1. General description

Planar passivated high commutation three quadrant triac in a SOT186A (TO-220F) “full pack” plastic package. This “series E” triac balances the requirements of commutation performance and gate sensitivity and is intended for interfacing with low power drivers including microcontrollers.

2. Features and benefits

- 3Q technology for improved noise immunity
- Direct interfacing with low power drivers and microcontrollers
- Good immunity to false turn-on by dV/dt
- High commutation capability with sensitive gate
- High voltage capability
- Isolated mounting base package
- Planar passivated for voltage ruggedness and reliability
- Sensitive gate for easy logic level triggering
- Triggering in three quadrants only

3. Applications

- Industrial and domestic heating circuits
- Motor controls e.g. washing machines and vacuum cleaners
- Refrigeration and air-conditioner compressor controls

4. Quick reference data

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{\text{DRM}}$</td>
<td>repetitive peak off-state voltage</td>
<td>full sine wave; $T_h \leq 73 , ^\circ\text{C}$; $I_{\text{T(RMS)}}$</td>
<td>-</td>
<td>-</td>
<td>600</td>
<td>V</td>
</tr>
<tr>
<td>$I_{\text{T(RMS)}}$</td>
<td>RMS on-state current</td>
<td>full sine wave; $T_{j(init)} = 25 , ^\circ\text{C}$; $I_{TSM}$</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>A</td>
</tr>
<tr>
<td>$I_{\text{TSM}}$</td>
<td>non-repetitive peak on-state current</td>
<td>full sine wave; $T_{j(init)} = 25 , ^\circ\text{C}$; $I_{G}$</td>
<td>-</td>
<td>-</td>
<td>85</td>
<td>A</td>
</tr>
<tr>
<td>$T_j$</td>
<td>junction temperature</td>
<td>full sine wave; $T_{j(init)} = 25 , ^\circ\text{C}$; $I_{TSM}$</td>
<td>-</td>
<td>-</td>
<td>93</td>
<td>A</td>
</tr>
</tbody>
</table>

**Static characteristics**

| Symbol | Parameter | Conditions | $V_D = 12 \, \text{V}$; $I_T = 0.1 \, \text{A}$; T2+ G+; $T_j = 25 \, ^\circ\text{C}$; $I_{GT}$ | 0.5 | - | 10 | mA |

Table 1. Quick reference data
### Symbol Parameter Conditions | Min | Typ | Max | Unit |
--- | --- | --- | --- | --- |
$I_H$ | holding current $V_D = 12\ V; I_T = 0.1\ A; T_2^+\ G_-; T_j = 25\ ^\circ\ C;\ Fig.\ 7$ | 0.5 | - | 10 | mA |
$I_H$ | holding current $V_D = 12\ V; I_T = 0.1\ A; T_2^-\ G_-; T_j = 25\ ^\circ\ C;\ Fig.\ 7$ | 0.5 | - | 10 | mA |
$I_H$ | holding current $V_D = 12\ V; T_j = 25\ ^\circ\ C;\ Fig.\ 9$ | - | - | 15 | mA |
$V_T$ | on-state voltage $I_T = 12\ A; T_j = 25\ ^\circ\ C;\ Fig.\ 10$ | - | 1.25 | 1.5 | V |

### Dynamic characteristics

| Parameter | Conditions | Min | Typ | Max | Unit |
--- | --- | --- | --- | --- | --- |
$dV_D/dt$ | rate of rise of off-state voltage $V_D = 402\ V; T_j = 125\ ^\circ\ C; (V_{DM} = 67\%\ of\ V_{DRM});\ exponential\ waveform;\ gate\ open\ circuit$ | 50 | - | - | V/µs |
$dV_D/dt$ | rate of rise of commutating current $V_D = 400\ V; T_j = 125\ ^\circ\ C; I_{TRMS} = 10\ A; dV_{com}/dt = 20\ V/µs; (snubberless\ condition);\ gate\ open\ circuit$ | 2 | - | - | A/µs |
$dV_D/dt$ | rate of rise of commutating current $V_D = 400\ V; T_j = 125\ ^\circ\ C; I_{TRMS} = 10\ A; dV_{com}/dt = 10\ V/µs;\ gate\ open\ circuit$ | 3 | - | - | A/µs |
$dV_D/dt$ | rate of rise of commutating current $V_D = 400\ V; T_j = 125\ ^\circ\ C; I_{TRMS} = 10\ A; dV_{com}/dt = 1\ V/µs;\ gate\ open\ circuit$ | 6 | - | - | A/µs |

### 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 |
--- | --- | --- | --- |
BTA310X-600E | 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).*

