

# Thyristor Module

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

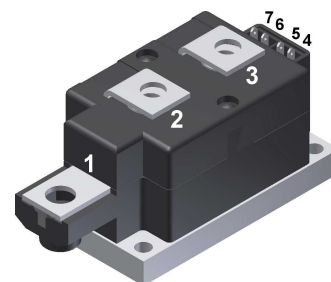
$$I_{TAV} = 220 \text{ A}$$

$$V_T = 0,97 \text{ V}$$

Phase leg

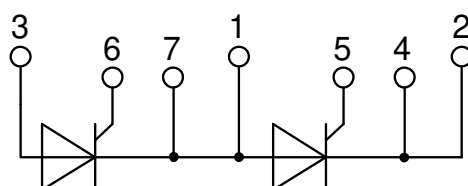
Part number

**MCC225-16io1**



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: 4800 V~
- Industry standard outline
- RoHS compliant
- Soldering pins for PCB mounting
- Base plate: Copper internally DCB isolated
- Advanced power cycling

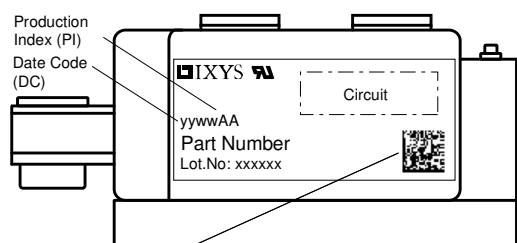
## Disclaimer Notice

Information furnished is believed to be accurate and reliable. However, users should independently evaluate the suitability of and test each product selected for their own applications. Littelfuse products are not designed for, and may not be used in, all applications. Read complete Disclaimer Notice at [www.littelfuse.com/disclaimer-electronics](http://www.littelfuse.com/disclaimer-electronics).



