



# BT138-800E

4Q Triac

30 August 2013

Product data sheet

## 1. General description

Planar passivated sensitive gate four quadrant triac in a SOT78 (TO-220AB) plastic package intended for use in general purpose bidirectional switching and phase control applications. This sensitive gate "series E" triac is intended to be interfaced directly to microcontrollers, logic integrated circuits and other low power gate trigger circuits.

## 2. Features and benefits

- Direct triggering from low power drivers and logic ICs
- High blocking voltage capability
- Planar passivated for voltage ruggedness and reliability
- Sensitive gate
- Triggering in all four quadrants

## 3. Applications

- General purpose motor control
- General purpose switching

## 4. Quick reference data

Table 1. Quick reference data

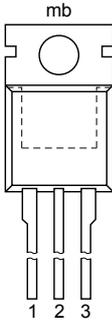
| Symbol                        | Parameter                            | Conditions  | Min | Typ | Max | Unit               |
|-------------------------------|--------------------------------------|---|-----|-----|-----|--------------------|
| $V_{DRM}$                     | repetitive peak off-state voltage    |   | -   | -   | 800 | V                  |
| $I_{TSM}$                     | non-repetitive peak on-state current | full sine wave; $T_{j(\text{init})} = 25\text{ }^{\circ}\text{C}$ ;<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; $T_{mb} \leq 99\text{ }^{\circ}\text{C}$ ; <a href="#">Fig. 1</a> ;<br><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>$T_j = 25\text{ }^{\circ}\text{C}$ ; <a href="#">Fig. 7</a>                           | -   | 2.5 | 10  | 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>                           | -   | 4   | 10  | mA                 |



| Symbol                         | Parameter                         | Conditions  | Min | Typ | Max | Unit             |
|--------------------------------|-----------------------------------|---|-----|-----|-----|------------------|
|                                |                                   | $V_D = 12\text{ V}$ ; $I_T = 0.1\text{ A}$ ; T2- G-;<br>$T_j = 25\text{ }^\circ\text{C}$ ; <a href="#">Fig. 7</a>                       | -   | 5   | 10  | 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>                       | -   | 11  | 25  | mA               |
| <b>Dynamic characteristics</b> |                                   |   |     |     |     |                  |
| $dV_D/dt$                      | rate of rise of off-state voltage | $V_{DM} = 536\text{ V}$ ; $T_j = 125\text{ }^\circ\text{C}$ ; ( $V_{DM} = 67\%$ of $V_{DRM}$ ); exponential waveform; gate open circuit | -   | 150 | -   | V/ $\mu\text{s}$ |

## 5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description                    | Simplified outline   | Graphic symbol  |
|-----|--------|--------------------------------|--|---|
| 1   | T1     | main terminal 1                |  <p>TO-220AB (SOT78)</p> |  <p>sym051</p> |
| 2   | T2     | main terminal 2                |  |   |
| 3   | G      | gate                           |  |   |
| mb  | T2     | mounting base; main terminal 2 |  |   |

## 6. Ordering information

Table 3. Ordering information

| Type number   | Package  |  | Version |
|---------------|----------|--|---------|
|               | Name     | Description  |         |
| BT138-800E    | TO-220AB | plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB | SOT78   |
| BT138-800E/DG | TO-220AB | plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB | SOT78   |

