

## 1. General description

Planar passivated four quadrant triac in a SOT186A (TO-220F) plastic package intended for use in applications requiring high bidirectional transient and blocking voltage capability and high thermal cycling performance. Typical applications include motor control, industrial and domestic lighting, heating and static switching.

## 2. Features and benefits

- High blocking voltage capability
- Planar passivated for voltage ruggedness and reliability
- Less sensitive gate for improved noise immunity
- Triggering in all four quadrants
- Isolated package

## 3. Applications

- General purpose motor control
- General purpose switching

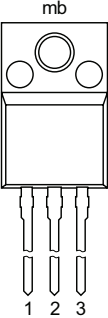
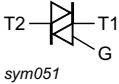
## 4. Quick reference data

Table 1. Quick reference data

| Symbol                  | Parameter                            | Conditions                                                                                                               | Values |     |     |     | Unit |
|-------------------------|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------|--------|-----|-----|-----|------|
| Absolute maximum rating |                                      |                                                                                                                          |        |     |     |     |      |
| V <sub>DRM</sub>        | repetitive peak off-state voltage    |                                                                                                                          | 600    |     |     |     | V    |
| I <sub>T(RMS)</sub>     | RMS on-state current                 | full sine wave; T <sub>h</sub> ≤ 38 °C;<br><a href="#">Fig. 1</a> ; <a href="#">Fig. 2</a> ; <a href="#">Fig. 3</a>      | 16     |     |     |     | A    |
| I <sub>TSM</sub>        | non-repetitive peak on-state current | full sine wave; T <sub>j(init)</sub> = 25 °C;<br>t <sub>p</sub> = 20 ms; <a href="#">Fig. 4</a> ; <a href="#">Fig. 5</a> | 155    |     |     |     | A    |
| Symbol                  | Parameter                            | Conditions                                                                                                               |        | Min | Typ | Max | Unit |
| Static characteristics  |                                      |                                                                                                                          |        |     |     |     |      |
| I <sub>GT</sub>         | gate trigger current                 | V <sub>D</sub> = 12 V; I <sub>T</sub> = 0.1 A; T2+ G+;<br>T <sub>j</sub> = 25 °C; <a href="#">Fig. 7</a>                 |        | -   | 5   | 25  | mA   |
|                         |                                      | V <sub>D</sub> = 12 V; I <sub>T</sub> = 0.1 A; T2+ G-;<br>T <sub>j</sub> = 25 °C; <a href="#">Fig. 7</a>                 |        | -   | 8   | 25  | mA   |
|                         |                                      | V <sub>D</sub> = 12 V; I <sub>T</sub> = 0.1 A; T2- G-;<br>T <sub>j</sub> = 25 °C; <a href="#">Fig. 7</a>                 |        | -   | 10  | 25  | mA   |
|                         |                                      | V <sub>D</sub> = 12 V; I <sub>T</sub> = 0.1 A; T2- G+;<br>T <sub>i</sub> = 25 °C; <a href="#">Fig. 7</a>                 |        | -   | 22  | 70  | mA   |

5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description             | Simplified outline                                                                | Graphic symbol                                                                      |
|-----|--------|-------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| 1   | T1     | main terminal 1         |  |  |
| 2   | T2     | main terminal 2         |                                                                                   |                                                                                     |
| 3   | G      | gate                    |                                                                                   |                                                                                     |
| mb  | n.c.   | mounting base; isolated |                                                                                   |                                                                                     |

6. Ordering information

Table 3. Ordering information

| Type number | Package |                                                                                                     |         |
|-------------|---------|-----------------------------------------------------------------------------------------------------|---------|
|             | Name    | Description                                                                                         | Version |
| BT139X-600F | TO-220F | plastic single-ended package; isolated heatsink mounted; 1 mounting hole; 3-lead TO-220 "full pack" | SOT186A |

7. Marking

Table 4. Marking codes

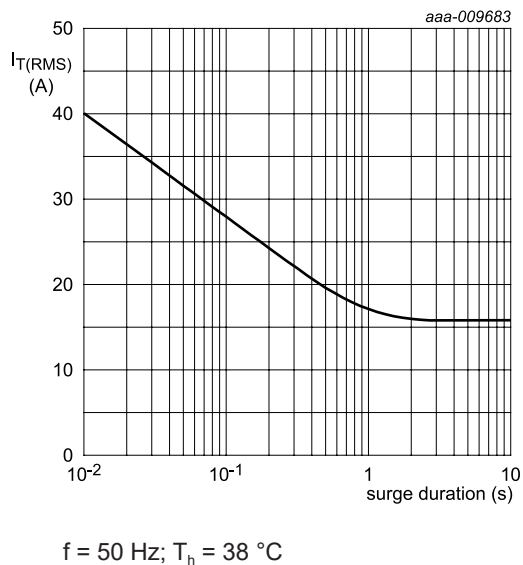
| Type number | Marking codes |
|-------------|---------------|
| BT139X-600F | BT139X-600F   |

