

# Thyristor \ Diode Module

$$V_{RRM} = 2 \times 1600 \text{ V}$$

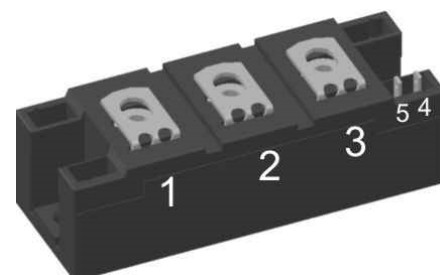
$$I_{TAV} = 181 \text{ A}$$

$$V_T = 1.03 \text{ V}$$

Phase leg

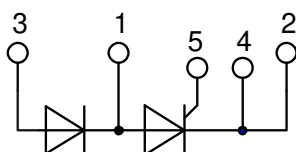
Part number

**MCD162-16io1**



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: Y4

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

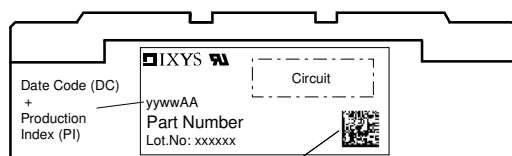
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| Rectifier      |                                                      |                                                                                                                                                                         |                                | Ratings |      |       |                   |
|----------------|------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|---------|------|-------|-------------------|
| Symbol         | Definition                                           | Conditions                                                                                                                                                              |                                | min.    | typ. | max.  | Unit              |
| $V_{RSM/DSM}$  | max. non-repetitive reverse/forward blocking voltage | $T_{VJ} = 25^{\circ}\text{C}$                                                                                                                                           |                                |         |      | 1700  | V                 |
| $V_{RRM/DRM}$  | max. repetitive reverse/forward blocking voltage     | $T_{VJ} = 25^{\circ}\text{C}$                                                                                                                                           |                                |         |      | 1600  | V                 |
| $I_{R/D}$      | reverse current, drain current                       | $V_{R/D} = 1600\text{ V}$                                                                                                                                               | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 300   | $\mu\text{A}$     |
|                |                                                      | $V_{R/D} = 1600\text{ V}$                                                                                                                                               | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 10    | mA                |
| $V_T$          | forward voltage drop                                 | $I_T = 150\text{ A}$                                                                                                                                                    | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 1.09  | V                 |
|                |                                                      | $I_T = 300\text{ A}$                                                                                                                                                    |                                |         |      | 1.25  | V                 |
|                |                                                      | $I_T = 150\text{ A}$                                                                                                                                                    | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 1.03  | V                 |
|                |                                                      | $I_T = 300\text{ A}$                                                                                                                                                    |                                |         |      | 1.25  | V                 |
| $I_{TAV}$      | average forward current                              | $T_C = 85^{\circ}\text{C}$                                                                                                                                              | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 181   | A                 |
| $I_{T(RMS)}$   | RMS forward current                                  | 180° sine                                                                                                                                                               |                                |         |      | 300   | A                 |
| $V_{T0}$       | threshold voltage                                    | } for power loss calculation only                                                                                                                                       | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 0.88  | V                 |
| $r_T$          | slope resistance                                     |                                                                                                                                                                         |                                |         |      | 1.15  | m $\Omega$        |
| $R_{thJC}$     | thermal resistance junction to case                  |                                                                                                                                                                         |                                |         |      | 0.155 | K/W               |
| $R_{thCH}$     | thermal resistance case to heatsink                  |                                                                                                                                                                         |                                |         | 0.07 |       | K/W               |
| $P_{tot}$      | total power dissipation                              |                                                                                                                                                                         | $T_C = 25^{\circ}\text{C}$     |         |      | 645   | W                 |
