

# Thyristor Module

$$V_{RRM} = 2 \times 2400 \text{ V}$$

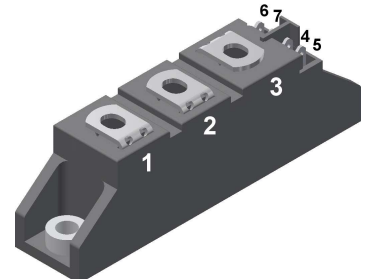
$$I_{TAV} = 104 \text{ A}$$

$$V_T = 1.46 \text{ V}$$

Phase leg

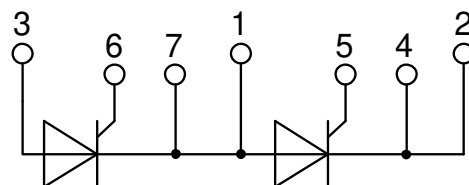
Part number

**MCC94-24io1B**



Backside: isolated

 E72873



## Features / Advantages:

- Thyristor for line frequency
- Planar passivated chip
- Long-term stability
- Direct Copper Bonded Al<sub>2</sub>O<sub>3</sub>-ceramic

## Applications:

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

## Package: TO-240AA

- Isolation Voltage: 4800 V~
- Industry standard outline
- RoHS compliant
- Soldering pins for PCB mounting
- Base plate: DCB ceramic
- Reduced weight
- Advanced power cycling