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{DRM}</td>
<td>repetitive peak off-state voltage</td>
<td>-</td>
<td>600 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I_{T(RMS)}</td>
<td>RMS on-state current</td>
<td>full sine wave; T_h ≤ 73 °C; [Fig. 1; Fig. 2; Fig. 3]</td>
<td>-</td>
<td>10 A</td>
<td></td>
</tr>
<tr>
<td>I_{TSM}</td>
<td>non-repetitive peak on-state current</td>
<td>full sine wave; T_{j(init)} = 25 °C; t_p = 20 ms; [Fig. 4; Fig. 5]</td>
<td>-</td>
<td>85 A</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>full sine wave; T_{j(init)} = 25 °C; t_p = 16.7 ms</td>
<td>-</td>
<td>93 A</td>
<td></td>
</tr>
<tr>
<td>I^2t</td>
<td>I^2t for fusing</td>
<td>t_p = 10 ms; SIN</td>
<td>-</td>
<td>36.1 A²s</td>
<td></td>
</tr>
<tr>
<td>dI/dt</td>
<td>rate of rise of on-state current</td>
<td>I_G = 0.2 A</td>
<td>-</td>
<td>100 A/µs</td>
<td></td>
</tr>
<tr>
<td>I_{GM}</td>
<td>peak gate current</td>
<td>-</td>
<td>2 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P_{GM}</td>
<td>peak gate power</td>
<td>-</td>
<td>5 W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P_{G(AV)}</td>
<td>average gate power</td>
<td>over any 20 ms period</td>
<td>-</td>
<td>0.5 W</td>
<td></td>
</tr>
<tr>
<td>T_{stg}</td>
<td>storage temperature</td>
<td>-40</td>
<td>150 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T_j</td>
<td>junction temperature</td>
<td>-</td>
<td>125 °C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

\[ P_{\text{tot}} \text{ (W)} \]

<table>
<thead>
<tr>
<th>Conduction angle (degrees)</th>
<th>Form factor a</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>2.816</td>
</tr>
<tr>
<td>60</td>
<td>1.967</td>
</tr>
<tr>
<td>90</td>
<td>1.570</td>
</tr>
<tr>
<td>120</td>
<td>1.329</td>
</tr>
<tr>
<td>180</td>
<td>1.110</td>
</tr>
</tbody>
</table>

\[ \alpha = 180^\circ \]

\[ \alpha = 120^\circ \]

\[ \alpha = 90^\circ \]

\[ \alpha = 60^\circ \]

\[ \alpha = 30^\circ \]

\[ \alpha = \text{conduction angle} \]

\[ a = \text{form factor} = \frac{I_{\text{TRMS}}}{I_{\text{AV}}} \]

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

\[ f = 50 \text{ Hz} \]

\[ I_{\text{TS}} \text{ (A)} \]

<table>
<thead>
<tr>
<th>( I_{\text{TS}} ) (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>120</td>
</tr>
<tr>
<td>100</td>
</tr>
<tr>
<td>80</td>
</tr>
<tr>
<td>60</td>
</tr>
<tr>
<td>40</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

\[ f = 50 \text{ Hz} \]

\[ I_{\text{TS}} \text{ (A)} \]

\[ n \text{ (number of cycles)} \]

\[ n = 1 \times 10^3 \]

\[ I_{\text{TRMS}} \]

\[ t_f \]

\[ t \]

\[ n = 25 \text{ °C max} \]
Fig. 5. Non-repetitive peak on-state current as a function of pulse width; maximum values
8. Thermal characteristics

Table 5. Thermal characteristics

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

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

9. Isolation characteristics

Table 6. Isolation characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{\text{isol} \text{(RMS)}}$</td>
<td>RMS isolation voltage</td>
<td>from all terminals to external heatsink; sinusoidal waveform; clean and dust free; 50 Hz ≤ f ≤ 60 Hz; RH ≤ 65 %; $T_h = 25 °C$</td>
<td>-</td>
<td>-</td>
<td>2500</td>
<td>V</td>
</tr>
<tr>
<td>$C_{\text{isol}}$</td>
<td>isolation capacitance</td>
<td>from main terminal 2 to external heatsink; $f = 1$ MHz; $T_h = 25 °C$</td>
<td>-</td>
<td>10</td>
<td>-</td>
<td>pF</td>
</tr>
</tbody>
</table>
## 10. Characteristics

