TMA166G-L

**Features and Benefits**
- Exceptional reliability
- Small SIP package with heatsink mounting for high thermal dissipation and long life
- $V_{DRM}$ of 600 V
- 16 $A_{RMS}$ on-state current
- Uniform switching

**Description**
This Sanken triac (bidirectional triode thyristor) is designed for AC power control, providing reliable, uniform switching for full-cycle AC applications.

In comparison with other products on the market, the TMA166G-L provides greater peak nonrepetitive off-state voltage, $V_{DSM}$ (700 V). In addition, commutation $dv/dt$ and $(dv/dt)c$ are improved.

**Applications**
- Residential and commercial appliances: vacuum cleaners, rice cookers, TVs, home entertainment
- White goods: washing machines
- Office automation power control, photocopiers
- Motor control for small tools
- Temperature control, light dimmers, electric blankets
- General use switching mode power supplies (SMPS)

**Package: 3-pin SIP (TO-220)**

Not to scale

**Typical Applications**

- **Heater control**
  (for example, LBP, PPC, MFP)

- **Two-phase motor control**
  (for example, washing machine)

- **In-rush current control**
  (for example, SMPS)**
**Triac (Bidirectional Triode Thyristor)**

### Selection Guide

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
<th>Packing</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMA166G-L</td>
<td>3-pin fully molded SIP with heatsink mount</td>
<td>50 pieces per tube</td>
</tr>
</tbody>
</table>

### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Notes</th>
<th>Rating</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Repetitive Off-State Voltage</td>
<td>V DRM</td>
<td>R GREF = ∞</td>
<td>600</td>
<td>V</td>
</tr>
<tr>
<td>Peak Non-Repetitive Off-State Voltage</td>
<td>V DSM</td>
<td>R GREF = ∞</td>
<td>700</td>
<td>V</td>
</tr>
<tr>
<td>RMS On-State Current</td>
<td>I T(RMS)</td>
<td>50/60 Hz full cycle sine wave, total Conduction angle (α+) + (α-) = 360°, T C = 100°C</td>
<td>16</td>
<td>A</td>
</tr>
<tr>
<td>Surge On-State Current</td>
<td>I TSM</td>
<td>f = 60 Hz Full cycle sine wave, peak value, non-repetitive, initial T J = 25°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>f = 50 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>168</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>160</td>
<td>A</td>
</tr>
<tr>
<td>Pt Value for Fusing</td>
<td>P T</td>
<td>Value for 50 Hz half cycle sine wave, 1 cycle, I TSM = 160 A</td>
<td>128</td>
<td>A²·s</td>
</tr>
<tr>
<td>Critical Rising Rate of On-State Current</td>
<td>di/dt</td>
<td>I T = I T(RMS) × √2, V D = V DRM × 0.5, f ≤ 60 Hz, t pf ≥ 10 μs, t gf ≤ 250 ns, I gp ≥ 60 mA (refer to Gate Trigger Current diagram)</td>
<td>25</td>
<td>A/µs</td>
</tr>
<tr>
<td>Peak Gate Current</td>
<td>I GM</td>
<td>f ≥ 50 Hz, duty cycle ≤ 10%</td>
<td>2</td>
<td>A</td>
</tr>
<tr>
<td>Peak Gate Power Dissipation</td>
<td>P GM</td>
<td>f ≥ 50 Hz, duty cycle ≤ 10%</td>
<td>5</td>
<td>W</td>
</tr>
<tr>
<td>Average Gate Power Dissipation</td>
<td>P GM(AV)</td>
<td></td>
<td>0.5</td>
<td>W</td>
</tr>
<tr>
<td>Junction Temperature</td>
<td>T J</td>
<td></td>
<td>–40 to 125</td>
<td>ºC</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>T stg</td>
<td></td>
<td>–40 to 125</td>
<td>ºC</td>
</tr>
</tbody>
</table>

### Thermal Characteristics

May require derating at maximum conditions

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Test Conditions</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Package Thermal Resistance (Junction to Case)</td>
<td>R JC</td>
<td>For AC</td>
<td>1.4</td>
<td>ºC/W</td>
</tr>
</tbody>
</table>

### Pin-out Diagram

**Terminal List Table**

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>T1</td>
<td>Main terminal, gate referenced</td>
</tr>
<tr>
<td>2</td>
<td>T2</td>
<td>Main terminal connect to signal side</td>
</tr>
<tr>
<td>3</td>
<td>G</td>
<td>Gate control</td>
</tr>
</tbody>
</table>