| $I_{TSM}$      | max. forward surge current                           | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                        | $T_{VJ} = 45^{\circ}\text{C}$  |         |      | 6.00  | kA                |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                       | $V_R = 0\text{ V}$             |         |      | 6.48  | kA                |
|                |                                                      | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                        | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 5.10  | kA                |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                       | $V_R = 0\text{ V}$             |         |      | 5.51  | kA                |
| $I^2t$         | value for fusing                                     | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                        | $T_{VJ} = 45^{\circ}\text{C}$  |         |      | 180.0 | kA <sup>2</sup> s |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                       | $V_R = 0\text{ V}$             |         |      | 174.7 | kA <sup>2</sup> s |
|                |                                                      | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                        | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 130.1 | kA <sup>2</sup> s |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                       | $V_R = 0\text{ V}$             |         |      | 126.3 | kA <sup>2</sup> s |
| $C_J$          | junction capacitance                                 | $V_R = 400\text{ V}$ $f = 1\text{ MHz}$                                                                                                                                 | $T_{VJ} = 25^{\circ}\text{C}$  |         | 273  |       | pF                |
| $P_{GM}$       | max. gate power dissipation                          | $t_p = 30\text{ }\mu\text{s}$                                                                                                                                           | $T_C = 125^{\circ}\text{C}$    |         |      | 120   | W                 |
|                |                                                      | $t_p = 500\text{ }\mu\text{s}$                                                                                                                                          |                                |         |      | 60    | W                 |
| $P_{GAV}$      | average gate power dissipation                       |                                                                                                                                                                         |                                |         |      | 8     | W                 |
| $(di/dt)_{cr}$ | critical rate of rise of current                     | $T_{VJ} = 125^{\circ}\text{C}; f = 50\text{ Hz}$ repetitive, $I_T = 540\text{ A}$                                                                                       |                                |         |      | 150   | A/ $\mu\text{s}$  |
|                |                                                      | $t_p = 200\text{ }\mu\text{s}; di_G/dt = 0.5\text{ A}/\mu\text{s};$<br>$I_G = 0.5\text{ A}; V = \frac{2}{3} V_{DRM}$ non-repet., $I_T = 180\text{ A}$                   |                                |         |      | 500   | A/ $\mu\text{s}$  |
| $(dv/dt)_{cr}$ | critical rate of rise of voltage                     | $V = \frac{2}{3} V_{DRM}$<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                                 | $V_D = 6\text{ V}$                                                                                                                                                      | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 2.5   | V                 |
|                |                                                      |                                                                                                                                                                         | $T_{VJ} = -40^{\circ}\text{C}$ |         |      | 2.6   | 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                             | $V_D = \frac{2}{3} V_{DRM}$                                                                                                                                             | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 0.2   | V                 |
| $I_{GD}$       | gate non-trigger current                             |                                                                                                                                                                         |                                |         |      | 10    | mA                |
| $I_L$          | latching current                                     | $t_p = 30\text{ }\mu\text{s}$                                                                                                                                           | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 300   | mA                |
|                |                                                      | $I_G = 0.5\text{ A}; di_G/dt = 0.5\text{ A}/\mu\text{s}$                                                                                                                |                                |         |      |       |                   |
| $I_H$          | 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     | $\mu\text{s}$     |
|                |                                                      | $I_G = 0.5\text{ A}; di_G/dt = 0.5\text{ A}/\mu\text{s}$                                                                                                                |                                |         |      |       |                   |
| $t_q$          | turn-off time                                        | $V_R = 100\text{ V}; I_T = 300\text{ A}; V = \frac{2}{3} V_{DRM}$<br>$di/dt = 10\text{ A}/\mu\text{s}$ $dv/dt = 20\text{ V}/\mu\text{s}$ $t_p = 200\text{ }\mu\text{s}$ | $T_{VJ} = 100^{\circ}\text{C}$ |         | 150  |       | $\mu\text{s}$     |

