

# Thyristor Module

$$V_{RRM} = 2 \times 1400 \text{ V}$$

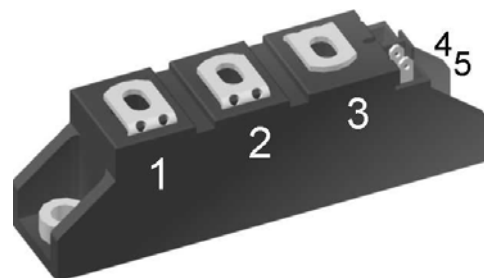
$$I_{TAV} = 49 \text{ A}$$

$$V_T = 1.34 \text{ V}$$

Phase leg

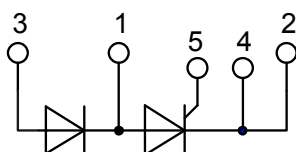
Part number

**MCD44-14io1B**



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:

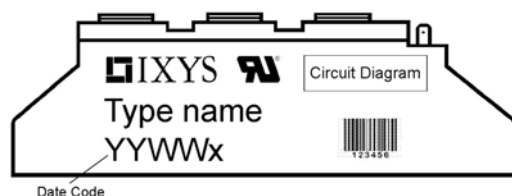
- Line rectifying 50/60 Hz
- Softstart AC motor control
- DC Motor control
- Power converter
- AC power control
- Lighting and temperature control

## Package: TO-240AA

- Isolation Voltage: 3600 V~
- Industry standard outline
- RoHS compliant
- Soldering pins for PCB mounting
- Base plate: DCB ceramic
- Reduced weight
- Advanced power cycling

