

# PBL54004D

40 V PNP BISS loadswitch

Rev. 02 — 19 July 2005

Product data sheet

## 1. Product profile

### 1.1 General description

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

### 1.2 Features

- Low  $V_{CEsat}$  (BISS) 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

### 1.3 Applications

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

### 1.4 Quick reference data

Table 1: Quick reference data

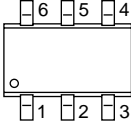
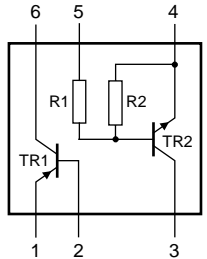
| Symbol  | Parameter                               | Conditions                         | Min  | Typ | Max  | Unit       |
|---|---|------------------------------------|------|-----|------|------------|
| <b>TR1; PNP low <math>V_{CEsat}</math> transistor</b> |   |                                    |      |     |      |            |
| $V_{CEO}$   | collector-emitter voltage               | open base                          | -    | -   | -40  | V          |
| $I_C$   | collector current (DC)                  |                                    | [1]  | -   | -1   | A          |
| $R_{CEsat}$   | collector-emitter saturation resistance | $I_C = -500$ mA;<br>$I_B = -50$ mA | [2]  | 240 | 340  | m $\Omega$ |
| <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)                 |                                    | 15.4 | 22  | 28.6 | k $\Omega$ |
| R2/R1   | bias resistor ratio                     |                                    | 0.8  | 1   | 1.2  |            |

[1] Device mounted on a ceramic Printed-Circuit Board (PCB), Al<sub>2</sub>O<sub>3</sub>, standard footprint.

[2] Pulse test:  $t_p \leq 300$   $\mu$ s;  $\delta \leq 0.02$ .

## 2. Pinning information

**Table 2: Pinning**

| Pin | Description            | Simplified outline   | Symbol  |
|-----|------------------------|--|---|
| 1   | emitter TR1            |  |  |
| 2   | base TR1               |  |   |
| 3   | output (collector) TR2 |  |   |
| 4   | GND (emitter) TR2      |  |   |
| 5   | input (base) TR2       |  |   |
| 6   | collector TR1          |  |   |

*sym036*

## 3. Ordering information

**Table 3: Ordering information**

| Type number | Package |  |         |
|-------------|---------|--|---------|
|             | Name    | Description                              | Version |
| PBLS4004D   | SC-74   | plastic surface mounted package; 6 leads | SOT457  |

## 4. Marking

**Table 4: Marking codes**

| Type number | Marking code |
|-------------|--------------|
| PBLS4004D   | R4           |

## 5. Limiting values

**Table 5: Limiting values**

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

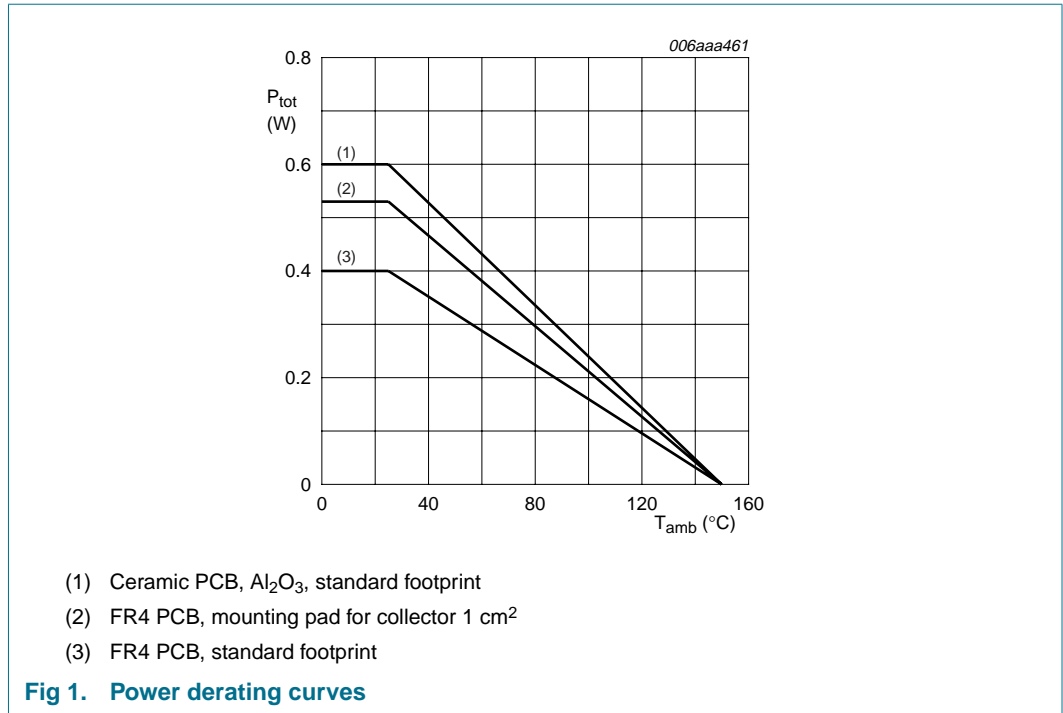
| Symbol  | Parameter                 | Conditions                    | Min | Max   | Unit |
|---|---------------------------|-------------------------------|-----|-------|------|
| <b>TR1; PNP low <math>V_{CEsat}</math> transistor</b> |                           |                               |     |       |      |
| $V_{CBO}$   | collector-base voltage    | open emitter                  | -   | -40   | V    |
| $V_{CEO}$   | collector-emitter voltage | open base                     | -   | -40   | V    |
| $V_{EBO}$   | emitter-base voltage      | open collector                | -   | -5    | V    |
| $I_C$   | collector current (DC)    |                               | [1] | -0.7  | A    |
|   |                           |                               | [2] | -0.85 | A    |
|   |                           |                               | [3] | -1    | A    |
| $I_{CM}$  | peak collector current    | single pulse; $t_p \leq 1$ ms | -   | -2    | A    |
| $I_B$   | base current (DC)         |                               | -   | -0.3  | A    |
| $I_{BM}$  | peak base current         | single pulse; $t_p \leq 1$ ms | -   | -1    | A    |

