



# BT138X-600

4Q Triac

1 May 2015

Product data sheet

## 1. General description

Planar passivated four quadrant triac in a SOT186A (TO-220F) "full pack" 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
- High noise immunity
- Isolated package
- Less sensitive gate for improved noise immunity
- Planar passivated for voltage ruggedness and reliability
- Triggering in all four quadrants

## 3. Applications

- General purpose motor control
- General purpose switching

## 4. Quick reference data

Table 1. Quick reference data

| Symbol                        | Parameter                            | Conditions   |  | Min | Typ | Max | Unit             |
|-------------------------------|--------------------------------------|--|--|-----|-----|-----|------------------|
| $V_{DRM}$                     | repetitive peak off-state voltage    |  |  | -   | -   | 600 | V                |
| $I_{TSM}$                     | non-repetitive peak on-state current | full sine wave; $T_{j(\text{init})} = 25^\circ\text{C}$ ;<br>$t_p = 20 \text{ ms}$ ; <a href="#">Fig. 4</a> ; <a href="#">Fig. 5</a> |  | -   | -   | 95  | A                |
| $T_j$                         | junction temperature                 |  |  | -   | -   | 125 | $^\circ\text{C}$ |
| $I_{T(\text{RMS})}$           | RMS on-state current                 | full sine wave; $T_h \leq 56^\circ\text{C}$ ; <a href="#">Fig. 1</a> ; <a href="#">Fig. 2</a> ; <a href="#">Fig. 3</a>               |  | -   | -   | 12  | A                |
| <b>Static characteristics</b> |                                      |  |  |     |     |     |                  |
| $I_{GT}$                      | gate trigger current                 | $V_D = 12 \text{ V}$ ; $I_T = 0.1 \text{ A}$ ; T2+ G+;<br>$T_j = 25^\circ\text{C}$ ; <a href="#">Fig. 7</a>                          |  | -   | 5   | 35  | mA               |
|                               |                                      | $V_D = 12 \text{ V}$ ; $I_T = 0.1 \text{ A}$ ; T2+ G-;<br>$T_j = 25^\circ\text{C}$ ; <a href="#">Fig. 7</a>                          |  | -   | 8   | 35  | mA               |



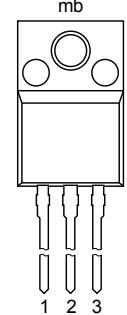
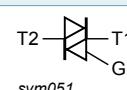
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| Symbol                         | Parameter                         | Conditions  |  | Min | Typ | Max | Unit       |
|--------------------------------|-----------------------------------|---|--|-----|-----|-----|------------|
|                                |                                   | $V_D = 12 \text{ V}$ ; $I_T = 0.1 \text{ A}$ ; T2- G-;<br>$T_j = 25 \text{ }^\circ\text{C}$ ; <a href="#">Fig. 7</a>                      |  | -   | 10  | 35  | 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         |
| <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 |  | 100 | 250 | -   | V/ $\mu$ s |

## 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 | <br><b>TO-220F (SOT186A)</b> |  |

## 6. Ordering information

Table 3. Ordering information

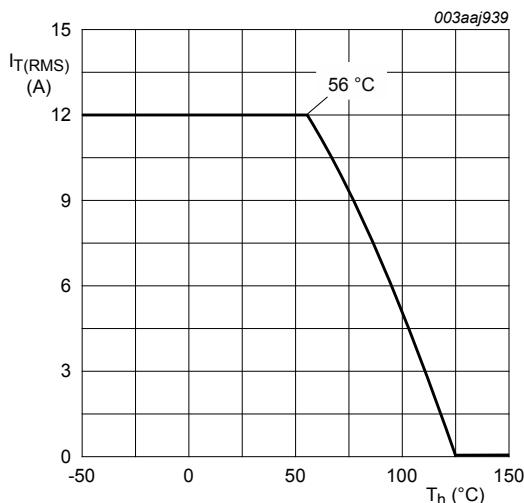
| Type number | Package |   |         |
|-------------|---------|---|---------|
|             | Name    | Description   | Version |
| BT138X-600  | TO-220F | plastic single-ended package; isolated heatsink mounted; 1 mounting hole; 3-lead TO-220 "full pack" | SOT186A |