| Rectifier      |                                                      |                                                                                                                                                                         |                                | Ratings |      |      |                   |
|----------------|------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|---------|------|------|-------------------|
| Symbol         | Definition                                           | Conditions                                                                                                                                                              |                                | min.    | typ. | max. | Unit              |
| $V_{RSM/DSM}$  | max. non-repetitive reverse/forward blocking voltage | $T_{VJ} = 25^{\circ}\text{C}$                                                                                                                                           |                                |         |      | 1600 | V                 |
| $V_{RRM/DRM}$  | max. repetitive reverse/forward blocking voltage     | $T_{VJ} = 25^{\circ}\text{C}$                                                                                                                                           |                                |         |      | 1400 | V                 |
| $I_{RD}$       | reverse current, drain current                       | $V_{R/D} = 1400\text{ V}$                                                                                                                                               | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 100  | $\mu\text{A}$     |
|                |                                                      | $V_{R/D} = 1400\text{ V}$                                                                                                                                               | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 5    | mA                |
| $V_T$          | forward voltage drop                                 | $I_T = 100\text{ A}$                                                                                                                                                    | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 1.34 | V                 |
|                |                                                      | $I_T = 200\text{ A}$                                                                                                                                                    |                                |         |      | 1.75 | V                 |
|                |                                                      | $I_T = 100\text{ A}$                                                                                                                                                    | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 1.34 | V                 |
|                |                                                      | $I_T = 200\text{ A}$                                                                                                                                                    |                                |         |      | 1.80 | V                 |
| $I_{TAV}$      | average forward current                              | $T_C = 85^{\circ}\text{C}$                                                                                                                                              | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 49   | A                 |
| $I_{T(RMS)}$   | RMS forward current                                  | 180° sine                                                                                                                                                               |                                |         |      | 77   | A                 |
| $V_{T0}$       | threshold voltage                                    | } for power loss calculation only                                                                                                                                       | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 0.85 | V                 |
| $r_T$          | slope resistance                                     |                                                                                                                                                                         |                                |         |      | 5.3  | m $\Omega$        |
| $R_{thJC}$     | thermal resistance junction to case                  |                                                                                                                                                                         |                                |         |      | 0.53 | K/W               |
| $R_{thCH}$     | thermal resistance case to heatsink                  |                                                                                                                                                                         |                                |         | 0.20 |      | K/W               |
| $P_{tot}$      | total power dissipation                              |                                                                                                                                                                         | $T_C = 25^{\circ}\text{C}$     |         |      | 180  | W                 |
| $I_{TSM}$      | max. forward surge current                           | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                        | $T_{VJ} = 45^{\circ}\text{C}$  |         |      | 1.15 | kA                |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                       | $V_R = 0\text{ V}$             |         |      | 1.24 | kA                |
|                |                                                      | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                        | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 980  | A                 |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                       | $V_R = 0\text{ V}$             |         |      | 1.06 | kA                |
| $I^2t$         | value for fusing                                     | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                        | $T_{VJ} = 45^{\circ}\text{C}$  |         |      | 6.62 | kA <sup>2</sup> s |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                       | $V_R = 0\text{ V}$             |         |      | 6.40 | kA <sup>2</sup> s |
|                |                                                      | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                        | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 4.80 | kA <sup>2</sup> s |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                       | $V_R = 0\text{ V}$             |         |      | 4.63 | kA <sup>2</sup> s |
| $C_J$          | junction capacitance                                 | $V_R = 400\text{ V}$ $f = 1\text{ MHz}$                                                                                                                                 | $T_{VJ} = 25^{\circ}\text{C}$  |         | 54   |      | 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, $I_T = 150\text{ A}$                                                                                       |                                |         |      | 150  | A/ $\mu\text{s}$  |
|                |                                                      | $t_P = 200\text{ }\mu\text{s}; di_G/dt = 0.45\text{ A}/\mu\text{s};$<br>$I_G = 0.45\text{ A}; V_D = \frac{2}{3} V_{DRM}$ non-repet., $I_T = 49\text{ A}$                |                                |         |      | 500  | A/ $\mu\text{s}$  |
| $(dv/dt)_{cr}$ | critical rate of rise of voltage                     | $V_D = \frac{2}{3} V_{DRM}$<br>$R_{GK} = \infty$ ; method 1 (linear voltage rise)                                                                                       | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 1000 | V/ $\mu\text{s}$  |
| $V_{GT}$       | 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                                 | $V_D = 6\text{ V}$                                                                                                                                                      | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 100  | mA                |
|                |                                                      |                                                                                                                                                                         | $T_{VJ} = -40^{\circ}\text{C}$ |         |      | 200  | mA                |
| $V_{GD}$       | gate non-trigger voltage                             | $V_D = \frac{2}{3} V_{DRM}$                                                                                                                                             | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 0.2  | V                 |
| $I_{GD}$       | gate non-trigger current                             |                                                                                                                                                                         |                                |         |      | 10   | mA                |
| $I_L$          | latching current                                     | $t_P = 10\text{ }\mu\text{s}$                                                                                                                                           | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 450  | mA                |
|                |                                                      | $I_G = 0.45\text{ A}; di_G/dt = 0.45\text{ A}/\mu\text{s}$                                                                                                              |                                |         |      |      |                   |
| $I_H$          | holding current                                      | $V_D = 6\text{ V}$ $R_{GK} = \infty$                                                                                                                                    | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 200  | 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                                        | $V_R = 100\text{ V}; I_T = 120\text{ A}; V_D = \frac{2}{3} V_{DRM}$<br>$di/dt = 10\text{ A}/\mu\text{s}; dv/dt = 20\text{ V}/\mu\text{s}; t_P = 200\text{ }\mu\text{s}$ | $T_{VJ} = 125^{\circ}\text{C}$ |         | 150  |      | $\mu\text{s}$     |

| Package TO-240AA      |                                                              |                      |                                         | Ratings |      |      |      |
|-----------------------|--------------------------------------------------------------|----------------------|-----------------------------------------|---------|------|------|------|
| Symbol                | Definition                                                   | Conditions           |                                         | min.    | typ. | max. | Unit |
| I <sub>RMS</sub>      | RMS current                                                  | per terminal         |                                         |         |      | 200  | A    |
| T <sub>stg</sub>      | storage temperature                                          |                      |                                         | -40     |      | 125  | °C   |
| T <sub>VJ</sub>       | virtual junction temperature                                 |                      |                                         | -40     |      | 125  | °C   |
| Weight                |                                                              |                      |                                         |         | 90   |      | g    |
| M <sub>D</sub>        | mounting torque                                              |                      |                                         | 2.5     |      | 4    | Nm   |
| M <sub>T</sub>        | terminal torque                                              |                      |                                         | 2.5     |      | 4    | Nm   |
| d <sub>Spp/App</sub>  | creepage distance on surface   striking distance through air | terminal to terminal | 13.0                                    | 9.7     |      |      | mm   |
| d <sub>Spb/Appb</sub> |                                                              | terminal to backside | 16.0                                    | 16.0    |      |      | mm   |
| V <sub>ISOL</sub>     | isolation voltage                                            | t = 1 second         | 50/60 Hz, RMS; I <sub>ISOL</sub> ≤ 1 mA | 3600    |      |      | V    |
|                       |                                                              | t = 1 minute         |                                         | 3000    |      |      | V    |