All performance characteristics given are typical values for circuit or system baseline design only and are at the nominal operating voltage and an ambient temperature, T A, of 25°C, unless otherwise stated.
**ELECTRICAL CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Symbol</th>
<th>Test Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off-State Leakage Current</td>
<td>$I_{DRM}$</td>
<td>$V_D = V_{ORM}, \ T_J = 125°C, \ R_{GREF} = \infty$ using test circuit 1</td>
<td>–</td>
<td>–</td>
<td>2.0</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_D = V_{ORM}, \ T_J = 25°C, \ R_{GREF} = \infty$ using test circuit 1</td>
<td>–</td>
<td>–</td>
<td>100</td>
<td>μA</td>
</tr>
<tr>
<td>On-State Voltage</td>
<td>$V_{TM}$</td>
<td>$I_T = 20 \ A, \ T_J = 25°C$</td>
<td>–</td>
<td>–</td>
<td>1.45</td>
<td>V</td>
</tr>
<tr>
<td>Gate Trigger Voltage</td>
<td>$V_{GT}$</td>
<td>Quadrant I: $T_2^+, \ G^+$</td>
<td>–</td>
<td>–</td>
<td>1.5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Quadrant II: $T_2^+, \ G^-$</td>
<td>–</td>
<td>–</td>
<td>1.5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Quadrant III: $T_2^-, \ G^-$</td>
<td>–</td>
<td>–</td>
<td>1.5</td>
<td>V</td>
</tr>
<tr>
<td>Gate Trigger Current</td>
<td>$I_{GT}$</td>
<td>Quadrant I: $T_2^+, \ G^+$</td>
<td>–</td>
<td>–</td>
<td>30</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Quadrant II: $T_2^+, \ G^-$</td>
<td>–</td>
<td>–</td>
<td>30</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Quadrant III: $T_2^-, \ G^-$</td>
<td>–</td>
<td>–</td>
<td>30</td>
<td>mA</td>
</tr>
<tr>
<td>Gate Non-trigger Voltage</td>
<td>$V_{GD}$</td>
<td>$V_D = V_{ORM} \times 0.5, \ R_L = 4 \ k\Omega, \ T_J = 125°C$</td>
<td>0.2</td>
<td>–</td>
<td>–</td>
<td>V</td>
</tr>
<tr>
<td>Critical Rising Rate of</td>
<td></td>
<td>$V_D = 400 \ V, \ (di/dt)<em>{c} = -8 \ A/\mu s, \ I</em>{TP} = 2 \ A, \ T_J = 125°C$</td>
<td>10</td>
<td>–</td>
<td>–</td>
<td>V/μs</td>
</tr>
<tr>
<td>Off-State Voltage during</td>
<td></td>
<td>$V_D = V_{ORM} \times 0.66, \ R_{GREF} = \infty$ using test circuit 1, $T_J = 125°C$</td>
<td>200</td>
<td>–</td>
<td>–</td>
<td>V/μs</td>
</tr>
</tbody>
</table>

*Where $I_{TP}$ is the peak current through $T_2$ to $T_1$."

**Test Circuit 1**

<table>
<thead>
<tr>
<th>Quadrant II</th>
<th>$+T_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_1^-\ [\ - ]$</td>
<td>$G\ [\ + ]$</td>
</tr>
<tr>
<td>$T_2\ [\ + ]$</td>
<td>$G\ [\ - ]$</td>
</tr>
</tbody>
</table>

**Gate Trigger Characteristics**

<table>
<thead>
<tr>
<th>Quadrant I</th>
<th>$+I_{GT}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_1\ [\ + ]$</td>
<td>$G\ [\ + ]$</td>
</tr>
<tr>
<td>$T_2\ [\ - ]$</td>
<td>$G\ [\ - ]$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quadrant III</th>
<th>$-T_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_1\ [\ + ]$</td>
<td>$G\ [\ - ]$</td>
</tr>
<tr>
<td>$T_2\ [\ - ]$</td>
<td>$G\ [\ + ]$</td>
</tr>
</tbody>
</table>

Polarities referenced to $T_1$
Triac (Bidirectional Triode Thyristor)

Commutation Timing Diagrams

Supply VAC

\( \theta \)

\( \alpha = \) Conduction angle

\( V_{GT} \)

\( V_{GATE} \)

\( I_{TSM} \)

On-State Current

\( \theta \)
Performance Characteristics at $T_A = 25^\circ C$

- **Maximum On-State Current versus Maximum On-State Voltage**
- **On-State Average Power Dissipation versus Maximum On-State RMS Current**
- **Gate Voltage versus Gate Current**
- **Proportional Change of Typical Trigger Current versus Junction Temperature**
- **Proportional Change of Typical Holding Current versus Junction Temperature**
Transient Thermal Impedence versus Triac Voltage Pulse Duration
For AC
Triac (Bidirectional Triode Thyristor)

**TMA166G-L**

Leadframe plating Pb-free. Device meets RoHS requirements.

