# MAC223A6

## 4Q Triac

15 September 2018 Product data sheet

## 1. General description

Planar passivated four quadrant triac in a SOT78 (T0-220AB) plastic package intended for use in applications requiring high bidirectional transient and blocking voltage capability and high thermal cycling performance.

## 2. Features and benefits

- High blocking voltage capability
- High noise immunity
- Planar passivated for voltage ruggedness and reliability
- Triggering in all four quadrants

## 3. Applications

- General purpose motor controls
- General purpose switching

## 4. Quick reference data

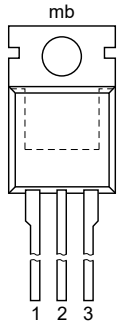
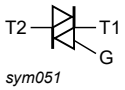
**Table 1. Quick reference data**

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{DRM}$ | repetitive peak off-state voltage | | | - | - | 400 | V |
| $I_{T(RMS)}$ | RMS on-state current | full sine wave; $T_{mb} \leq 91$ °C; Fig. 1; Fig. 2; Fig. 3 | | - | - | 25 | A |
| $I_{TSM}$ | non-repetitive peak on-state current | full sine wave; $T_{j(init)} = 25$ °C; $t_p = 20$ ms; Fig. 4; Fig. 5 | | - | - | 190 | A |
| | | full sine wave; $T_{j(init)} = 25$ °C; $t_p = 16.7$ ms | | - | - | 230 | A |
| $T_j$ | junction temperature | | | - | - | 125 | °C |
| **Static characteristics** | | | | | | | |
| $I_{GT}$ | gate trigger current | $V_D = 12$ V; $I_T = 0.1$ A; T2+ G+; $T_j = 25$ °C; Fig. 7 | | - | 6 | 50 | mA |
| | | $V_D = 12$ V; $I_T = 0.1$ A; T2+ G-; $T_j = 25$ °C; Fig. 7 | | - | 10 | 50 | mA |
| | | $V_D = 12$ V; $I_T = 0.1$ A; T2- G-; $T_j = 25$ °C; Fig. 7 | | - | 11 | 50 | mA |
| | | $V_D = 12$ V; $I_T = 0.1$ A; T2- G+; $T_j = 25$ °C; Fig. 7 | | - | 23 | 75 | mA |
| $I_H$ | holding current | $V_D = 12$ V; $T_j = 25$ °C; T2+; Fig. 9 | | - | 7 | 30 | mA |

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| | | $V_D$ = 12 V; $T_j$ = 25 °C; T2-; Fig. 9 | | - | 12 | 30 | mA |
| $V_T$ | on-state voltage | $I_T$ = 30 A; $T_j$ = 25 °C; Fig. 10 | | - | 1.3 | 1.55 | V |
| **Dynamic characteristics** | | | | | | | |
| $dV_D/dt$ | rate of rise of off-state voltage | $V_{DM}$ = 268 V; $T_j$ = 125 °C; ($V_{DM}$ = 67% of $V_{DRM}$); exponential waveform; gate open circuit | | 100 | 300 | - | V/µs |
| $dV_{com}/dt$ | rate of change of commutating voltage | $V_D$ = 400 V; $T_j$ = 95 °C; $dI_{com}/dt$ = 9 A/ms; $I_T$ = 25 A; gate open circuit | | - | 10 | - | V/µs |

## 5. Pinning information

**Table 2. Pinning information**

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

## 6. Ordering information

**Table 3. Ordering information**

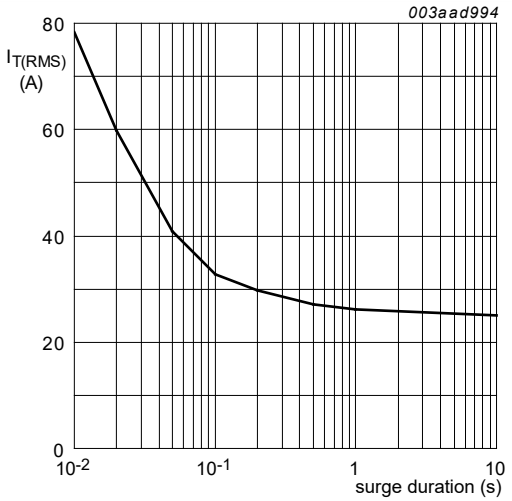
| Type number | Package | | |
|---|---|---|---|
| | Name | Description | Version |
| MAC223A6 | TO-220AB | plastic single-ended package; heatsink mounted; 1 mounting hole; 3-lead TO-220AB | SOT78 |