| Package Y4           |                                                              |                      |                                         | Ratings |      |      |      |
|----------------------|--------------------------------------------------------------|----------------------|-----------------------------------------|---------|------|------|------|
| Symbol               | Definition                                                   | Conditions           |                                         | min.    | typ. | max. | Unit |
| I <sub>RMS</sub>     | RMS current                                                  | per terminal         |                                         |         |      | 300  | A    |
| T <sub>VJ</sub>      | virtual junction temperature                                 |                      |                                         | -40     |      | 125  | °C   |
| T <sub>op</sub>      | operation temperature                                        |                      |                                         | -40     |      | 100  | °C   |
| T <sub>stg</sub>     | storage temperature                                          |                      |                                         | -40     |      | 125  | °C   |
| Weight               |                                                              |                      |                                         |         | 150  |      | g    |
| M <sub>D</sub>       | mounting torque                                              |                      |                                         | 2.25    |      | 2.75 | Nm   |
| M <sub>T</sub>       | terminal torque                                              |                      |                                         | 4.5     |      | 5.5  | Nm   |
| d <sub>Spp/App</sub> | creepage distance on surface   striking distance through air | terminal to terminal | 14.0                                    | 10.0    |      |      | mm   |
| d <sub>Spb/Apb</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    |



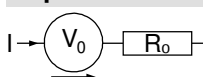
Data Matrix: part no. (1-19), DC + PI (20-25), lot.no.# (26-31), blank (32), serial no.# (33-36)

| Ordering | Ordering Number | Marking on Product | Delivery Mode | Quantity | Code No. |
|----------|-----------------|--------------------|---------------|----------|----------|
| Standard | MCD162-16io1    | MCD162-16io1       | Box           | 6        | 429678   |

### Equivalent Circuits for Simulation

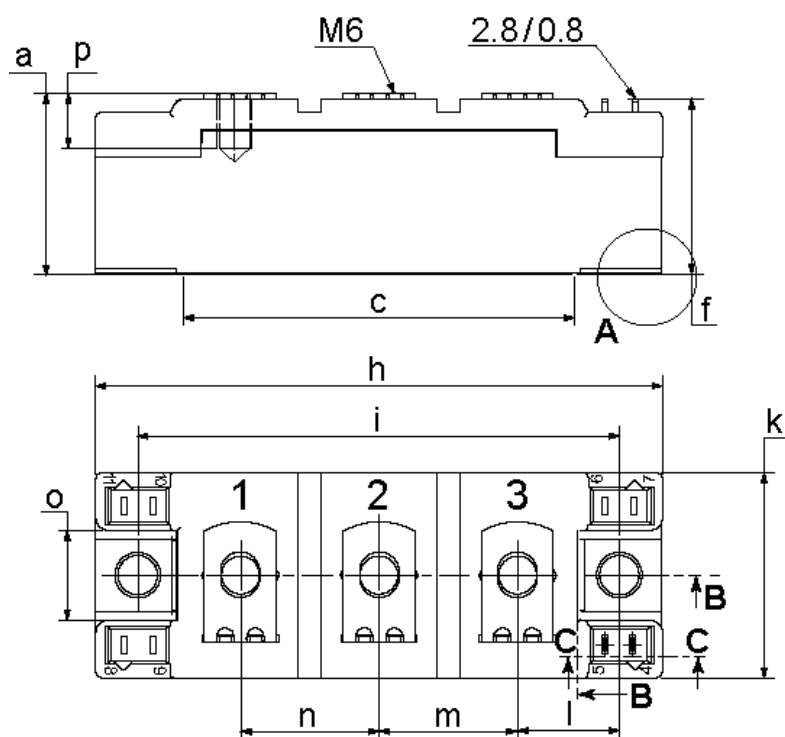
\* on die level

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



Thyristor

|             |                    |      |    |
|-------------|--------------------|------|----|
| $V_{0\max}$ | threshold voltage  | 0.88 | V  |
| $R_{0\max}$ | slope resistance * | 0.8  | mΩ |

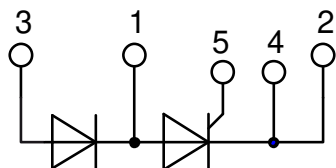
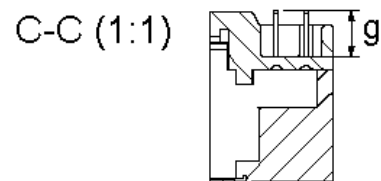
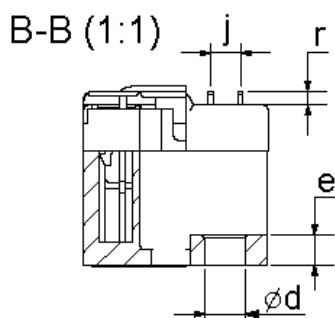
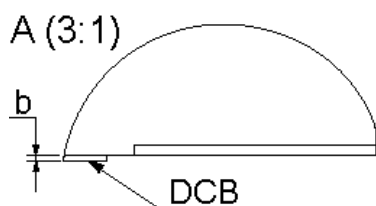
**Outlines Y4**


