## Thyristor

| | | |
|---|---|---|
| $V_{RRM}$ | = | 1600 V |
| $I_{TAV}$ | = | 30 A |
| $V_T$ | = | 1,4 V |

Three Quadrants operation: QI - QIII
1~ Triac

**Part number**

**CMA60MT1600NHB**

Backside:Terminal 2

### Three Quadrants Operation

*Positive Half Cycle*

T2

(-) $I_{GT}$      (+) $I_{GT}$

T1          T1

REF          REF

QII | QI

$I_{GT}$ —    QIII | QIV    → + $I_{GT}$

T2

(-) $I_{GT}$

T1

REF

*Negative Half Cycle*

<u>Note</u>: All Polarities are referenced to T1
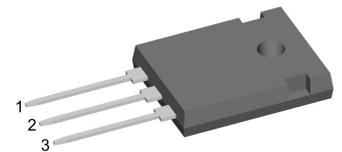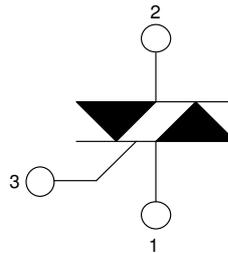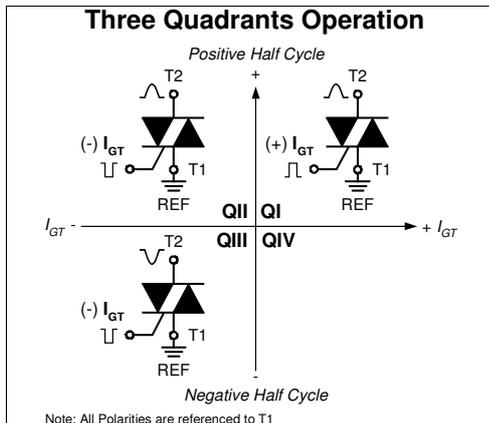
**Features / Advantages:**
- Triac for line frequency
- Three Quadrants Operation
  - QI - QIII
- Planar passivated chip
- Long-term stability
  of blocking currents and voltages

**Applications:**
- Line rectifying 50/60 Hz
- Softstart AC motor control
- DC Motor control
- Power converter
- AC power control
- Lighting and temperature control

**Package:** TO-247
- Industry standard outline
- RoHS compliant
- Epoxy meets UL 94V-0

**Terms ‗Conditions of usage:**

The data contained in this product data sheet is exclusively intended for technically trained staff. The user will have to evaluate the suitability of the product for the intended application and the completeness of the product data with respect to his application. The specifications of our components may not be considered as an assurance of component characteristics. The information in the valid application- and assembly notes must be considered. Should you require product information in excess of the data given in this product data sheet or which concerns the specific application of your product, please contact the sales office, which is responsible for you.
Due to technical requirements our product may contain dangerous substances. For information on the types in question please contact the sales office, which is responsible for you.
Should you intend to use the product in aviation, in health or live endangering or life support applications, please notify. For any such application we urgently recommend
- to perform joint risk and quality assessments;
- the conclusion of quality agreements;
- to establish joint measures of an ongoing product survey, and that we may make delivery dependent on the realization of any such measures.

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| Rectifier | | | | | | Ratings |
|---|---|---|---|---|---|---|