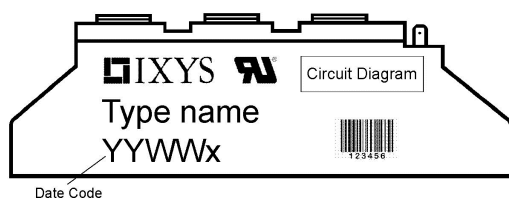
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| Thyristor      |                                                      |                                                                                                                                                                                                        |                                | Ratings |      |      |                   |
|----------------|------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|---------|------|------|-------------------|
| Symbol         | Definition                                           | Conditions                                                                                                                                                                                             |                                | min.    | typ. | max. | Unit              |
| $V_{RSM/DSM}$  | max. non-repetitive reverse/forward blocking voltage | $T_{VJ} = 25^{\circ}\text{C}$                                                                                                                                                                          |                                |         |      | 2500 | V                 |
| $V_{RRM/DRM}$  | max. repetitive reverse/forward blocking voltage     | $T_{VJ} = 25^{\circ}\text{C}$                                                                                                                                                                          |                                |         |      | 2400 | V                 |
| $I_{R/D}$      | reverse current, drain current                       | $V_{R/D} = 2400\text{ V}$                                                                                                                                                                              | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 200  | $\mu\text{A}$     |
|                |                                                      | $V_{R/D} = 2400\text{ V}$                                                                                                                                                                              | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 15   | mA                |
| $V_T$          | forward voltage drop                                 | $I_T = 150\text{ A}$                                                                                                                                                                                   | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 1.44 | V                 |
|                |                                                      | $I_T = 300\text{ A}$                                                                                                                                                                                   |                                |         |      | 1.74 | V                 |
|                |                                                      | $I_T = 150\text{ A}$                                                                                                                                                                                   | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 1.46 | V                 |
|                |                                                      | $I_T = 300\text{ A}$                                                                                                                                                                                   |                                |         |      | 1.99 | V                 |
| $I_{TAV}$      | average forward current                              | $T_C = 85^{\circ}\text{C}$                                                                                                                                                                             | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 104  | A                 |
| $I_{T(RMS)}$   | RMS forward current                                  | 180° sine                                                                                                                                                                                              |                                |         |      | 163  | A                 |
| $V_{T0}$       | threshold voltage                                    | } for power loss calculation only                                                                                                                                                                      | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 0.85 | V                 |
| $r_T$          | slope resistance                                     |                                                                                                                                                                                                        |                                |         |      | 3.2  | m $\Omega$        |
| $R_{thJC}$     | thermal resistance junction to case                  |                                                                                                                                                                                                        |                                |         |      | 0.22 | K/W               |
| $R_{thCH}$     | thermal resistance case to heatsink                  |                                                                                                                                                                                                        |                                |         | 0.2  |      | K/W               |
| $P_{tot}$      | total power dissipation                              |                                                                                                                                                                                                        | $T_C = 25^{\circ}\text{C}$     |         |      | 455  | W                 |
| $I_{TSM}$      | max. forward surge current                           | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                                                       | $T_{VJ} = 45^{\circ}\text{C}$  |         |      | 1.70 | kA                |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                                                      | $V_R = 0\text{ V}$             |         |      | 1.84 | kA                |
|                |                                                      | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                                                       | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 1.45 | kA                |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                                                      | $V_R = 0\text{ V}$             |         |      | 1.56 | kA                |
| $I^2t$         | value for fusing                                     | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                                                       | $T_{VJ} = 45^{\circ}\text{C}$  |         |      | 14.5 | kA <sup>2</sup> s |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                                                      | $V_R = 0\text{ V}$             |         |      | 14.0 | kA <sup>2</sup> s |
|                |                                                      | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                                                       | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 10.4 | kA <sup>2</sup> s |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                                                      | $V_R = 0\text{ V}$             |         |      | 10.1 | kA <sup>2</sup> s |
| $C_J$          | junction capacitance                                 | $V_R = 700\text{ V}$ $f = 1\text{ MHz}$                                                                                                                                                                | $T_{VJ} = 25^{\circ}\text{C}$  |         | 63   |      | pF                |
| $P_{GM}$       | max. gate power dissipation                          | $t_p = 30\text{ }\mu\text{s}$                                                                                                                                                                          | $T_C = 125^{\circ}\text{C}$    |         |      | 10   | W                 |
|                |                                                      | $t_p = 300\text{ }\mu\text{s}$                                                                                                                                                                         |                                |         |      | 5    | W                 |
| $P_{GAV}$      | average gate power dissipation                       |                                                                                                                                                                                                        |                                |         |      | 0.5  | W                 |
| $(di/dt)_{cr}$ | critical rate of rise of current                     | $T_{VJ} = 125^{\circ}\text{C}; f = 50\text{ Hz}$ repetitive, $I_T = 250\text{ A}$                                                                                                                      |                                |         |      | 150  | A/ $\mu\text{s}$  |
|                |                                                      | $t_p = 200\text{ }\mu\text{s}; di_G/dt = 0.45\text{ A}/\mu\text{s};$<br>$I_G = 0.45\text{ A}; V = \frac{2}{3} V_{DRM}$ non-repet., $I_T = 104\text{ A}$                                                |                                |         |      | 500  | A/ $\mu\text{s}$  |
| $(dv/dt)_{cr}$ | critical rate of rise of voltage                     | $V = \frac{2}{3} V_{DRM}$                                                                                                                                                                              | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 1000 | V/ $\mu\text{s}$  |
|                |                                                      | $R_{GK} = \infty$ ; method 1 (linear voltage rise)                                                                                                                                                     |                                |         |      |      |                   |
| $V_{GT}$       | gate trigger voltage                                 | $V_D = 6\text{ V}$                                                                                                                                                                                     | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 1.5  | V                 |
|                |                                                      |                                                                                                                                                                                                        | $T_{VJ} = -40^{\circ}\text{C}$ |         |      | 1.6  | V                 |
| $I_{GT}$       | gate trigger current                                 | $V_D = 6\text{ V}$                                                                                                                                                                                     | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 150  | mA                |
|                |                                                      |                                                                                                                                                                                                        | $T_{VJ} = -40^{\circ}\text{C}$ |         |      | 200  | mA                |
| $V_{GD}$       | gate non-trigger voltage                             | $V_D = \frac{2}{3} V_{DRM}$                                                                                                                                                                            | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 0.25 | V                 |
| $I_{GD}$       | gate non-trigger current                             |                                                                                                                                                                                                        |                                |         |      | 10   | mA                |
| $I_L$          | latching current                                     | $t_p = 10\text{ }\mu\text{s}$                                                                                                                                                                          | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 200  | mA                |
|                |                                                      | $I_G = 0.45\text{ A}; di_G/dt = 0.45\text{ A}/\mu\text{s}$                                                                                                                                             |                                |         |      |      |                   |
| $I_H$          | holding current                                      | $V_D = 6\text{ V}$ $R_{GK} = \infty$                                                                                                                                                                   | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 150  | mA                |
| $t_{gd}$       | gate controlled delay time                           | $V_D = \frac{1}{2} V_{DRM}$                                                                                                                                                                            | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 2    | $\mu\text{s}$     |
|                |                                                      | $I_G = 0.45\text{ A}; di_G/dt = 0.45\text{ A}/\mu\text{s}$                                                                                                                                             |                                |         |      |      |                   |
| $t_q$          | turn-off time                                        | $V_R = 100\text{ V}; I_T = 150\text{ A}; V = \frac{2}{3} V_{DRM}$ $T_{VJ} = 100^{\circ}\text{C}$<br>$di/dt = 10\text{ A}/\mu\text{s}$ $dv/dt = 20\text{ V}/\mu\text{s}$ $t_p = 200\text{ }\mu\text{s}$ |                                |         | 185  |      | $\mu\text{s}$     |