| Dim. | MIN<br>[mm] | MAX<br>[mm] | MIN<br>[inch] | MAX<br>[inch] |
|------|-------------|-------------|---------------|---------------|
| a    | 30.0        | 30.6        | 1.181         | 1.205         |
| b    | typ. 0.25   |             | typ. 0.010    |               |
| c    | 64.0        | 65.0        | 2.520         | 2.559         |
| d    | 6.5         | 7.0         | 0.256         | 0.275         |
| e    | 4.9         | 5.1         | 0.193         | 0.201         |
| f    | 28.6        | 29.2        | 1.126         | 1.150         |
| g    | 7.3         | 7.7         | 0.287         | 0.303         |
| h    | 93.5        | 94.5        | 3.681         | 3.720         |
| i    | 79.5        | 80.5        | 3.130         | 3.169         |
| j    | 4.8         | 5.2         | 0.189         | 0.205         |
| k    | 33.4        | 34.0        | 1.315         | 1.339         |
| l    | 16.7        | 17.3        | 0.657         | 0.681         |
| m    | 22.7        | 23.3        | 0.894         | 0.917         |
| n    | 22.7        | 23.3        | 0.894         | 0.917         |
| o    | 14.0        | 15.0        | 0.551         | 0.591         |
| p    | typ. 10.5   |             | typ. 0.413    |               |
| r    | 1.8         | 2.4         | 0.071         | 0.041         |

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

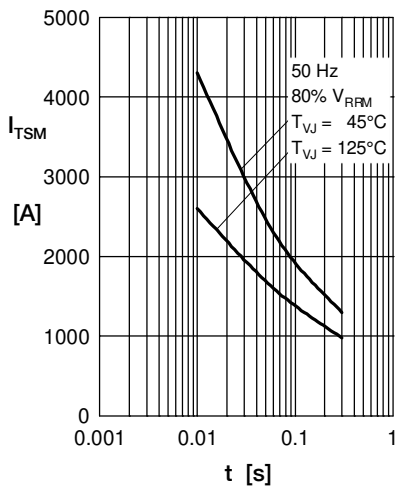


Fig. 1 Surge overload current  $I_{TSM}$ ,  
 $I_{FSM}$ : Crest value, t: duration

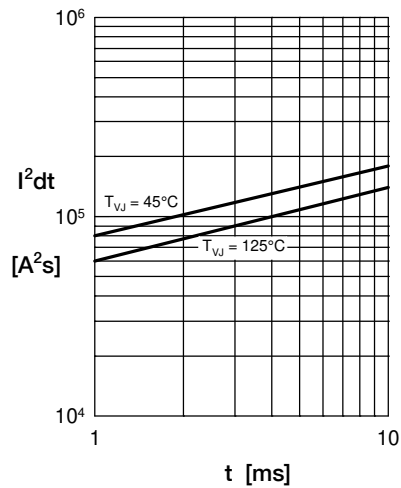


Fig. 2  $I^2t$  versus time (1-10 ms)

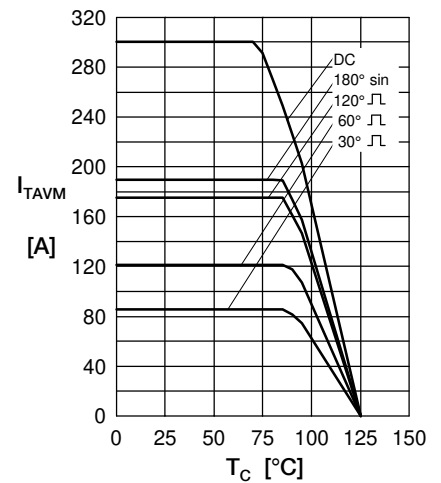


Fig. 3 Max. forward current at case temperature

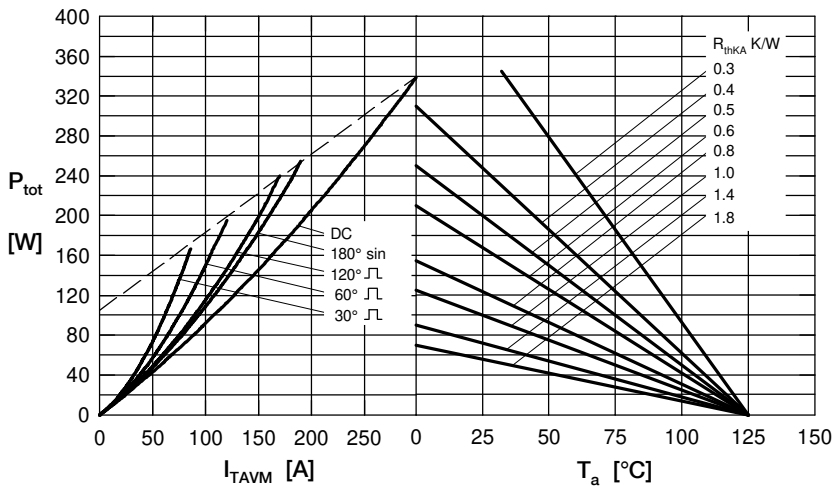


Fig. 4 Power dissipation vs. on-state current & ambient temperature (per thyristor or diode)