## 7. Limiting values

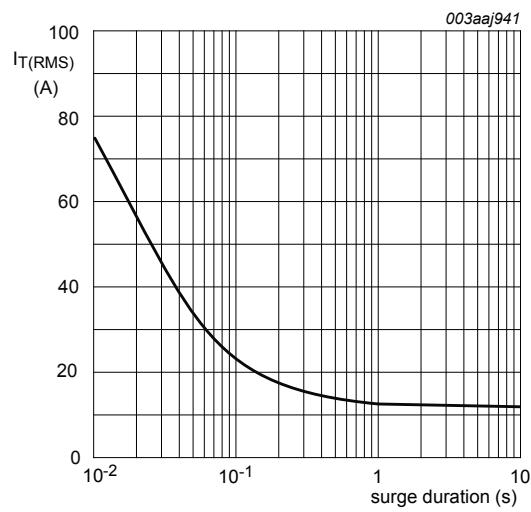
**Table 4. Limiting values**

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

| Symbol       | Parameter                            | Conditions   | Min | Max | Unit                   |
|--------------|--------------------------------------|--|-----|-----|------------------------|
| $V_{DRM}$    | repetitive peak off-state voltage    |  | -   | 600 | V                      |
| $I_{T(RMS)}$ | RMS on-state current                 | full sine wave; $T_h \leq 56^\circ\text{C}$ ; <a href="#">Fig. 1</a> ; <a href="#">Fig. 2</a> ; <a href="#">Fig. 3</a>           | -   | 12  | A                      |
| $I_{TSM}$    | non-repetitive peak on-state current | full sine wave; $T_{j(\text{init})} = 25^\circ\text{C}$ ; $t_p = 20\text{ ms}$ ; <a href="#">Fig. 4</a> ; <a href="#">Fig. 5</a> | -   | 95  | A                      |
|              |                                      | full sine wave; $T_{j(\text{init})} = 25^\circ\text{C}$ ; $t_p = 16.7\text{ ms}$   | -   | 105 | A                      |
| $I^2t$       | $I^2t$ for fusing                    | $t_p = 10\text{ ms}$ ; sine-wave pulse   | -   | 45  | $\text{A}^2\text{s}$   |
| $dI_T/dt$    | rate of rise of on-state current     | $I_G = 70\text{ mA}$ ; T2+ G+  | -   | 50  | $\text{A}/\mu\text{s}$ |
|              |                                      | $I_G = 70\text{ mA}$ ; T2+ G-  | -   | 50  | $\text{A}/\mu\text{s}$ |
|              |                                      | $I_G = 140\text{ mA}$ ; T2- G+   | -   | 10  | $\text{A}/\mu\text{s}$ |
|              |                                      | $I_G = 70\text{ mA}$ ; T2- G-  | -   | 50  | $\text{A}/\mu\text{s}$ |
| $I_{GM}$     | peak gate current                    |  | -   | 2   | A                      |
| $P_{GM}$     | peak gate power                      |  | -   | 5   | W                      |
| $P_{G(AV)}$  | average gate power                   | over any 20 ms period  | -   | 0.5 | W                      |
| $T_{stg}$    | storage temperature                  |  | -40 | 150 | $^\circ\text{C}$       |
| $T_j$        | junction temperature                 |  | -   | 125 | $^\circ\text{C}$       |