| Package TO-240AA |                                                              |                      |                                     | Ratings |      |      |      |
|------------------|--------------------------------------------------------------|----------------------|-------------------------------------|---------|------|------|------|
| Symbol           | Definition                                                   | Conditions           |                                     | min.    | typ. | max. | Unit |
| $I_{RMS}$        | RMS current                                                  | per terminal         |                                     |         |      | 200  | A    |
| $T_{VJ}$         | virtual junction temperature                                 |                      |                                     | -40     |      | 125  | °C   |
| $T_{op}$         | operation temperature                                        |                      |                                     | -40     |      | 100  | °C   |
| $T_{stg}$        | storage temperature                                          |                      |                                     | -40     |      | 125  | °C   |
| <b>Weight</b>    |                                                              |                      |                                     |         | 81   |      | g    |
| $M_D$            | mounting torque                                              |                      |                                     | 2.5     |      | 4    | Nm   |
| $M_T$            | terminal torque                                              |                      |                                     | 2.5     |      | 4    | Nm   |
| $d_{Spp/App}$    | creepage distance on surface   striking distance through air | terminal to terminal | 13.0                                | 9.7     |      |      | mm   |
| $d_{Spb/Apb}$    |                                                              | terminal to backside | 16.0                                | 16.0    |      |      | mm   |
| $V_{ISOL}$       | isolation voltage                                            | t = 1 second         | 50/60 Hz, RMS; $I_{ISOL} \leq 1$ mA | 4800    |      |      | V    |
|                  |                                                              | t = 1 minute         |                                     | 4000    |      |      | V    |

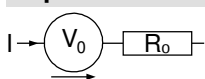


| Ordering | Ordering Number | Marking on Product | Delivery Mode | Quantity | Code No. |
|----------|-----------------|--------------------|---------------|----------|----------|
| Standard | MCC94-24io1B    | MCC94-24io1B       | Box           | 36       | 508871   |

