



# PBLS6023D

60 V, 1.5 A PNP BISS loadswitch

Rev. 01 — 13 August 2009

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
- Space-saving solution
- Reduction of component count
- AEC-Q101 qualified

### 1.3 Applications

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

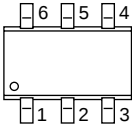
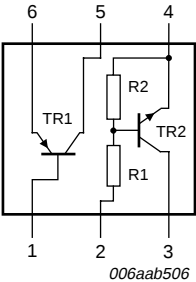
### 1.4 Quick reference data

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                          | -                     | -   | -60  | V          |
| $I_C$                                                 | collector current                       |                                    | -                     | -   | -1.5 | A          |
| $I_{CM}$                                              | peak collector current                  | single pulse;<br>$t_p \leq 1$ ms   | -                     | -   | -3   | A          |
| $R_{CEsat}$                                           | collector-emitter saturation resistance | $I_C = -1.5$ A;<br>$I_B = -100$ mA | <a href="#">[1]</a> - | 110 | 175  | 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)                 |                                    | 7                     | 10  | 13   | k $\Omega$ |
| R2/R1                                                 | bias resistor ratio                     |                                    | 0.8                   | 1   | 1.2  |            |

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

2. Pinning information

| Table 2. Pinning |                        |                                                                                    |                                                                                     |
|------------------|------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Pin              | Description            | Simplified outline                                                                 | Graphic symbol                                                                      |
| 1                | base TR1               |  |  |
| 2                | input (base) TR2       |                                                                                    |                                                                                     |
| 3                | output (collector) TR2 |                                                                                    |                                                                                     |
| 4                | GND (emitter) TR2      |                                                                                    |                                                                                     |
| 5                | collector TR1          |                                                                                    |                                                                                     |
| 6                | emitter TR1            |                                                                                    |                                                                                     |

3. Ordering information

| Table 3. Ordering information |         |                                                  |         |
|-------------------------------|---------|--------------------------------------------------|---------|
| Type number                   | Package |                                                  |         |
|                               | Name    | Description                                      | Version |
| PBLS6023D                     | SC-74   | plastic surface-mounted package (TSOP6); 6 leads | SOT457  |

4. Marking

| Table 4. Marking codes |              |
|------------------------|--------------|
| Type number            | Marking code |
| PBLS6023D              | KG           |

## 5. Limiting values

**Table 5. Limiting values**

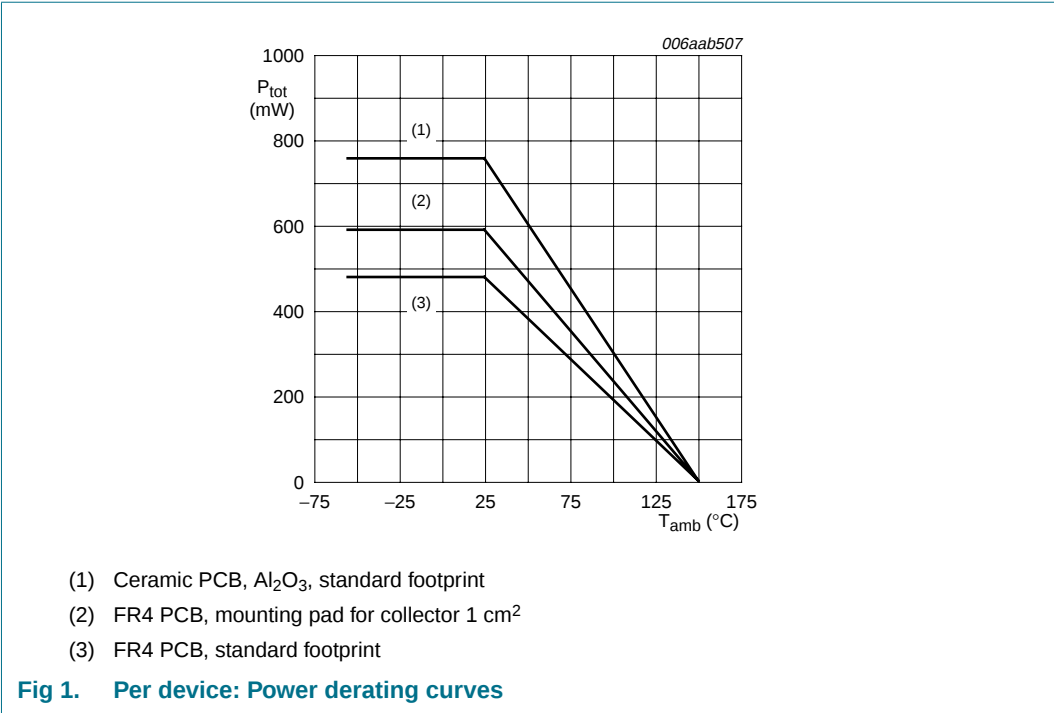
*In accordance with the Absolute Maximum Rating System (IEC 60134).*

| 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    | single pulse;<br>t <sub>p</sub> ≤ 1 ms | -               | −3   | A    |
| I <sub>B</sub>                             | base current              |                                        | -               | −300 | mA   |
| I <sub>BM</sub>                            | peak base current         | single pulse;<br>t <sub>p</sub> ≤ 1 ms | -               | −1   | A    |
| 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    | single pulse;<br>t <sub>p</sub> ≤ 1 ms | -               | 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 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.