## 8. Limiting values

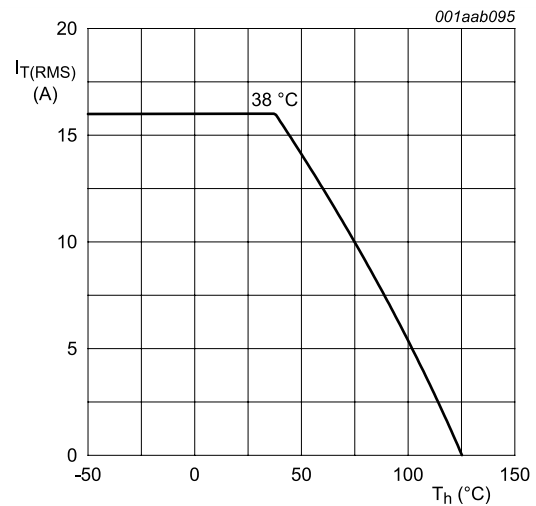
**Table 5. Limiting values**

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

| Symbol              | Parameter                            | Conditions                                                                                                                                  | Values     | Unit                   |
|---------------------|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|------------|------------------------|
| $V_{\text{DRM}}$    | repetitive peak off-state voltage    |                                                                                                                                             | 600        | V                      |
| $I_{\text{T(RMS)}}$ | RMS on-state current                 | full sine wave; $T_h \leq 38\text{ }^{\circ}\text{C}$ ;<br><a href="#">Fig 1</a> ; <a href="#">Fig 2</a> ; <a href="#">Fig 3</a>            | 16         | A                      |
| $I_{\text{TSM}}$    | non-repetitive peak on-state current | full sine wave; $T_{\text{j(init)}} = 25\text{ }^{\circ}\text{C}$ ; $t_p = 20\text{ ms}$ ;<br><a href="#">Fig 4</a> ; <a href="#">Fig 5</a> | 155        | A                      |
|                     |                                      | full sine wave; $T_{\text{j(init)}} = 25\text{ }^{\circ}\text{C}$ ; $t_p = 16.7\text{ ms}$                                                  | 170        | A                      |
| $I^2t$              | $I^2t$ for fusing                    | $t_p = 10\text{ ms}$ ; SIN                                                                                                                  | 120        | $\text{A}^2\text{s}$   |
| $di_{\text{T}}/dt$  | rate of rise of on-state current     | $I_G = 50\text{ mA}$ ; T2+ G+                                                                                                               | 50         | $\text{A}/\mu\text{s}$ |
|                     |                                      | $I_G = 50\text{ mA}$ ; T2+ G-                                                                                                               | 50         | $\text{A}/\mu\text{s}$ |
|                     |                                      | $I_G = 50\text{ mA}$ ; T2- G-                                                                                                               | 50         | $\text{A}/\mu\text{s}$ |
|                     |                                      | $I_G = 140\text{ mA}$ ; T2- G+                                                                                                              | 10         | $\text{A}/\mu\text{s}$ |
| $I_{\text{GM}}$     | peak gate current                    |                                                                                                                                             | 2          | A                      |
| $P_{\text{GM}}$     | peak gate power                      |                                                                                                                                             | 5          | W                      |
| $P_{\text{G(AV)}}$  | average gate power                   | over any 20 ms period                                                                                                                       | 0.5        | W                      |
| $T_{\text{stg}}$    | storage temperature                  |                                                                                                                                             | -40 to 150 | $^{\circ}\text{C}$     |
| $T_{\text{j}}$      | junction temperature                 |                                                                                                                                             | 125        | $^{\circ}\text{C}$     |



