

## 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

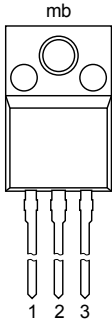
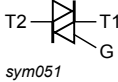
**Table 1. Quick reference data**

| Symbol                        | Parameter                            | Conditions                                                                                                            | Min | Typ | Max | Unit |
|-------------------------------|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------|-----|-----|-----|------|
| $V_{DRM}$                     | repetitive peak off-state voltage    |                                                                                                                       | -   | -   | 800 | V    |
| $I_{TSM}$                     | non-repetitive peak on-state current | full sine wave; $T_{j(init)} = 25\text{ °C}$ ; $t_p = 20\text{ ms}$ ; <a href="#">Fig. 4</a> ; <a href="#">Fig. 5</a> | -   | -   | 95  | A    |
| $T_j$                         | junction temperature                 |                                                                                                                       | -   | -   | 125 | °C   |
| $I_{T(RMS)}$                  | RMS on-state current                 | full sine wave; $T_h \leq 56\text{ °C}$ ; <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+; $T_j = 25\text{ °C}$ ; <a href="#">Fig. 7</a>                    | -   | 5   | 35  | mA   |
|                               |                                      | $V_D = 12\text{ V}$ ; $I_T = 0.1\text{ A}$ ; T2+ G-; $T_j = 25\text{ °C}$ ; <a href="#">Fig. 7</a>                    | -   | 8   | 35  | mA   |

| Symbol                         | Parameter                         | Conditions                                                                                                                  |  | Min | Typ | Max | Unit       |
|--------------------------------|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------|--|-----|-----|-----|------------|
|                                |                                   | $V_D = 12\text{ V}$ ; $I_T = 0.1\text{ A}$ ; T2- G-;<br>$T_j = 25\text{ °C}$ ; <a href="#">Fig. 7</a>                       |  | -   | 10  | 35  | mA         |
|                                |                                   | $V_D = 12\text{ V}$ ; $I_T = 0.1\text{ A}$ ; T2- G+;<br>$T_j = 25\text{ °C}$ ; <a href="#">Fig. 7</a>                       |  | -   | 22  | 70  | mA         |
| <b>Dynamic characteristics</b> |                                   |                                                                                                                             |  |     |     |     |            |
| $dV_D/dt$                      | rate of rise of off-state voltage | $V_{DM} = 402\text{ V}$ ; $T_j = 125\text{ °C}$ ; ( $V_{DM} = 67\%$ 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         |  <p>TO-220F (SOT186A)</p> |  |
| 2   | T2     | main terminal 2         |                                                                                                             |                                                                                     |
| 3   | G      | gate                    |                                                                                                             |                                                                                     |
| mb  | n.c.   | mounting base; isolated |                                                                                                             |                                                                                     |

## 6. Ordering information

Table 3. Ordering information

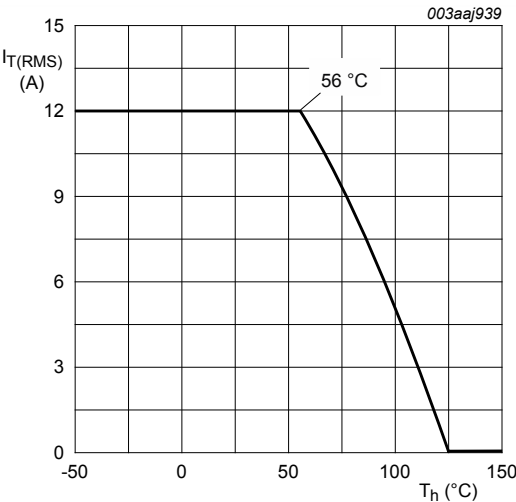
| Type number | Package |                                                                                                     |         |
|-------------|---------|-----------------------------------------------------------------------------------------------------|---------|
|             | Name    | Description                                                                                         | Version |
| BT138X-800F | TO-220F | plastic single-ended package; isolated heatsink mounted; 1 mounting hole; 3-lead TO-220 "full pack" | SOT186A |