# 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 | | | - | 400 | V |
| $I_{T(RMS)}$ | RMS on-state current | full sine wave; $T_{mb} \leq 91$ °C; Fig. 1; Fig. 2; Fig. 3 | | - | 25 | A |
| $I_{TSM}$ | non-repetitive peak on-state current | full sine wave; $T_{j(init)} = 25$ °C; $t_p = 20$ ms; Fig. 4; Fig. 5 | | - | 190 | A |
| | | full sine wave; $T_{j(init)} = 25$ °C; $t_p = 16.7$ ms | | - | 230 | A |
| $I^2t$ | $I^2t$ for fusing | $t_p = 10$ ms; SIN | | - | 180 | $A^2s$ |
| $dI_T/dt$ | rate of rise of on-state current | $I_G = 200$ mA; T2+ G+ | | - | 50 | A/µs |
| | | $I_G = 200$ mA; T2+ G- | | - | 50 | A/µs |
| | | $I_G = 200$ mA; T2- G- | | - | 50 | A/µs |
| | | $I_G = 200$ mA; T2- G+ | | - | 10 | A/µs |
| $I_{GM}$ | 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 | °C |
| $T_j$ | junction temperature | | | - | 125 | °C |




f = 50 Hz; $T_{mb}$ = 91 °C

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

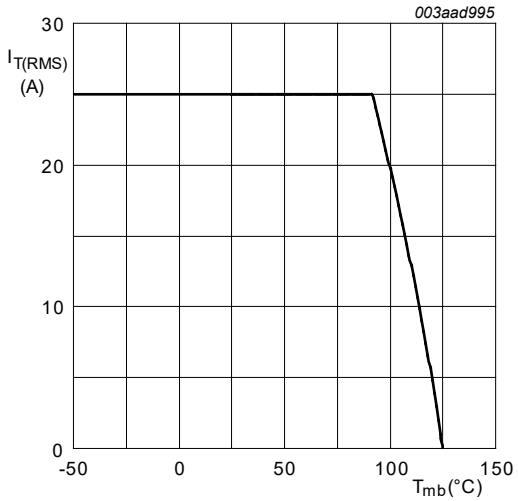
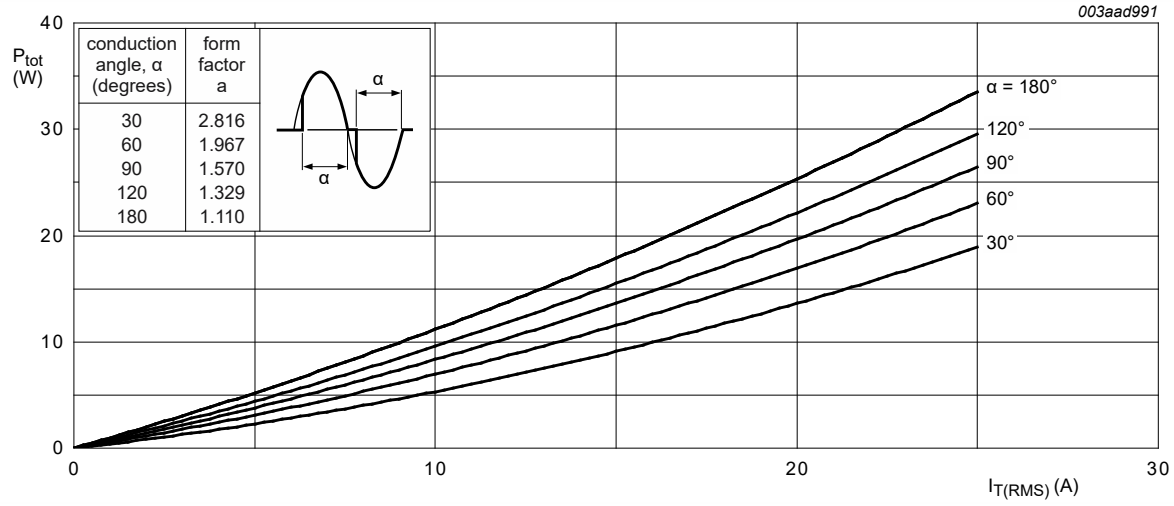


