

# Thyristor \ Diode Module

$$V_{RRM} = 2 \times 1200 \text{ V}$$

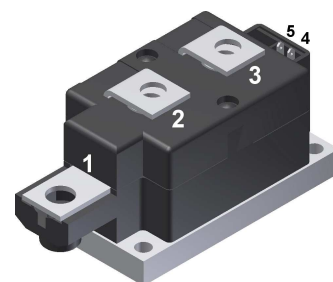
$$I_{TAV} = 320 \text{ A}$$

$$V_T = 1.06 \text{ V}$$

Phase leg

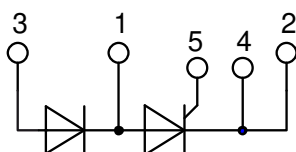
Part number

**MCD312-12io1**



Backside: isolated

 E72873



## Features / Advantages:

- International standard package
- Direct copper bonded Al<sub>2</sub>O<sub>3</sub>-ceramic with copper base plate
- Planar passivated chip
- Keyed gate/cathode twin pins

## Applications:

- Motor control, softstarter
- Power converter
- Heat and temperature control for industrial furnaces and chemical processes
- Lighting control
- Solid state switches

## Package: Y1

- Isolation Voltage: 3600 V~
- Industry standard outline
- RoHS compliant
- Soldering pins for PCB mounting
- Base plate: Copper internally DCB isolated
- Advanced power cycling