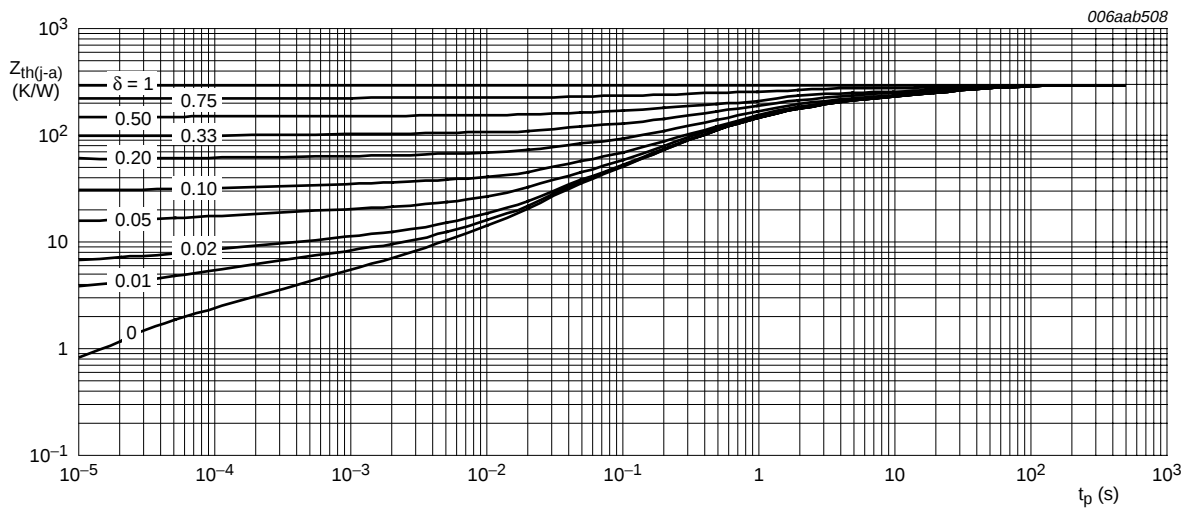


6. Thermal characteristics

Table 6. Thermal characteristics

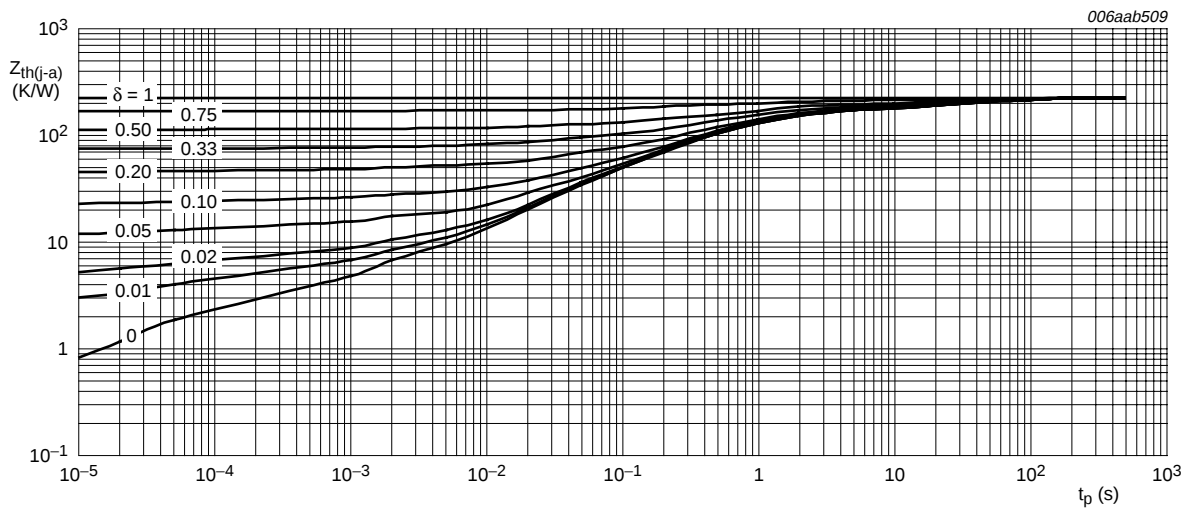
| Symbol                | Parameter                                        | Conditions  | Min | Typ | Max | Unit    |
|-----------------------|--------------------------------------------------|-------------|-----|-----|-----|---------|
| Per device            |                                                  |             |     |     |     |         |
| 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 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.