## 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    |  | -   | 800 | V                      |
| $I_{T(RMS)}$ | RMS on-state current                 | full sine wave; $T_{mb} \leq 99\text{ }^{\circ}\text{C}$ ; <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; $T_{j(\text{init})} = 25\text{ }^{\circ}\text{C}$ ; $t_p = 20\text{ ms}$ ; <a href="#">Fig. 4</a> ; <a href="#">Fig. 5</a> | -   | 95  | A                      |
|              |                                      | full sine wave; $T_{j(\text{init})} = 25\text{ }^{\circ}\text{C}$ ; $t_p = 16.7\text{ ms}$   | -   | 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     | $I_T = 20\text{ A}$ ; $I_G = 0.2\text{ A}$ ; $dI_G/dt = 0.2\text{ A}/\mu\text{s}$ ; T2+ G+   | -   | 50  | $\text{A}/\mu\text{s}$ |
|              |                                      | $I_T = 20\text{ A}$ ; $I_G = 0.2\text{ A}$ ; $dI_G/dt = 0.2\text{ A}/\mu\text{s}$ ; T2+ G-   | -   | 50  | $\text{A}/\mu\text{s}$ |
|              |                                      | $I_T = 20\text{ A}$ ; $I_G = 0.2\text{ A}$ ; $dI_G/dt = 0.2\text{ A}/\mu\text{s}$ ; T2- G-   | -   | 50  | $\text{A}/\mu\text{s}$ |
|              |                                      | $I_T = 20\text{ A}$ ; $I_G = 0.2\text{ A}$ ; $dI_G/dt = 0.2\text{ A}/\mu\text{s}$ ; T2- G+   | -   | 10  | $\text{A}/\mu\text{s}$ |
| $I_{GM}$     | 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 | $^{\circ}\text{C}$     |

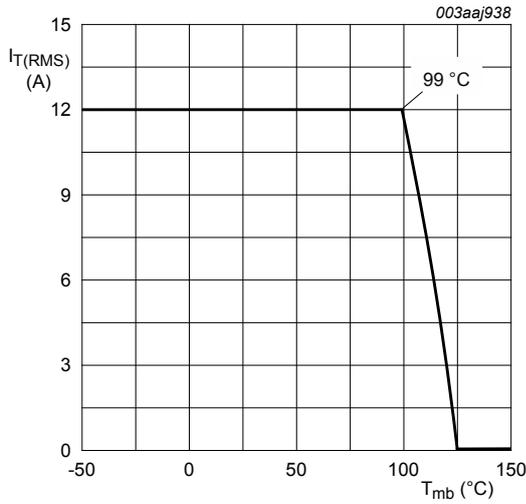
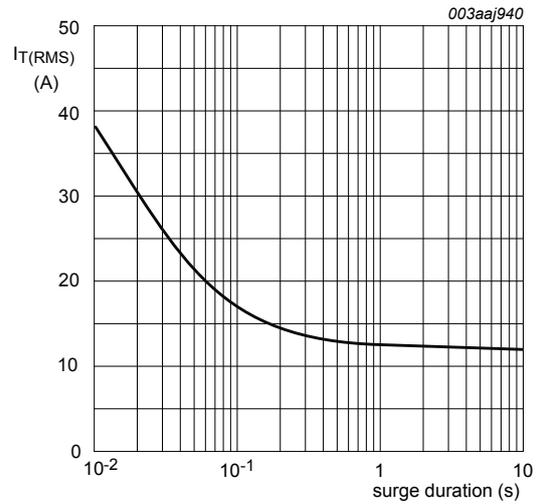


Fig. 1. RMS on-state current as a function of mounting base temperature; maximum values