| 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                       | $V_{R/D} = 1600\text{ V}$                                                                                                                                                                              | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 1     | mA                |
|                |                                                      | $V_{R/D} = 1600\text{ V}$                                                                                                                                                                              | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 40    | mA                |
| $V_T$          | forward voltage drop                                 | $I_T = 200\text{ A}$                                                                                                                                                                                   | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 1,04  | V                 |
|                |                                                      | $I_T = 400\text{ A}$                                                                                                                                                                                   |                                |         |      | 1,18  | V                 |
|                |                                                      | $I_T = 200\text{ A}$                                                                                                                                                                                   | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 0,97  | V                 |
|                |                                                      | $I_T = 400\text{ A}$                                                                                                                                                                                   |                                |         |      | 1,14  | V                 |
|                |                                                      |                                                                                                                                                                                                        |                                |         |      |       |                   |
| $I_{TAV}$      | average forward current                              | $T_C = 85^{\circ}\text{C}$                                                                                                                                                                             | $T_{VJ} = 140^{\circ}\text{C}$ |         |      | 220   | A                 |
| $I_{T(RMS)}$   | RMS forward current                                  | 180° sine                                                                                                                                                                                              |                                |         |      | 400   | A                 |
| $V_{T0}$       | threshold voltage                                    | } for power loss calculation only                                                                                                                                                                      | $T_{VJ} = 140^{\circ}\text{C}$ |         |      | 0,79  | V                 |
| $r_T$          | slope resistance                                     |                                                                                                                                                                                                        |                                |         |      | 0,83  | mΩ                |
| $R_{thJC}$     | thermal resistance junction to case                  |                                                                                                                                                                                                        |                                |         |      | 0,157 | K/W               |
| $R_{thCH}$     | thermal resistance case to heatsink                  |                                                                                                                                                                                                        |                                |         | 0,04 |       | K/W               |
| $P_{tot}$      | total power dissipation                              |                                                                                                                                                                                                        | $T_C = 25^{\circ}\text{C}$     |         |      | 730   | W                 |
| $I_{TSM}$      | max. forward surge current                           | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                                                       | $T_{VJ} = 45^{\circ}\text{C}$  |         |      | 8,00  | kA                |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                                                      | $V_R = 0\text{ V}$             |         |      | 8,64  | kA                |
|                |                                                      | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                                                       | $T_{VJ} = 140^{\circ}\text{C}$ |         |      | 6,80  | kA                |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                                                      | $V_R = 0\text{ V}$             |         |      | 7,35  | kA                |
| $I^2t$         | value for fusing                                     | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                                                       | $T_{VJ} = 45^{\circ}\text{C}$  |         |      | 320,0 | kA <sup>2</sup> s |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                                                      | $V_R = 0\text{ V}$             |         |      | 310,5 | kA <sup>2</sup> s |
|                |                                                      | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                                                       | $T_{VJ} = 140^{\circ}\text{C}$ |         |      | 231,2 | kA <sup>2</sup> s |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                                                      | $V_R = 0\text{ V}$             |         |      | 224,4 | kA <sup>2</sup> s |
| $C_J$          | junction capacitance                                 | $V_R = 400\text{ V}$ $f = 1\text{ MHz}$                                                                                                                                                                | $T_{VJ} = 25^{\circ}\text{C}$  |         | 366  |       | 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, $I_T = 660\text{ A}$                                                                                                                      |                                |         |      | 100   | A/ $\mu\text{s}$  |
|                |                                                      | $t_p = 200\text{ }\mu\text{s}; di_G/dt = 1\text{ A}/\mu\text{s};$<br>$I_G = 1\text{ A}; V_D = \frac{2}{3} V_{DRM}$ non-repet., $I_T = 220\text{ A}$                                                    |                                |         |      | 500   | A/ $\mu\text{s}$  |
| $(dv/dt)_{cr}$ | critical rate of rise of voltage                     | $V_D = \frac{2}{3} V_{DRM}$                                                                                                                                                                            | $T_{VJ} = 140^{\circ}\text{C}$ |         |      | 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                                        | $V_R = 100\text{ V}; I_T = 220\text{ A}; V_D = \frac{2}{3} V_{DRM}$ $T_{VJ} = 125^{\circ}\text{C}$<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 |
| $I_{RMS}$     | RMS current                                                  | per terminal         |         |      | 600  | A    |
| $T_{VJ}$      | virtual junction temperature                                 |                      | -40     |      | 140  | °C   |
| $T_{op}$      | operation temperature                                        |                      | -40     |      | 125  | °C   |
| $T_{stg}$     | storage temperature                                          |                      | -40     |      | 125  | °C   |
| Weight        |                                                              |                      |         | 680  |      | g    |
| $M_D$         | mounting torque                                              |                      | 4,5     |      | 7    | Nm   |
| $M_T$         | terminal torque                                              |                      | 11      |      | 13   | Nm   |
| $d_{Spp/App}$ | creepage distance on surface   striking distance through air | terminal to terminal | 16,0    |      |      | mm   |
| $d_{Spb/Apb}$ |                                                              | terminal to backside | 16,0    |      |      | mm   |
| $V_{ISOL}$    | isolation voltage                                            | t = 1 second         | 4800    |      |      | V    |
|               |                                                              | t = 1 minute         | 4000    |      |      | V    |



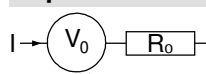
Data Matrix: part no. (1-19), DC + PI (20-25), lot.no.# (26-31), blank (32), serial no.# (33-36)

| Ordering | Ordering Number | Marking on Product | Delivery Mode | Quantity | Code No. |
|----------|-----------------|--------------------|---------------|----------|----------|
| Standard | MCC225-16io1    | MCC225-16io1       | Box           | 3        | 463299   |