**Fig. 1. RMS on-state current as a function of surge duration; maximum values**



**Fig. 2. RMS on-state current as a function of heatsink temperature; maximum values**

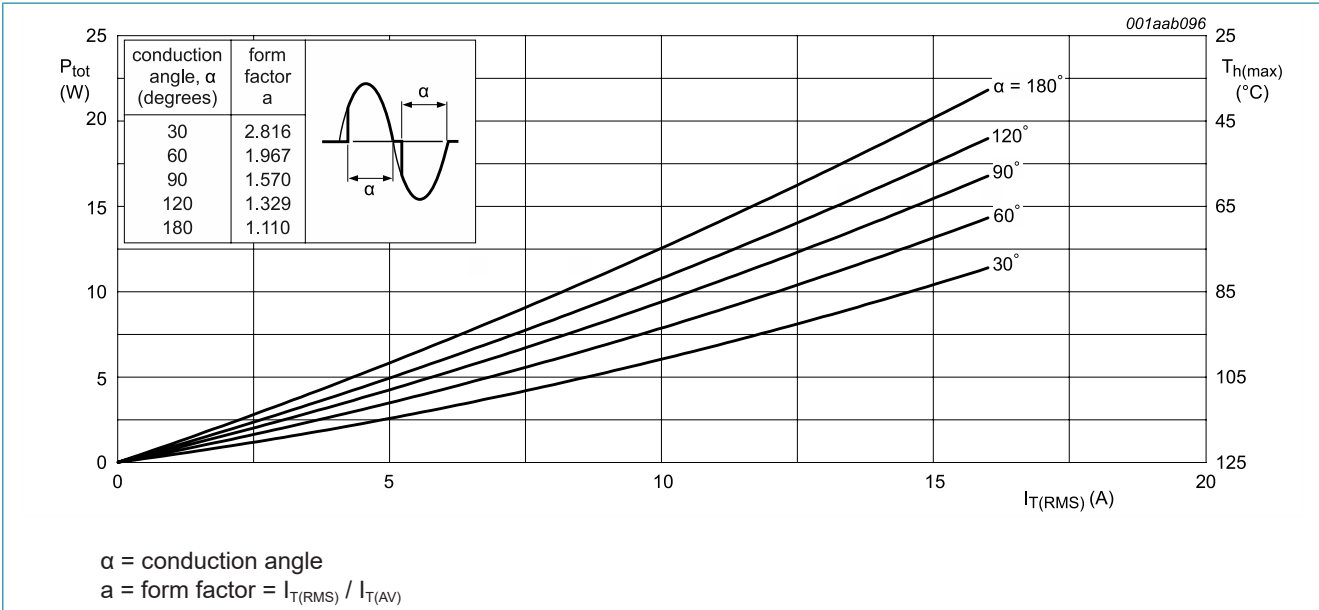


Fig. 3. Total power dissipation as a function of RMS on-state current; maximum values