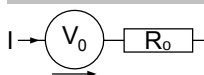
| Ordering | Part Number  | Marking on Product | Delivery Mode | Quantity | Code No. |
|----------|--------------|--------------------|---------------|----------|----------|
| Standard | MCD44-14io1B | MCD44-14io1B       | Box           | 4        |          |

| Similar Part   | Package     | Voltage class |
|----------------|-------------|---------------|
| MCMA50PD1600TB | TO-240AA-1B | 1600          |
| MCMA65PD1600TB | TO-240AA-1B | 1600          |

### Equivalent Circuits for Simulation

\* on die level

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



Thyristor

$V_{0\max}$  threshold voltage

0.85

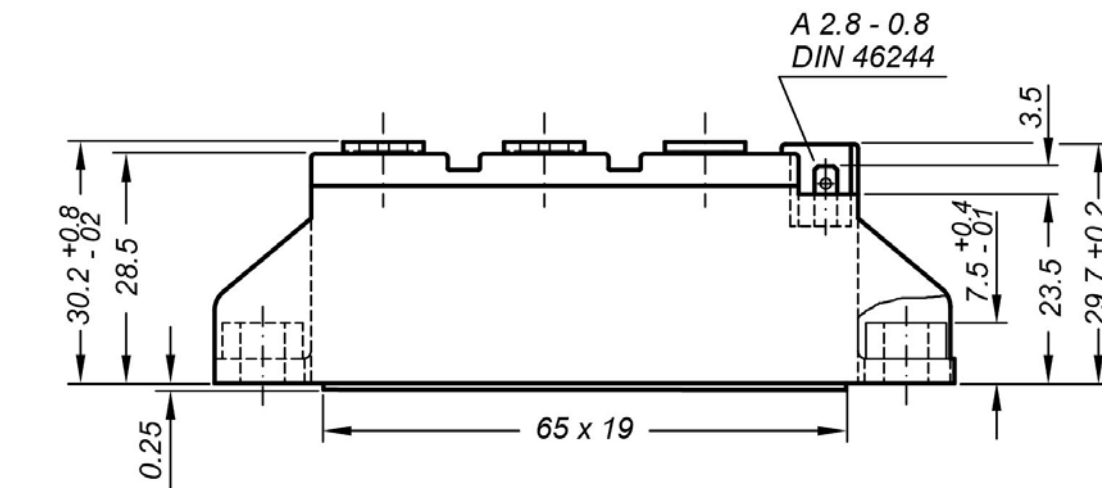
V

$R_{0\max}$  slope resistance \*

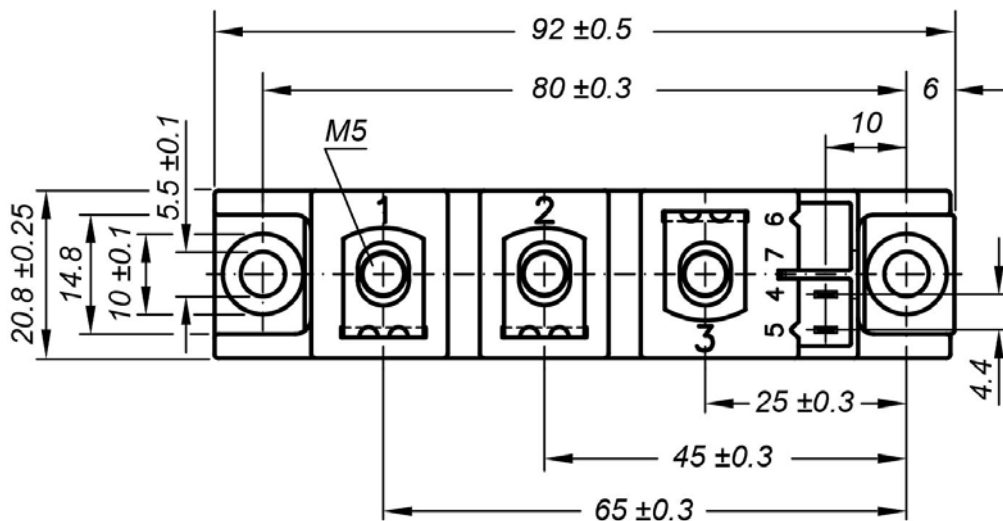