| Symbol | Definition | Conditions | | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|---|
| $V_{RSM/DSM}$ | max. non-repetitive reverse/forward blocking voltage | $T_{VJ} = 25°C$ | | | | 1700 | V |
| $V_{RRM/DRM}$ | max. repetitive reverse/forward blocking voltage | $T_{VJ} = 25°C$ | | | | 1600 | V |
| $I_{R/D}$ | reverse current, drain current | $V_{R/D} = 1600$ V | $T_{VJ} = 25°C$ | | | 10 | µA |
| | | $V_{R/D} = 1600$ V | $T_{VJ} = 125°C$ | | | 2 | mA |
| $V_T$ | forward voltage drop | $I_T = 30$ A | $T_{VJ} = 25°C$ | | | 1,40 | V |
| | | $I_T = 60$ A | | | | 1,77 | V |
| | | $I_T = 30$ A | $T_{VJ} = 125°C$ | | | 1,40 | V |
| | | $I_T = 60$ A | | | | 1,88 | V |
| $I_{TAV}$ | average forward current | $T_C = 115°C$ | $T_{VJ} = 150°C$ | | | 30 | A |
| $I_{RMS}$ | RMS forward current per phase | 180° sine | | | | 66 | A |
| $V_{T0}$ | threshold voltage | } for power loss calculation only | $T_{VJ} = 150°C$ | | | 0,90 | V |
| $r_T$ | slope resistance | | | | | 16,6 | mΩ |
| $R_{thJC}$ | thermal resistance junction to case | | | | | 0,55 | K/W |
| $R_{thCH}$ | thermal resistance case to heatsink | | | | 0,25 | | K/W |
| $P_{tot}$ | total power dissipation | $T_C = 25°C$ | | | | 230 | W |
| $I_{TSM}$ | max. forward surge current | t = 10 ms; (50 Hz), sine | $T_{VJ} = 45°C$ | | | 260 | A |
| | | t = 8,3 ms; (60 Hz), sine | $V_R = 0$ V | | | 280 | A |
| | | t = 10 ms; (50 Hz), sine | $T_{VJ} = 150°C$ | | | 220 | A |
| | | t = 8,3 ms; (60 Hz), sine | $V_R = 0$ V | | | 240 | A |
| $I^2t$ | value for fusing | t = 10 ms; (50 Hz), sine | $T_{VJ} = 45°C$ | | | 340 | A²s |
| | | t = 8,3 ms; (60 Hz), sine | $V_R = 0$ V | | | 325 | A²s |
| | | t = 10 ms; (50 Hz), sine | $T_{VJ} = 150°C$ | | | 240 | A²s |
| | | t = 8,3 ms; (60 Hz), sine | $V_R = 0$ V | | | 240 | A²s |
| $C_J$ | junction capacitance | $V_R = 400$ V   f = 1 MHz | $T_{VJ} = 25°C$ | | 9 | | pF |
| $P_{GM}$ | max. gate power dissipation | $t_P = 30$ µs | $T_C = 150°C$ | | | 10 | W |
| | | $t_P = 300$ µs | | | | 5 | W |
| $P_{GAV}$ | average gate power dissipation | | | | | 0,5 | W |
| $(di/dt)_{cr}$ | critical rate of rise of current | $T_{VJ} = 125°C$; f = 50 Hz    repetitive, $I_T = 90$ A | | | | 150 | A/µs |
| | | $t_P = 200$ µs; $di_G/dt = 0,2$ A/µs; | | | | | |
| | | $I_G = 0,2$A; V = ⅔ $V_{DRM}$    non-repet., $I_T = 30$ A | | | | 500 | A/µs |
| $(dv/dt)_{cr}$ | critical rate of rise of voltage | V = ⅔ $V_{DRM}$ | $T_{VJ} = 125°C$ | | | 500 | V/µs |
| | | $R_{GK} = ∞$; method 1 (linear voltage rise) | | | | | |
| $V_{GT}$ | gate trigger voltage | $V_D = 6$ V | $T_{VJ} = 25°C$ | | | 1,3 | V |
| | | | $T_{VJ} = -40°C$ | | | 1,6 | V |
| $I_{GT}$ | gate trigger current | $V_D = 6$ V | $T_{VJ} = 25°C$ | | | ± 60 | mA |
| | | | $T_{VJ} = -40°C$ | | | ± 80 | mA |
| $V_{GD}$ | gate non-trigger voltage | $V_D = ⅔ V_{DRM}$ | $T_{VJ} = 125°C$ | | | 0,2 | V |
| $I_{GD}$ | gate non-trigger current | | | | | ± 1 | mA |
| $I_L$ | latching current | $t_p = 10$ µs | $T_{VJ} = 25°C$ | | | 90 | mA |
| | | $I_G = 0,2$A; $di_G/dt = 0,2$ A/µs | | | | | |
| $I_H$ | holding current | $V_D = 6$ V   $R_{GK} = ∞$ | $T_{VJ} = 25°C$ | | | 60 | mA |
| $t_{gd}$ | gate controlled delay time | $V_D = ½ V_{DRM}$ | $T_{VJ} = 25°C$ | | | 2 | µs |
| | | $I_G = 0,5$A; $di_G/dt = 0,5$ A/µs | | | | | |
| $t_q$ | turn-off time | $V_R = 100$ V; $I_T = 30$ A; V = ⅔ $V_{DRM}$   $T_{VJ} = 125$ °C | | | 150 | | µs |
| | | di/dt = 10 A/µs   dv/dt = 20 V/µs   $t_p = 200$ µs | | | | | |