### Table 7. Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>static characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{GT}$</td>
<td>gate trigger current</td>
<td>$V_D = 12 , V; , I_T = 0.1 , A; , T2+ , G+; , T_j = 25 , ^\circ C; , \text{Fig. 7}$</td>
<td>0.5</td>
<td>-</td>
<td>10</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_D = 12 , V; , I_T = 0.1 , A; , T2+ , G-; , T_j = 25 , ^\circ C; , \text{Fig. 7}$</td>
<td>0.5</td>
<td>-</td>
<td>10</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_D = 12 , V; , I_T = 0.1 , A; , T2- , G-; , T_j = 25 , ^\circ C; , \text{Fig. 7}$</td>
<td>0.5</td>
<td>-</td>
<td>10</td>
<td>mA</td>
</tr>
<tr>
<td>$I_L$</td>
<td>latching current</td>
<td>$V_D = 12 , V; , I_C = 0.1 , A; , T2+ , G+; , T_j = 25 , ^\circ C; , \text{Fig. 8}$</td>
<td>-</td>
<td>-</td>
<td>25</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_D = 12 , V; , I_C = 0.1 , A; , T2+ , G-; , T_j = 25 , ^\circ C; , \text{Fig. 8}$</td>
<td>-</td>
<td>-</td>
<td>30</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_D = 12 , V; , I_C = 0.1 , A; , T2- , G-; , T_j = 25 , ^\circ C; , \text{Fig. 8}$</td>
<td>-</td>
<td>-</td>
<td>25</td>
<td>mA</td>
</tr>
<tr>
<td>$I_H$</td>
<td>holding current</td>
<td>$V_D = 12 , V; , T_j = 25 , ^\circ C; , \text{Fig. 9}$</td>
<td>-</td>
<td>-</td>
<td>15</td>
<td>mA</td>
</tr>
<tr>
<td>$V_T$</td>
<td>on-state voltage</td>
<td>$I_T = 12 , A; , T_j = 25 , ^\circ C; , \text{Fig. 10}$</td>
<td>-</td>
<td>1.25</td>
<td>1.5</td>
<td>V</td>
</tr>
<tr>
<td>$V_{GT}$</td>
<td>gate trigger voltage</td>
<td>$V_D = 12 , V; , I_T = 0.1 , A; , T_j = 25 , ^\circ C; , \text{Fig. 11}$</td>
<td>0.7</td>
<td>1</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_D = 400 , V; , I_T = 0.1 , A; , T_j = 125 , ^\circ C; , \text{Fig. 11}$</td>
<td>0.25</td>
<td>0.4</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>$I_D$</td>
<td>off-state current</td>
<td>$V_D = 600 , V; , T_j = 125 , ^\circ C$</td>
<td>-</td>
<td>0.1</td>
<td>0.5</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td>dynamic characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$dV_D/dt$</td>
<td>rate of rise of off-state voltage</td>
<td>$V_{DM} = 402 , V; , T_j = 125 , ^\circ C; , (V_{DM} = 67% , of , V_{DRM}); , \text{exponential waveform; , gate open circuit}$</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>V/\mu s</td>
</tr>
<tr>
<td>$dI_{com}/dt$</td>
<td>rate of change of commutating current</td>
<td>$V_D = 400 , V; , T_j = 125 , ^\circ C; , I_{(RMS)} = 10 , A; , dV_{com}/dt = 20 , V/\mu s; , \text{(snubberless condition; , gate open circuit)}$</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>A/\mu s</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_D = 400 , V; , T_j = 125 , ^\circ C; , I_{(RMS)} = 10 , A; , dV_{com}/dt = 10 , V/\mu s; , \text{gate open circuit}$</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>A/\mu s</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_D = 400 , V; , T_j = 125 , ^\circ C; , I_{(RMS)} = 10 , A; , dV_{com}/dt = 1 , V/\mu s; , \text{gate open circuit}$</td>
<td>6</td>
<td>-</td>
<td>-</td>
<td>A/\mu s</td>
</tr>
</tbody>
</table>
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

For the graphs:
- (1) $T_j = 125^\circ C$; typical values
- (2) $T_j = 125^\circ C$; maximum values
- (3) $T_j = 25^\circ C$; maximum values

For the values:
- $V_o = 1.103 \, V$; $R_s = 0.030 \, \Omega$
Fig. 11. Normalized gate trigger voltage as a function of junction temperature
11. Package outline

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

Data sheet status

<table>
<thead>
<tr>
<th>Document status</th>
<th>Product status</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preliminary [short] data sheet</td>
<td>Qualification</td>
<td>This document contains data from the preliminary specification.</td>
</tr>
<tr>
<td>Objective [short] data sheet</td>
<td>Development</td>
<td>This document contains data from the objective specification for product development.</td>
</tr>
<tr>
<td>Product [short] data sheet</td>
<td>Production</td>
<td>This document contains the product specification.</td>
</tr>
</tbody>
</table>

[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".
[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.ween-semi.com.

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13. Contents

1. General description......................................................1
2. Features and benefits.................................................. 1
3. Applications.................................................................. 1
4. Quick reference data....................................................1
5. Pinning information......................................................2
6. Ordering information....................................................2
7. Limiting values............................................................. 3
8. Thermal characteristics............................................... 6
9. Isolation characteristics...............................................6
10. Characteristics............................................................. 7
11. Package outline........................................................ 10
12. Legal information.......................................................11

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