f = 50 Hz; T<sub>mb</sub> = 99 °C

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

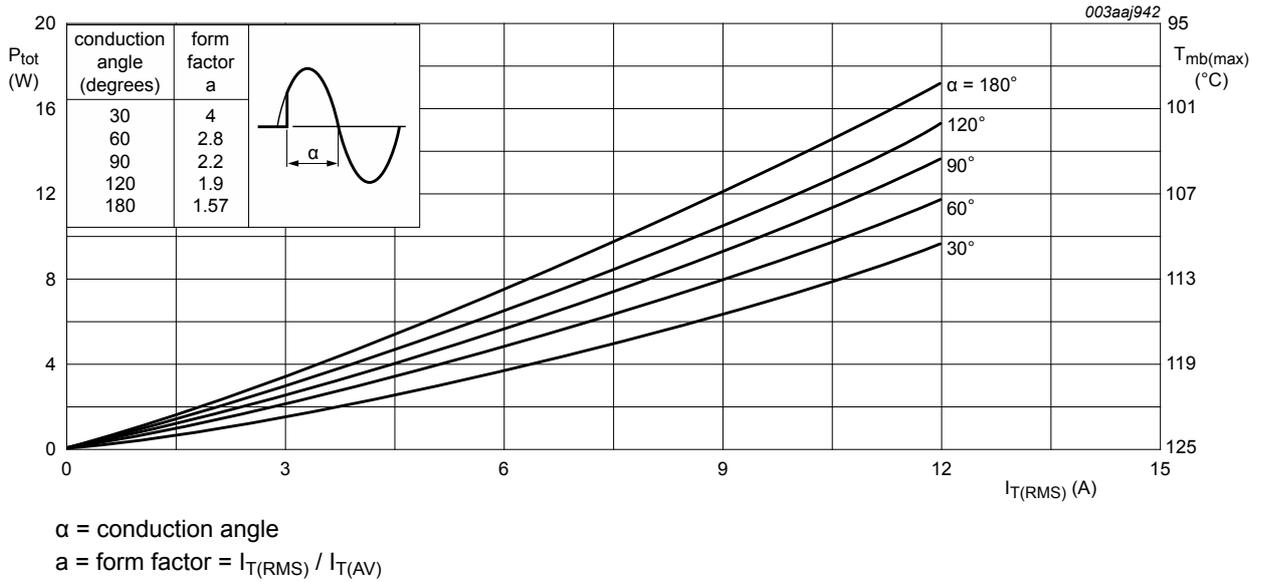
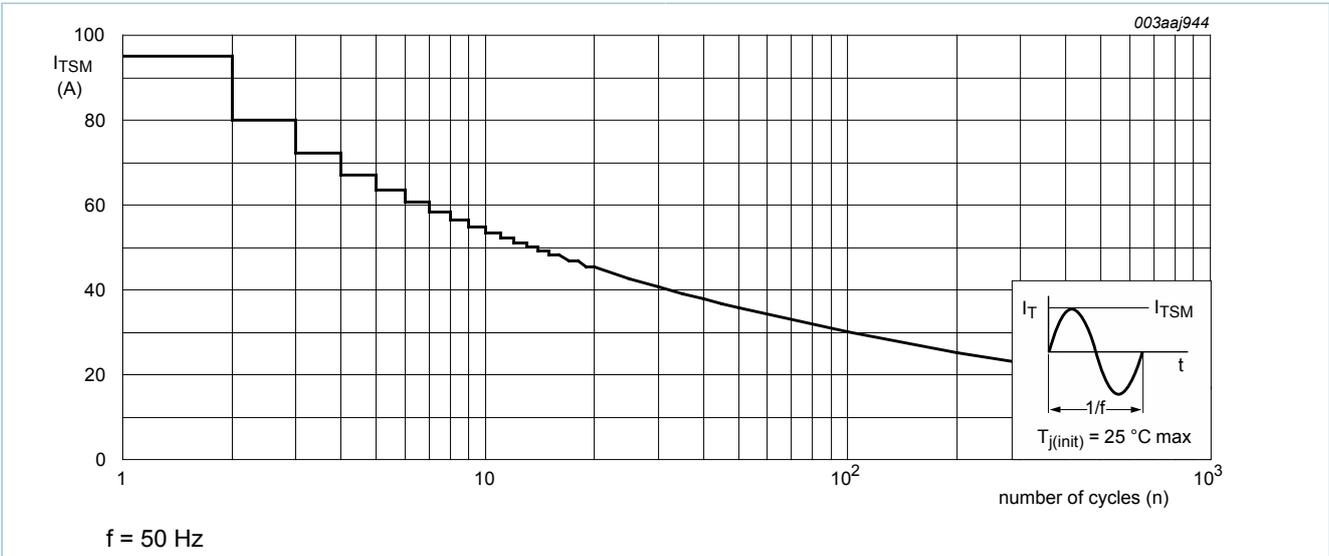
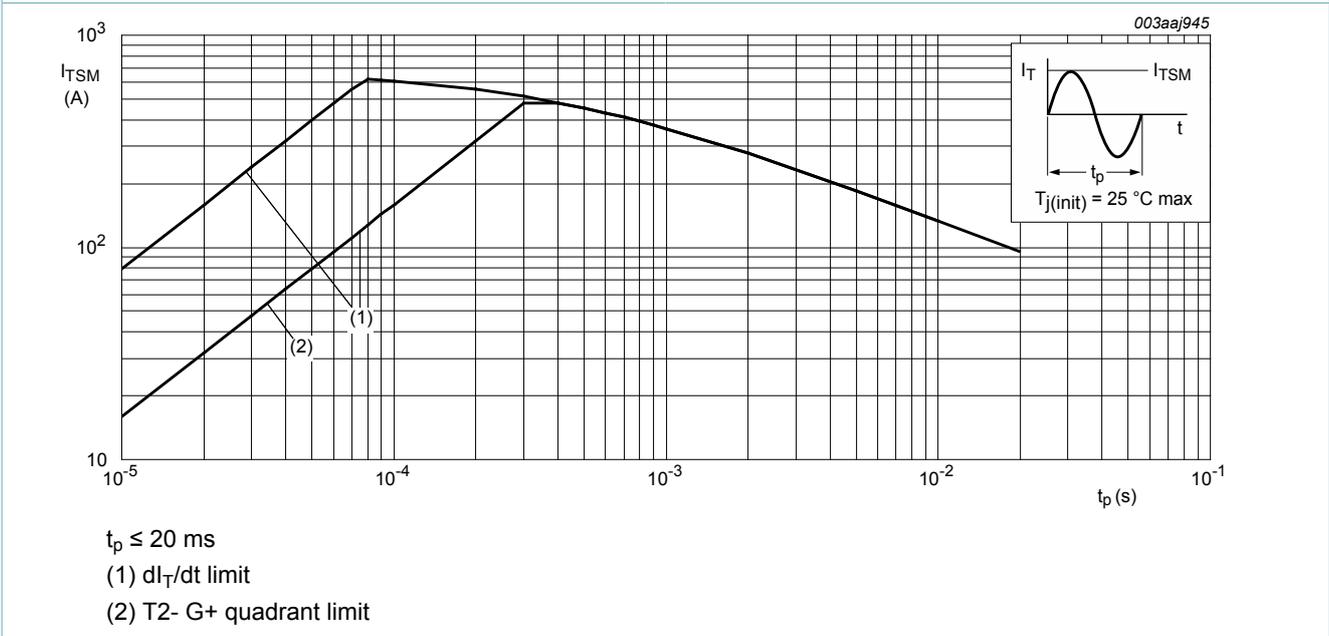