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| Package | TO-247 | | | Ratings | | | |
|---|---|---|---|---|---|---|---|
| Symbol | Definition | Conditions | min. | typ. | max. | Unit |
| $I_{RMS}$ | RMS current | per terminal | | | 70 | A |
| $T_{VJ}$ | virtual junction temperature | | -40 | | 150 | °C |
| $T_{op}$ | operation temperature | | -40 | | 125 | °C |
| $T_{stg}$ | storage temperature | | -40 | | 150 | °C |
| **Weight** | | | | 6 | | g |
| $M_D$ | mounting torque | | 0,8 | | 1,2 | Nm |
| $F_C$ | mounting force with clip | | 20 | | 120 | N |

## Product Marking



Logo → IXYS
Part No. → XXXXXXXXX
Assembly Line → Zyyww
Assembly Code → abcd
Date Code
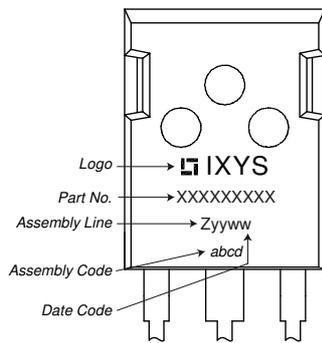
## Part description

C = Thyristor (SCR)
M = Thyristor
A = (up to 1800V)
60 = Current Rating [A]
MT = 1~ Triac
1600 = Reverse Voltage [V]
N = Three Quadrants operation: QI - QIII
HB = TO-247AD (3)

| Ordering | Ordering Number | Marking on Product | Delivery Mode | Quantity | Code No. |
|---|---|---|---|---|---|
| Standard | CMA60MT1600NHB | CMA60MT1600NHB | Tube | 30 | 516795 |

| Similar Part | Package | Voltage class |
|---|---|---|
| CMA60MT1600NHR | ISO247 (3) | 1600 |

## Equivalent Circuits for Simulation

*on die level*   $T_{VJ} = 150\,°C$
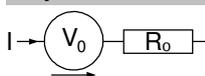


**Thyristor**

| | | | |
|---|---|---|---|
| $V_{0\,max}$ | threshold voltage | 0,9 | V |
| $R_{0\,max}$ | slope resistance * | 14,1 | mΩ |

**Outlines   TO-247**
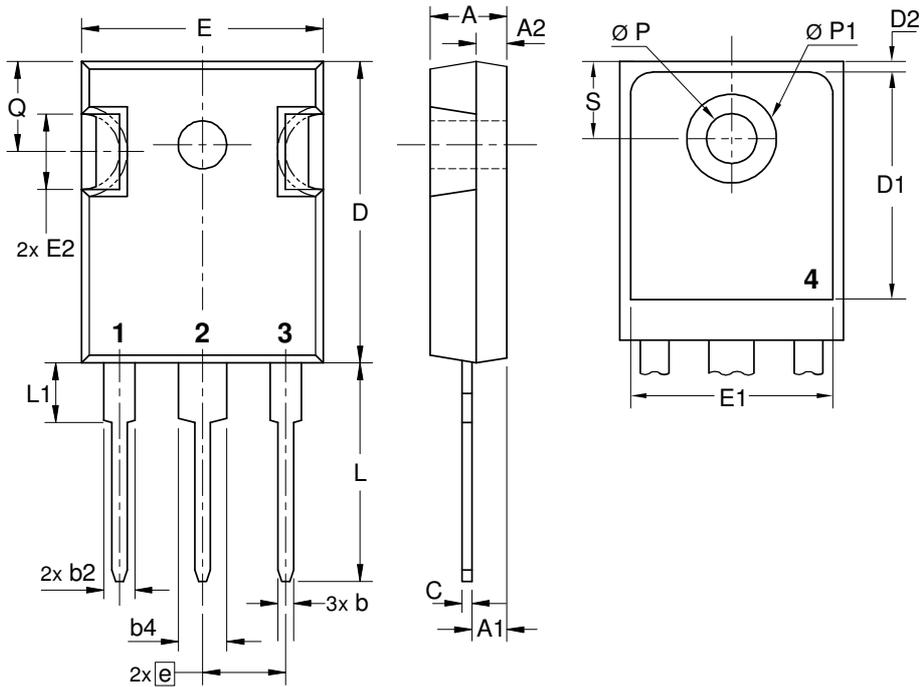
| Sym. | Inches | | Millimeter | |
|------|------|------|------|------|
| | min. | max. | min. | max. |
| A | 0.185 | 0.209 | 4.70 | 5.30 |
| A1 | 0.087 | 0.102 | 2.21 | 2.59 |
| A2 | 0.059 | 0.098 | 1.50 | 2.49 |
| D | 0.819 | 0.845 | 20.79 | 21.45 |
| E | 0.610 | 0.640 | 15.48 | 16.24 |
| E2 | 0.170 | 0.216 | 4.31 | 5.48 |
| e | 0.215 BSC | | 5.46 BSC | |
| L | 0.780 | 0.800 | 19.80 | 20.30 |
| L1 | - | 0.177 | - | 4.49 |
| Ø P | 0.140 | 0.144 | 3.55 | 3.65 |
| Q | 0.212 | 0.244 | 5.38 | 6.19 |
| S | 0.242 BSC | | 6.14 BSC | |
| b | 0.039 | 0.055 | 0.99 | 1.40 |
| b2 | 0.065 | 0.094 | 1.65 | 2.39 |
| b4 | 0.102 | 0.135 | 2.59 | 3.43 |
| c | 0.015 | 0.035 | 0.38 | 0.89 |
| D1 | 0.515 | - | 13.07 | - |
| D2 | 0.020 | 0.053 | 0.51 | 1.35 |
| E1 | 0.530 | - | 13.45 | - |
| Ø P1 | - | 0.29 | - | 7.39 |