## 7. Limiting values

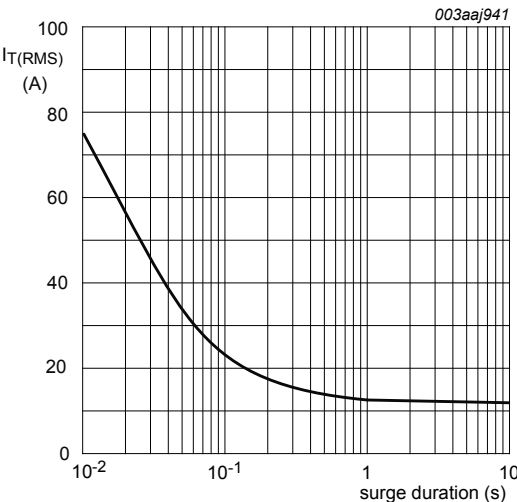
**Table 4. Limiting values**

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

| Symbol              | Parameter                            | Conditions                                                                                                                                          | Min | Max | Unit                   |
|---------------------|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|------------------------|
| $V_{\text{DRM}}$    | repetitive peak off-state voltage    |                                                                                                                                                     | -   | 800 | V                      |
| $I_{\text{T(RMS)}}$ | RMS on-state current                 | full sine wave; $T_{\text{h}} \leq 56\text{ }^{\circ}\text{C}$ ; <a href="#">Fig. 1</a> ; <a href="#">Fig. 2</a> ; <a href="#">Fig. 3</a>           | -   | 12  | A                      |
| $I_{\text{TSM}}$    | non-repetitive peak on-state current | full sine wave; $T_{\text{j(init)}} = 25\text{ }^{\circ}\text{C}$ ; $t_{\text{p}} = 20\text{ ms}$ ; <a href="#">Fig. 4</a> ; <a href="#">Fig. 5</a> | -   | 95  | A                      |
|                     |                                      | full sine wave; $T_{\text{j(init)}} = 25\text{ }^{\circ}\text{C}$ ; $t_{\text{p}} = 16.7\text{ ms}$                                                 | -   | 105 | A                      |
| $I^2t$              | $I^2t$ for fusing                    | $t_{\text{p}} = 10\text{ ms}$ ; sine-wave pulse                                                                                                     | -   | 45  | $\text{A}^2\text{s}$   |
| $dl_{\text{T}}/dt$  | rate of rise of on-state current     | $I_{\text{G}} = 70\text{ mA}$ ; T2+ G+                                                                                                              | -   | 50  | $\text{A}/\mu\text{s}$ |
|                     |                                      | $I_{\text{G}} = 70\text{ mA}$ ; T2+ G-                                                                                                              | -   | 50  | $\text{A}/\mu\text{s}$ |
|                     |                                      | $I_{\text{G}} = 140\text{ mA}$ ; T2- G+                                                                                                             | -   | 10  | $\text{A}/\mu\text{s}$ |
|                     |                                      | $I_{\text{G}} = 70\text{ mA}$ ; T2- G-                                                                                                              | -   | 50  | $\text{A}/\mu\text{s}$ |
| $I_{\text{GM}}$     | 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 | 150 | $^{\circ}\text{C}$     |
| $T_{\text{j}}$      | junction temperature                 |                                                                                                                                                     | -   | 125 | $^{\circ}\text{C}$     |