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



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

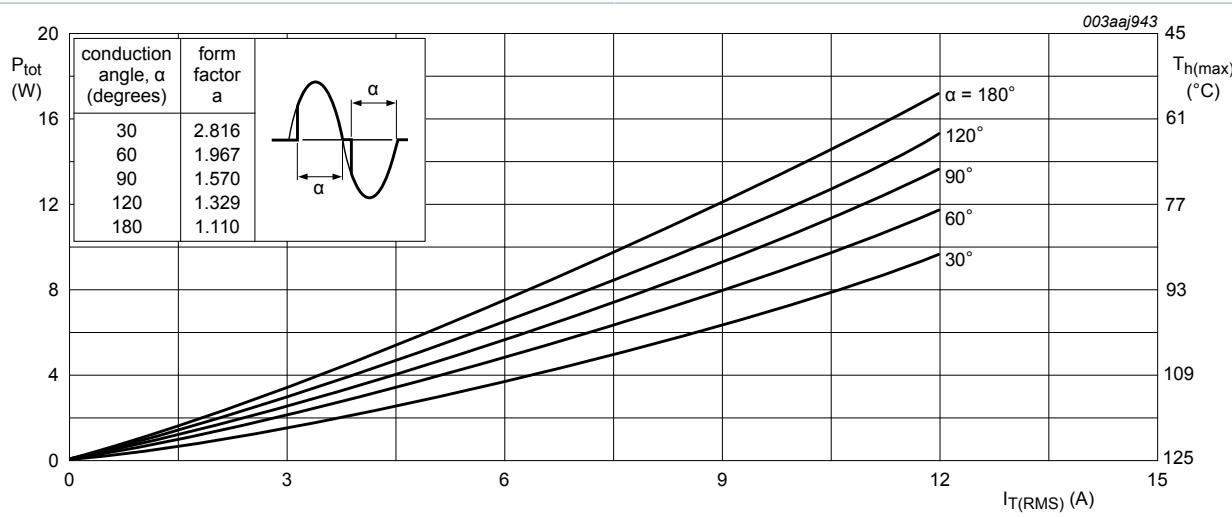


Fig. 3. Total power dissipation as a function of RMS on-state current; maximum values

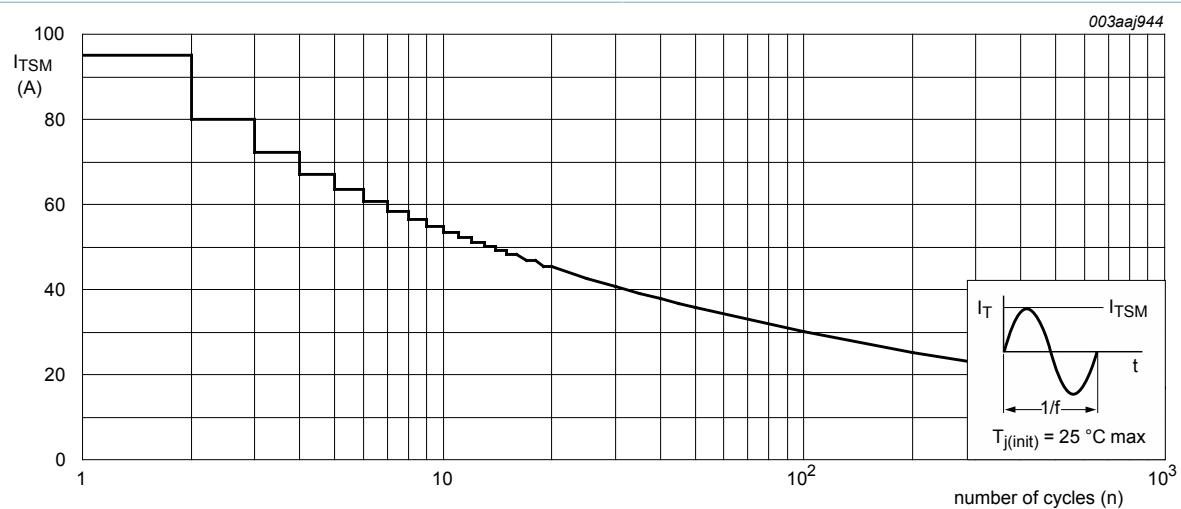


Fig. 4. Non-repetitive peak on-state current as a function of the number of sinusoidal current cycles; maximum values