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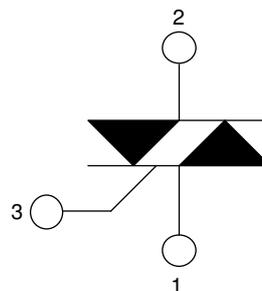
**Thyristor**
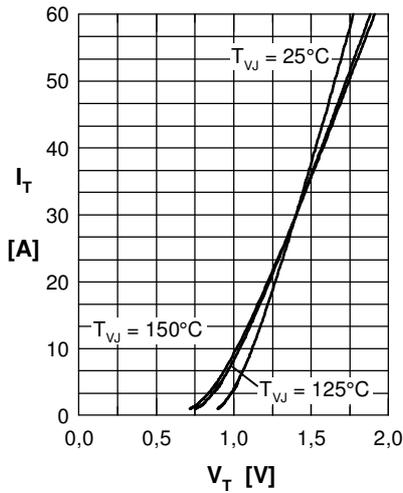


Fig. 1  Forward characteristics
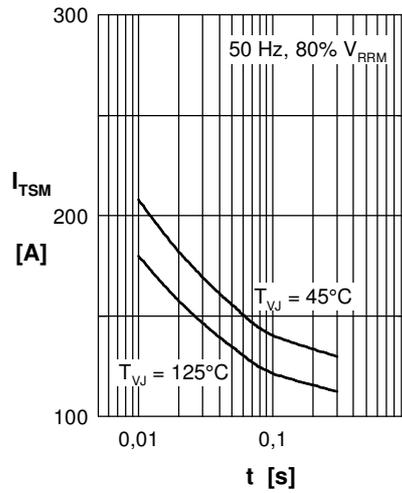


Fig. 2  Surge overload current
$I_{TSM}$: crest value, t: duration
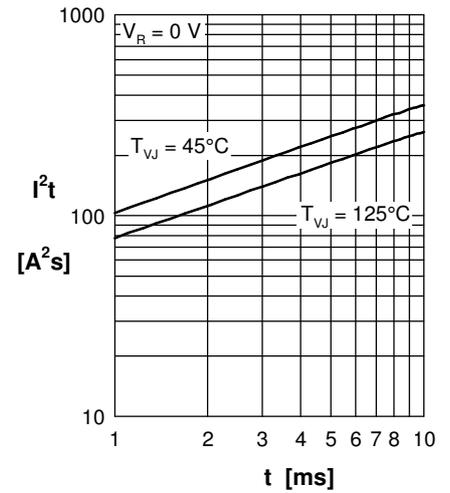