### Equivalent Circuits for Simulation

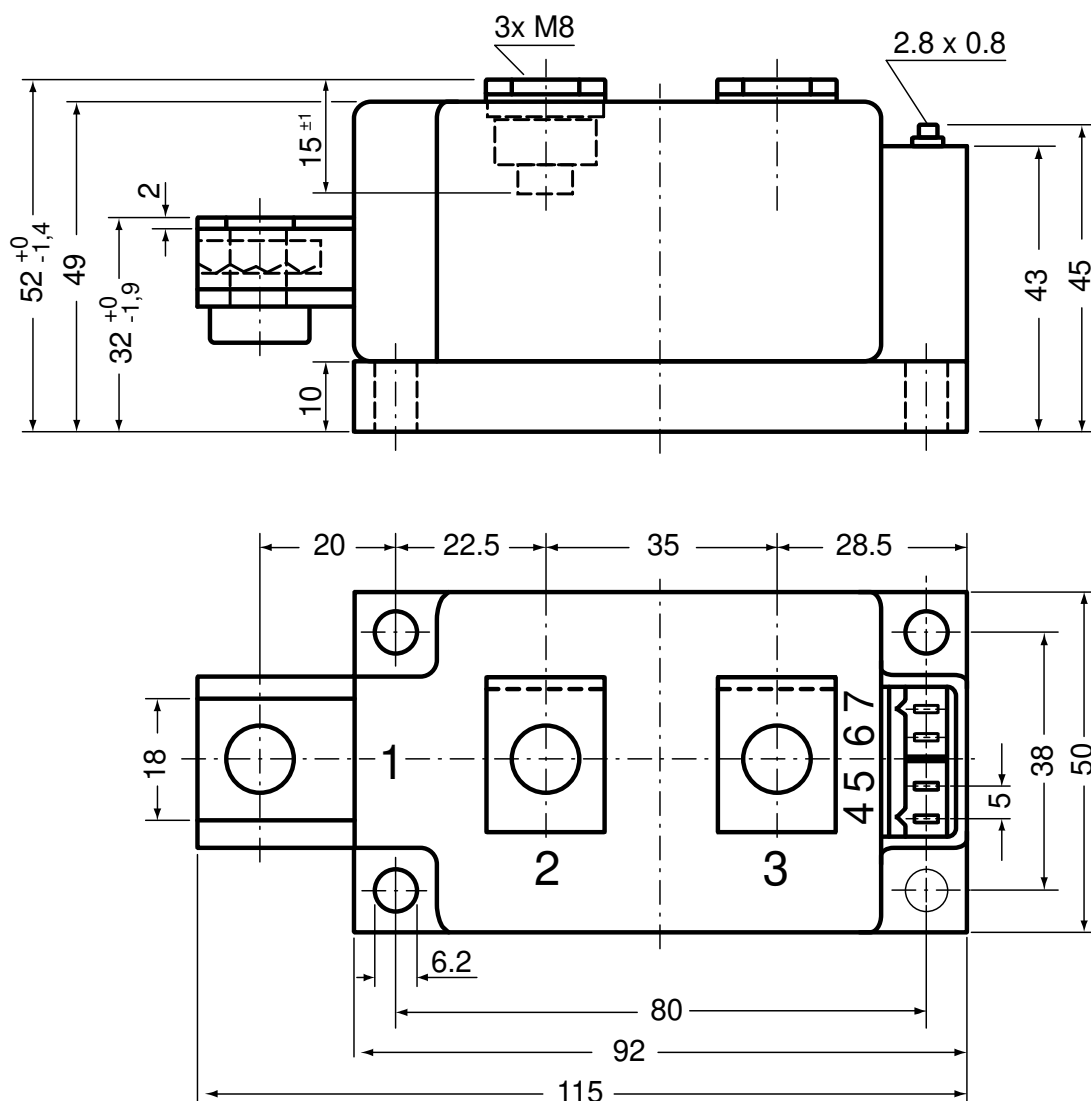
\* on die level

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



Thyristor

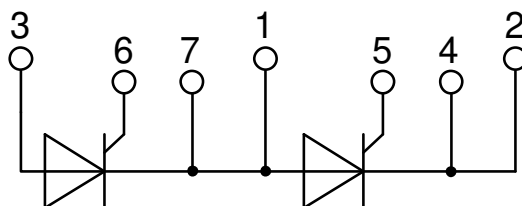
|             |                    |      |    |
|-------------|--------------------|------|----|
| $V_{0\max}$ | threshold voltage  | 0,79 | V  |
| $R_{0\max}$ | slope resistance * | 0,64 | mΩ |