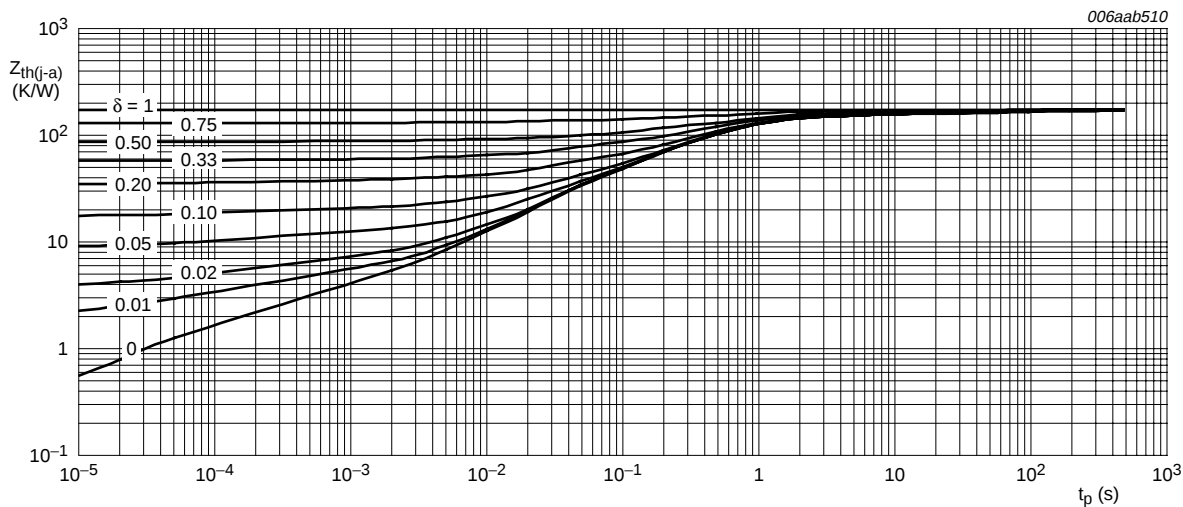
FR4 PCB, standard footprint

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



FR4 PCB, mounting pad for collector 1 cm²

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

7. Characteristics

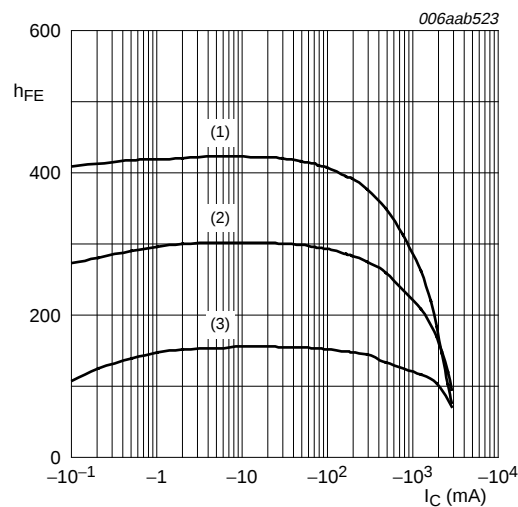
Table 7. Characteristics  
*T<sub>amb</sub> = 25 °C unless otherwise specified.*

| Symbol                                     | Parameter                               | Conditions                                                             | Min     | Typ   | Max  | Unit |
|--------------------------------------------|-----------------------------------------|------------------------------------------------------------------------|---------|-------|------|------|
| TR1; PNP low V <sub>CEsat</sub> transistor |                                         |                                                                        |         |       |      |      |
| I <sub>CBO</sub>                           | collector-base cut-off current          | V <sub>CB</sub> = -60 V; I <sub>E</sub> = 0 A                          | -       | -     | -100 | nA   |
|                                            |                                         | V <sub>CB</sub> = -60 V; I <sub>E</sub> = 0 A; T <sub>J</sub> = 150 °C | -       | -     | -50  | μA   |
| I <sub>CES</sub>                           | collector-emitter cut-off current       | V <sub>CE</sub> = -48 V; V <sub>BE</sub> = 0 A                         | -       | -     | -100 | nA   |
| I <sub>EBO</sub>                           | emitter-base cut-off current            | V <sub>EB</sub> = -5 V; I <sub>C</sub> = 0 A                           | -       | -     | -100 | nA   |
| h <sub>FE</sub>                            | DC current gain                         | V <sub>CE</sub> = -2 V; I <sub>C</sub> = -100 mA                       | 180     | 285   | -    |      |
|                                            |                                         | V <sub>CE</sub> = -2 V; I <sub>C</sub> = -500 mA                       | [1] 150 | 255   | -    |      |
|                                            |                                         | V <sub>CE</sub> = -2 V; I <sub>C</sub> = -1 A                          | [1] 140 | 210   | -    |      |
|                                            |                                         | V <sub>CE</sub> = -2 V; I <sub>C</sub> = -1.5 A                        | [1] 120 | 185   | -    |      |
| V <sub>CEsat</sub>                         | collector-emitter saturation voltage    | I <sub>C</sub> = -0.5 A; I <sub>B</sub> = -50 mA                       | [1] -   | -65   | -100 | mV   |
|                                            |                                         | I <sub>C</sub> = -1 A; I <sub>B</sub> = -50 mA                         | [1] -   | -130  | -200 | mV   |
|                                            |                                         | I <sub>C</sub> = -1 A; I <sub>B</sub> = -100 mA                        | [1] -   | -110  | -170 | mV   |
|                                            |                                         | I <sub>C</sub> = -1.5 A; I <sub>B</sub> = -100 mA                      | [1] -   | -165  | -260 | mV   |
| R <sub>CEsat</sub>                         | collector-emitter saturation resistance | I <sub>C</sub> = -1 A; I <sub>B</sub> = -100 mA                        | [1] -   | 110   | 170  | mΩ   |
|                                            |                                         | I <sub>C</sub> = -1.5 A; I <sub>B</sub> = -100 mA                      | [1] -   | 110   | 175  | mΩ   |
| V <sub>BEsat</sub>                         | base-emitter saturation voltage         | I <sub>C</sub> = -0.5 A; I <sub>B</sub> = -50 mA                       | [1] -   | -0.85 | -1   | V    |
|                                            |                                         | I <sub>C</sub> = -1.5 A; I <sub>B</sub> = -100 mA                      | [1] -   | -0.93 | -1.1 | V    |