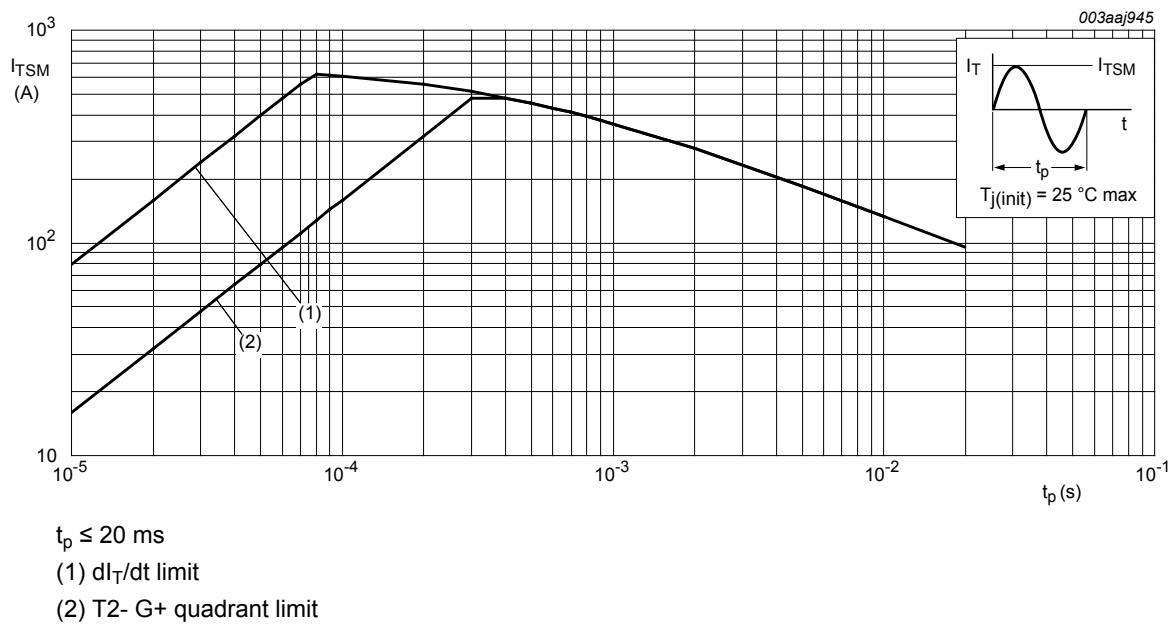
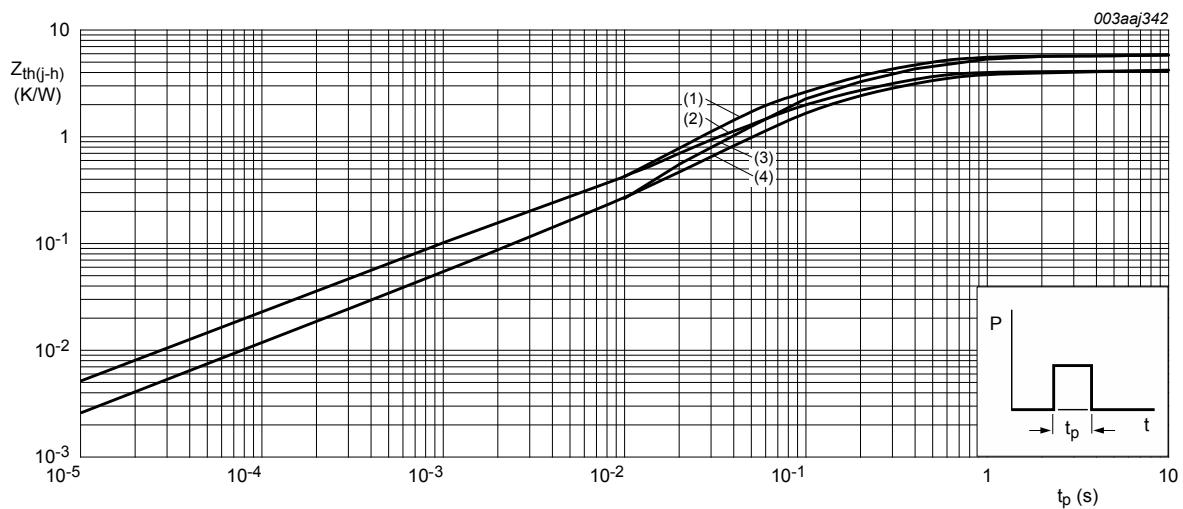


Fig. 5. Non-repetitive peak on-state current as a function of pulse width; maximum values