**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)

Type ZY 180R (R = Right for pin pair 6/7) } UL 758, style 3751



## Thyristor

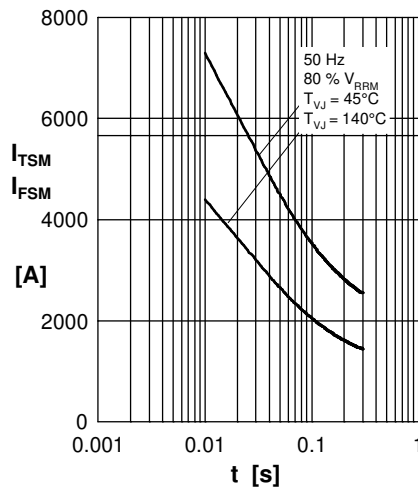


Fig. 1 Surge overload current  
 $I_{TSM/FSM}$ : Crest value,  $t$ : duration

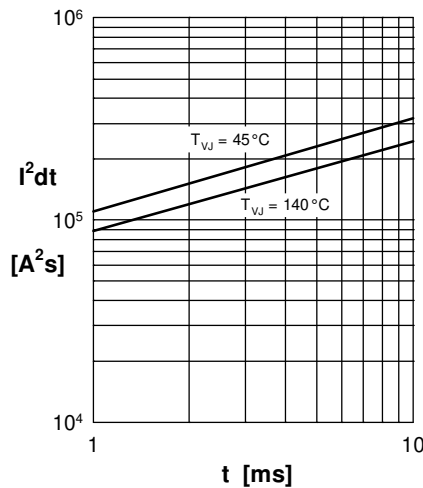


Fig. 2  $I^2dt$  versus time

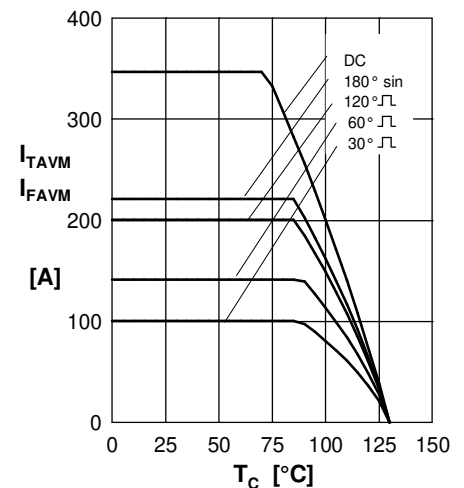


Fig. 3 Max. forward current  
 at case temperature

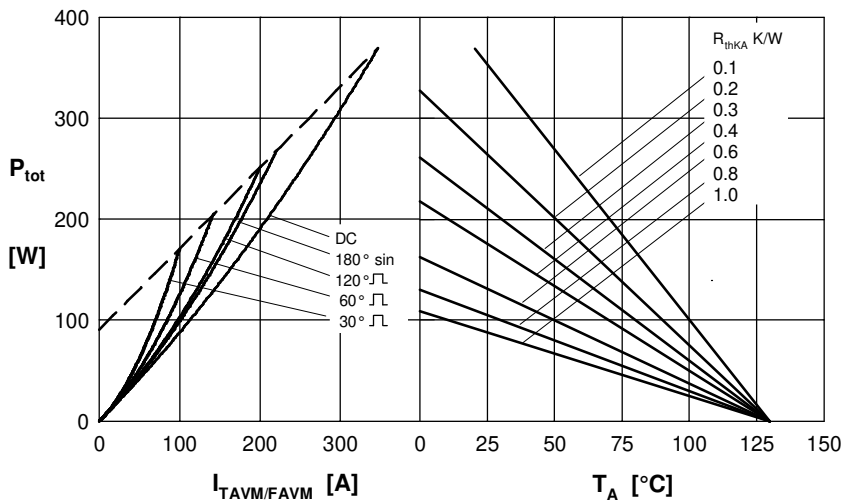


Fig. 4 Power dissipation versus on-state current and  
 ambient temperature (per thyristor or diode)