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

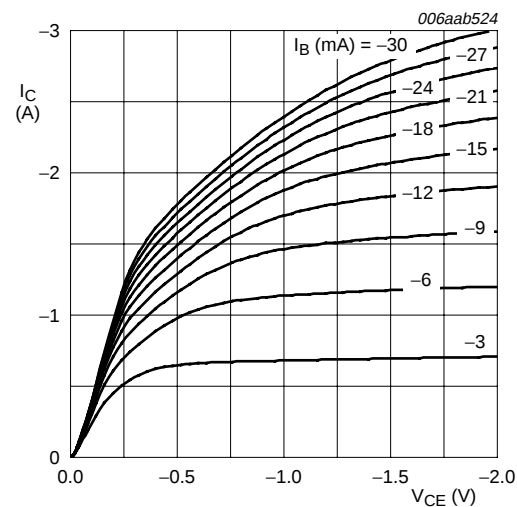
| Symbol                                       | Parameter                            | Conditions                                                                                                  | Min   | Typ   | Max  | Unit          |
|----------------------------------------------|--------------------------------------|-------------------------------------------------------------------------------------------------------------|-------|-------|------|---------------|
| $V_{BEon}$                                   | base-emitter turn-on voltage         | $V_{CE} = -10\text{ V}$ ; $I_C = -1\text{ A}$                                                               | [1] - | -0.75 | -1.1 | V             |
| $t_d$                                        | delay time                           | $V_{CC} = -10\text{ V}$ ; $I_C = -1\text{ A}$ ;<br>$I_{Bon} = -50\text{ mA}$ ;<br>$I_{Boff} = 50\text{ mA}$ | -     | 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            |
| $f_T$                                        | 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>$f = 1\text{ MHz}$                                  | -     | 30    | -    | 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         | $V_{EB} = 5\text{ V}$ ; $I_C = 0\text{ A}$                                                                  | -     | -     | 400  | $\mu\text{A}$ |
| $h_{FE}$                                     | DC current gain                      | $V_{CE} = 5\text{ V}$ ; $I_C = 5\text{ mA}$                                                                 | 30    | -     | -    |               |
| $V_{CEsat}$                                  | 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               | $V_{CE} = 0.3\text{ V}$ ; $I_C = 10\text{ mA}$                                                              | 2.5   | 1.8   | -    | V             |
| R1                                           | bias resistor 1 (input)              |                                                                                                             | 7     | 10    | 13   | 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:  $t_p \leq 300\text{ }\mu\text{s}$ ;  $\delta \leq 0.02$ .



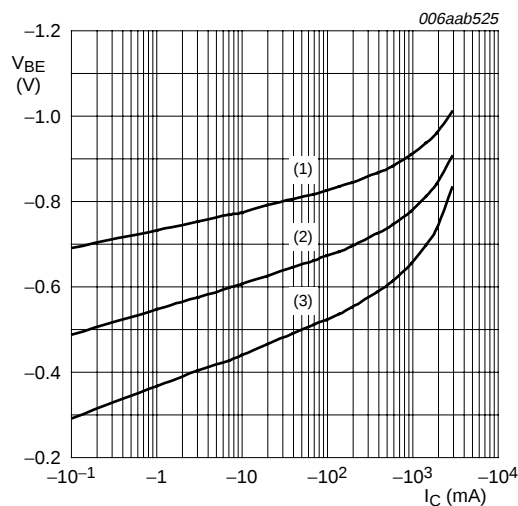
- $V_{CE} = -2\text{ V}$
- (1)  $T_{amb} = 100\text{ }^{\circ}\text{C}$
  - (2)  $T_{amb} = 25\text{ }^{\circ}\text{C}$
  - (3)  $T_{amb} = -55\text{ }^{\circ}\text{C}$