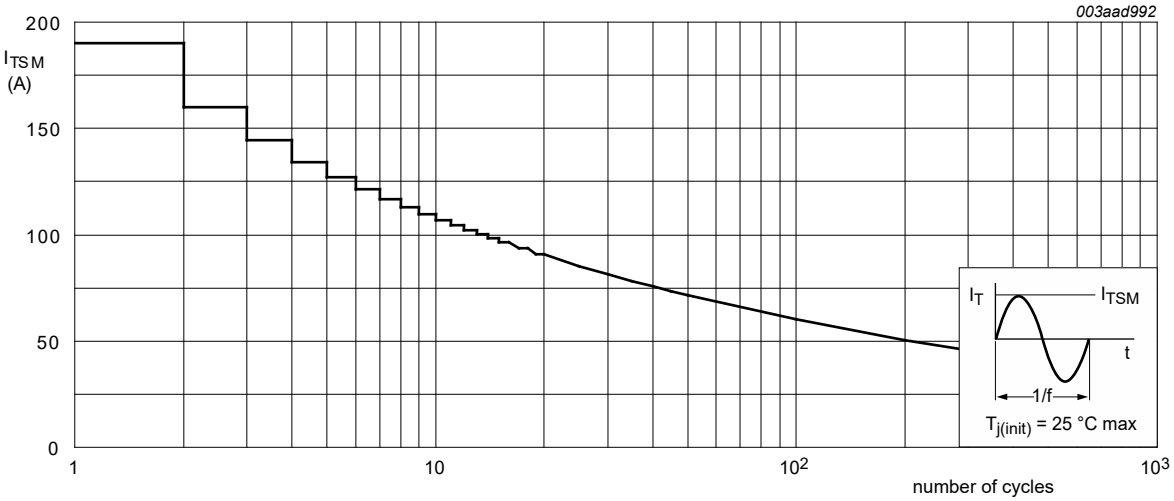

**Fig. 2. RMS on-state current as a function of mounting base temperature; maximum values**




α = conduction angle

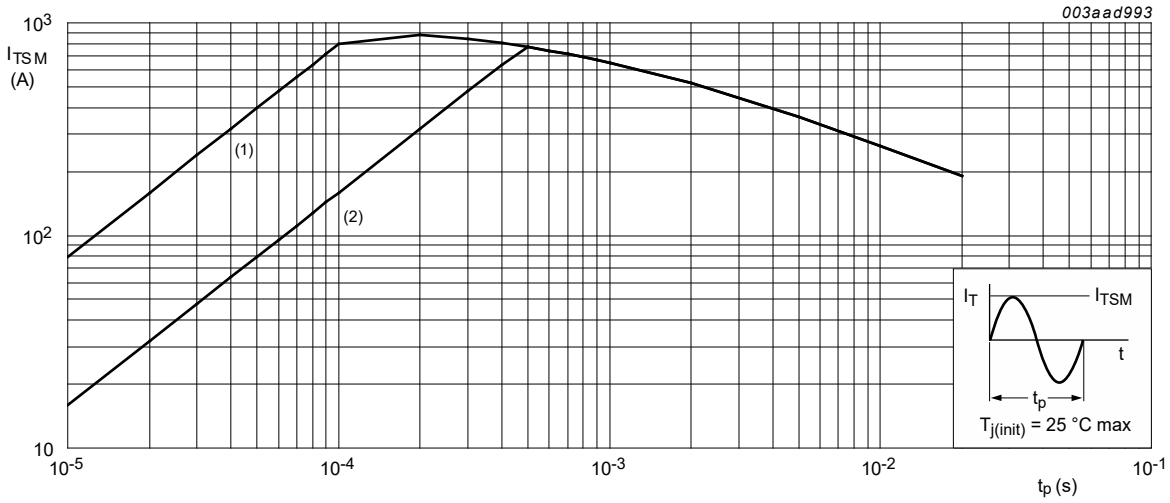
a = form factor = $I_{T(RMS)}$ / $I_{T(AV)}$