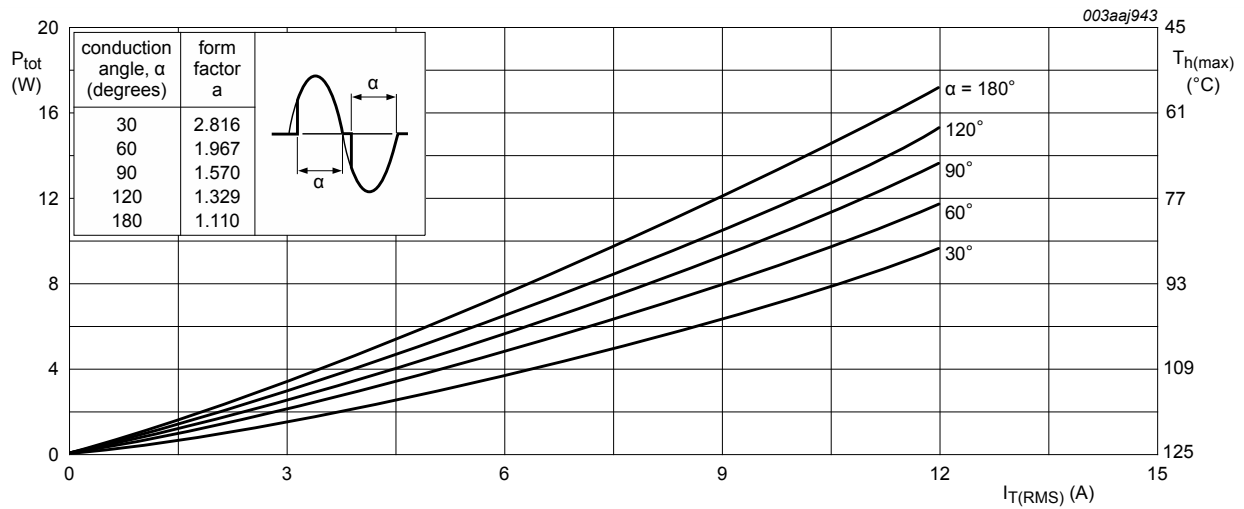


**Fig. 1. RMS on-state current as a function of heatsink temperature; maximum values**



$f = 50\text{ Hz}$ ;  $T_{\text{h}} = 56\text{ }^{\circ}\text{C}$

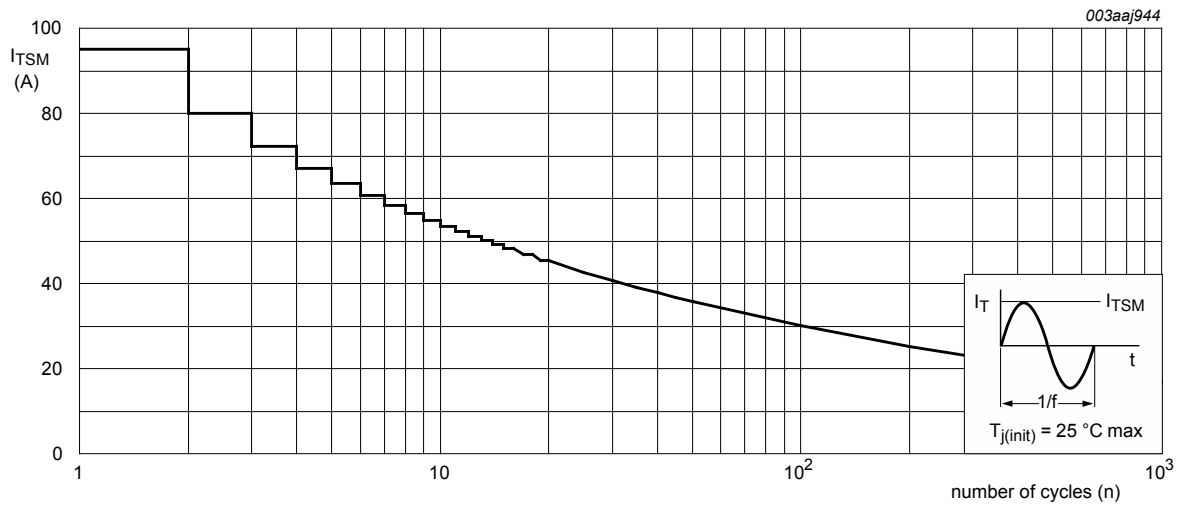
**Fig. 2. RMS on-state current as a function of surge duration; maximum values**



$\alpha$  = conduction angle

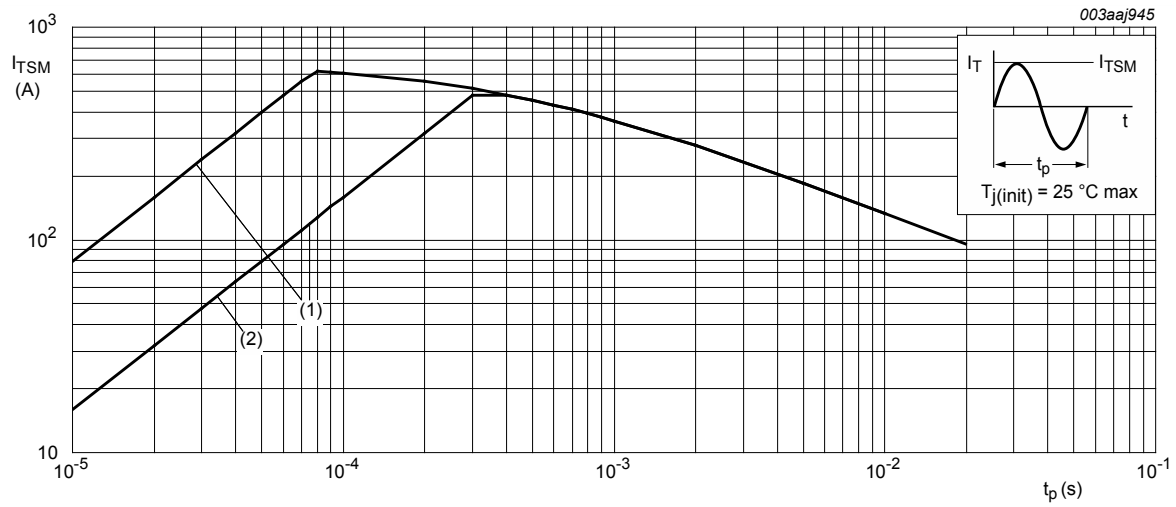
$a$  = form factor =  $I_{T(RMS)} / I_{T(AV)}$