**Table 5: Limiting values ...continued***In accordance with the Absolute Maximum Rating System (IEC 60134).*

| Symbol                                       | Parameter                 | Conditions                          | Min      | Max  | Unit |   |
|--|---------------------------|-------------------------------------|----------|------|------|---|
| P <sub>tot</sub>                             | total power dissipation   | T <sub>amb</sub> ≤ 25 °C            | [1] -    | 250  | mW   |   |
|  |                           |                                     | [2] -    | 350  | mW   |   |
|  |                           |                                     | [3] -    | 400  | mW   |   |
| <b>TR2; NPN resistor-equipped transistor</b> |                           |                                     |          |      |      |   |
| 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             |                                     | -        | +40  | V    |   |
|  |                           |                                     | positive | -    | +40  | V |
|  |                           |                                     | negative | -    | -10  | V |
| I <sub>O</sub>                               | output current            |                                     | -        | 100  | mA   |   |
| I <sub>CM</sub>                              | peak collector current    | single pulse; t <sub>p</sub> ≤ 1 ms | -        | 100  | mA   |   |
| P <sub>tot</sub>                             | total power dissipation   | T <sub>amb</sub> ≤ 25 °C            | -        | 200  | mW   |   |
| <b>Per device</b>                            |                           |                                     |          |      |      |   |
| P <sub>tot</sub>                             | total power dissipation   | T <sub>amb</sub> ≤ 25 °C            | [1] -    | 400  | mW   |   |
|  |                           |                                     | [2] -    | 530  | mW   |   |
|  |                           |                                     | [3] -    | 600  | mW   |   |
| T <sub>stg</sub>                             | storage temperature       |                                     | -65      | +150 | °C   |   |
| T <sub>j</sub>                               | junction temperature      |                                     | -        | 150  | °C   |   |
| T <sub>amb</sub>                             | ambient temperature       |                                     | -65      | +150 | °C   |   |

[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.