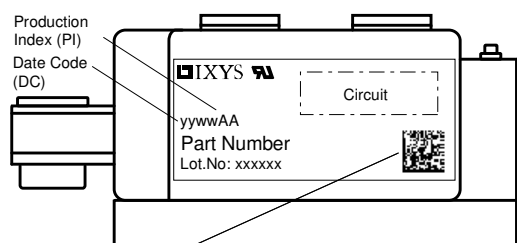
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| Rectifier      |                                                      |                                                                                                                                                                                                        |                                | Ratings |      |       |                   |
|----------------|------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|---------|------|-------|-------------------|
| Symbol         | Definition                                           | Conditions                                                                                                                                                                                             |                                | min.    | typ. | max.  | Unit              |
| $V_{RSM/DSM}$  | max. non-repetitive reverse/forward blocking voltage | $T_{VJ} = 25^{\circ}\text{C}$                                                                                                                                                                          |                                |         |      | 1300  | V                 |
| $V_{RRM/DRM}$  | max. repetitive reverse/forward blocking voltage     | $T_{VJ} = 25^{\circ}\text{C}$                                                                                                                                                                          |                                |         |      | 1200  | V                 |
| $I_{R/D}$      | reverse current, drain current                       | $V_{R/D} = 1200\text{ V}$                                                                                                                                                                              | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 1     | mA                |
|                |                                                      | $V_{R/D} = 1200\text{ V}$                                                                                                                                                                              | $T_{VJ} = 140^{\circ}\text{C}$ |         |      | 40    | mA                |
| $V_T$          | forward voltage drop                                 | $I_T = 300\text{ A}$                                                                                                                                                                                   | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 1.12  | V                 |
|                |                                                      | $I_T = 600\text{ A}$                                                                                                                                                                                   |                                |         |      | 1.32  | V                 |
|                |                                                      | $I_T = 300\text{ A}$                                                                                                                                                                                   | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 1.06  | V                 |
|                |                                                      | $I_T = 600\text{ A}$                                                                                                                                                                                   |                                |         |      | 1.29  | V                 |
| $I_{TAV}$      | average forward current                              | $T_C = 85^{\circ}\text{C}$                                                                                                                                                                             | $T_{VJ} = 140^{\circ}\text{C}$ |         |      | 320   | A                 |
| $I_{T(RMS)}$   | RMS forward current                                  | 180° sine                                                                                                                                                                                              |                                |         |      | 520   | A                 |
| $V_{T0}$       | threshold voltage                                    | } for power loss calculation only                                                                                                                                                                      | $T_{VJ} = 140^{\circ}\text{C}$ |         |      | 0.80  | V                 |
| $r_T$          | slope resistance                                     |                                                                                                                                                                                                        |                                |         |      | 0.68  | mΩ                |
| $R_{thJC}$     | thermal resistance junction to case                  |                                                                                                                                                                                                        |                                |         |      | 0.12  | K/W               |
| $R_{thCH}$     | thermal resistance case to heatsink                  |                                                                                                                                                                                                        |                                |         | 0.04 |       | K/W               |
| $P_{tot}$      | total power dissipation                              |                                                                                                                                                                                                        | $T_C = 25^{\circ}\text{C}$     |         |      | 960   | W                 |
| $I_{TSM}$      | max. forward surge current                           | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                                                       | $T_{VJ} = 45^{\circ}\text{C}$  |         |      | 9.60  | kA                |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                                                      | $V_R = 0\text{ V}$             |         |      | 10.4  | kA                |
|                |                                                      | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                                                       | $T_{VJ} = 140^{\circ}\text{C}$ |         |      | 8.16  | kA                |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                                                      | $V_R = 0\text{ V}$             |         |      | 8.82  | kA                |
| $I^2t$         | value for fusing                                     | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                                                       | $T_{VJ} = 45^{\circ}\text{C}$  |         |      | 460.8 | kA <sup>2</sup> s |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                                                      | $V_R = 0\text{ V}$             |         |      | 447.4 | kA <sup>2</sup> s |
|                |                                                      | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                                                       | $T_{VJ} = 140^{\circ}\text{C}$ |         |      | 332.9 | kA <sup>2</sup> s |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                                                      | $V_R = 0\text{ V}$             |         |      | 323.3 | kA <sup>2</sup> s |
| $C_J$          | junction capacitance                                 | $V_R = 400\text{ V}$ $f = 1\text{ MHz}$                                                                                                                                                                | $T_{VJ} = 25^{\circ}\text{C}$  |         | 438  |       | pF                |
| $P_{GM}$       | max. gate power dissipation                          | $t_p = 30\text{ }\mu\text{s}$                                                                                                                                                                          | $T_C = 140^{\circ}\text{C}$    |         |      | 120   | W                 |
|                |                                                      | $t_p = 500\text{ }\mu\text{s}$                                                                                                                                                                         |                                |         |      | 60    | W                 |
| $P_{GAV}$      | average gate power dissipation                       |                                                                                                                                                                                                        |                                |         |      | 20    | W                 |
| $(di/dt)_{cr}$ | critical rate of rise of current                     | $T_{VJ} = 140^{\circ}\text{C}; f = 50\text{ Hz}$ repetitive, $I_T = 960\text{ A}$                                                                                                                      |                                |         |      | 100   | A/ $\mu\text{s}$  |
|                |                                                      | $t_p = 200\text{ }\mu\text{s}; di_G/dt = 1\text{ A}/\mu\text{s};$<br>$I_G = 1\text{ A}; V = \frac{2}{3} V_{DRM}$ non-repet., $I_T = 320\text{ A}$                                                      |                                |         |      | 500   | A/ $\mu\text{s}$  |
| $(dv/dt)_{cr}$ | critical rate of rise of voltage                     | $V = \frac{2}{3} V_{DRM}$                                                                                                                                                                              | $T_{VJ} = 140^{\circ}\text{C}$ |         |      | 1000  | V/ $\mu\text{s}$  |
|                |                                                      | $R_{GK} = \infty$ ; method 1 (linear voltage rise)                                                                                                                                                     |                                |         |      |       |                   |
| $V_{GT}$       | gate trigger voltage                                 | $V_D = 6\text{ V}$                                                                                                                                                                                     | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 2     | V                 |
|                |                                                      |                                                                                                                                                                                                        | $T_{VJ} = -40^{\circ}\text{C}$ |         |      | 3     | V                 |
| $I_{GT}$       | gate trigger current                                 | $V_D = 6\text{ V}$                                                                                                                                                                                     | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 150   | mA                |
|                |                                                      |                                                                                                                                                                                                        | $T_{VJ} = -40^{\circ}\text{C}$ |         |      | 220   | mA                |
| $V_{GD}$       | gate non-trigger voltage                             | $V_D = \frac{2}{3} V_{DRM}$                                                                                                                                                                            | $T_{VJ} = 140^{\circ}\text{C}$ |         |      | 0.25  | V                 |
| $I_{GD}$       | gate non-trigger current                             |                                                                                                                                                                                                        |                                |         |      | 10    | mA                |
| $I_L$          | latching current                                     | $t_p = 30\text{ }\mu\text{s}$                                                                                                                                                                          | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 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     | $\mu\text{s}$     |
|                |                                                      | $I_G = 1\text{ A}; di_G/dt = 1\text{ A}/\mu\text{s}$                                                                                                                                                   |                                |         |      |       |                   |
| $t_q$          | turn-off time                                        | $V_R = 100\text{ V}; I_T = 300\text{ A}; V = \frac{2}{3} V_{DRM}$ $T_{VJ} = 125^{\circ}\text{C}$<br>$di/dt = 10\text{ A}/\mu\text{s}$ $dv/dt = 50\text{ V}/\mu\text{s}$ $t_p = 200\text{ }\mu\text{s}$ |                                |         | 200  |       | $\mu\text{s}$     |