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



$f = 50 \text{ Hz}$

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



$t_p \leq 20 \text{ ms}$

(1)  $dI_T/dt$  limit

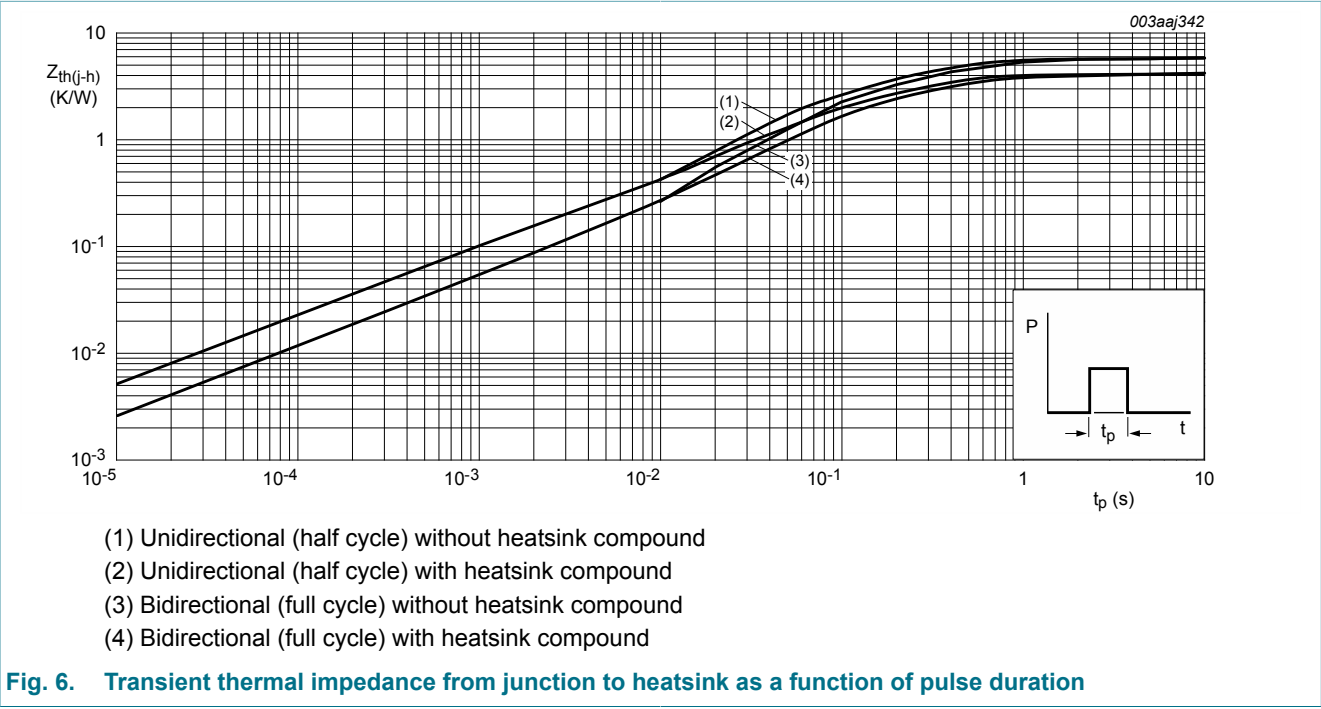
(2) T2- G+ quadrant limit

**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; 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  |



## 9. Isolation characteristics

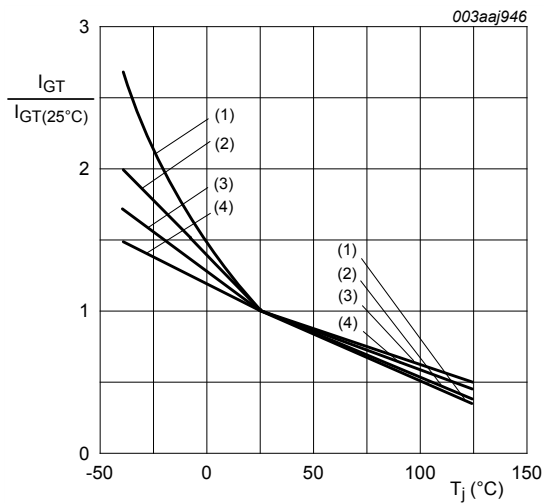
Table 6. Isolation characteristics

| 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 Hz ≤ f ≤ 60 Hz; RH ≤ 65 %; T <sub>n</sub> = 25 °C | -   | -   | 2500 | V    |
| $C_{isol}$      | isolation capacitance | from main terminal 2 to external heatsink; f = 1 MHz; T <sub>n</sub> = 25 °C                                                            | -   | 10  | -    | pF   |

## 10. Characteristics

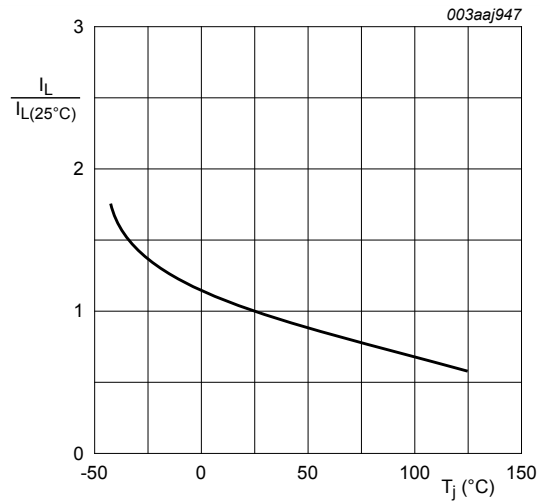
Table 7. Characteristics

| 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>$T_j = 25\text{ °C}$ ; <a href="#">Fig. 7</a>                       |  | -    | 5   | 35   | mA               |
|                                |                                   | $V_D = 12\text{ V}$ ; $I_T = 0.1\text{ A}$ ; T2+ G-;<br>$T_j = 25\text{ °C}$ ; <a href="#">Fig. 7</a>                       |  | -    | 8   | 35   | mA               |
|                                |                                   | $V_D = 12\text{ V}$ ; $I_T = 0.1\text{ A}$ ; T2- G-;<br>$T_j = 25\text{ °C}$ ; <a href="#">Fig. 7</a>                       |  | -    | 10  | 35   | mA               |
|                                |                                   | $V_D = 12\text{ V}$ ; $I_T = 0.1\text{ A}$ ; T2- G+;<br>$T_j = 25\text{ °C}$ ; <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>$T_j = 25\text{ °C}$ ; <a href="#">Fig. 8</a>                       |  | -    | 7   | 40   | mA               |
|                                |                                   | $V_D = 12\text{ V}$ ; $I_G = 0.1\text{ A}$ ; T2+ G-;<br>$T_j = 25\text{ °C}$ ; <a href="#">Fig. 8</a>                       |  | -    | 20  | 60   | mA               |
|                                |                                   | $V_D = 12\text{ V}$ ; $I_G = 0.1\text{ A}$ ; T2- G-;<br>$T_j = 25\text{ °C}$ ; <a href="#">Fig. 8</a>                       |  | -    | 8   | 40   | mA               |