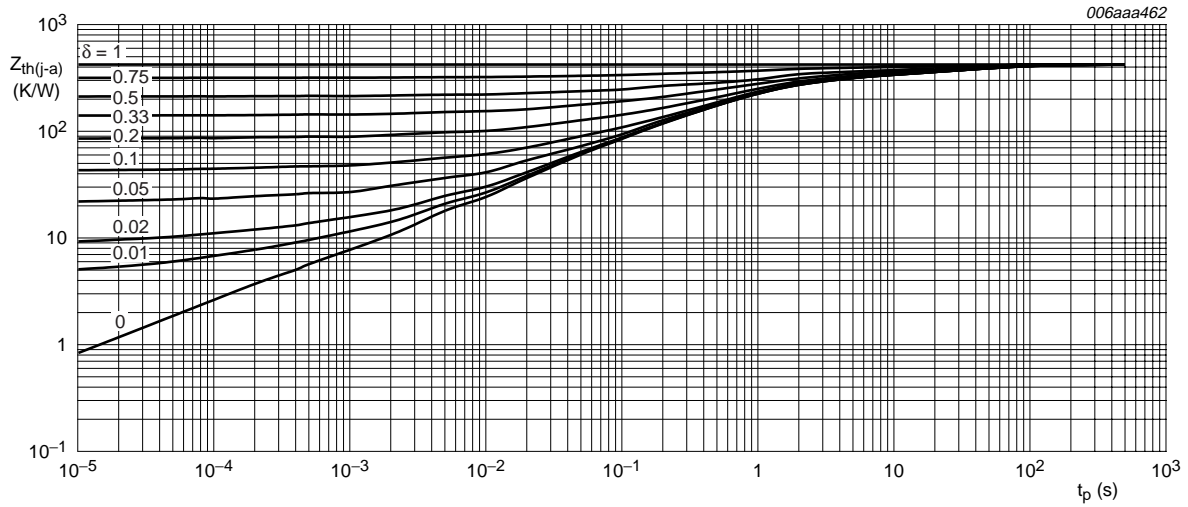


## 6. Thermal characteristics

**Table 6: Thermal characteristics**

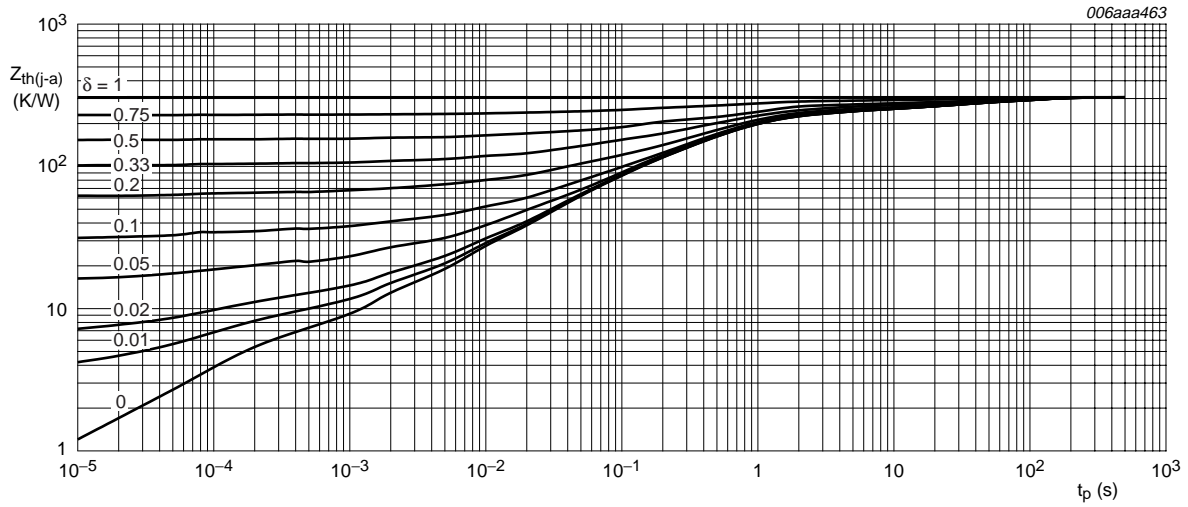
| Symbol   | Parameter  | Conditions  | Min | Typ | Max | Unit |
|--|--|-------------|-----|-----|-----|------|
| <b>Per device</b>                                    |  |             |     |     |     |      |
| R <sub>th(j-a)</sub>                                 | thermal resistance from junction to ambient      | in free air | [1] | -   | 312 | K/W  |
|  |  |             | [2] | -   | 236 | K/W  |
|  |  |             | [3] | -   | 210 | K/W  |
| <b>Per TR1; PNP low V<sub>CEsat</sub> transistor</b> |  |             |     |     |     |      |
| 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.



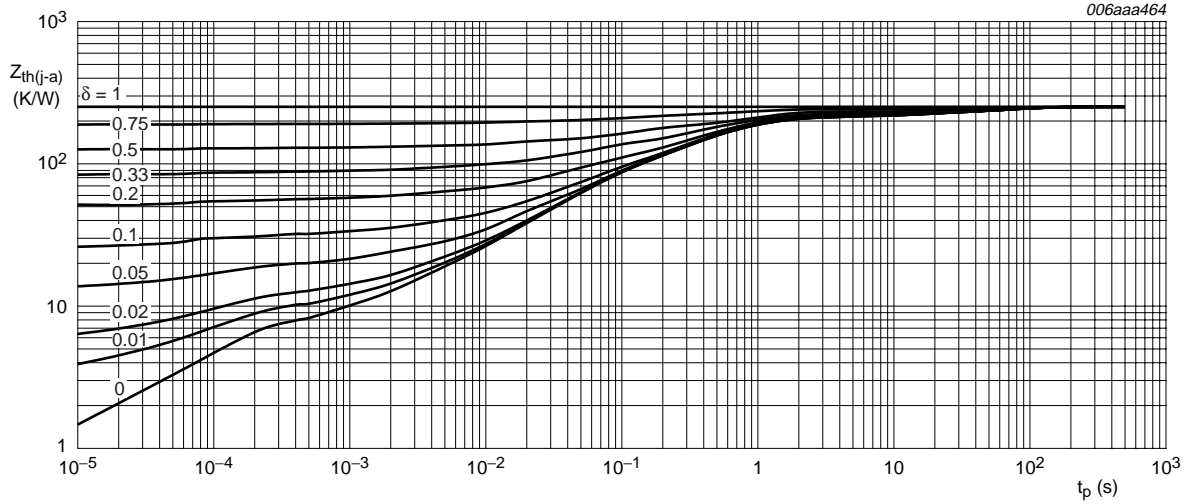
FR4 PCB, standard footprint

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



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

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

## 7. Characteristics

Table 7: Characteristics

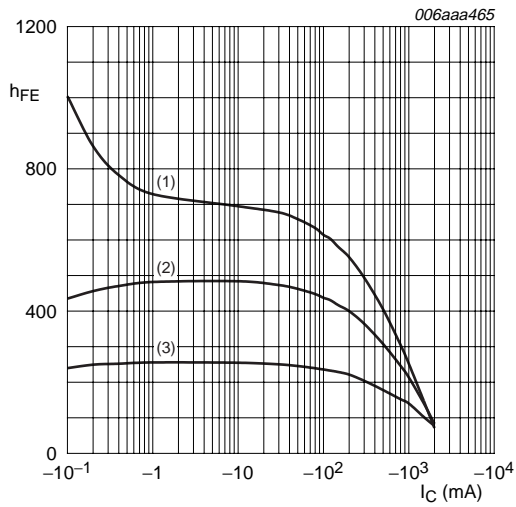
$T_{amb} = 25^{\circ}C$  unless otherwise specified.