| Package Y1           |                                                              |                      | Ratings                                 |      |      |      |
|----------------------|--------------------------------------------------------------|----------------------|-----------------------------------------|------|------|------|
| Symbol               | Definition                                                   | Conditions           | min.                                    | typ. | max. | Unit |
| I <sub>RMS</sub>     | RMS current                                                  | per terminal         |                                         |      | 600  | A    |
| T <sub>VJ</sub>      | virtual junction temperature                                 |                      | -40                                     |      | 140  | °C   |
| T <sub>op</sub>      | operation temperature                                        |                      | -40                                     |      | 125  | °C   |
| T <sub>stg</sub>     | storage temperature                                          |                      | -40                                     |      | 125  | °C   |
| Weight               |                                                              |                      |                                         | 680  |      | g    |
| M <sub>D</sub>       | mounting torque                                              |                      | 4.5                                     |      | 7    | Nm   |
| M <sub>T</sub>       | terminal torque                                              |                      | 11                                      |      | 13   | Nm   |
| d <sub>Spp/App</sub> | creepage distance on surface   striking distance through air | terminal to terminal | 16.0                                    |      |      | mm   |
| d <sub>Spb/Apb</sub> |                                                              | terminal to backside | 16.0                                    |      |      | mm   |
| V <sub>ISOL</sub>    | isolation voltage                                            | t = 1 second         | 3600                                    |      |      | V    |
|                      |                                                              | t = 1 minute         | 3000                                    |      |      | V    |
|                      |                                                              |                      | 50/60 Hz, RMS; I <sub>ISOL</sub> ≤ 1 mA |      |      |      |



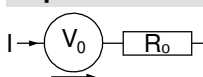
Data Matrix: part no. (1-19), DC + PI (20-25), lot.no.# (26-31), blank (32), serial no.# (33-36)

| Ordering | Ordering Number | Marking on Product | Delivery Mode | Quantity | Code No. |
|----------|-----------------|--------------------|---------------|----------|----------|
| Standard | MCD312-12io1    | MCD312-12io1       | Box           | 3        | 461849   |