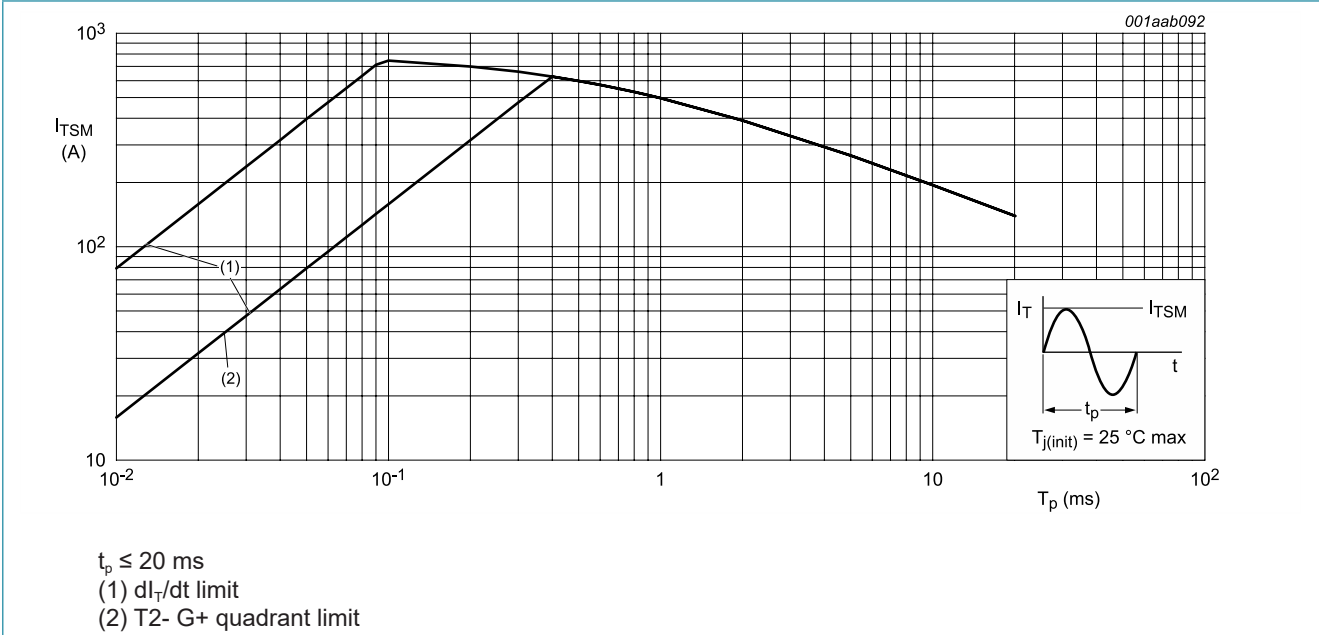
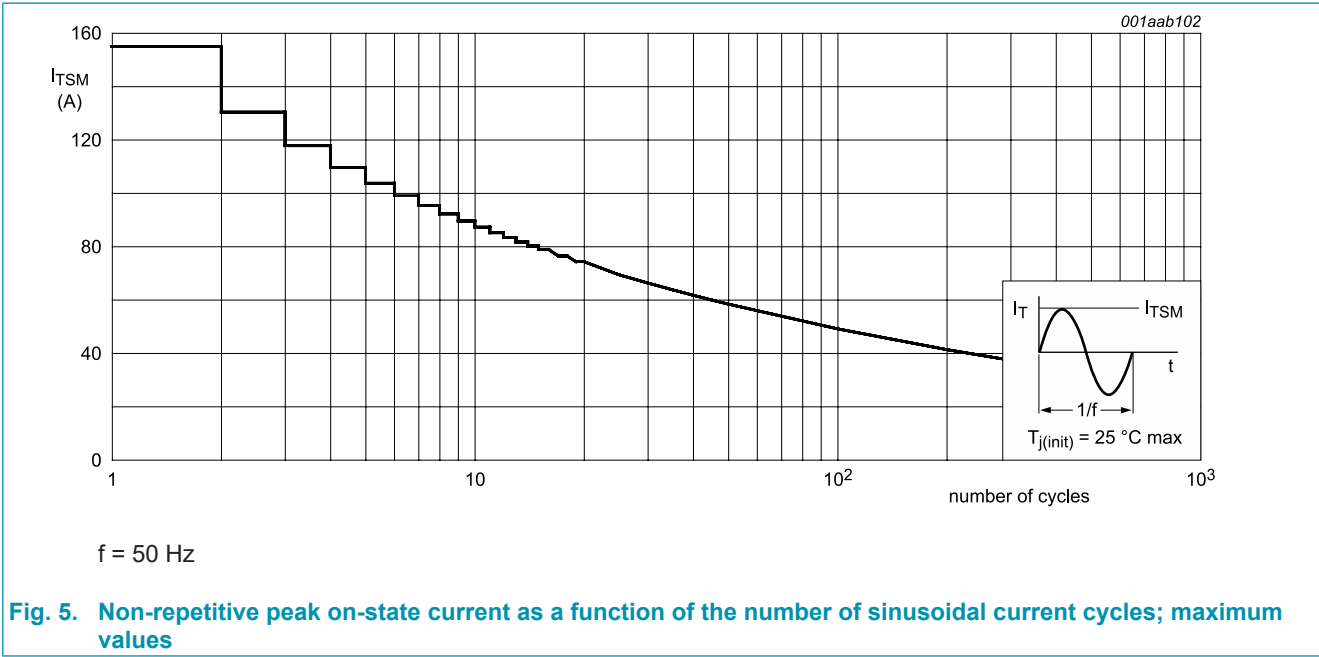


Fig. 4. Non-repetitive peak on-state current as a function of pulse width; maximum values



9. Thermal characteristics

Table 6. Thermal characteristics

| Symbol        | Parameter                                    | Conditions                                           | Min | Typ | Max | Unit |
|---------------|----------------------------------------------|------------------------------------------------------|-----|-----|-----|------|
| $R_{th(j-h)}$ | thermal resistance from junction to heatsink | full or half cycle; with heatsink compound; Fig 6    | -   | -   | 4   | K/W  |
|               |                                              | full or half cycle; without heatsink compound; Fig 6 | -   | -   | 5.5 | K/W  |
| $R_{th(j-a)}$ | thermal resistance from junction to ambient  | in free air                                          | -   | 55  | -   | K/W  |