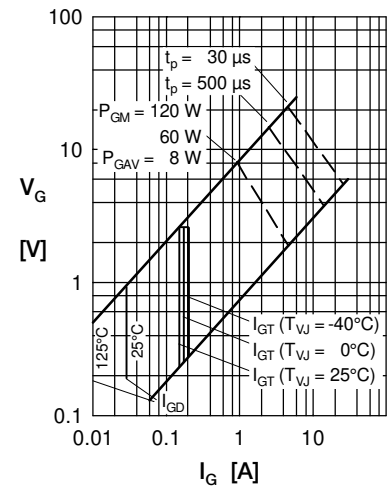


Fig. 5 Gate trigger characteristics

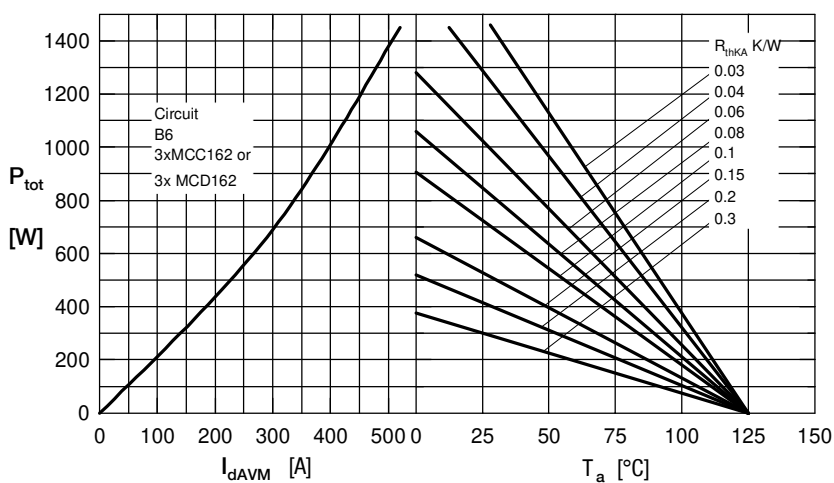


Fig. 6 Three phase rectifier bridge: Power dissipation versus direct output current and ambient temperature