### Equivalent Circuits for Simulation

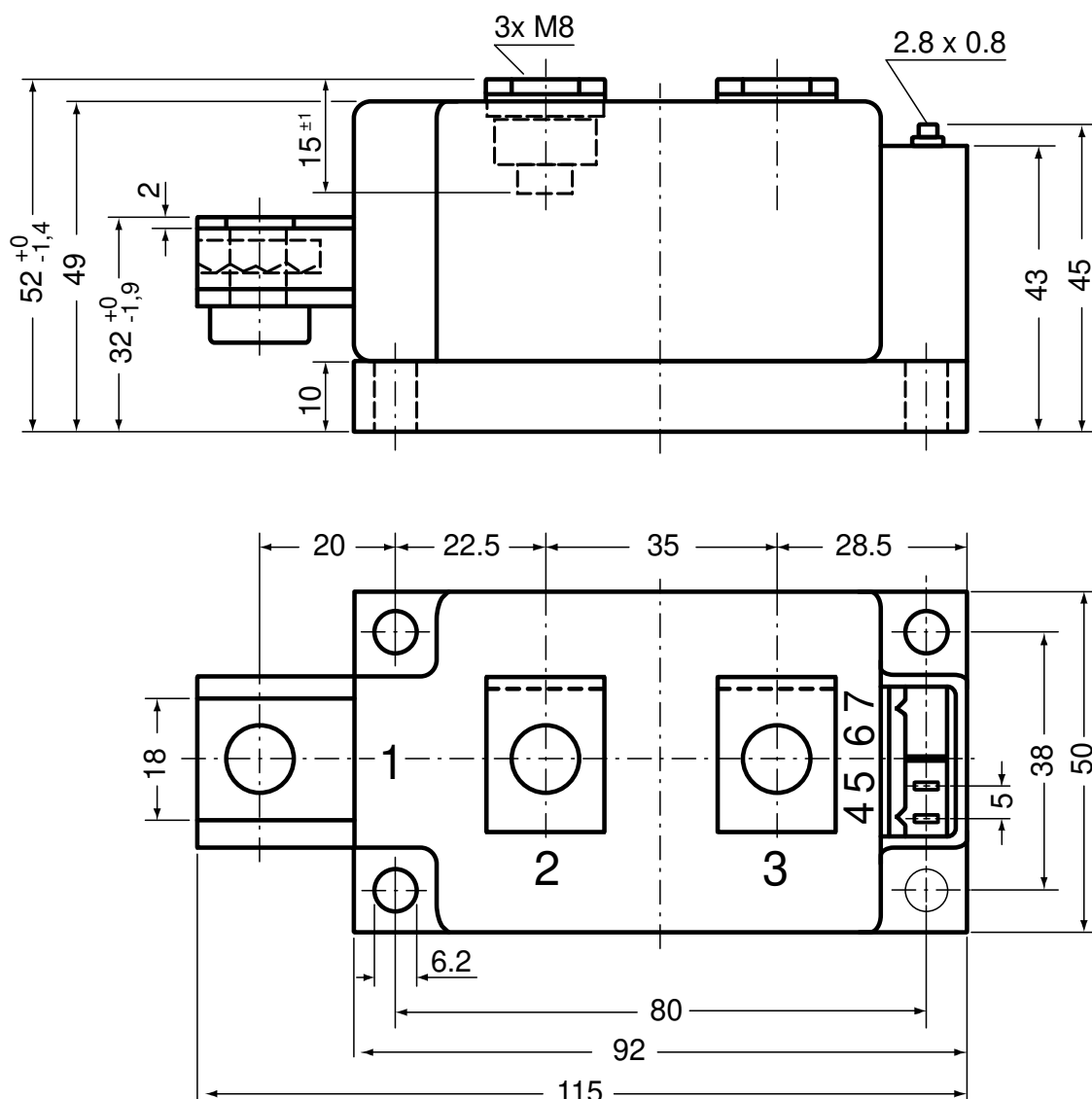
\* on die level

$T_{VJ} = 140^{\circ}\text{C}$



**Thyristor**

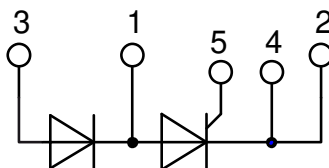
|             |                    |     |    |
|-------------|--------------------|-----|----|
| $V_{0\max}$ | threshold voltage  | 0.8 | V  |
| $R_{0\max}$ | slope resistance * | 0.5 | mΩ |

