

# High Voltage Thyristor Module

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

$$I_{TAV} = 250 \text{ A}$$

$$V_T = 1,03 \text{ V}$$

Phase leg

Part number

**MCC224-24io1**



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: 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

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| Thyristor      |                                                      |                                                                                                                                                                         |                                | Ratings |      |       |                   |
|----------------|------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|---------|------|-------|-------------------|
| Symbol         | Definition                                           | Conditions                                                                                                                                                              |                                | min.    | typ. | max.  | Unit              |
| $V_{RSM/DSM}$  | max. non-repetitive reverse/forward blocking voltage | $T_{VJ} = 25^{\circ}\text{C}$                                                                                                                                           |                                |         |      | 2500  | V                 |
| $V_{RRM/DRM}$  | max. repetitive reverse/forward blocking voltage     | $T_{VJ} = 25^{\circ}\text{C}$                                                                                                                                           |                                |         |      | 2400  | V                 |
| $I_{R/D}$      | reverse current, drain current                       | $V_{R/D} = 2400\text{ V}$                                                                                                                                               | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 1     | mA                |
|                |                                                      | $V_{R/D} = 2400\text{ V}$                                                                                                                                               | $T_{VJ} = 140^{\circ}\text{C}$ |         |      | 40    | mA                |
| $V_T$          | forward voltage drop                                 | $I_T = 250\text{ A}$                                                                                                                                                    | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 1,08  | V                 |
|                |                                                      | $I_T = 500\text{ A}$                                                                                                                                                    |                                |         |      | 1,31  | V                 |
|                |                                                      | $I_T = 250\text{ A}$                                                                                                                                                    | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 1,03  | V                 |
|                |                                                      | $I_T = 500\text{ A}$                                                                                                                                                    |                                |         |      | 1,33  | V                 |
| $I_{TAV}$      | average forward current                              | $T_C = 85^{\circ}\text{C}$                                                                                                                                              | $T_{VJ} = 140^{\circ}\text{C}$ |         |      | 250   | A                 |
| $I_{T(RMS)}$   | RMS forward current                                  | 180° sine                                                                                                                                                               |                                |         |      | 390   | A                 |
| $V_{T0}$       | threshold voltage                                    | } for power loss calculation only                                                                                                                                       | $T_{VJ} = 140^{\circ}\text{C}$ |         |      | 0,72  | V                 |
| $r_T$          | slope resistance                                     |                                                                                                                                                                         |                                |         |      | 1,2   | mΩ                |
| $R_{thJC}$     | thermal resistance junction to case                  |                                                                                                                                                                         |                                |         |      | 0,139 | K/W               |
| $R_{thCH}$     | thermal resistance case to heatsink                  |                                                                                                                                                                         |                                |         | 0,04 |       | K/W               |
| $P_{tot}$      | total power dissipation                              |                                                                                                                                                                         | $T_C = 25^{\circ}\text{C}$     |         |      | 820   | 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                                 | $V_R = 700\text{ V}$ $f = 1\text{ MHz}$                                                                                                                                 | $T_{VJ} = 25^{\circ}\text{C}$  |         | 235  |       | 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                     | $T_{VJ} = 125^{\circ}\text{C}; f = 50\text{ Hz}$ repetitive, $I_T = 750\text{ A}$                                                                                       |                                |         |      | 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., $I_T = 250\text{ A}$                     |                                |         |      | 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                                 | $V_D = 6\text{ V}$                                                                                                                                                      | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 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     | $\mu\text{s}$     |
|                |                                                      | $I_G = 0,5\text{ A}; di_G/dt = 0,5\text{ A}/\mu\text{s}$                                                                                                                |                                |         |      |       |                   |
| $t_q$          | turn-off time                                        | $V_R = 100\text{ V}; I_T = 250\text{ A}; V_D = \frac{2}{3} V_{DRM}$<br>$di/dt = 10\text{ A}/\mu\text{s}; dv/dt = 50\text{ V}/\mu\text{s}; t_p = 200\text{ }\mu\text{s}$ | $T_{VJ} = 125^{\circ}\text{C}$ |         | 350  |       | $\mu\text{s}$     |

| 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   |
| <b>Weight</b> |                                                              |                      |         | 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 | MCC224-24io1    | MCC224-24io1       | Box           | 3        | 508283   |