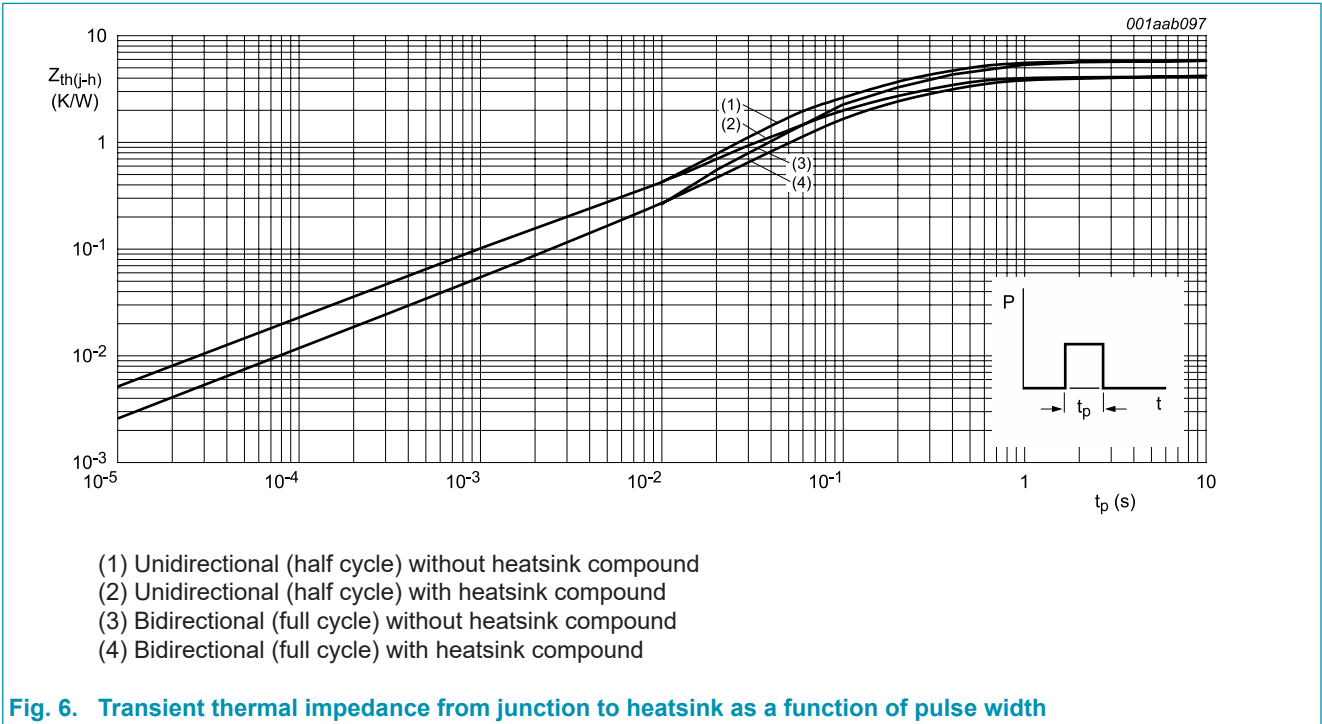


Fig. 6. Transient thermal impedance from junction to heatsink as a function of pulse width

10. Isolation characteristics

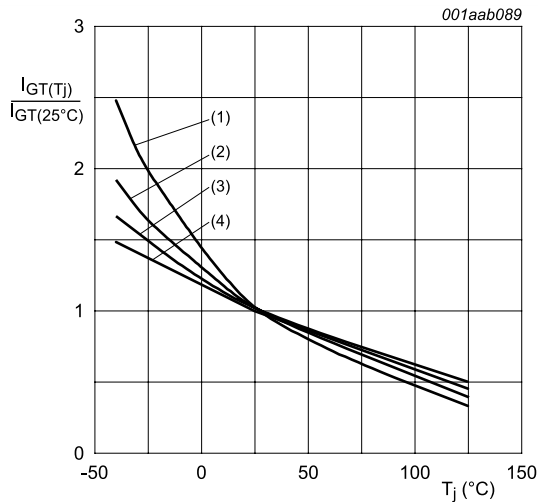
Table 7. Isolation characteristics

| Symbol          | Parameter             | Conditions                                                                                                                              | Min | Typ | Max  | Unit |
|-----------------|-----------------------|-----------------------------------------------------------------------------------------------------------------------------------------|-----|-----|------|------|
| $V_{isol(RMS)}$ | RMS isolation voltage | from all terminals to external heatsink; sinusoidal waveform; clean and dust free; 50 Hz ≤ f ≤ 60 Hz; RH ≤ 65 %; T <sub>h</sub> = 25 °C | -   | -   | 2500 | V    |
| $C_{isol}$      | isolation capacitance | from main terminal 2 to external heatsink; f = 1 MHz; T <sub>h</sub> = 25 °C                                                            | -   | 10  | -    | pF   |