## 8. Thermal characteristics

Table 5. 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; <a href="#">Fig. 6</a>    | -   | -   | 4   | K/W  |
|               |  | full or half cycle; without heatsink compound; <a href="#">Fig. 6</a> | -   | -   | 5.5 | K/W  |
| $R_{th(j-a)}$ | thermal resistance from junction to ambient  | in free air   | -   | 55  | -   | K/W  |



- (1) Unidirectional (half cycle) without heatsink compound
- (2) Unidirectional (half cycle) with heatsink compound
- (3) Bidirectional (full cycle) without heatsink compound
- (4) Bidirectional (full cycle) with heatsink compound

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

## 9. Isolation characteristics

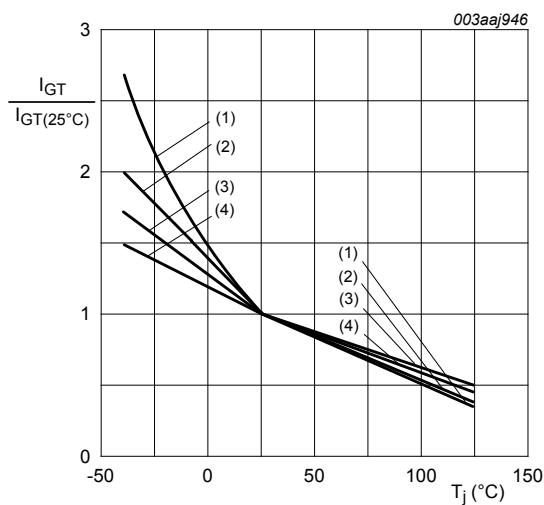
Table 6. Isolation characteristics

| 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; $50 \text{ Hz} \leq f \leq 60 \text{ Hz}$ ; $\text{RH} \leq 65 \%$ ; $T_h = 25^\circ\text{C}$ | -   | -   | 2500 | V    |
| $C_{isol}$      | isolation capacitance | from main terminal 2 to external heatsink; $f = 1 \text{ MHz}$ ; $T_h = 25^\circ\text{C}$  | -   | 10  | -    | pF   |