Fig. 3. Total power dissipation as a function of RMS on-state current; maximum values



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

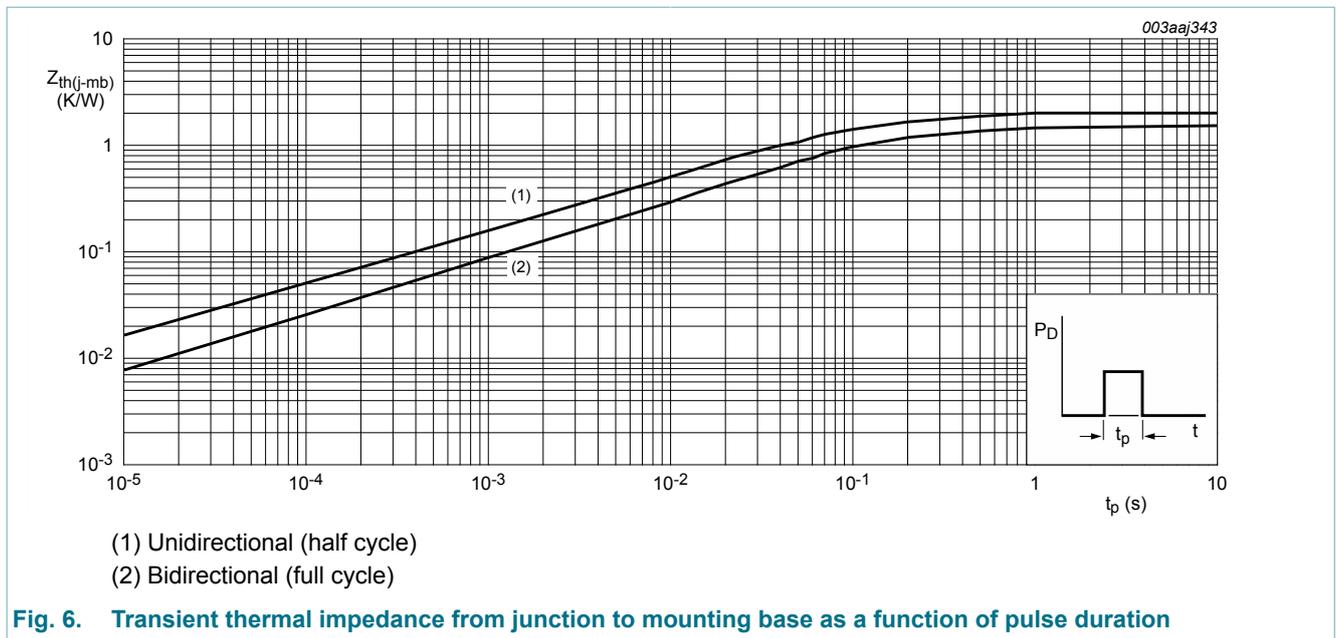


**Fig. 5. Non-repetitive peak on-state current as a function of pulse width; maximum values**

## 8. Thermal characteristics

Table 5. Thermal characteristics

| Symbol         | Parameter   | Conditions                         | Min | Typ | Max | Unit |
|----------------|---|------------------------------------|-----|-----|-----|------|
| $R_{th(j-mb)}$ | thermal resistance from junction to mounting base | full cycle; <a href="#">Fig. 6</a> | -   | -   | 1.5 | K/W  |
|                |   | half cycle; <a href="#">Fig. 6</a> | -   | -   | 2   | K/W  |
| $R_{th(j-a)}$  | thermal resistance from junction to ambient       | in free air                        | -   | 60  | -   | K/W  |



## 9. Characteristics

Table 6. 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>                                | -    | 2.5 | 10   | 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>                                | -    | 4   | 10   | 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>                                | -    | 5   | 10   | 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>                                | -    | 11  | 25   | 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>                                | -    | -   | 30   | 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>                                | -    | -   | 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>                                | -    | -   | 30   | 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>                                | -    | -   | 40   | mA   |
| I <sub>H</sub>                 | holding current                   | V <sub>D</sub> = 12 V; T <sub>j</sub> = 25 °C; <a href="#">Fig. 9</a>   | -    | -   | 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> = 800 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> = 536 V; T <sub>j</sub> = 125 °C; (V <sub>DM</sub> = 67% of V <sub>DRM</sub> ); exponential waveform; gate open circuit | -    | 150 | -    | V/μs |
| t <sub>gt</sub>                | gate-controlled turn-on time      | I <sub>TM</sub> = 16 A; V <sub>D</sub> = 800 V; I <sub>G</sub> = 0.1 A; dI <sub>G</sub> /dt = 5 A/μs                                    | -    | 2   | -    | μs   |