## 11. Characteristics

Table 8. Characteristics

| Symbol                         | Parameter                             | Conditions                                                                                                                              |  | Min  | Typ | Max | Unit             |
|--------------------------------|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|--|------|-----|-----|------------------|
| <b>Static characteristics</b>  |                                       |                                                                                                                                         |  |      |     |     |                  |
| $I_{GT}$                       | gate trigger current                  | $V_D = 12\text{ V}$ ; $I_T = 0.1\text{ A}$ ; T2+ G+;<br>$T_J = 25\text{ }^\circ\text{C}$ ; <a href="#">Fig. 7</a>                       |  | -    | 5   | 25  | mA               |
|                                |                                       | $V_D = 12\text{ V}$ ; $I_T = 0.1\text{ A}$ ; T2+ G-;<br>$T_J = 25\text{ }^\circ\text{C}$ ; <a href="#">Fig. 7</a>                       |  | -    | 8   | 25  | mA               |
|                                |                                       | $V_D = 12\text{ V}$ ; $I_T = 0.1\text{ A}$ ; T2- G-;<br>$T_J = 25\text{ }^\circ\text{C}$ ; <a href="#">Fig. 7</a>                       |  | -    | 10  | 25  | mA               |
|                                |                                       | $V_D = 12\text{ V}$ ; $I_T = 0.1\text{ A}$ ; T2- G+;<br>$T_J = 25\text{ }^\circ\text{C}$ ; <a href="#">Fig. 7</a>                       |  | -    | 22  | 70  | mA               |
| $I_L$                          | latching current                      | $V_D = 12\text{ V}$ ; $I_G = 0.1\text{ A}$ ; T2+ G+;<br>$T_J = 25\text{ }^\circ\text{C}$ ; <a href="#">Fig. 8</a>                       |  | -    | 7   | 40  | mA               |
|                                |                                       | $V_D = 12\text{ V}$ ; $I_G = 0.1\text{ A}$ ; T2+ G-;<br>$T_J = 25\text{ }^\circ\text{C}$ ; <a href="#">Fig. 8</a>                       |  | -    | 20  | 60  | mA               |
|                                |                                       | $V_D = 12\text{ V}$ ; $I_G = 0.1\text{ A}$ ; T2- G-;<br>$T_J = 25\text{ }^\circ\text{C}$ ; <a href="#">Fig. 8</a>                       |  | -    | 8   | 40  | mA               |
|                                |                                       | $V_D = 12\text{ V}$ ; $I_G = 0.1\text{ A}$ ; T2- G+;<br>$T_J = 25\text{ }^\circ\text{C}$ ; <a href="#">Fig. 8</a>                       |  | -    | 10  | 60  | mA               |
| $I_H$                          | holding current                       | $V_D = 12\text{ V}$ ; $T_J = 25\text{ }^\circ\text{C}$ ; <a href="#">Fig. 9</a>                                                         |  | -    | 6   | 45  | mA               |
| $V_T$                          | on-state voltage                      | $I_T = 20\text{ A}$ ; $T_J = 25\text{ }^\circ\text{C}$ ; <a href="#">Fig. 10</a>                                                        |  | -    | 1.2 | 1.6 | V                |
| $V_{GT}$                       | gate trigger voltage                  | $V_D = 12\text{ V}$ ; $I_T = 0.1\text{ A}$ ; $T_J = 25\text{ }^\circ\text{C}$ ;<br><a href="#">Fig. 11</a>                              |  | -    | 0.7 | 1   | V                |
|                                |                                       | $V_D = 400\text{ V}$ ; $I_T = 0.1\text{ A}$ ; $T_J = 125\text{ }^\circ\text{C}$ ;<br><a href="#">Fig. 11</a>                            |  | 0.25 | 0.4 | -   | V                |
| $I_D$                          | off-state current                     | $V_D = 600\text{ V}$ ; $T_J = 125\text{ }^\circ\text{C}$                                                                                |  | -    | 0.1 | 0.5 | mA               |
| <b>Dynamic characteristics</b> |                                       |                                                                                                                                         |  |      |     |     |                  |
| $dV_D/dt$                      | rate of rise of off-state voltage     | $V_{DM} = 402\text{ V}$ ; $T_J = 125\text{ }^\circ\text{C}$ ; ( $V_{DM} = 67\%$ of $V_{DRM}$ ); exponential waveform; gate open circuit |  | 50   | 250 | -   | V/ $\mu\text{s}$ |
| $dV_{com}/dt$                  | rate of change of commutating voltage | $V_D = 400\text{ V}$ ; $T_J = 95\text{ }^\circ\text{C}$ ; $dI_{com}/dt = 7.2\text{ A/ms}$ ; $I_T = 16\text{ A}$ ; gate open circuit     |  | -    | 20  | -   | V/ $\mu\text{s}$ |
| $t_{gt}$                       | gate-controlled turn-on time          | $V_D = 600\text{ V}$ ; $I_{TM} = 20\text{ A}$ ; $I_G = 0.1\text{ A}$ ;<br>$dI_G/dt = 5\text{ A}/\mu\text{s}$                            |  | -    | 2   | -   | $\mu\text{s}$    |