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



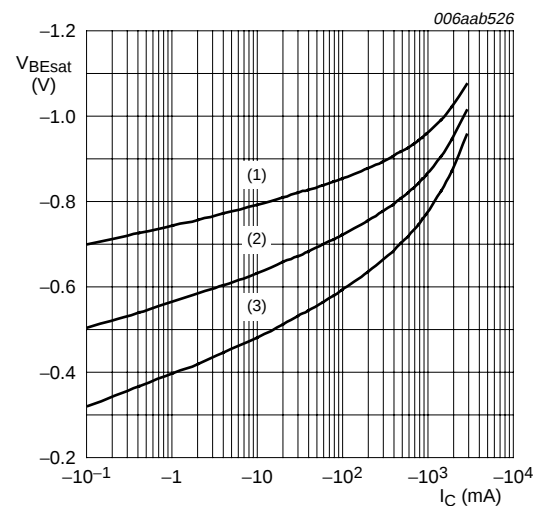
$T_{amb} = 25\text{ }^{\circ}\text{C}$

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



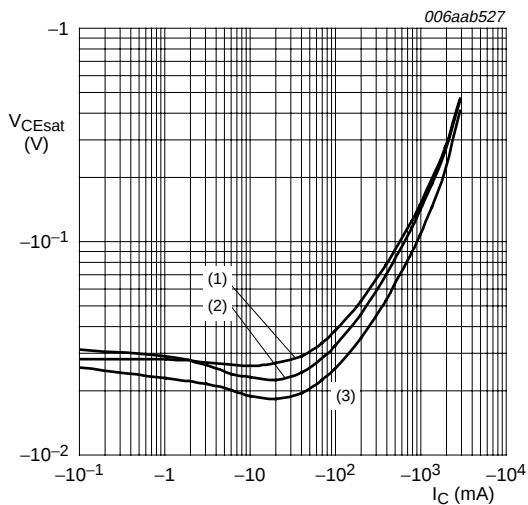
- $V_{CE} = -2\text{ V}$
- (1)  $T_{amb} = -55\text{ }^{\circ}\text{C}$
  - (2)  $T_{amb} = 25\text{ }^{\circ}\text{C}$
  - (3)  $T_{amb} = 100\text{ }^{\circ}\text{C}$

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



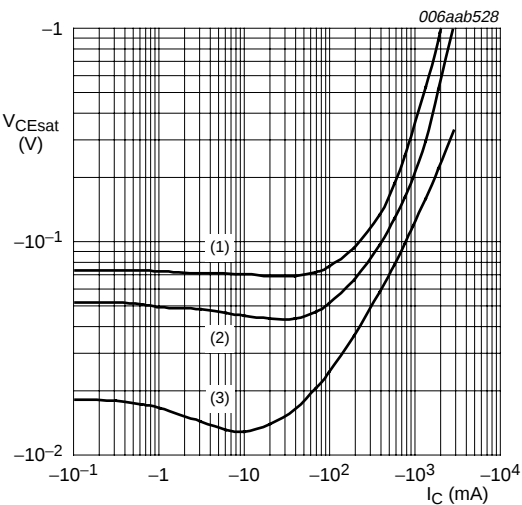
- $I_C/I_B = 20$
- (1)  $T_{amb} = -55\text{ }^{\circ}\text{C}$
  - (2)  $T_{amb} = 25\text{ }^{\circ}\text{C}$
  - (3)  $T_{amb} = 100\text{ }^{\circ}\text{C}$

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



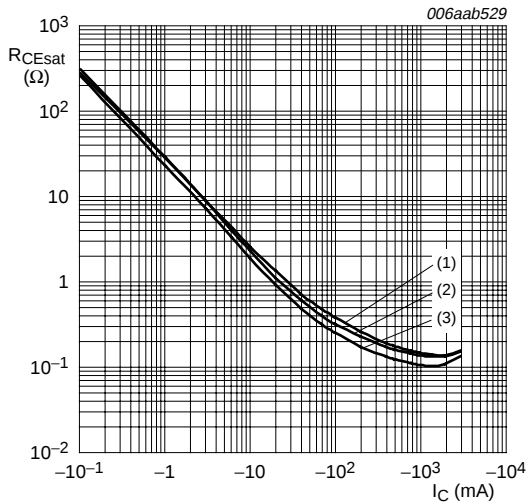
- $I_C/I_B = 20$
- (1)  $T_{amb} = 100\text{ }^{\circ}\text{C}$
  - (2)  $T_{amb} = 25\text{ }^{\circ}\text{C}$
  - (3)  $T_{amb} = -55\text{ }^{\circ}\text{C}$