4.1

mΩ

# Outlines TO-240AA



General tolerance: DIN ISO 2768 class „c“

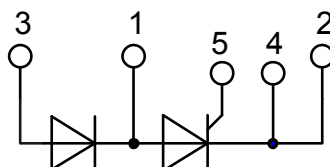


Optional accessories: Keyed gate/cathode twin plugs

Wire length: 350 mm, gate = white, cathode = red

UL 758, style 3751

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



## Thyristor

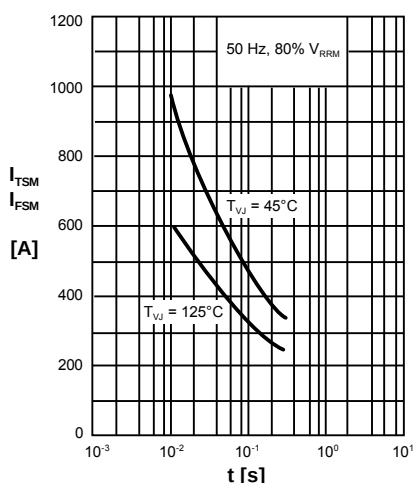


Fig. 1 Surge overload current  
 $I_{TSM}$ ,  $I_{FSM}$ : Crest value,  $t$ : duration

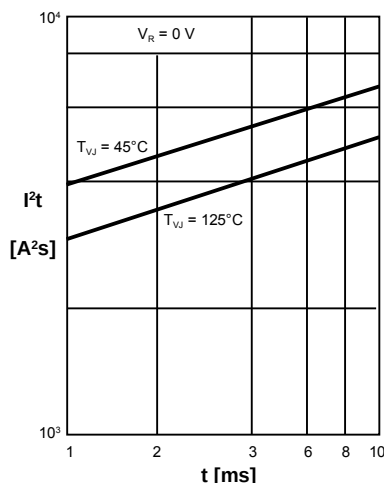


Fig. 2  $I^2t$  versus time (1-10 ms)

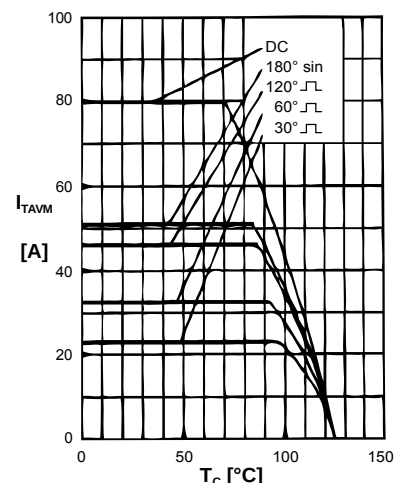


Fig. 3 Maximum forward current at case temperature

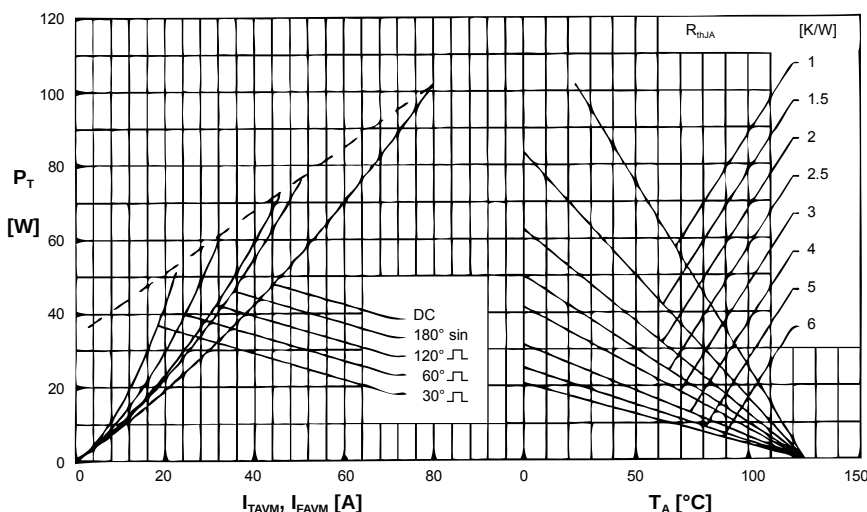


Fig. 4 Power dissipation vs. onstate current and ambient temperature (per thyristor/diode)