- (1) T2- G+
- (2) T2- G-
- (3) T2+ G-
- (4) T2+ G+

Fig. 7. Normalized gate trigger current as a function of junction temperature

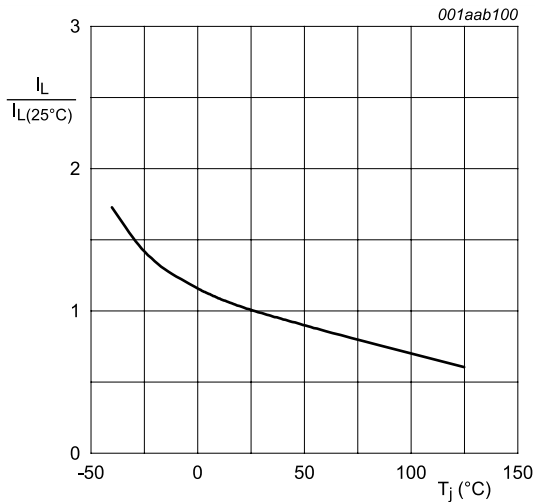


Fig. 8. Normalized latching current as a function of junction temperature

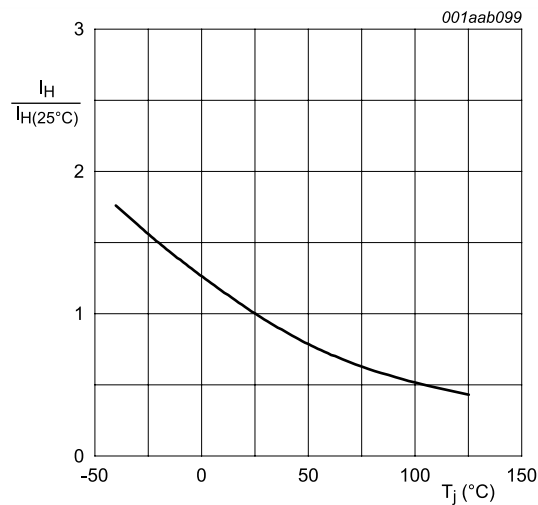
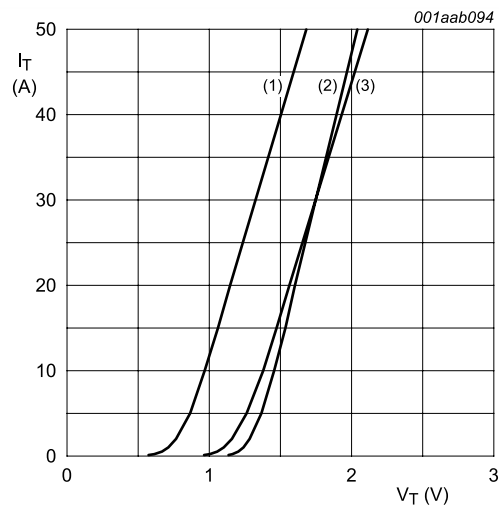


Fig. 9. Normalized holding current as a function of junction temperature



- $V_o = 1.195\text{ V}$ ;  $R_s = 0.018\text{ }\Omega$
- (1)  $T_j = 125^\circ\text{C}$ ; typical values
  - (2)  $T_j = 125^\circ\text{C}$ ; maximum values
  - (3)  $T_j = 25^\circ\text{C}$ ; maximum values