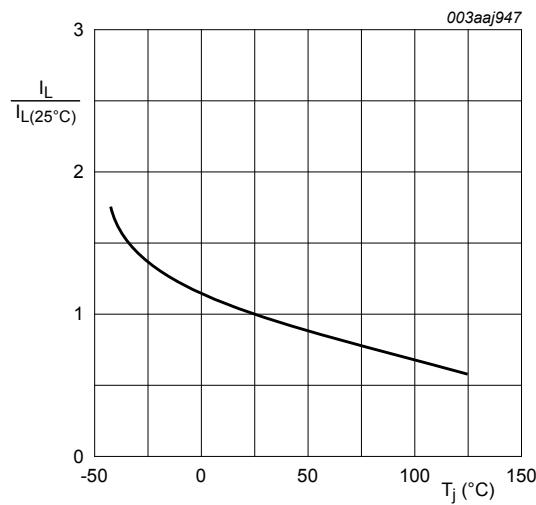
## 10. Characteristics

Table 7. Characteristics

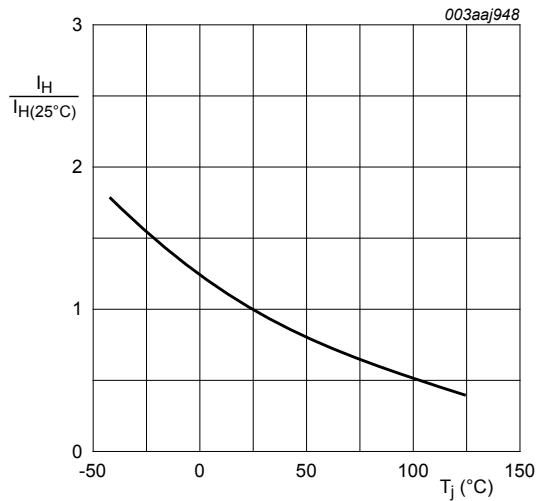
| Symbol                         | Parameter                         | Conditions  |  | Min  | Typ | Max  | Unit |
|--------------------------------|-----------------------------------|---|--|------|-----|------|------|
| <b>Static characteristics</b>  |                                   |   |  |      |     |      |      |
| 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   | 35   | 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   | 35   | 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  | 35   | 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>                                |  | -    | 22  | 70   | mA   |
| I <sub>L</sub>                 | latching current                  | V <sub>D</sub> = 12 V; I <sub>G</sub> = 0.1 A; T2+ G+;<br>T <sub>j</sub> = 25 °C; <a href="#">Fig. 8</a>                                |  | -    | 7   | 40   | mA   |
|                                |                                   | V <sub>D</sub> = 12 V; I <sub>G</sub> = 0.1 A; T2+ G-;<br>T <sub>j</sub> = 25 °C; <a href="#">Fig. 8</a>                                |  | -    | 20  | 60   | mA   |
|                                |                                   | V <sub>D</sub> = 12 V; I <sub>G</sub> = 0.1 A; T2- G-;<br>T <sub>j</sub> = 25 °C; <a href="#">Fig. 8</a>                                |  | -    | 8   | 40   | mA   |
|                                |                                   | V <sub>D</sub> = 12 V; I <sub>G</sub> = 0.1 A; T2- G+;<br>T <sub>j</sub> = 25 °C; <a href="#">Fig. 8</a>                                |  | -    | 10  | 60   | mA   |
| I <sub>H</sub>                 | holding current                   | V <sub>D</sub> = 12 V; T <sub>j</sub> = 25 °C; <a href="#">Fig. 9</a>   |  | -    | 6   | 30   | mA   |
| V <sub>T</sub>                 | on-state voltage                  | I <sub>T</sub> = 15 A; T <sub>j</sub> = 25 °C; <a href="#">Fig. 10</a>  |  | -    | 1.4 | 1.65 | V    |
| V <sub>GT</sub>                | gate trigger voltage              | V <sub>D</sub> = 12 V; I <sub>T</sub> = 0.1 A; T <sub>j</sub> = 25 °C;<br><a href="#">Fig. 11</a>                                       |  | -    | 0.7 | 1    | V    |
|                                |                                   | V <sub>D</sub> = 400 V; I <sub>T</sub> = 0.1 A; T <sub>j</sub> = 125 °C;<br><a href="#">Fig. 11</a>                                     |  | 0.25 | 0.4 | -    | V    |
| I <sub>D</sub>                 | off-state current                 | V <sub>D</sub> = 600 V; T <sub>j</sub> = 125 °C   |  | -    | 0.1 | 0.5  | mA   |
| <b>Dynamic characteristics</b> |                                   |   |  |      |     |      |      |
| dV <sub>D</sub> /dt            | rate of rise of off-state voltage | V <sub>DM</sub> = 402 V; T <sub>j</sub> = 125 °C; (V <sub>DM</sub> = 67% of V <sub>DRM</sub> ); exponential waveform; gate open circuit |  | 100  | 250 | -    | V/μs |
| t <sub>gt</sub>                | gate-controlled turn-on time      | I <sub>TM</sub> = 16 A; V <sub>D</sub> = 600 V; I <sub>G</sub> = 0.1 A; dI <sub>G</sub> /dt = 5 A/μs                                    |  | -    | 2   | -    | μs   |



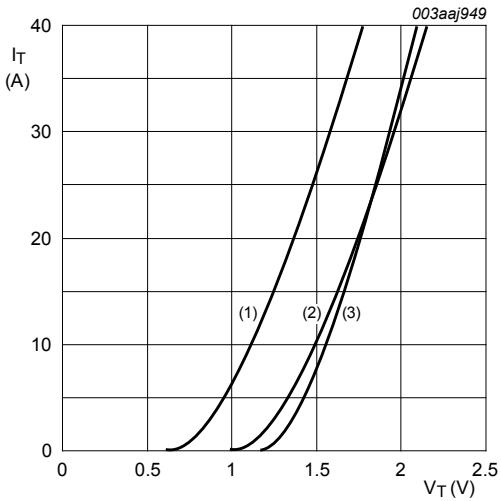
**Fig. 7. Normalized gate trigger current as a function of junction temperature**