**Outlines Y1**


Optional accessories for modules

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

Type ZY 180L (L = Left for pin pair 4/5) UL 758, style 3751



## Thyristor

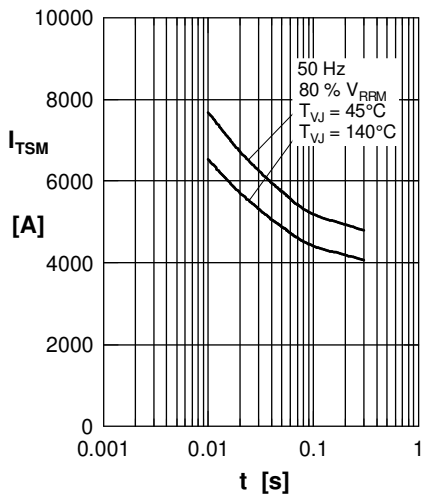


Fig. 1 Surge overload current  
 $I_{TSM}$ : Crest value,  $t$ : duration

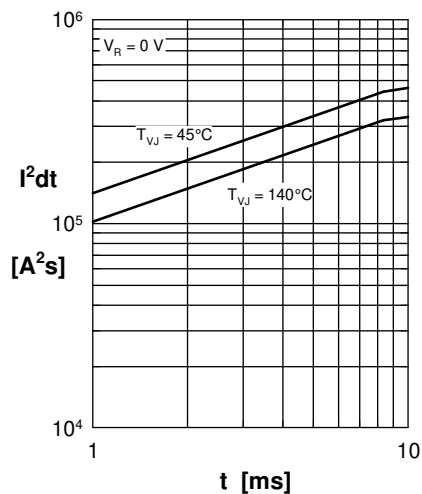


Fig. 2  $I^2dt$  versus time

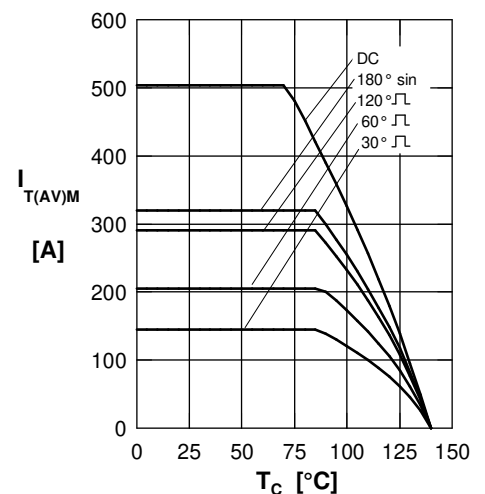


Fig. 3 Max. forward current  
 at case temperature

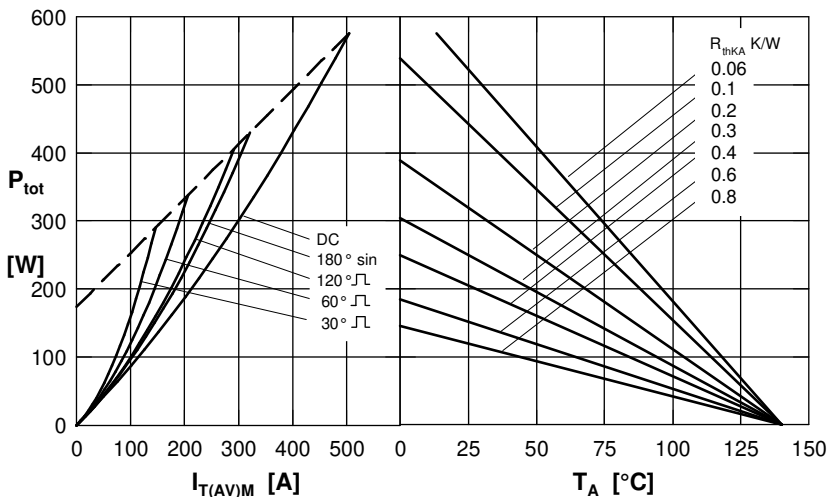


Fig. 4 Power dissipation versus on-state current and  
 ambient temperature (per thyristor)