| Symbol  | Parameter                               | Conditions                                      | Min     | Typ  | Max  | Unit       |
|---|---|---|---------|------|------|------------|
| <b>TR1; PNP low <math>V_{CEsat}</math> transistor</b> |   |   |         |      |      |            |
| $I_{CBO}$   | collector-base cut-off current          | $V_{CB} = -40 V; I_E = 0 A$                     | -       | -    | -0.1 | $\mu A$    |
|   |   | $V_{CB} = -40 V; I_E = 0 A; T_j = 150^{\circ}C$ | -       | -    | -50  | $\mu A$    |
| $I_{CES}$   | collector-emitter cut-off current       | $V_{CE} = -30 V; V_{BE} = 0 V$                  | -       | -    | -0.1 | $\mu A$    |
| $I_{EBO}$   | emitter-base cut-off current            | $V_{EB} = -5 V; I_C = 0 A$                      | -       | -    | -0.1 | $\mu A$    |
| $h_{FE}$  | DC current gain                         | $V_{CE} = -5 V; I_C = -1 mA$                    | 300     | -    | -    |            |
|   |   | $V_{CE} = -5 V; I_C = -100 mA$                  | [1] 300 | -    | 800  |            |
|   |   | $V_{CE} = -5 V; I_C = -500 mA$                  | [1] 215 | -    | -    |            |
|   |   | $V_{CE} = -5 V; I_C = -1 A$                     | [1] 150 | -    | -    |            |
| $V_{CEsat}$   | collector-emitter saturation voltage    | $I_C = -100 mA; I_B = -1 mA$                    | -       | -80  | -140 | mV         |
|   |   | $I_C = -500 mA; I_B = -50 mA$                   | [1] -   | -120 | -170 | mV         |
|   |   | $I_C = -1 A; I_B = -100 mA$                     | [1] -   | -220 | -310 | mV         |
| $R_{CEsat}$   | collector-emitter saturation resistance | $I_C = -500 mA; I_B = -50 mA$                   | [1] -   | 240  | 340  | m $\Omega$ |
| $V_{BEsat}$   | base-emitter saturation voltage         | $I_C = -1 A; I_B = -50 mA$                      | [1] -   | -    | -1.1 | V          |
| $V_{BEon}$  | base-emitter turn-on voltage            | $V_{CE} = -5 V; I_C = -1 A$                     | [1] -   | -    | -1   | V          |

**Table 7: Characteristics ...continued**  
 $T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified.

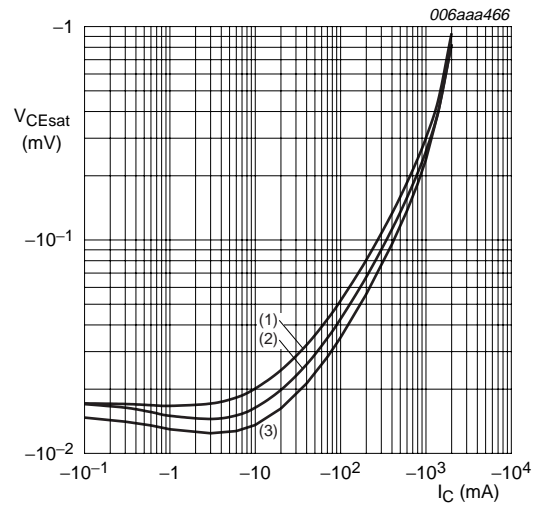
| Symbol                                       | Parameter                            | Conditions   | Min  | Typ | Max  | Unit          |
|--|--------------------------------------|--|------|-----|------|---------------|
| $f_T$  | transition frequency                 | $I_C = -50\text{ mA}$ ; $V_{CE} = -10\text{ V}$ ;<br>$f = 100\text{ MHz}$            | 150  | -   | -    | MHz           |
| $C_C$  | collector capacitance                | $V_{CB} = -10\text{ V}$ ; $I_E = i_e = 0\text{ A}$ ;<br>$f = 1\text{ MHz}$           | -    | -   | 12   | pF            |
| <b>TR2; NPN resistor-equipped transistor</b> |                                      |  |      |     |      |               |
| $I_{CBO}$                                    | collector-base cut-off current       | $V_{CB} = 50\text{ V}$ ; $I_E = 0\text{ A}$  | -    | -   | 100  | nA            |
| $I_{CEO}$                                    | collector-emitter cut-off current    | $V_{CE} = 30\text{ V}$ ; $I_B = 0\text{ A}$  | -    | -   | 1    | $\mu\text{A}$ |
|  |                                      | $V_{CE} = 30\text{ V}$ ; $I_B = 0\text{ A}$ ;<br>$T_j = 150\text{ }^{\circ}\text{C}$ | -    | -   | 50   | $\mu\text{A}$ |
| $I_{EBO}$                                    | emitter-base cut-off current         | $V_{EB} = 5\text{ V}$ ; $I_C = 0\text{ A}$   | -    | -   | 180  | $\mu\text{A}$ |
| $h_{FE}$                                     | DC current gain                      | $V_{CE} = 5\text{ V}$ ; $I_C = 5\text{ mA}$  | 60   | -   | -    |               |
| $V_{CEsat}$                                  | collector-emitter saturation voltage | $I_C = 10\text{ mA}$ ; $I_B = 0.5\text{ mA}$   | -    | -   | 150  | mV            |
| $V_{I(off)}$                                 | off-state input voltage              | $V_{CE} = 5\text{ V}$ ; $I_C = 100\text{ }\mu\text{A}$                               | -    | 1.1 | 0.8  | V             |
| $V_{I(on)}$                                  | on-state input voltage               | $V_{CE} = 0.3\text{ V}$ ; $I_C = 5\text{ mA}$  | 2.5  | 1.7 | -    | V             |
| R1   | bias resistor 1 (input)              |  | 15.4 | 22  | 28.6 | k $\Omega$    |
| R2/R1  | bias resistor ratio                  |  | 0.8  | 1   | 1.2  |               |
| $C_C$  | collector capacitance                | $V_{CB} = 10\text{ V}$ ; $I_E = i_e = 0\text{ A}$ ;<br>$f = 1\text{ MHz}$            | -    | -   | 2.5  | pF            |