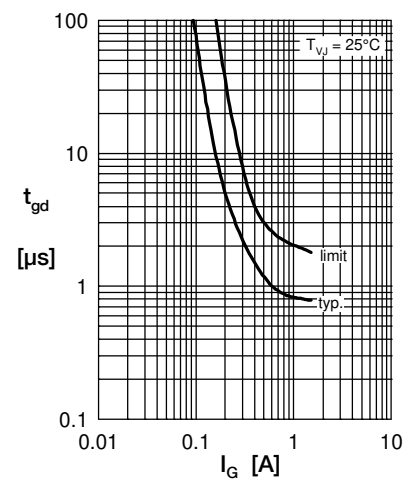


Fig. 7 Gate trigger delay time

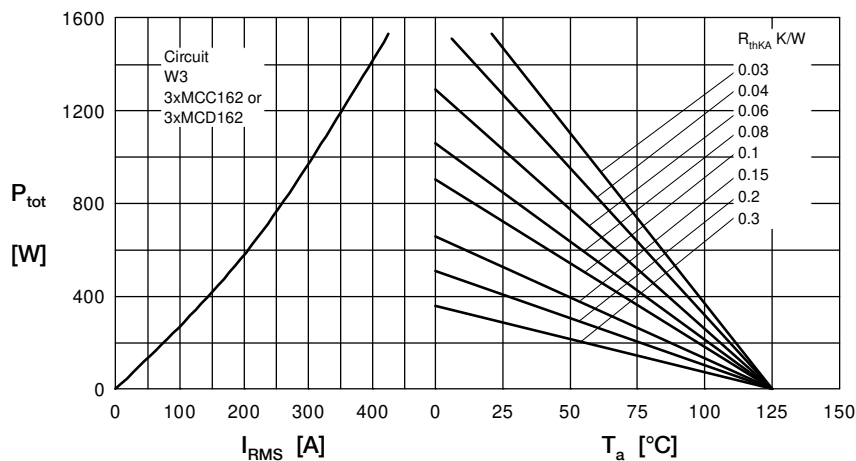
**Rectifier**


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

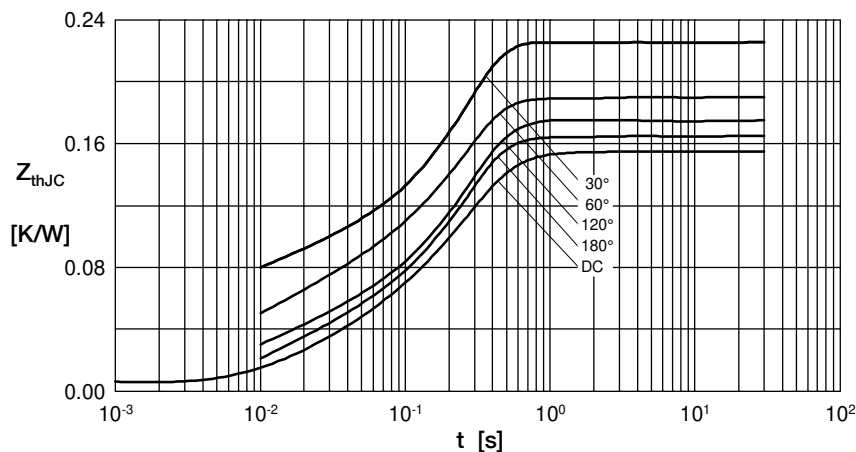


Fig. 9 Transient thermal impedance junction to case (per thyristor/diode)

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

| d    | $R_{thJC}$ [K/W] |
|------|------------------|
| DC   | 0.155            |
| 180° | 0.167            |
| 120° | 0.176            |
| 60°  | 0.197            |
| 30°  | 0.227            |

Constants for  $Z_{thJC}$  calculation:

| i | $R_{thi}$ [K/W] | $t_i$ [s] |
|---|-----------------|-----------|
| 1 | 0.0072          | 0.001     |
| 2 | 0.0188          | 0.080     |
| 3 | 0.1290          | 0.200     |

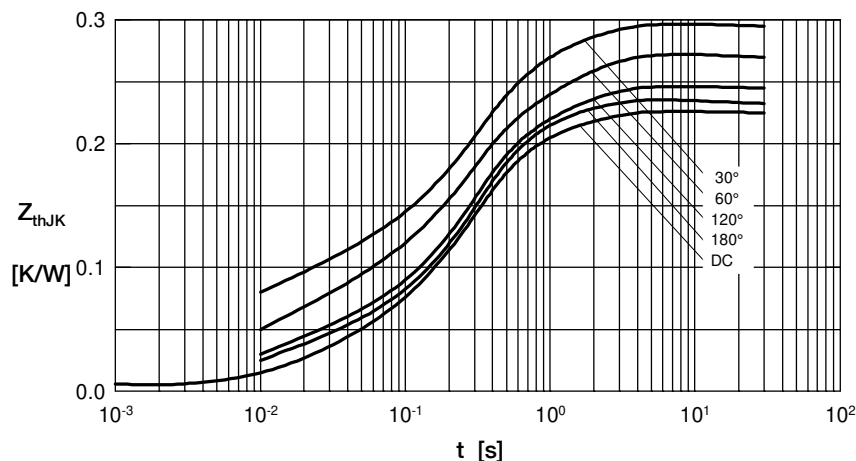


Fig. 10 Transient thermal impedance junction to heatsink (per thyristor/diode)

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

| d    | $R_{thJK}$ [K/W] |
|------|------------------|
| DC   | 0.225            |
| 180° | 0.237            |
| 120° | 0.246            |
| 60°  | 0.267            |
| 30°  | 0.297            |

Constants for  $Z_{thJK}$  calculation:

| i | $R_{thi}$ [K/W] | $t_i$ [s] |
|---|-----------------|-----------|
| 1 | 0.0072          | 0.001     |
| 2 | 0.0188          | 0.080     |
| 3 | 0.1290          | 0.200     |
| 4 | 0.0700          | 1.000     |