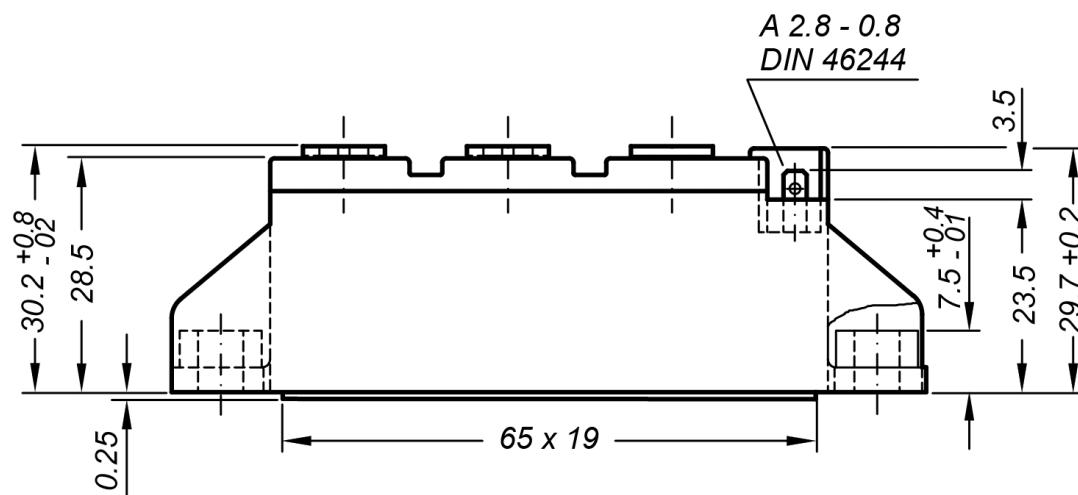
### Equivalent Circuits for Simulation

\* on die level

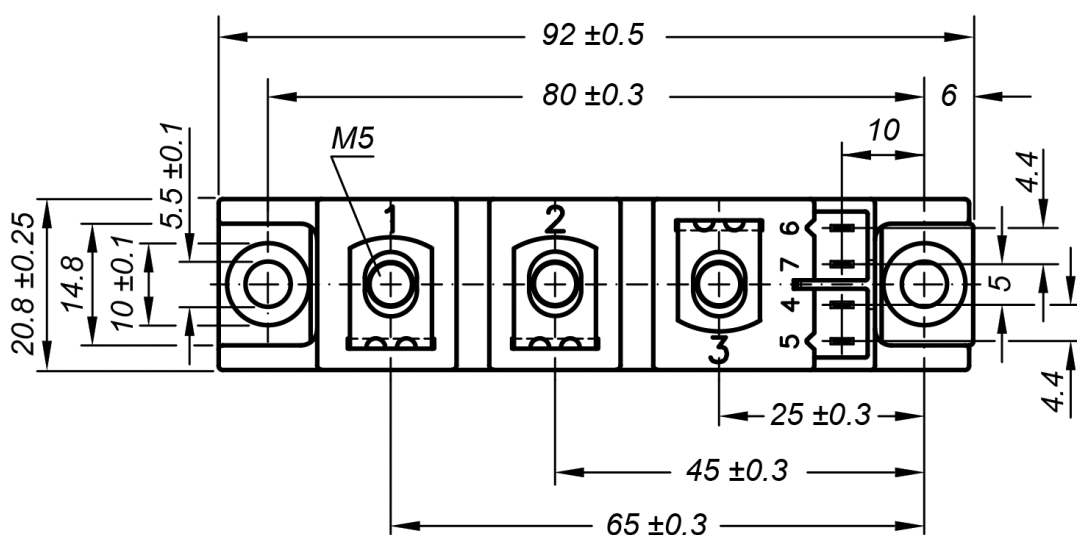
$T_{VJ} = 125^{\circ}\text{C}$

|                                                                                     |                    |      |                  |
|-------------------------------------------------------------------------------------|--------------------|------|------------------|
|  |                    |      | <b>Thyristor</b> |
| $V_{0\max}$                                                                         | threshold voltage  | 0.85 | V                |
| $R_{0\max}$                                                                         | slope resistance * | 2    | mΩ               |

## Outlines TO-240AA



*General tolerance: DIN ISO 2768 class „C“*



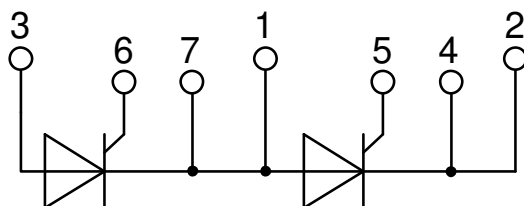
## Optional accessories for modules

Keyed gate/cathode twin plugs with wire length = 350 mm, gate = white, cathode = red

Type ZY 200L (L = Left for pin pair 4/5)

Type ZY 200R (R = Right for pin pair 6/7) }

- UL 758, style 3751



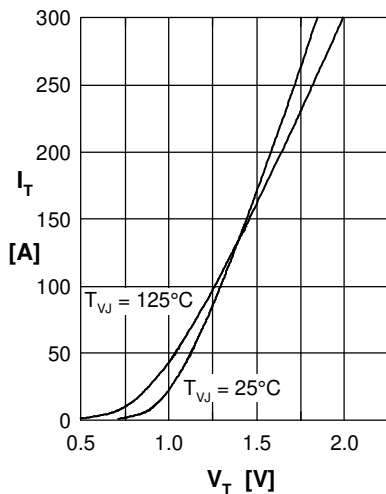
**Thyristor**


Fig. 1 Forward characteristics

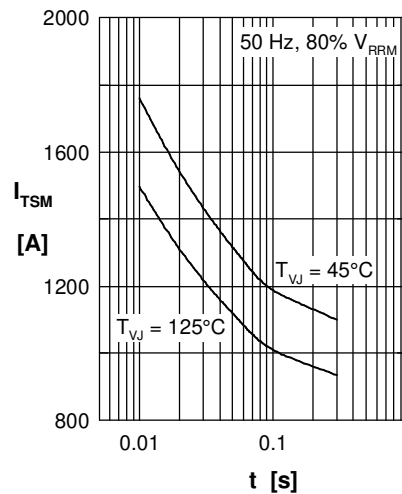
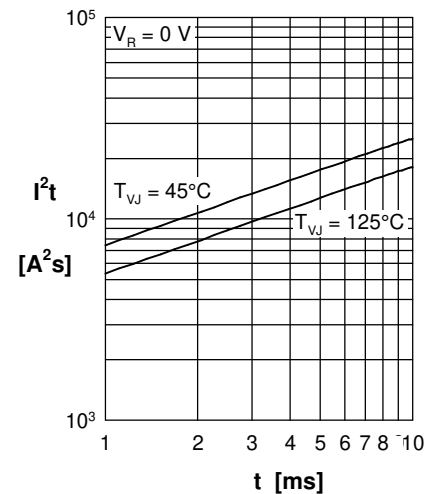
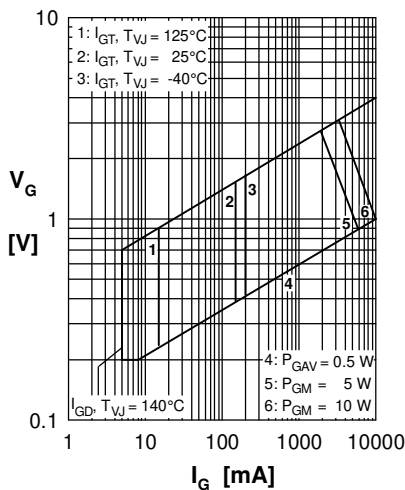