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




f = 50 Hz

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



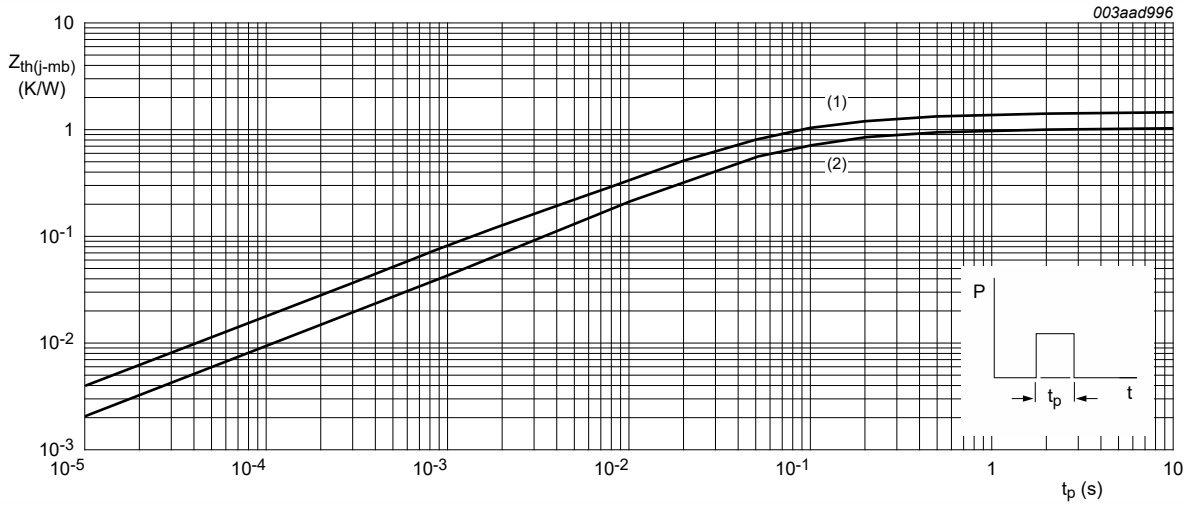

$t_p \leq 20$ ms
(1) $dI_T/dt$ limit
(2) T2- G+ quadrant limit

**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 |
|---|---|---|---|---|---|---|---|
| $R_{th(j-mb)}$ | thermal resistance from junction to mounting base | full cycle; Fig. 6 | | - | - | 1 | K/W |
| | | half cycle; Fig. 6 | | - | - | 1.4 | K/W |
| $R_{th(j-a)}$ | thermal resistance from junction to ambient free air | in free air | | - | 60 | - | K/W |



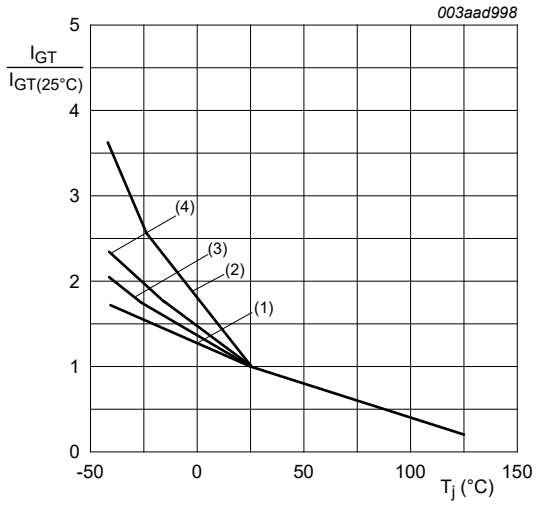

(1) Unidirectional (half cycle)
(2) Bidirectional (full cycle)