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



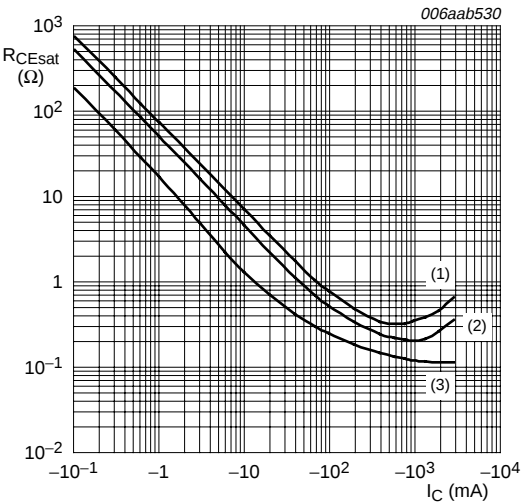
- $T_{amb} = 25\text{ }^{\circ}\text{C}$
- (1)  $I_C/I_B = 100$
  - (2)  $I_C/I_B = 50$
  - (3)  $I_C/I_B = 10$

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



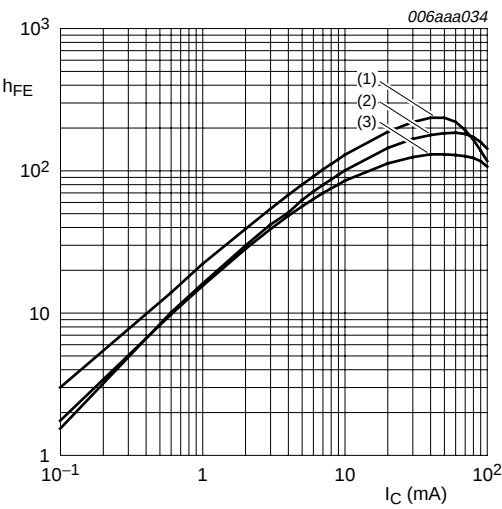
- $I_C/I_B = 20$
- (1)  $T_{amb} = 100\text{ }^{\circ}\text{C}$
  - (2)  $T_{amb} = 25\text{ }^{\circ}\text{C}$
  - (3)  $T_{amb} = -55\text{ }^{\circ}\text{C}$

Fig 11. 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)  $I_C/I_B = 10$

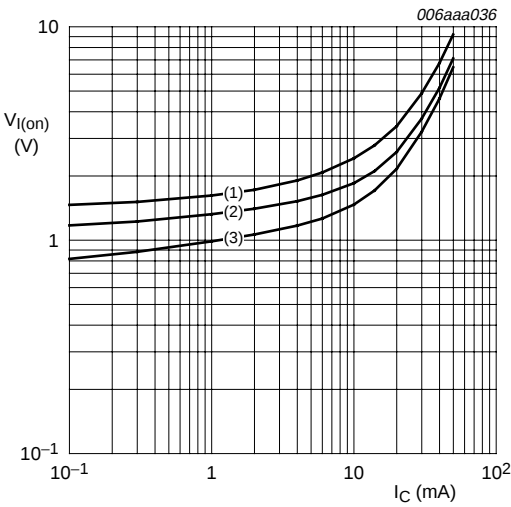
Fig 12. TR1 (PNP): Collector-emitter saturation resistance as a function of collector current; typical values



$V_{CE} = 5\text{ V}$

- (1)  $T_{amb} = 150\text{ °C}$
- (2)  $T_{amb} = 25\text{ °C}$
- (3)  $T_{amb} = -40\text{ °C}$

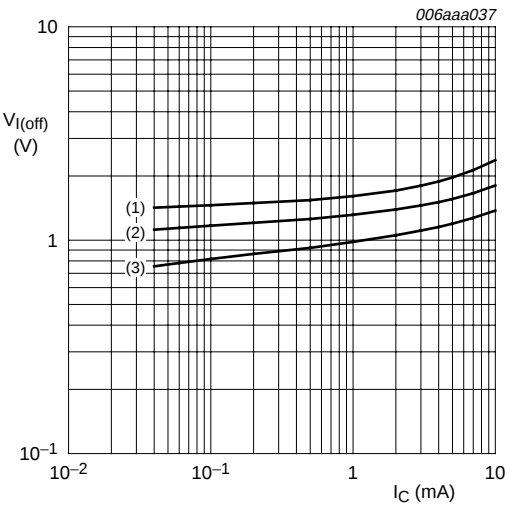
Fig 13. TR2 (NPN): DC current gain as a function of collector current; typical values



$V_{CE} = 0.3\text{ V}$

- (1)  $T_{amb} = -40\text{ °C}$
- (2)  $T_{amb} = 25\text{ °C}$
- (3)  $T_{amb} = 100\text{ °C}$