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



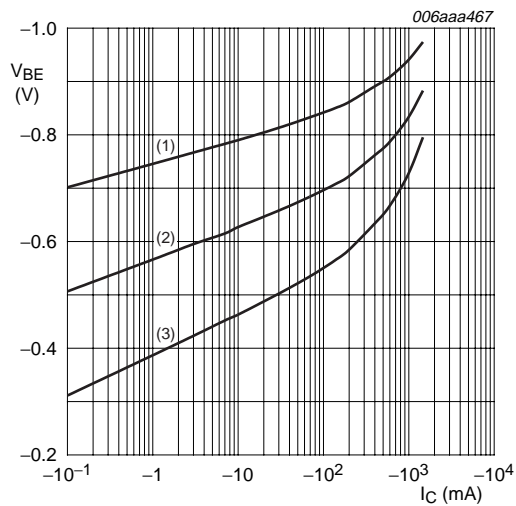
$V_{CE} = -5\text{ V}$   
 (1)  $T_{amb} = 100\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -55\text{ °C}$

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



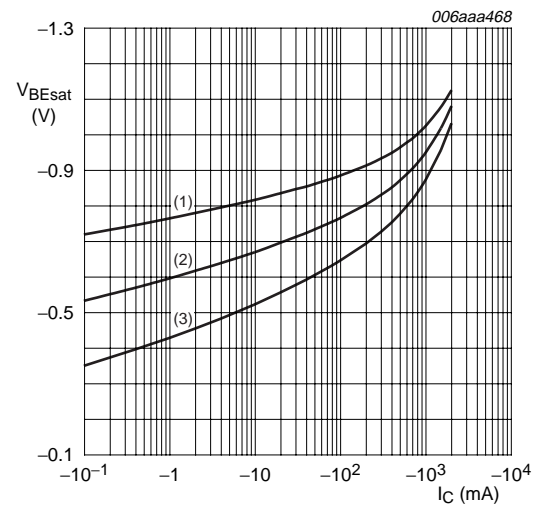
$I_C/I_B = 20$   
 (1)  $T_{amb} = 100\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = -55\text{ °C}$

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



$V_{CE} = -5\text{ V}$   
 (1)  $T_{amb} = -55\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = 100\text{ °C}$

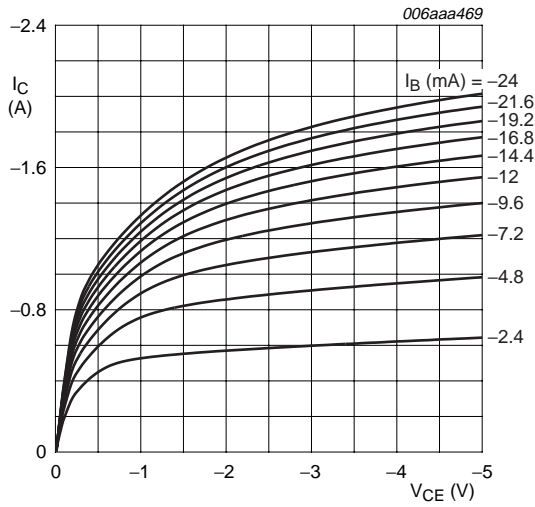
**Fig 7. TR1 (PNP): Base-emitter voltage as a function of collector current; typical values**



$I_C/I_B = 20$   
 (1)  $T_{amb} = -55\text{ °C}$   
 (2)  $T_{amb} = 25\text{ °C}$   
 (3)  $T_{amb} = 100\text{ °C}$

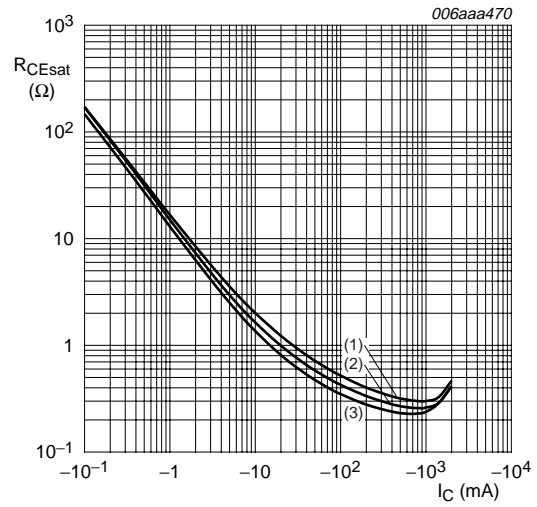
**Fig 8. TR1 (PNP): Base-emitter saturation voltage as a function of collector current; typical values**