**Fig. 6. Transient thermal impedance from junction to mounting base as a function of pulse width**

# 9. Characteristics

**Table 6. Characteristics**

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **Static characteristics** | | | | | | | |
| $I_{GT}$ | gate trigger current | $V_D$ = 12 V; $I_T$ = 0.1 A; T2+ G+; $T_j$ = 25 °C; Fig. 7 | | - | 6 | 50 | mA |
| | | $V_D$ = 12 V; $I_T$ = 0.1 A; T2+ G-; $T_j$ = 25 °C; Fig. 7 | | - | 10 | 50 | mA |
| | | $V_D$ = 12 V; $I_T$ = 0.1 A; T2- G-; $T_j$ = 25 °C; Fig. 7 | | - | 11 | 50 | mA |
| | | $V_D$ = 12 V; $I_T$ = 0.1 A; T2- G+; $T_j$ = 25 °C; Fig. 7 | | - | 23 | 75 | mA |
| $I_L$ | latching current | $V_D$ = 12 V; $I_G$ = 0.1 A; T2+ G+; $T_j$ = 25 °C; Fig. 8 | | - | 8 | 40 | mA |
| | | $V_D$ = 12 V; $I_G$ = 0.1 A; T2+ G-; $T_j$ = 25 °C; Fig. 8 | | - | 30 | 60 | mA |
| | | $V_D$ = 12 V; $I_G$ = 0.1 A; T2- G-; $T_j$ = 25 °C; Fig. 8 | | - | 18 | 40 | mA |
| | | $V_D$ = 12 V; $I_G$ = 0.1 A; T2- G+; $T_j$ = 25 °C; Fig. 8 | | - | 15 | 60 | mA |
| $I_H$ | holding current | $V_D$ = 12 V; $T_j$ = 25 °C; T2+; Fig. 9 | | - | 7 | 30 | mA |
| | | $V_D$ = 12 V; $T_j$ = 25 °C; T2-; Fig. 9 | | - | 12 | 30 | mA |
| $V_T$ | on-state voltage | $I_T$ = 30 A; $T_j$ = 25 °C; Fig. 10 | | - | 1.3 | 1.55 | V |
| $V_{GT}$ | gate trigger voltage | $V_D$ = 12 V; $I_T$ = 0.1 A; $T_j$ = 25 °C; Fig. 11 | | - | 0.7 | 1 | V |
| | | $V_D$ = 400 V; $I_T$ = 0.1 A; $T_j$ = 125 °C; Fig. 11 | | 0.25 | 0.4 | - | V |
| $I_D$ | off-state current | $V_D$ = 400 V; $T_j$ = 125 °C | | - | 0.1 | 0.5 | mA |
| **Dynamic characteristics** | | | | | | | |
| $dV_D/dt$ | rate of rise of off-state voltage | $V_{DM}$ = 268 V; $T_j$ = 125 °C; ($V_{DM}$ = 67% of $V_{DRM}$); exponential waveform; gate open circuit | | 100 | 300 | - | V/µs |
| $dV_{com}/dt$ | rate of change of commutating voltage | $V_D$ = 400 V; $T_j$ = 95 °C; $dI_{com}/dt$ = 9 A/ms; $I_T$ = 25 A; gate open circuit | | - | 10 | - | V/µs |
| $t_{gt}$ | gate-controlled turn-on time | $I_{TM}$ = 30 A; $V_D$ = 400 V; $I_G$ = 0.1 A; $dI_G/dt$ = 5 A/µs | | - | 2 | - | µs |