### Equivalent Circuits for Simulation

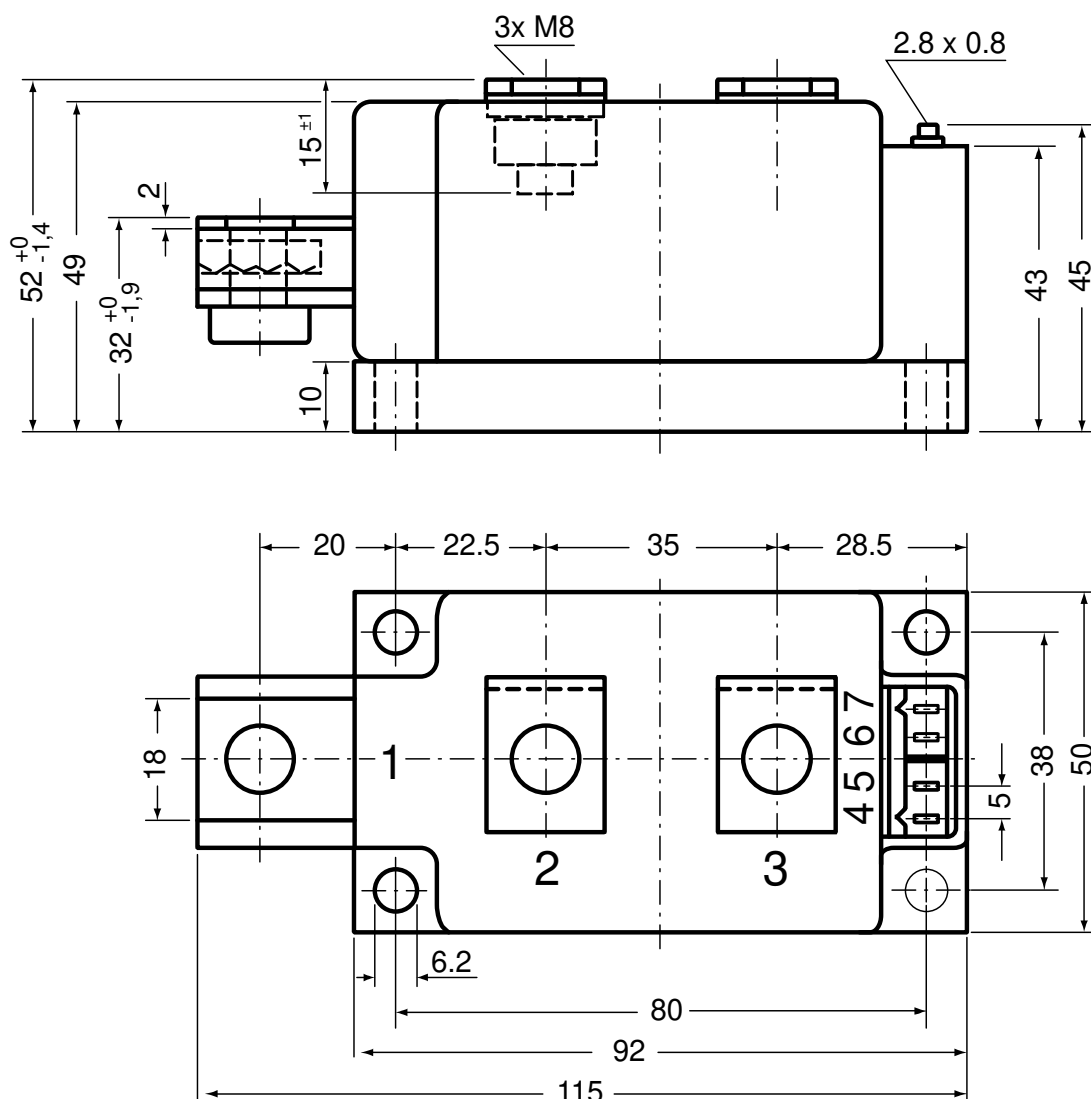
\* on die level

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



Thyristor

|             |                    |      |    |
|-------------|--------------------|------|----|
| $V_{0\max}$ | threshold voltage  | 0,72 | V  |
| $R_{0\max}$ | slope resistance * | 1,01 | 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