 Fig. 2 Surge overload current  
 $I_{TSM}$ : crest value,  $t$ : duration

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


Fig. 4 Gate voltage &amp; gate current

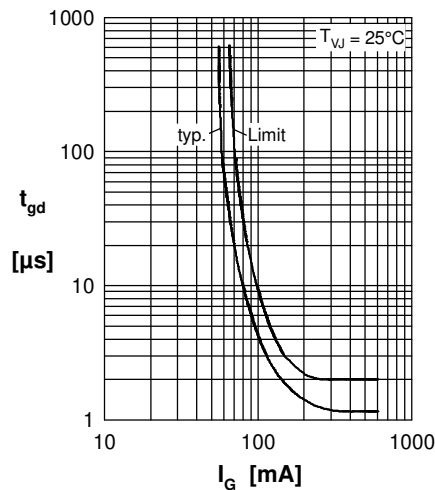
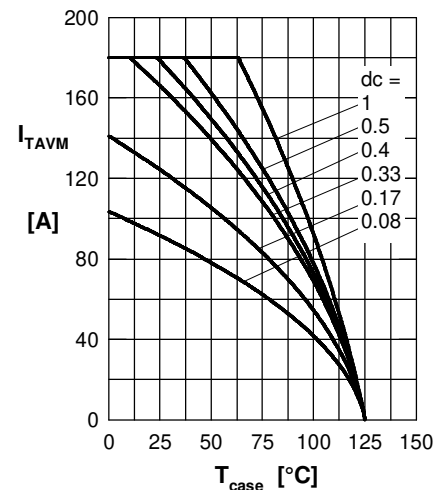

 Fig. 5 Gate controlled delay time  $t_{gd}$ 


Fig. 6 Max. forward current at case temperature

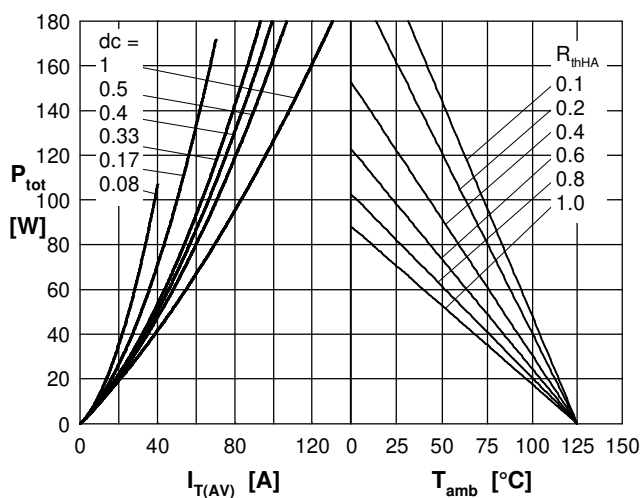
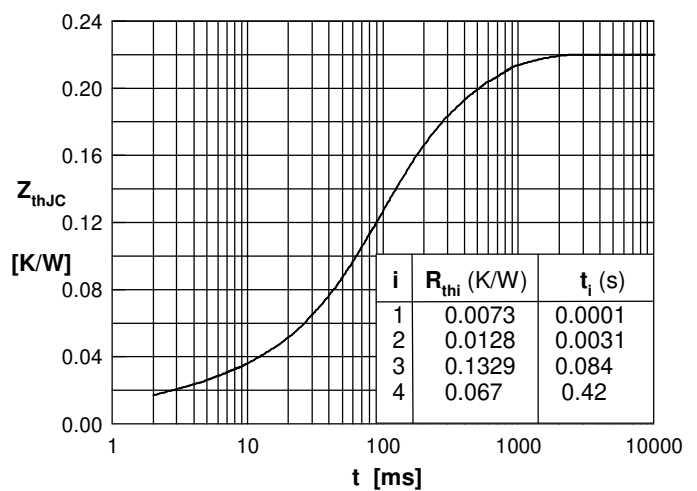

 Fig. 7a Power dissipation versus direct output current  
 Fig. 7b and ambient temperature


Fig. 8 Transient thermal impedance junction to case

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