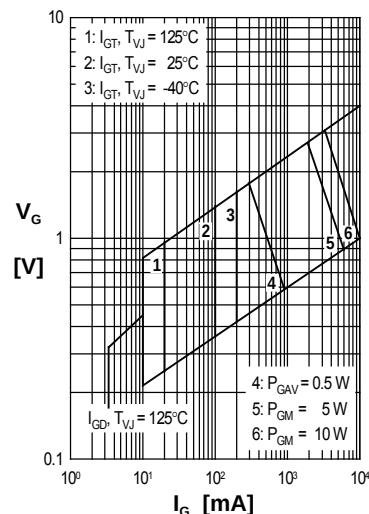


Fig. 5 Gate trigger characteristics

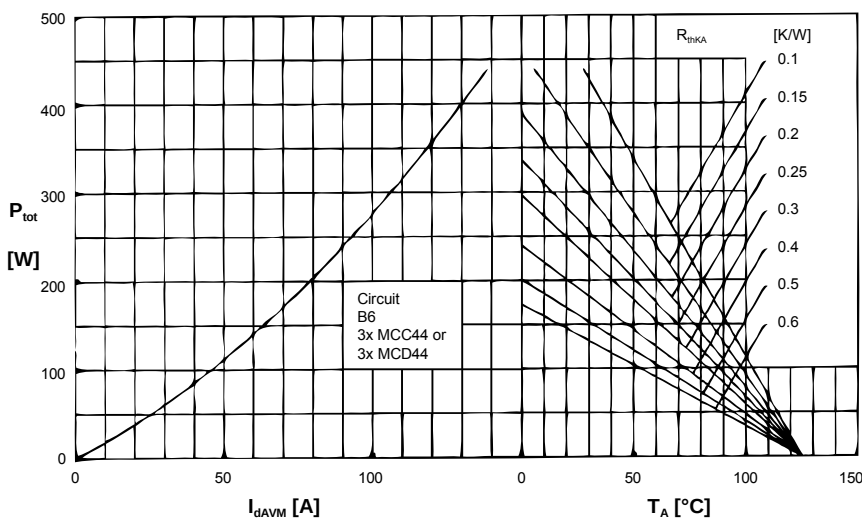


Fig. 6 Three phase rectifier bridge: Power dissipation versus direct output current and ambient temperature

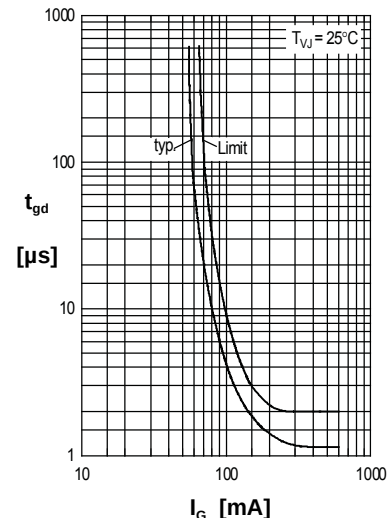


Fig. 7 Gate trigger delay time

## Rectifier

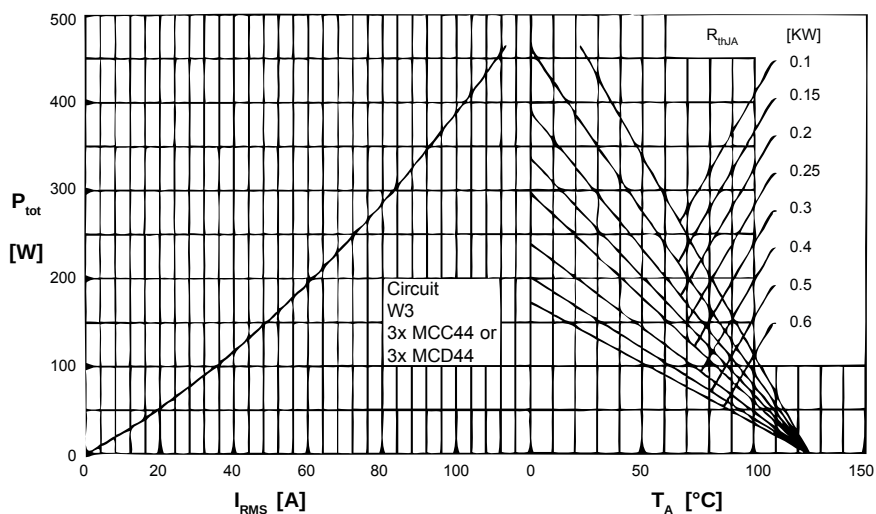


Fig. 8 Three phase AC-controller: Power dissipation versus RMS output current and ambient temperature