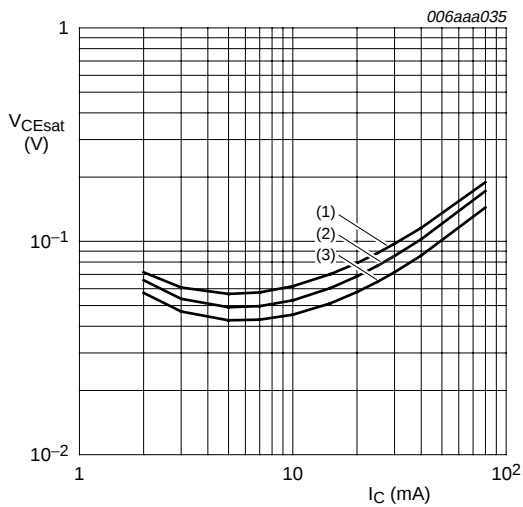
Fig 14. TR2 (NPN): On-state input voltage as a function of collector current; typical values



$V_{CE} = 5\text{ V}$

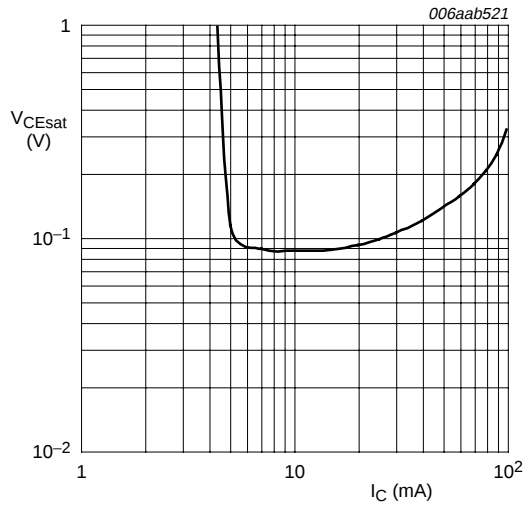
- (1)  $T_{amb} = -40\text{ °C}$
- (2)  $T_{amb} = 25\text{ °C}$
- (3)  $T_{amb} = 100\text{ °C}$

Fig 15. TR2 (NPN): Off-state input voltage 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)  $T_{amb} = -40\text{ }^{\circ}\text{C}$

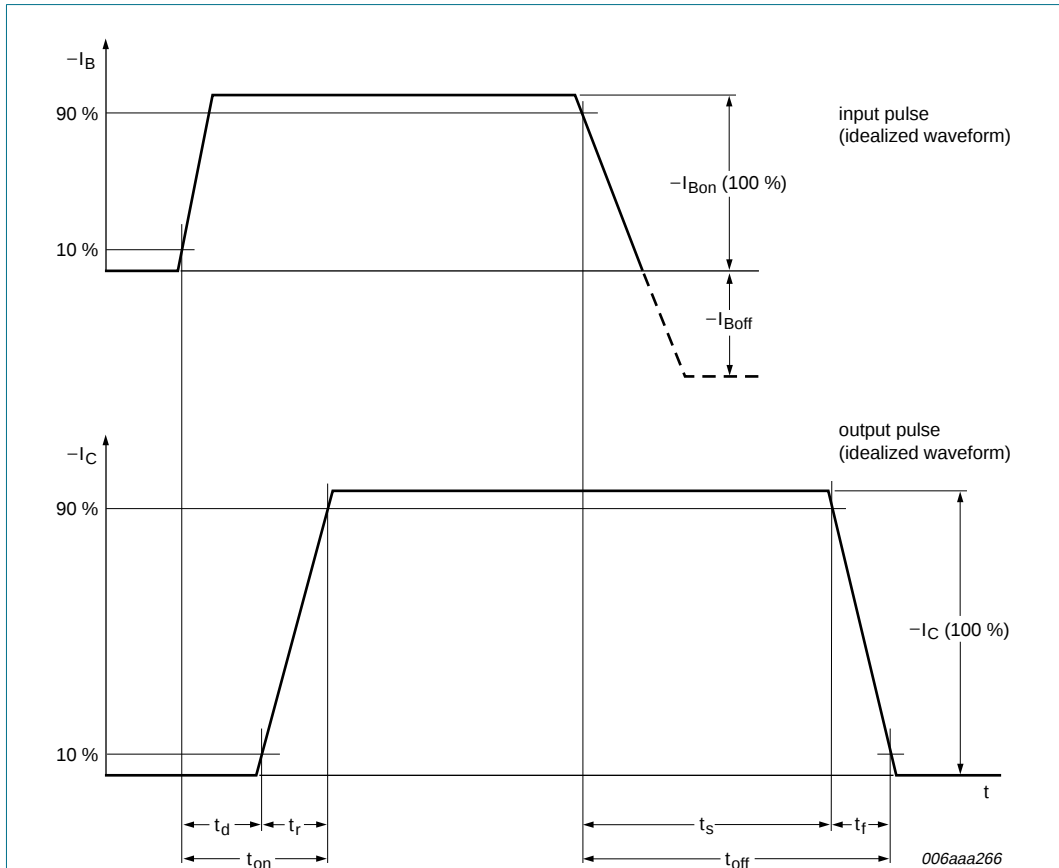
Fig 16. TR2 (NPN): Collector-emitter saturation voltage as a function of collector current; typical values