$T_{amb} = 25\text{ }^\circ\text{C}$

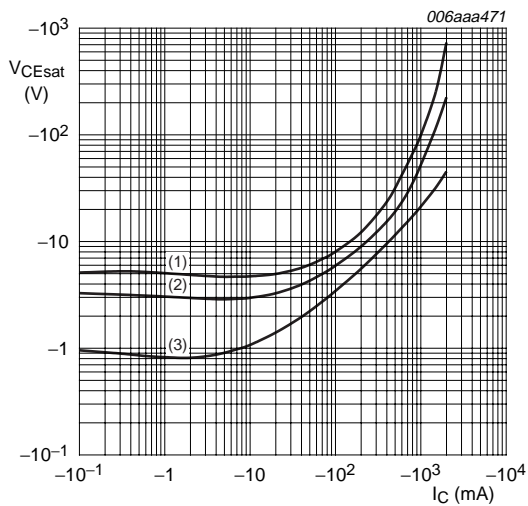
Fig 9. TR1 (PNP): Collector current as a function of collector-emitter voltage; typical values



$I_C/I_B = 20$

- (1)  $T_{amb} = 100\text{ }^\circ\text{C}$
- (2)  $T_{amb} = 25\text{ }^\circ\text{C}$
- (3)  $T_{amb} = -55\text{ }^\circ\text{C}$

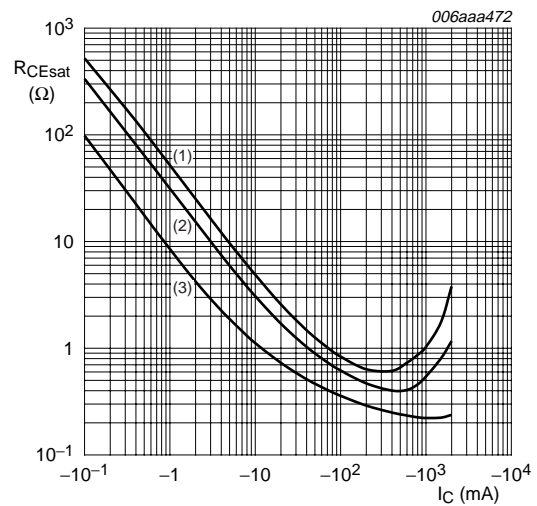
Fig 10. TR1 (PNP): Collector-emitter saturation resistance as a function of collector current; typical values



$T_{amb} = 25\text{ }^\circ\text{C}$

- (1)  $I_C/I_B = 100$
- (2)  $I_C/I_B = 50$
- (3)  $I_C/I_B = 10$

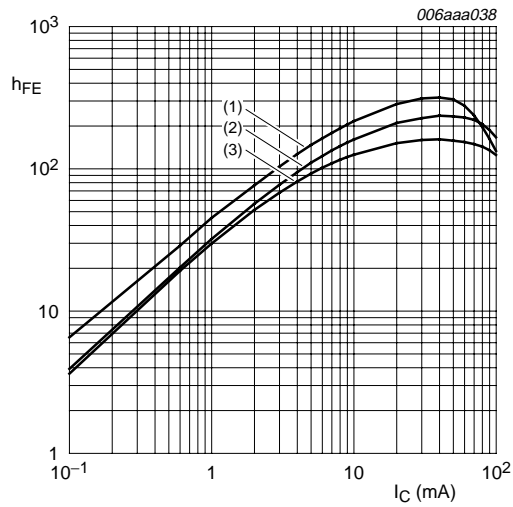
Fig 11. TR1 (PNP): Collector-emitter saturation voltage as a function of collector current; typical values



$T_{amb} = 25\text{ }^\circ\text{C}$

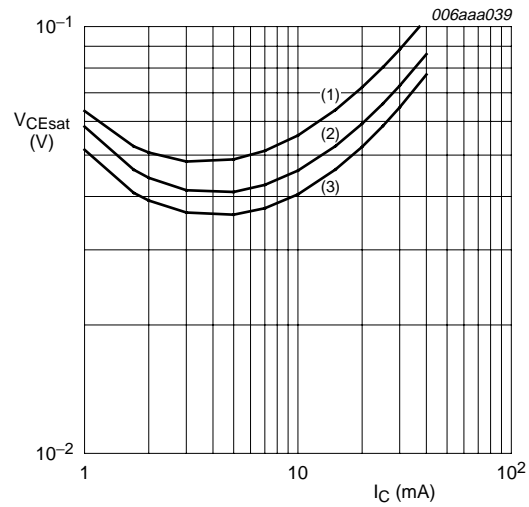
- (1)  $I_C/I_B = 100$
- (2)  $I_C/I_B = 50$
- (3)  $I_C/I_B = 10$

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



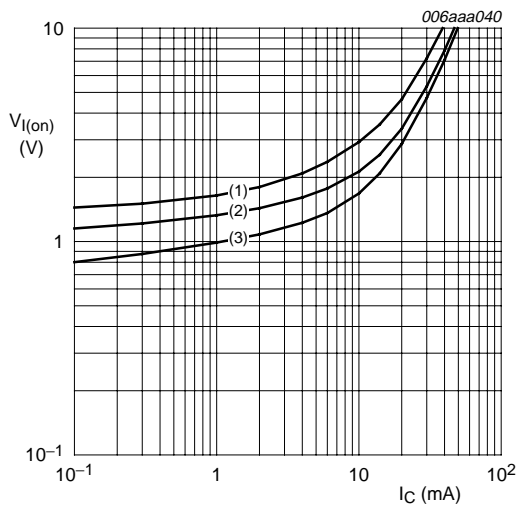
$V_{CE} = 5 \text{ V}$   
 (1)  $T_{amb} = 150 \text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{amb} = -40 \text{ }^\circ\text{C}$