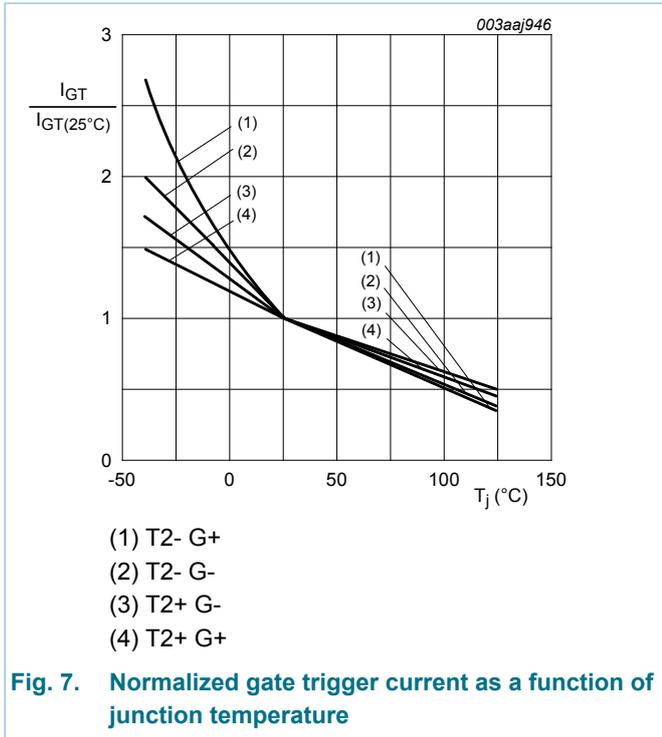


Fig. 7. Normalized gate trigger current as a function of junction temperature

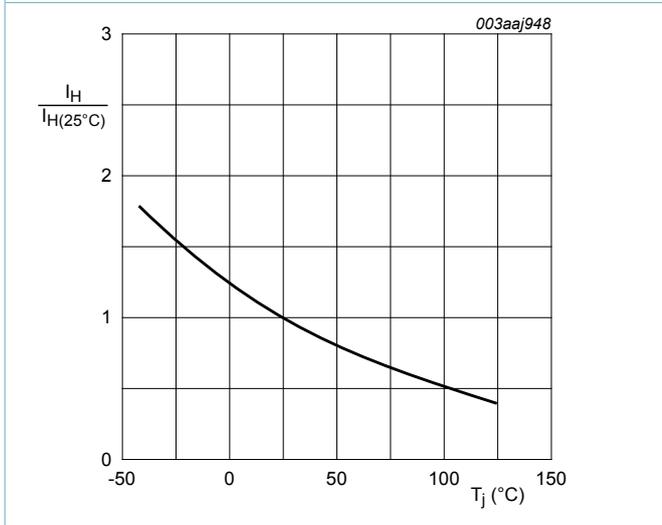


Fig. 9. Normalized holding current as a function of junction temperature

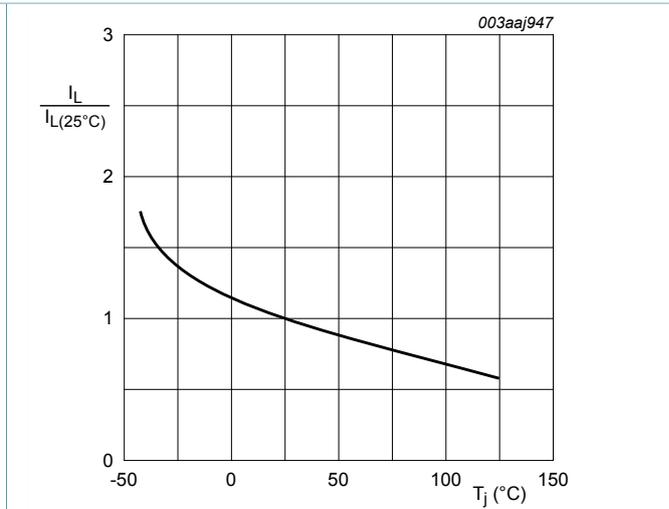


Fig. 8. Normalized latching current as a function of junction temperature

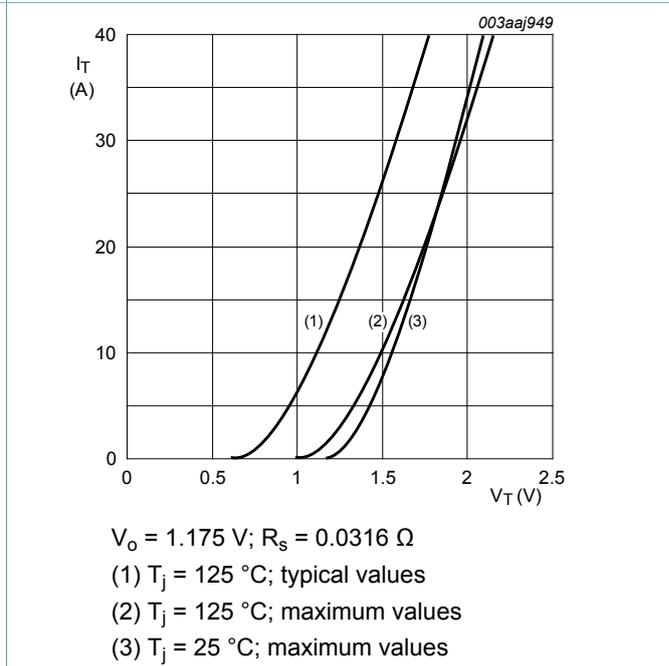


Fig. 10. On-state current as a function of on-state voltage

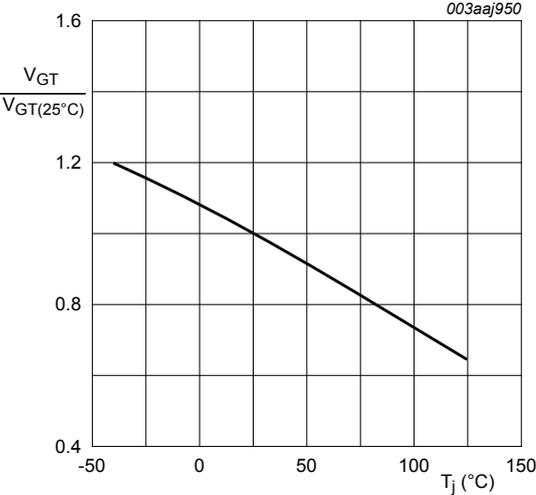
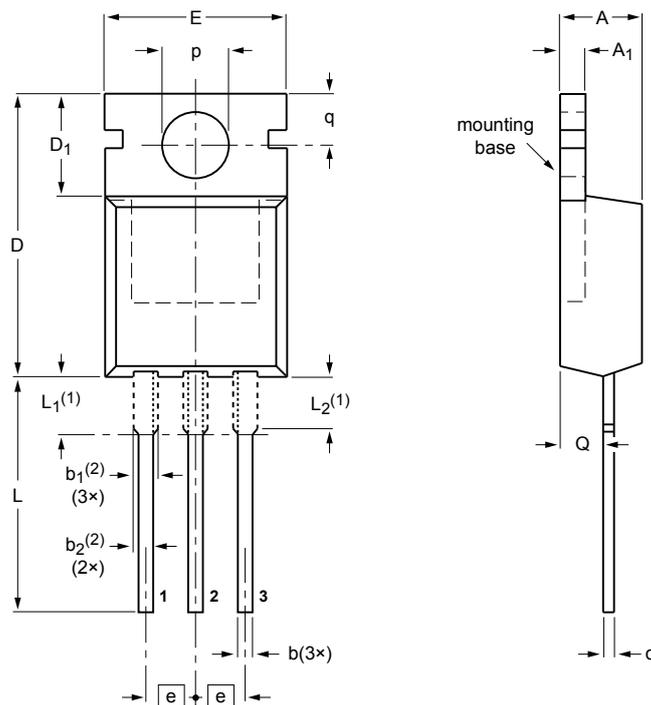


Fig. 11. Normalized gate trigger voltage as a function of junction temperature

### 10. Package outline

Plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB

SOT78



**DIMENSIONS** (mm are the original dimensions)

| UNIT | A          | A <sub>1</sub> | b          | b <sub>1</sub> (2) | b <sub>2</sub> (2) | c          | D            | D <sub>1</sub> | E           | e    | L            | L <sub>1</sub> (1) | L <sub>2</sub> (1) max. | p          | q          | Q          |
|------|------------|----------------|------------|--------------------|--------------------|------------|--------------|----------------|-------------|------|--------------|--------------------|-------------------------|------------|------------|------------|
| mm   | 4.7<br>4.1 | 1.40<br>1.25   | 0.9<br>0.6 | 1.6<br>1.0         | 1.3<br>1.0         | 0.7<br>0.4 | 16.0<br>15.2 | 6.6<br>5.9     | 10.3<br>9.7 | 2.54 | 15.0<br>12.8 | 3.30<br>2.79       | 3.0                     | 3.8<br>3.5 | 3.0<br>2.7 | 2.6<br>2.2 |

**Notes**

- Lead shoulder designs may vary.
- Dimension includes excess dambar.

| OUTLINE VERSION | REFERENCES |                 |       | EUROPEAN PROJECTION | ISSUE DATE           |
|-----------------|------------|-----------------|-------|---------------------|----------------------|
|                 | IEC        | JEDEC           | JEITA |                     |                      |
| SOT78           |            | 3-lead TO-220AB | SC-46 |                     | 08-04-23<br>08-06-13 |

Fig. 12. Package outline TO-220AB (SOT78)

## 11. Legal information

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| 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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