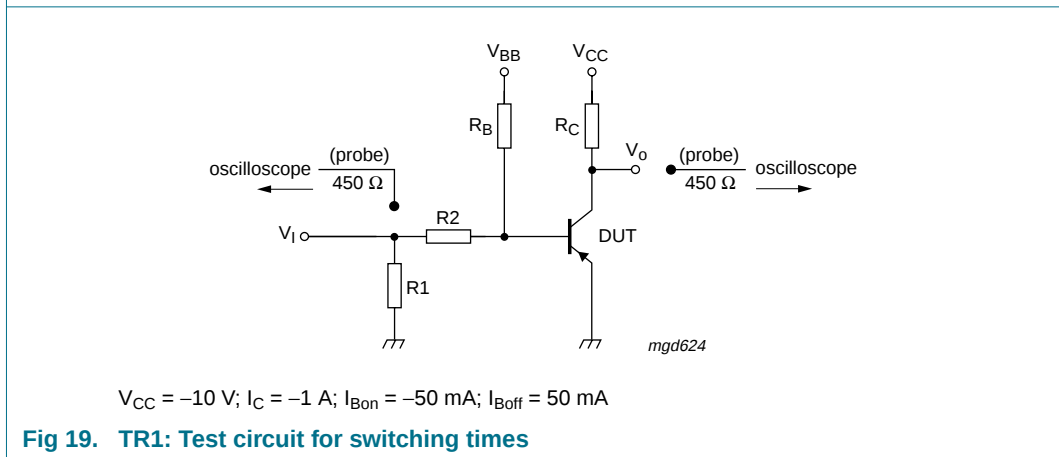
$I_C/I_B = 50$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$

Fig 17. TR2 (NPN): Collector-emitter saturation voltage as a function of collector current; typical values

## 8. Test information



**Fig 18. TR1: BISS transistor switching time definition**

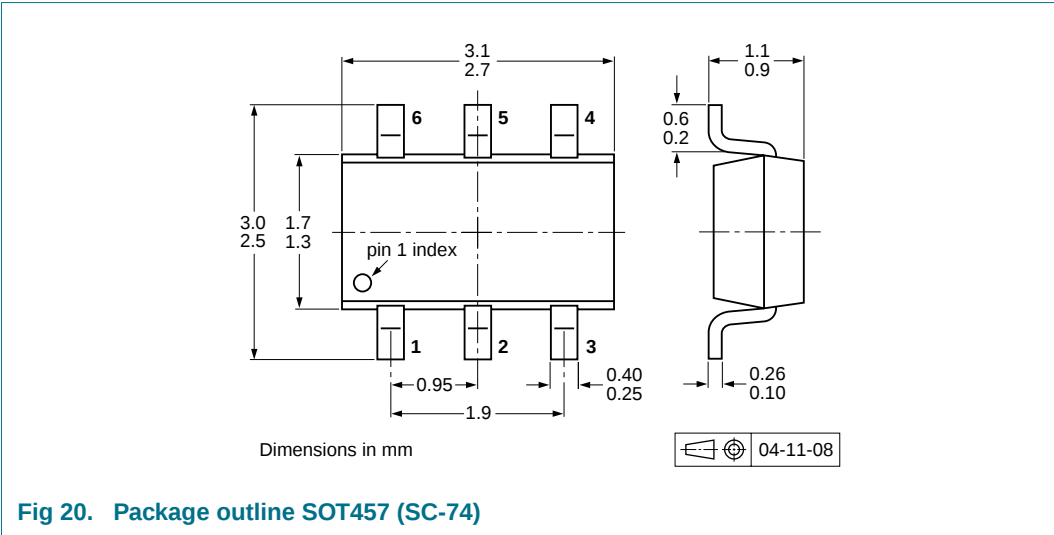


**Fig 19. TR1: Test circuit for switching times**

### 8.1 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.

9. Package outline



10. Packing information

Table 8. Packing methods

The indicated -xxx are the last three digits of the 12NC ordering code.<sup>[1]</sup>

| Type number | Package | Description                        | Packing quantity    |       |
|-------------|---------|------------------------------------|---------------------|-------|
|             |         |                                    | 3000                | 10000 |
| PBLS6023D   | SOT457  | 4 mm pitch, 8 mm tape and reel; T1 | <sup>[2]</sup> -115 | -135  |
|             |         | 4 mm pitch, 8 mm tape and reel; T2 | <sup>[3]</sup> -125 | -165  |

[1] For further information and the availability of packing methods, see [Section 13](#).

[2] T1: normal taping

[3] T2: reverse taping

11. Revision history

Table 9. Revision history

| Document ID | Release date | Data sheet status  | Change notice | Supersedes |
|-------------|--------------|--------------------|---------------|------------|
| PBLS6023D_1 | 20090813     | Product data sheet | -             | -          |

## 12. Legal information

### 12.1 Data sheet status

| Document status <sup>[1][2]</sup> | Product status <sup>[3]</sup> | 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 URL <http://www.nxp.com>.

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