Terminal core material: Cu
Terminal treatment: Sn plating
Package: TO-220

Dimensions in millimeters:
- **Ø3.6 ±0.2**
- **9.9 ±0.3 (8.7)**
- **2.8 ±0.2**
- **15.9 ±0.3**
- **18.96 MAX**
- **2.4 ±0.2**
- **5.5 ±0.2**
- **1.3 ±0.2**
- **0.8 ±0.15**
- **0.6 MAX**
- **1.4 ±0.15**
- **1.27 ±0.15**
- **2.54 ±0.2**
- **10 ±0.2**
- **0.6 MAX**

**Branding codes (exact appearance at manufacturer discretion):**

1st line left, lot: **YM**
Where: Y is the last digit of the year of manufacture
M is the month (1 to 9, O, N, D)

1st line right, lot: **DDR**
Where: DD is the date
R is a tracking letter

2nd line, type: **MA166G**

**Exposed heatsink pad**

**Exposed terminal dimension at case surface**

Allegro MicroSystems, Inc.
115 Northeast CutOff
Worcester, Massachusetts 01615-0036 U.S.A.
1.508.853.5000; www.allegromicro.com
Packing Specification

Tube Packing

Dimensions in millimeters

50 pieces per tube
20 tubes per layer
1 layer per inner carton
1000 pieces per inner carton
4 inner cartons per outer carton
4000 pieces per outer carton

Allegro MicroSystems, Inc.
115 Northeast Cutoff
Worcester, Massachusetts 01615-0036 U.S.A.
1.508.853.5000; www.allegromicro.com
WARNING — These devices are designed to be operated at lethal voltages and energy levels. Circuit designs that embody these components must conform with applicable safety requirements. Precautions must be taken to prevent accidental contact with power-line potentials. Do not connect grounded test equipment. The use of an isolation transformer is recommended during circuit development and breadboarding.

Because reliability can be affected adversely by improper storage environments and handling methods, please observe the following cautions.

Cautions for Storage
- Ensure that storage conditions comply with the standard temperature (5°C to 35°C) and the standard relative humidity (approximately 40% to 75%); avoid storage locations that experience extreme changes in temperature or humidity.
- Avoid locations where dust or harmful gases are present and avoid direct sunlight.
- Reinspect for rust on leads and solderability of products that have been stored for a long time.

Cautions for Testing and Handling
When tests are carried out during inspection testing and other standard test periods, protect the products from power surges from the testing device, shorts between adjacent products, and shorts to the heatsink.

Remarks About Using Silicone Grease with a Heatsink
- When silicone grease is used in mounting this product on a heatsink, it shall be applied evenly and thinly. If more silicone grease than required is applied, it may produce stress.
- Coat the back surface of the product and both surfaces of the insulating plate to improve heat transfer between the product and the heatsink.
- Volatile-type silicone greases may permeate the product and produce cracks after long periods of time, resulting in reduced heat radiation effect, and possibly shortening the lifetime of the product.
- Our recommended silicone greases for heat radiation purposes, which will not cause any adverse effect on the product life, are indicated below:

<table>
<thead>
<tr>
<th>Type</th>
<th>Suppliers</th>
</tr>
</thead>
<tbody>
<tr>
<td>G746</td>
<td>Shin-Etsu Chemical Co., Ltd.</td>
</tr>
<tr>
<td>YG6260</td>
<td>Momentive Performance Materials</td>
</tr>
<tr>
<td>SC102</td>
<td>Dow Corning Toray Silicone Co., Ltd.</td>
</tr>
</tbody>
</table>

Heatsink Mounting Method
- Torque When Tightening Mounting Screws. Thermal resistance increases when tightening torque is low, and radiation effects are decreased. When the torque is too high, the screw can strip, the heatsink can be deformed, and distortion can arise in the product frame. To avoid these problems, observe the recommended tightening torques for this product package type 0.490 to 0.686 N•m (5 to 7 kgf•cm).
- For effective heat transfer, the contact area between the product and the heatsink should be free from burrs and metal fragments, and the heatsink should be flat and large enough to contact over the entire side of the product, including mounting flange and exposed thermal pad.
- The mounting hole in customer-supplied heatsink must be less than Ø4 mm; this includes the diameter of any dimple around punched holes. This is to prevent possible deflection and cracking of the product case when fastened to the heatsink.

Soldering
- When soldering the products, please be sure to minimize the working time, within the following limits:
  - 260°C 10 s
  - 350°C 3 s
- Soldering iron should be at a distance of at least 1.5 mm from the body of the products.
The products described herein are manufactured in Japan by Sanken Electric Co., Ltd. for sale by Allegro MicroSystems, Inc.

Sanken and Allegro reserve the right to make, from time to time, such departures from the detail specifications as may be required to permit improvements in the performance, reliability, or manufacturability of its products. Therefore, the user is cautioned to verify that the information in this publication is current before placing any order.

When using the products described herein, the applicability and suitability of such products for the intended purpose shall be reviewed at the user’s responsibility.

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TMA166G-L

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