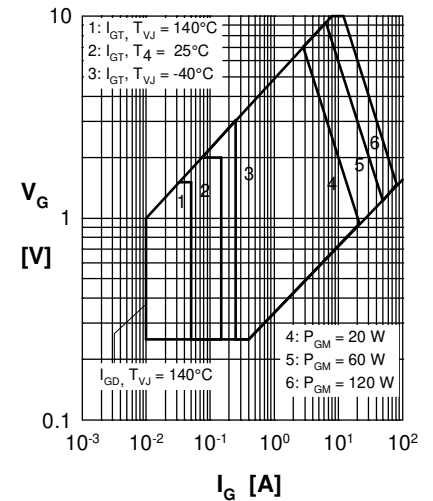


Fig. 5 Gate voltage and current

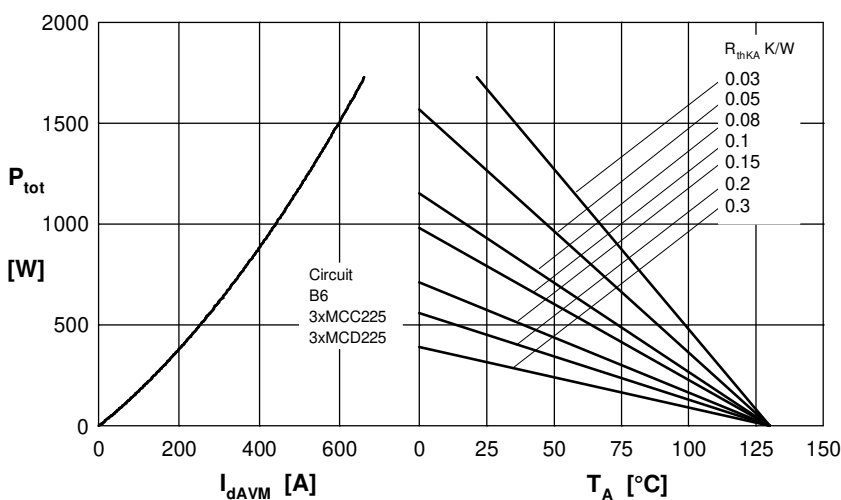


Fig. 6 Three phase rectifier bridge: Power dissipation versus direct  
 output current and ambient temperature