|                                |                                   | $V_D = 12\text{ V}$ ; $I_G = 0.1\text{ A}$ ; T2- G+;<br>$T_j = 25\text{ °C}$ ; <a href="#">Fig. 8</a>                       |  | -    | 10  | 60   | mA               |
| $I_H$                          | holding current                   | $V_D = 12\text{ V}$ ; $T_j = 25\text{ °C}$ ; <a href="#">Fig. 9</a>                                                         |  | -    | 6   | 30   | mA               |
| $V_T$                          | on-state voltage                  | $I_T = 15\text{ A}$ ; $T_j = 25\text{ °C}$ ; <a href="#">Fig. 10</a>                                                        |  | -    | 1.4 | 1.65 | V                |
| $V_{GT}$                       | gate trigger voltage              | $V_D = 12\text{ V}$ ; $I_T = 0.1\text{ A}$ ; $T_j = 25\text{ °C}$ ;<br><a href="#">Fig. 11</a>                              |  | -    | 0.7 | 1    | V                |
|                                |                                   | $V_D = 400\text{ V}$ ; $I_T = 0.1\text{ A}$ ; $T_j = 125\text{ °C}$ ;<br><a href="#">Fig. 11</a>                            |  | 0.25 | 0.4 | -    | V                |
| $I_D$                          | off-state current                 | $V_D = 600\text{ V}$ ; $T_j = 125\text{ °C}$                                                                                |  | -    | 0.1 | 0.5  | mA               |
| <b>Dynamic characteristics</b> |                                   |                                                                                                                             |  |      |     |      |                  |
| $dV_D/dt$                      | rate of rise of off-state voltage | $V_{DM} = 402\text{ V}$ ; $T_j = 125\text{ °C}$ ; ( $V_{DM} = 67\%$ of $V_{DRM}$ ); exponential waveform; gate open circuit |  | 100  | 250 | -    | V/ $\mu\text{s}$ |
| $t_{gt}$                       | gate-controlled turn-on time      | $I_{TM} = 16\text{ A}$ ; $V_D = 600\text{ V}$ ; $I_G = 0.1\text{ A}$ ; $dI_G/dt = 5\text{ A}/\mu\text{s}$                   |  | -    | 2   | -    | $\mu\text{s}$    |

