qualified in accordance with the Automotive Electronics Council (AEC) standard Q101 - Stress test qualification for discrete semiconductors, and is suitable for use in automotive applications.

12. Package outline



13. Soldering





**Fig. 22. Wave soldering footprint for TSOP6 (SOT457)**

## 14. Revision history

Table 8. Revision history

| Data sheet ID  | Release date                                                                                                                                                                                                                                                                          | Data sheet status  | Change notice | Supersedes  |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|---------------|-------------|
| PBLS6024D v.2  | 20231020                                                                                                                                                                                                                                                                              | Product data sheet | -             | PBLS6024D_1 |
| 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><li>Section "Packing information" removed.</li></ul> |                    |               |             |
| PBLS6024D_1    | 20090814                                                                                                                                                                                                                                                                              | 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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For more information, please visit: <http://www.nexperia.com>

For sales office addresses, please send an email to: [salesaddresses@nexperia.com](mailto:salesaddresses@nexperia.com)

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