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



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



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

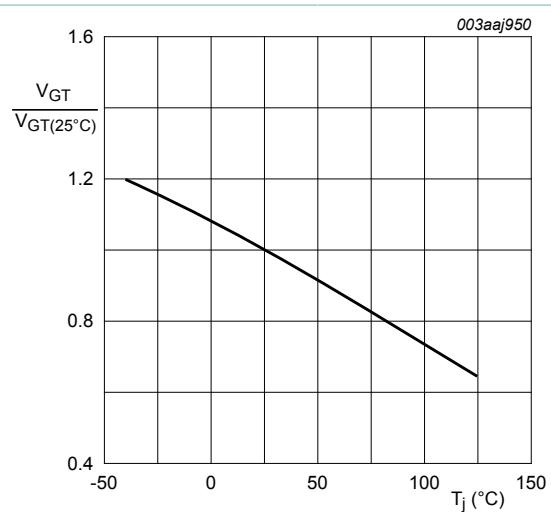
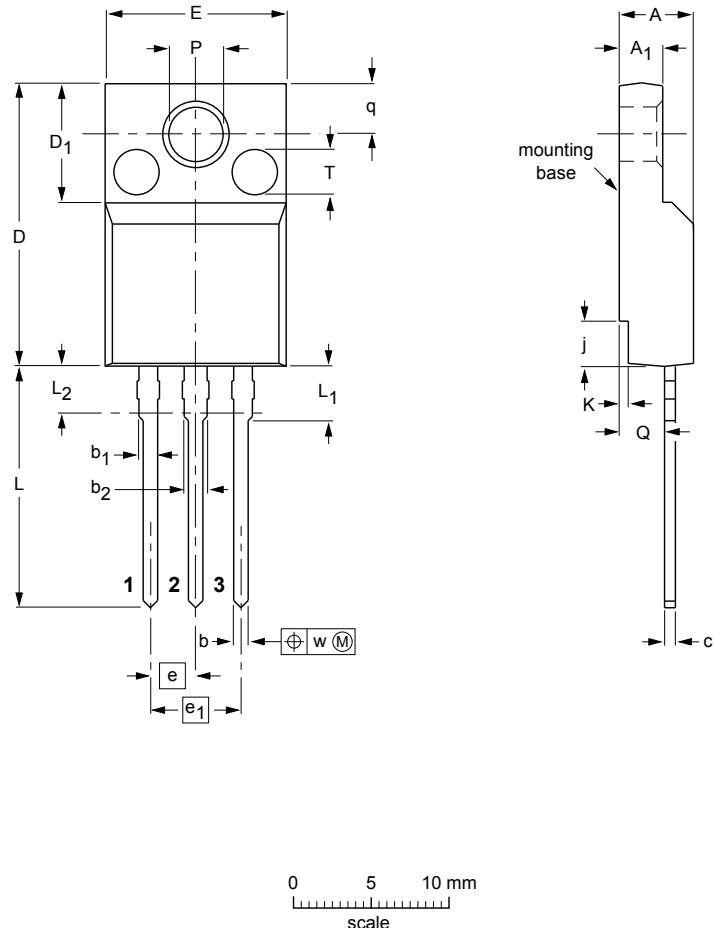


Fig. 11. Normalized gate trigger voltage as a function of junction temperature

## 11. Package outline

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

SOT186A



### DIMENSIONS (mm are the original dimensions)

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

### Notes

1. Terminal dimensions within this zone are uncontrolled.
2. Both recesses are # 2.5 × 0.8 max. depth

| OUTLINE<br>VERSION | REFERENCES |                |       |  | EUROPEAN<br>PROJECTION | ISSUE DATE         |
|--------------------|------------|----------------|-------|--|------------------------|--------------------|
|                    | IEC        | JEDEC          | JEITA |  |                        |                    |
| SOT186A            |            | 3-lead TO-220F |       |  |                        | -02-04-09-06-02-14 |

Fig. 12. Package outline TO-220F (SOT186A)

## 12. Legal information

### 12.1 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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## 13. Contents

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