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



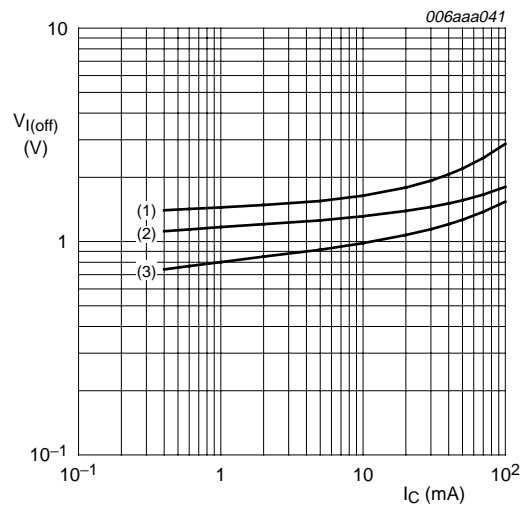
$I_C/I_B = 20$   
 (1)  $T_{amb} = 100 \text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{amb} = -40 \text{ }^\circ\text{C}$

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



$V_{CE} = 0.3 \text{ V}$   
 (1)  $T_{amb} = -40 \text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100 \text{ }^\circ\text{C}$

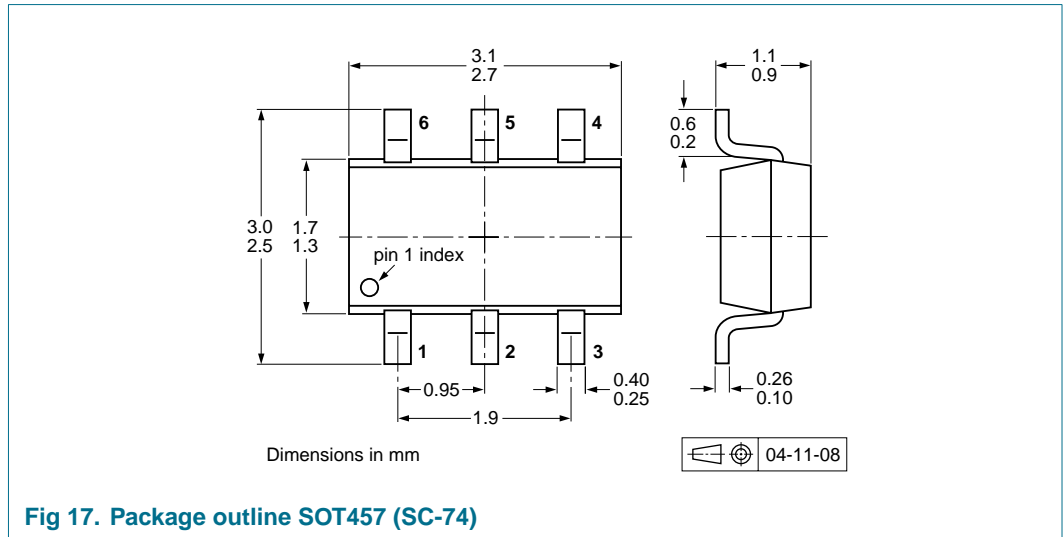
**Fig 15. TR2 (NPN): On-state input voltage as a function of collector current; typical values**



$V_{CE} = 5 \text{ V}$   
 (1)  $T_{amb} = -40 \text{ }^\circ\text{C}$   
 (2)  $T_{amb} = 25 \text{ }^\circ\text{C}$   
 (3)  $T_{amb} = 100 \text{ }^\circ\text{C}$

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

## 8. Package outline



## 9. Packing information

**Table 8: Packing methods**

The indicated -xxx are the last three digits of the 12NC ordering code. [\[1\]](#)

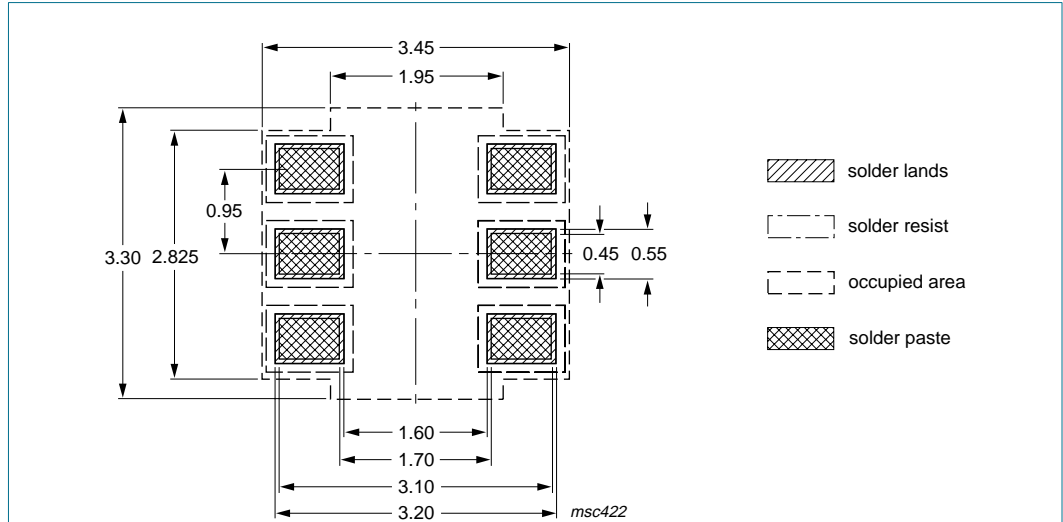
| Type number | Package | Description                        | Packing quantity         |       |
|-------------|---------|------------------------------------|--------------------------|-------|
|             |         |                                    | 3000                     | 10000 |
| PBLS4004D   | SOT457  | 4 mm pitch, 8 mm tape and reel; T1 | <a href="#">[2]</a> -115 | -135  |
|             |         | 4 mm pitch, 8 mm tape and reel; T2 | <a href="#">[3]</a> -125 | -165  |