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

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

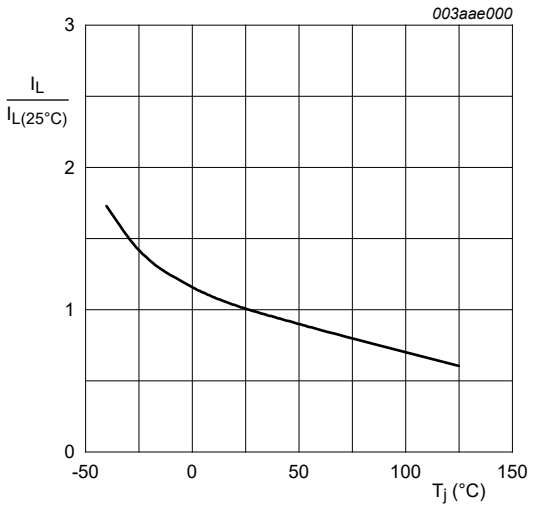



**Fig. 8. Normalized latching current as a function of junction temperature**

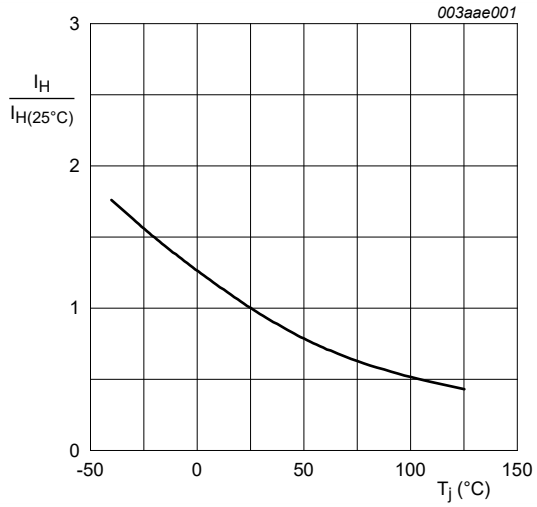
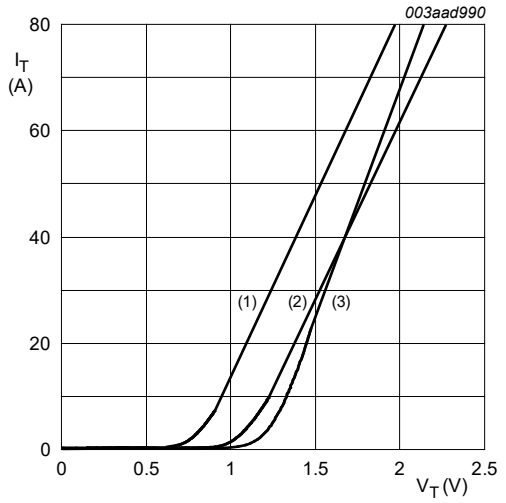



**Fig. 9. Normalized holding current as a function of junction temperature**




$V_o$ = 1.073 V; $R_s$ = 0.015 Ω
(1) $T_j$ = 125 °C; typical values
(2) $T_j$ = 125 °C; maximum values
(3) $T_j$ = 25 °C; maximum values

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

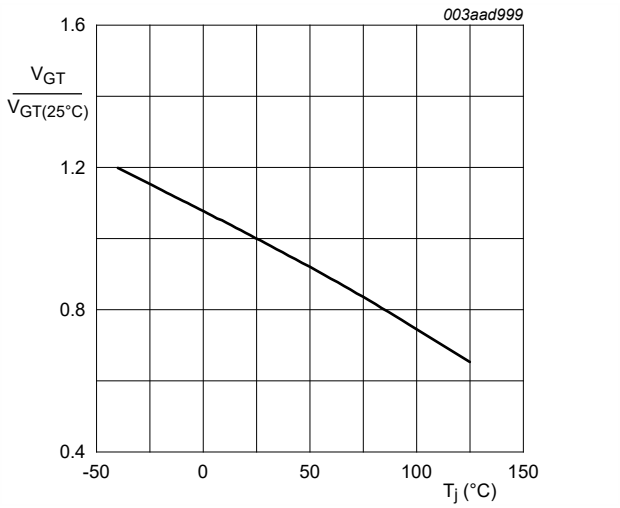
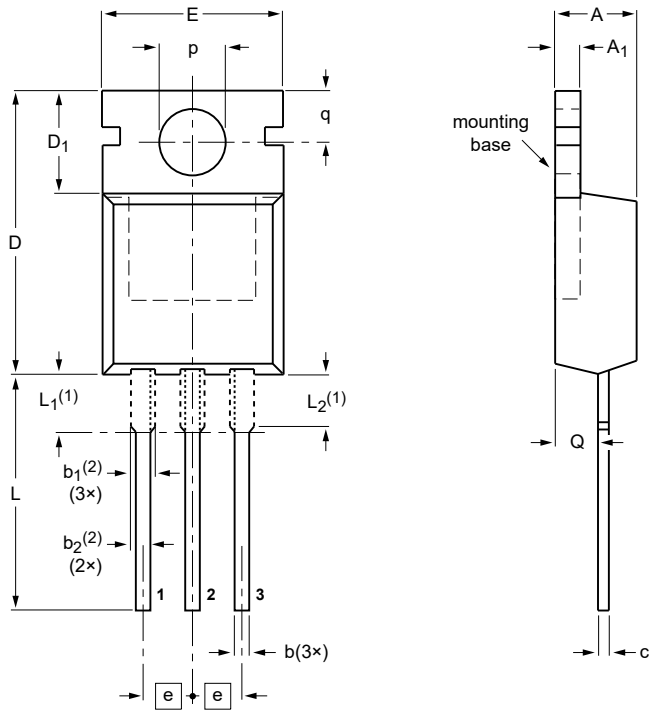



**Fig. 11. Normalized gate trigger voltage as a function of junction temperature**

## 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 | $A_1$ | b | $b_1$(2) | $b_2$(2) | c | D | $D_1$ | E | e | L | $L_1$(1) | $L_2$(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**

1. Lead shoulder designs may vary.
2. 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

## 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. |
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**Date of release: 15 September 2018**

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