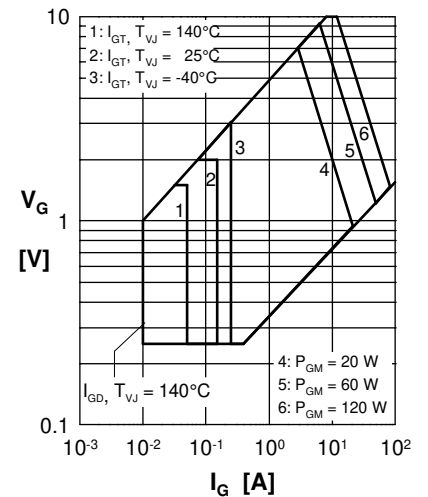


Fig. 5 Gate voltage & gate current

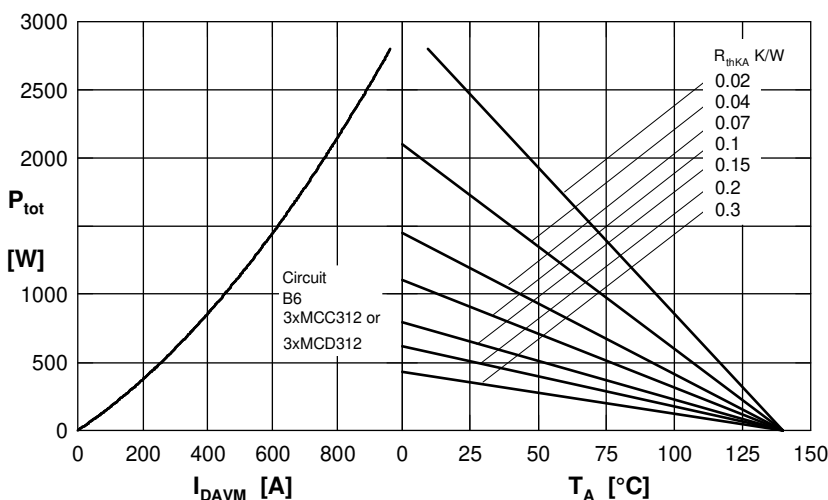


Fig. 6 Three phase rectifier bridge: Power dissipation versus direct  
 output current and ambient temperature

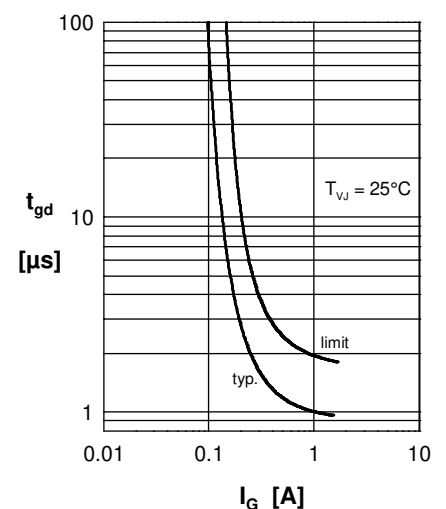


Fig. 7 Gate controlled delay time  $t_{gd}$

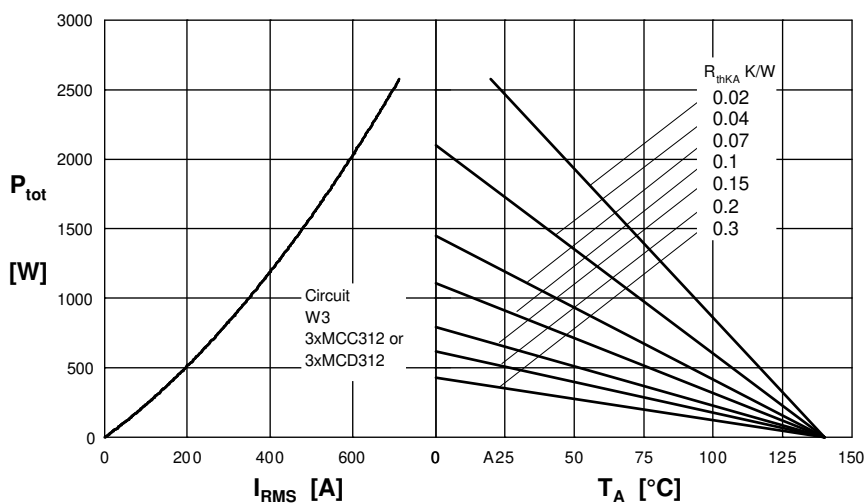
**Rectifier**


Fig. 8 Three phase AC-controller: Power dissipation versus  $R_{MS}$  output current and ambient temperature