[1] For further information and the availability of packing methods, see [Section 16](#).

[2] T1: normal taping

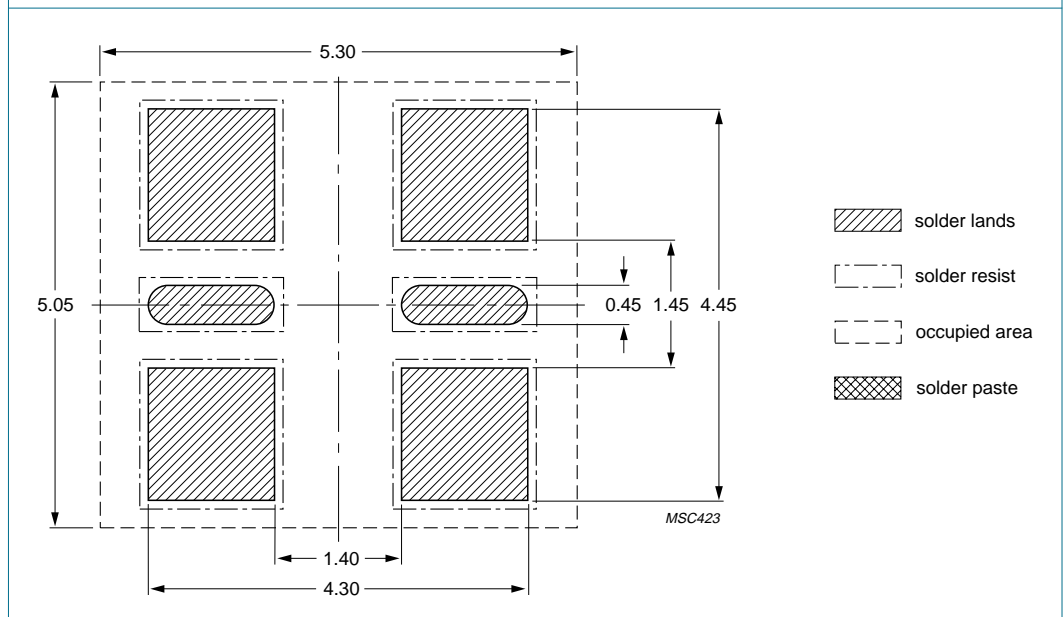
[3] T2: reverse taping

10. Soldering



Dimensions in mm

**Fig 18. Reflow soldering footprint**



Dimensions in mm

**Fig 19. Wave soldering footprint**

## 11. Revision history

**Table 9: Revision history**

| Document ID    | Release date   | Data sheet status    | Change notice | Doc. number    | Supersedes |
|----------------|--|----------------------|---------------|----------------|------------|
| PBL4004D_2     | 20050719   | Product data sheet   | -             | 9397 750 15097 | PBL4004D_1 |
| Modifications: | <ul style="list-style-type: none"><li>• <a href="#">Figure 1</a>, <a href="#">2</a>, <a href="#">3</a>, <a href="#">4</a>, <a href="#">6</a>, <a href="#">8</a>, <a href="#">10</a>, <a href="#">11</a> and <a href="#">12</a>: added</li><li>• <a href="#">Figure 5</a>, <a href="#">7</a> and <a href="#">9</a>: amended</li><li>• <a href="#">Figure 17</a>: superseded by minimized package outline</li><li>• <a href="#">Section 10 "Soldering"</a>: added</li><li>• <a href="#">Section 15 "Trademarks"</a>: added</li></ul> |                      |               |                |            |
| PBL4004D_1     | 20041109   | Objective data sheet | -             | 9397 750 13909 | -          |

## 12. Data sheet status

| Level | Data sheet status <sup>[1]</sup> | Product status <sup>[2] [3]</sup> | Definition   |
|-------|----------------------------------|-----------------------------------|--|
| I     | Objective data                   | Development                       | This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.  |
| II    | Preliminary data                 | Qualification                     | This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product.             |
| III   | Product data                     | Production                        | This data sheet contains data from the product specification. Philips Semiconductors reserves the right to make changes at any time in order to improve the design, manufacturing and supply. Relevant changes will be communicated via a Customer Product/Process Change Notification (CPCN). |

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[2] The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL <http://www.semiconductors.philips.com>.

[3] For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

## 13. Definitions

**Short-form specification** — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

**Limiting values definition** — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

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## 16. Contact information

For additional information, please visit: <http://www.semiconductors.philips.com>

For sales office addresses, send an email to: [sales.addresses@www.semiconductors.philips.com](mailto:sales.addresses@www.semiconductors.philips.com)

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