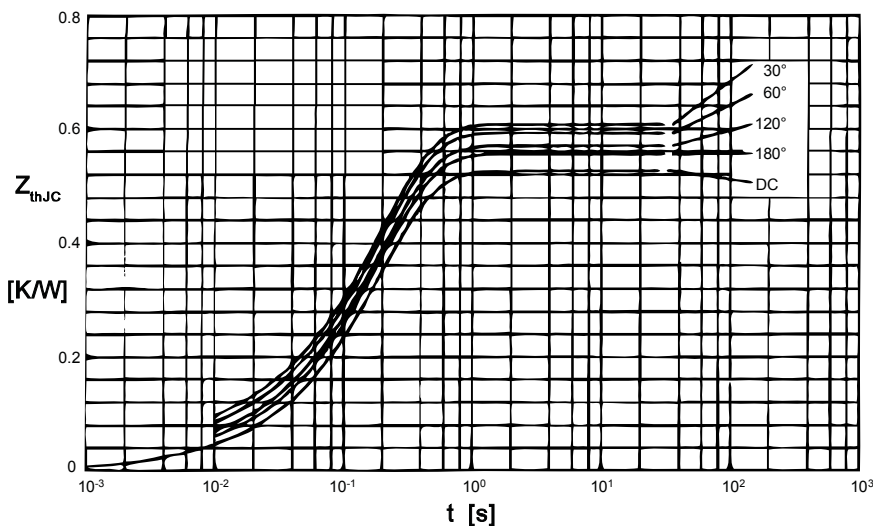


Fig. 9 Transient thermal impedance junction to case (per thyristor)

$R_{thJC}$  for various conduction angles d:

| d    | $R_{thJC}$ [KW] |
|------|-----------------|
| DC   | 0.53            |
| 180° | 0.55            |
| 120° | 0.58            |
| 60°  | 0.60            |
| 30°  | 0.62            |

Constants for  $Z_{thJC}$  calculation:

| i | $R_{thi}$ [KW] | $t_i$ [s] |
|---|----------------|-----------|
| 1 | 0.015          | 0.0035    |
| 2 | 0.026          | 0.0200    |
| 3 | 0.489          | 0.1950    |

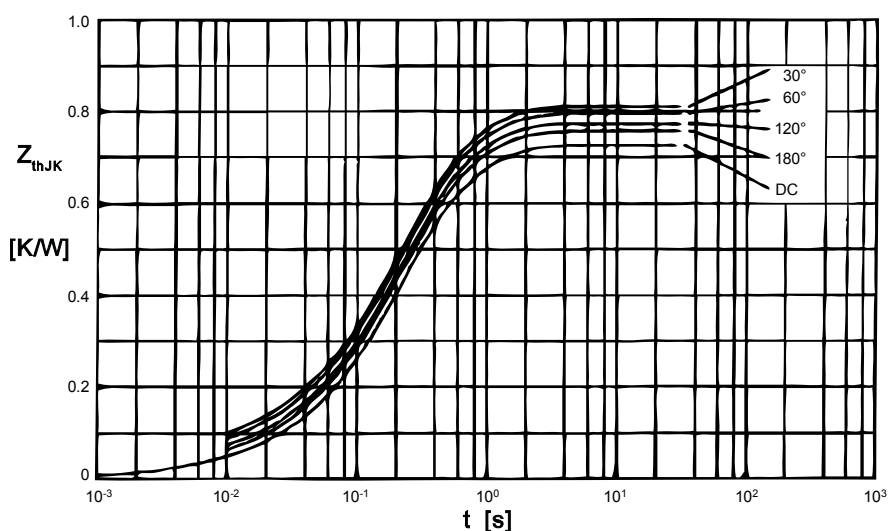


Fig. 10 Transient thermal impedance junction to heatsink (per thyristor)

$R_{thJK}$  for various conduction angles d:

| d    | $R_{thJK}$ [KW] |
|------|-----------------|
| DC   | 0.73            |
| 180° | 0.75            |
| 120° | 0.78            |
| 60°  | 0.80            |
| 30°  | 0.82            |

Constants for  $Z_{thJK}$  calculation:

| i | $R_{thi}$ [KW] | $t_i$ [s] |
|---|----------------|-----------|
| 1 | 0.015          | 0.0035    |
| 2 | 0.026          | 0.0200    |
| 3 | 0.489          | 0.0195    |
| 4 | 0.200          | 0.6800    |