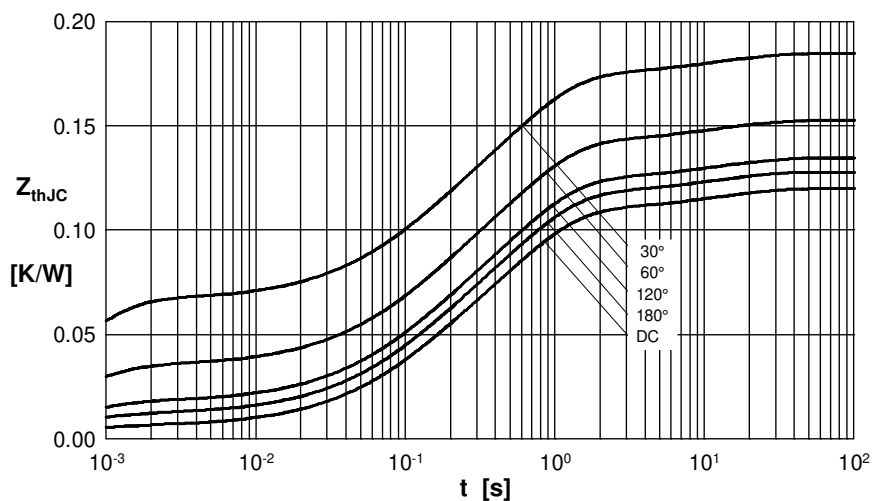


Fig. 9 Transient thermal impedance junction to case (per thyristor)

$R_{thJC}$  for various conduct. angles d:

| d    | $R_{thJC}$ [K/W] |
|------|------------------|
| DC   | 0.120            |
| 180° | 0.128            |
| 120° | 0.135            |
| 60°  | 0.153            |
| 30°  | 0.185            |

Constants for  $Z_{thJC}$  calculation:

| i | $R_{thi}$ [K/W] | $t_i$ [s] |
|---|-----------------|-----------|
| 1 | 0.0058          | 0.00054   |
| 2 | 0.0310          | 0.098     |
| 3 | 0.0720          | 0.54      |
| 4 | 0.0112          | 12        |

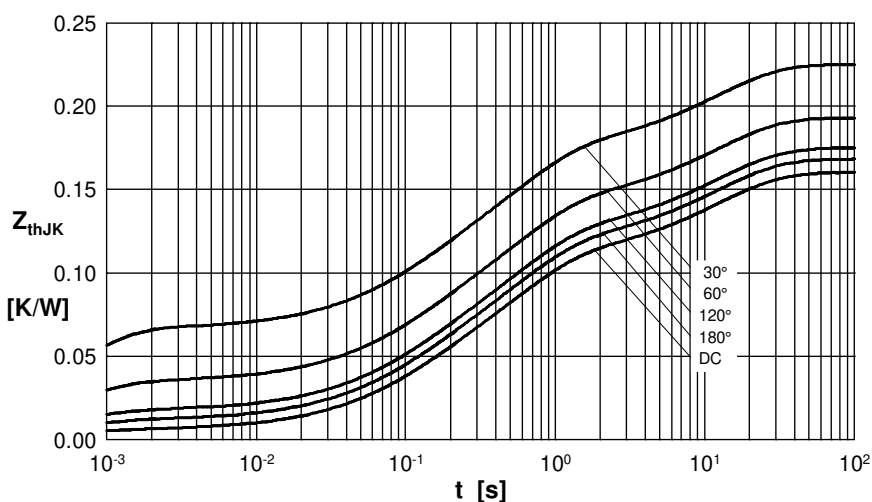


Fig. 10 Transient thermal impedance junction to heatsink (per thyristor)

$R_{thJK}$  for various conduct. angles d:

| d    | $R_{thJK}$ [K/W] |
|------|------------------|
| DC   | 0.160            |
| 180° | 0.168            |
| 120° | 0.175            |
| 60°  | 0.193            |
| 30°  | 0.225            |

Constants for  $Z_{thJK}$  calculation:

| i | $R_{thi}$ [K/W] | $t_i$ [s] |
|---|-----------------|-----------|
| 1 | 0.0058          | 0.00054   |
| 2 | 0.0310          | 0.098     |
| 3 | 0.0720          | 0.54      |
| 4 | 0.0114          | 12        |
| 5 | 0.0400          | 12        |