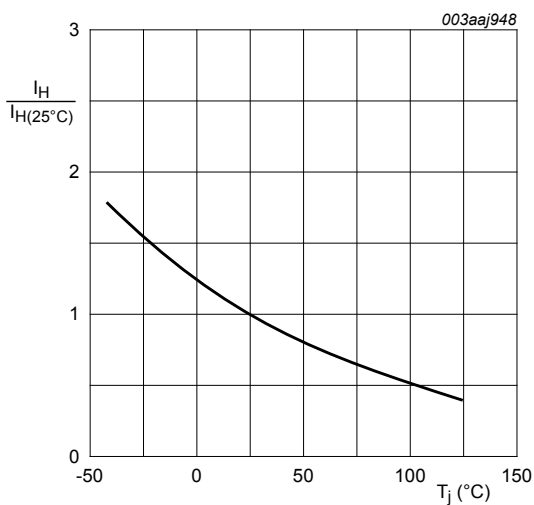


- (1) T2- G+
- (2) T2- G-
- (3) T2+ G-
- (4) T2+ G+

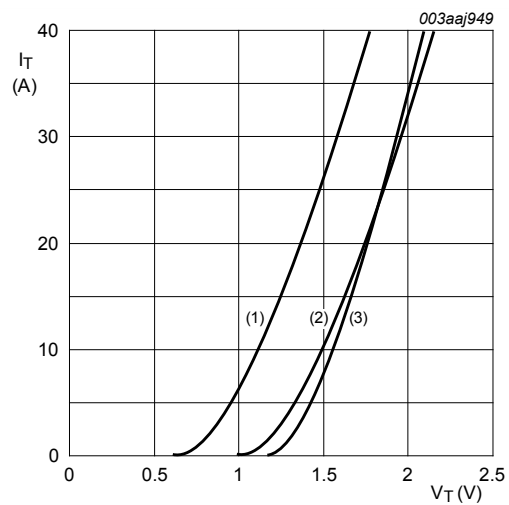
**Fig. 7. Normalized gate trigger current as a function of junction temperature**