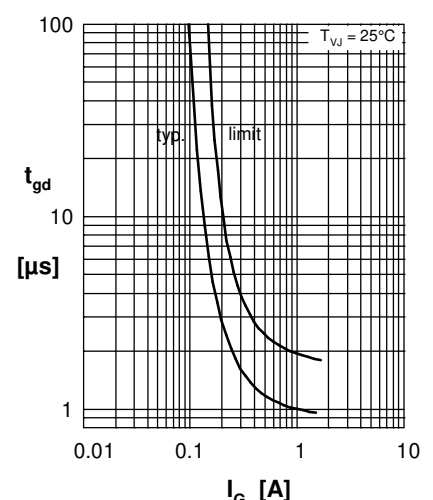


Fig. 7 Gate trigger characteristics

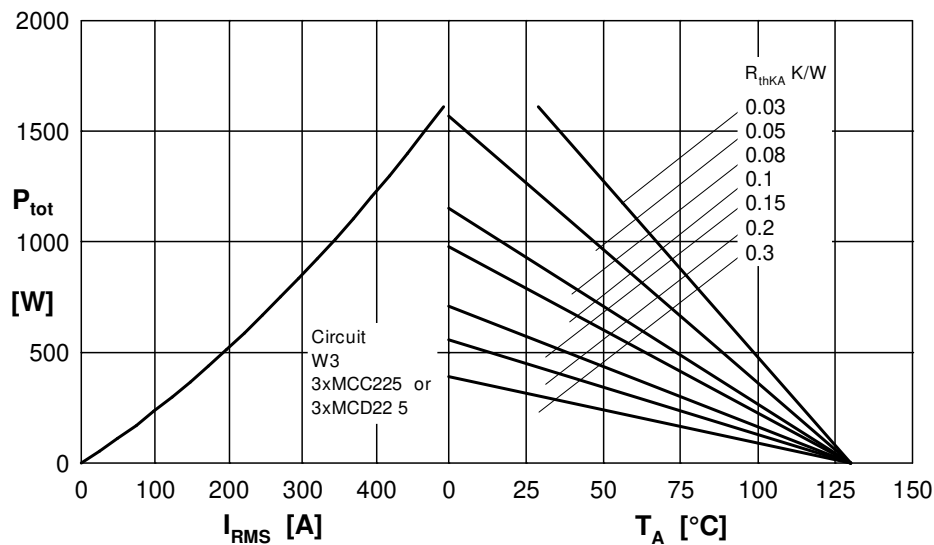
**Rectifier**


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

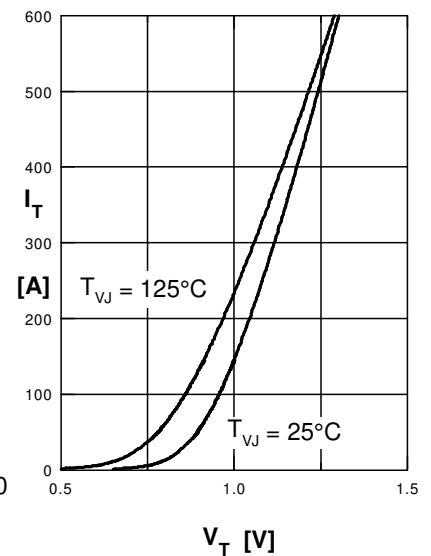


Fig. 9 Forward characteristics

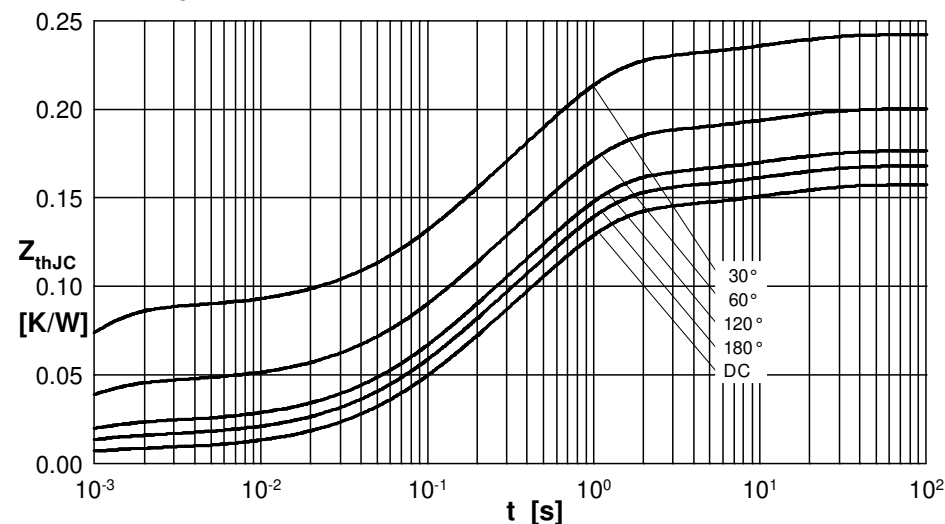


Fig. 10 Transient thermal impedance junction to case (per thyristor/diode)

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

| d    | $R_{thJC}$ (K/W) |
|------|------------------|
| DC   | 0.157            |
| 180° | 0.168            |
| 120° | 0.177            |
| 60°  | 0.200            |
| 30°  | 0.243            |

Constants for  $Z_{thJC}$  calculation:

| i | $R_{thi}$ (K/W) | t (s)   |
|---|-----------------|---------|
| 1 | 0.0076          | 0.00054 |
| 2 | 0.0406          | 0.09800 |
| 3 | 0.0944          | 0.54000 |
| 4 | 0.0147          | 12.0000 |

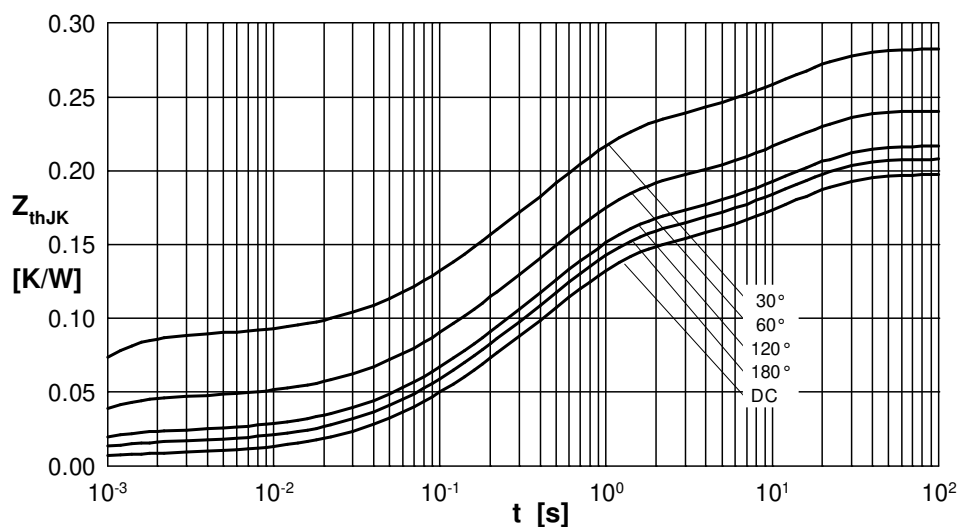


Fig. 11 Transient thermal impedance junction to heatsink (per thyristor/diode)

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

| d    | $R_{thJK}$ (K/W) |
|------|------------------|
| DC   | 0.197            |
| 180° | 0.208            |
| 120° | 0.217            |
| 60°  | 0.240            |
| 30°  | 0.283            |

Constants for  $Z_{thJK}$  calculation:

| i | $R_{thi}$ (K/W) | t (s)   |
|---|-----------------|---------|
| 1 | 0.0076          | 0.00054 |
| 2 | 0.0406          | 0.09800 |
| 3 | 0.0944          | 0.54000 |
| 4 | 0.0147          | 12.0000 |
| 5 | 0.0400          | 12.0000 |