Fig. 10. On-state current as a function of on-state voltage



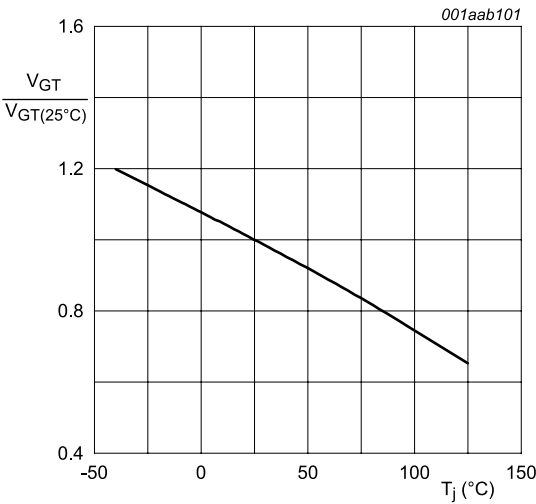
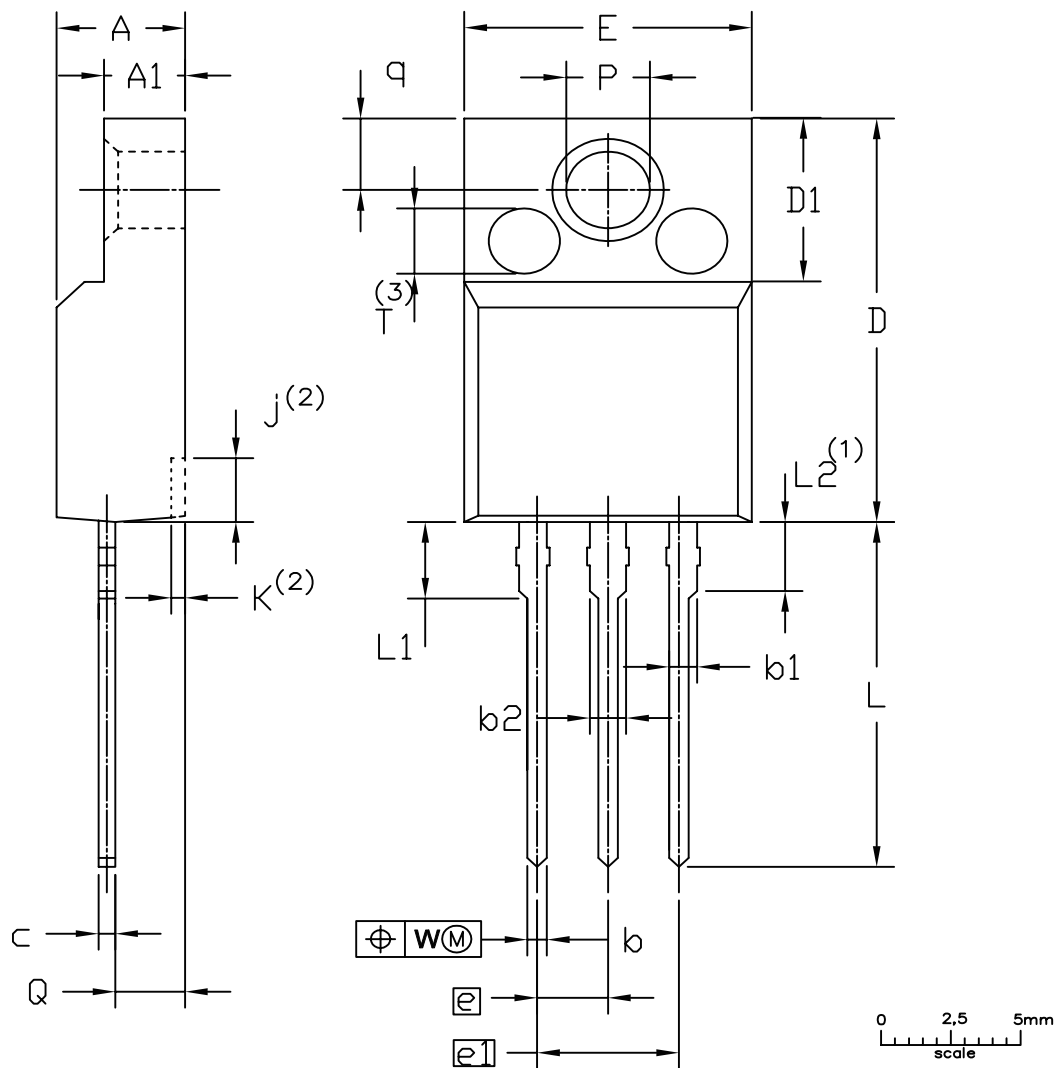


Fig. 11. Normalized gate trigger voltage as a function of junction temperature

12. Package outline

Plastic single-ended package; isolated heatsink mounted; 1 mounting hole; 3-lead TO-220 "full pack" SOT186A



| UNIT | A          | A <sub>1</sub> | b          | b <sub>1</sub> | b <sub>2</sub> | c          | D            | D <sub>1</sub> | E           | e    | e <sub>1</sub> | j <sup>(2)</sup> | k <sup>(2)</sup> | L            | L <sub>1</sub> | L <sub>2</sub> <sup>(1)</sup><br>max. | P          | Q          | q          | W   | T <sup>(3)</sup> |
|------|------------|----------------|------------|----------------|----------------|------------|--------------|----------------|-------------|------|----------------|------------------|------------------|--------------|----------------|---------------------------------------|------------|------------|------------|-----|------------------|
| mm   | 4.6<br>4.0 | 2.9<br>2.5     | 0.9<br>0.7 | 1.1<br>0.9     | 1.4<br>1.0     | 0.7<br>0.4 | 15.8<br>15.2 | 6.5<br>6.3     | 10.3<br>9.7 | 2.54 | 5.08           | 2.7<br>1.7       | 0.6<br>0.4       | 14.4<br>13.5 | 3.30<br>2.79   | 3                                     | 3.2<br>3.0 | 2.6<br>2.3 | 3.0<br>2.6 | 0.4 | 2.5              |

- Notes
1. Terminal dimensions within this zone are uncontrolled
  2. Dot lines area designs may vary
  3. Eject pin mark is for reference only

| OUTLINE<br>VERSION | REFERENCES |                |       |  | EUROPEAN<br>PROJECTION | ISSUE DATE |
|--------------------|------------|----------------|-------|--|------------------------|------------|
|                    | IEC        | JEDEC          | JEITA |  |                        |            |
| SOT186A            |            | 3 LEADS TO220F |       |  |                        | 2013-11-14 |

## 13. 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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