Fig. 3  $I^2$t versus time (1-10 s)
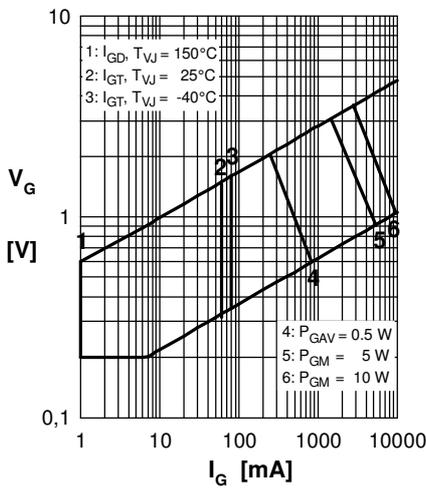


Fig. 4  Gate voltage & gate current
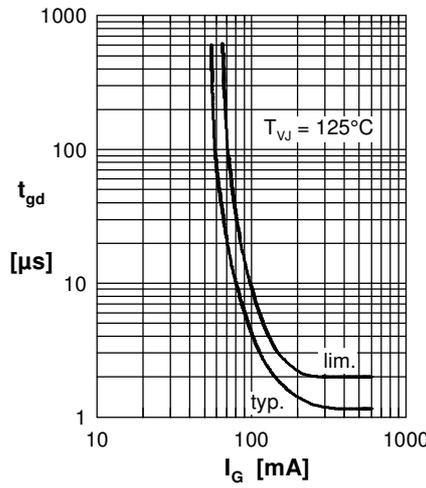


Fig. 5  Gate controlled delay time $t_{gd}$
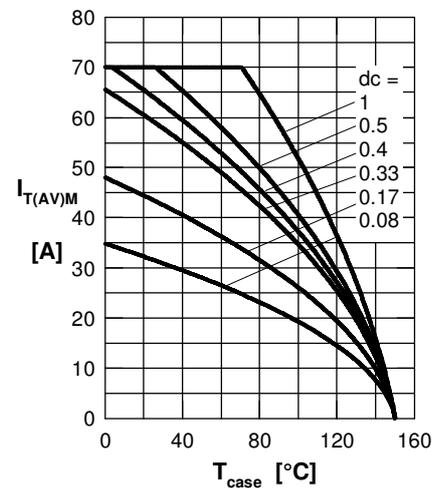


Fig. 6  Max. forward current at
case temperature
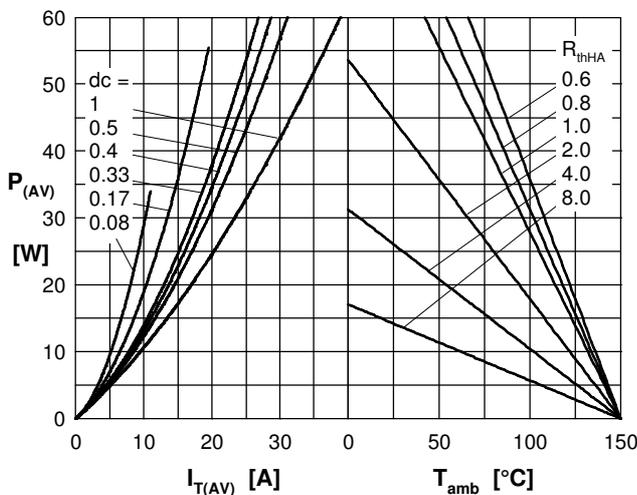


Fig. 7a  Power dissipation versus direct output current
Fig. 7b  and ambient temperature



| i | $R_{thi}$ (K/W) | $t_i$ (s) |
|---|---|---|
| 1 | 0.080 | 0.0100 |
| 2 | 0.060 | 0.0001 |
| 3 | 0.215 | 0.0200 |
| 4 | 0.060 | 0.2000 |
| 5 | 0.135 | 0.1100 |
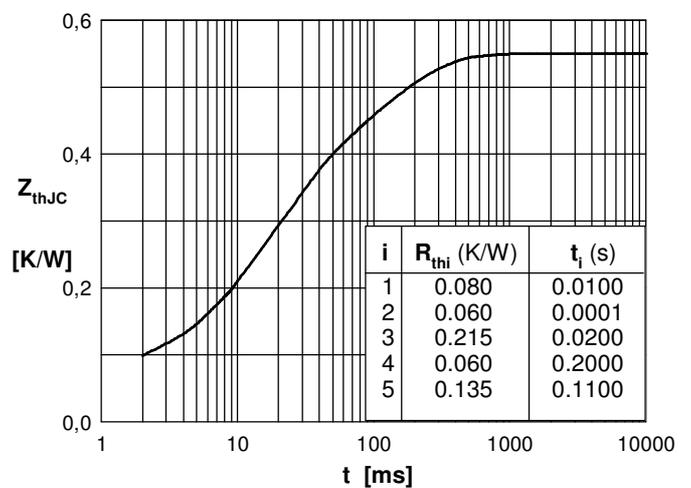
Fig. 7  Transient thermal impedance junction to case

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