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



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

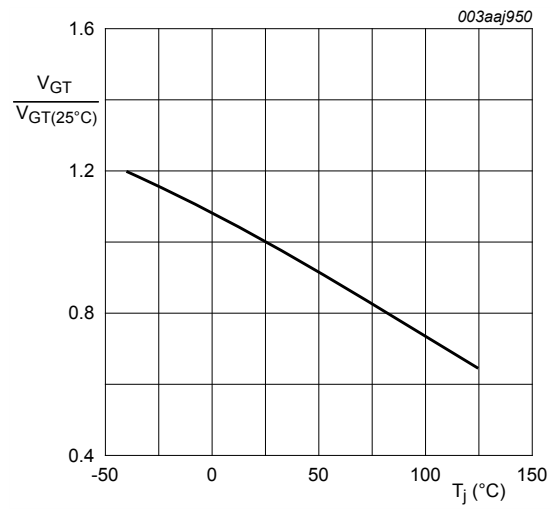


$V_o = 1.145 \text{ V}; R_s = 0.031 \Omega$

- (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**

# 11. Package outline

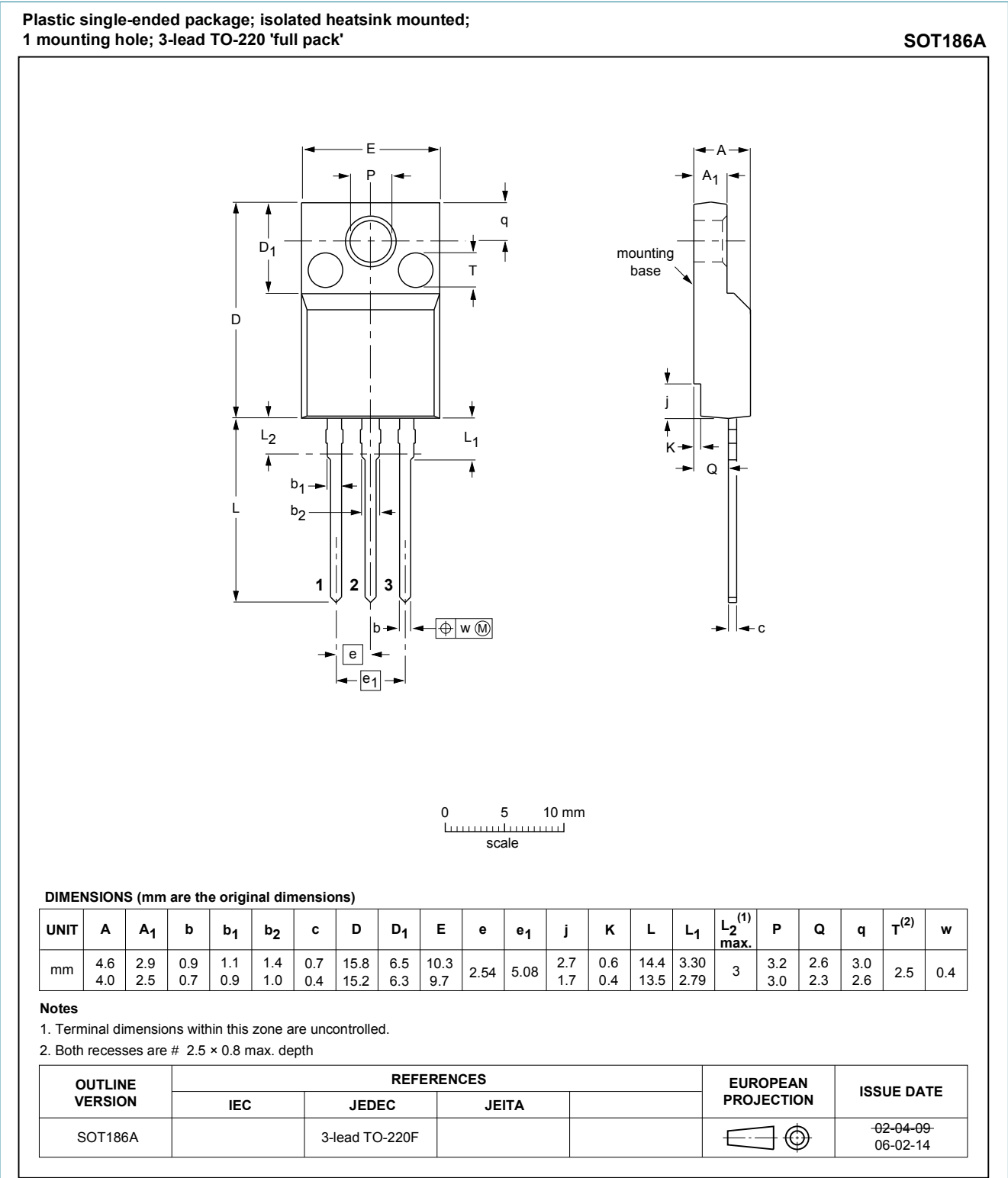


Fig. 12. Package outline TO-220F (SOT186A)