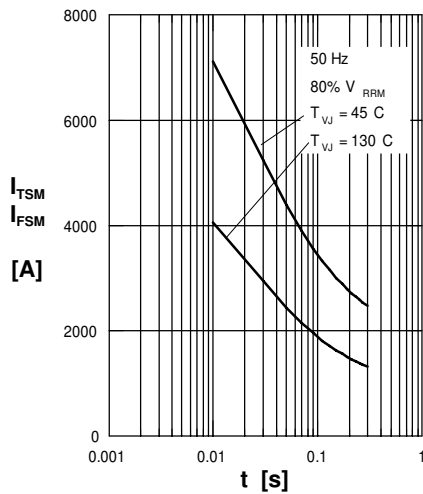


Fig. 1 Surge overload current  
 $I_{T(F)SM}$ : crest value,  $t$ : duration

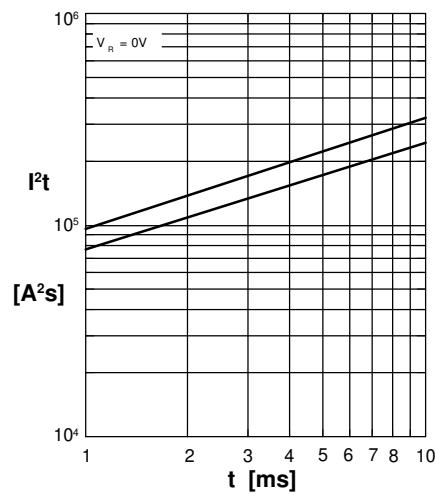


Fig. 2  $I^2t$  versus time (1-10 ms)

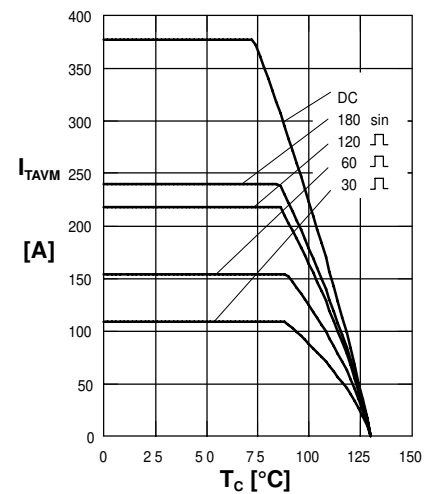


Fig. 3 Max. forward current  
 at case temperature

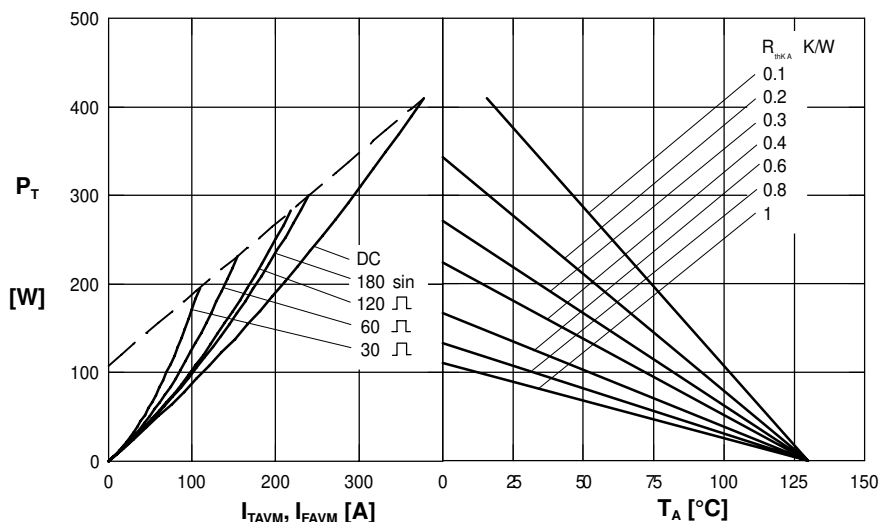


Fig. 4 Power dissipation versus onstate current and  
 ambient temperature (per thyristor/diode)

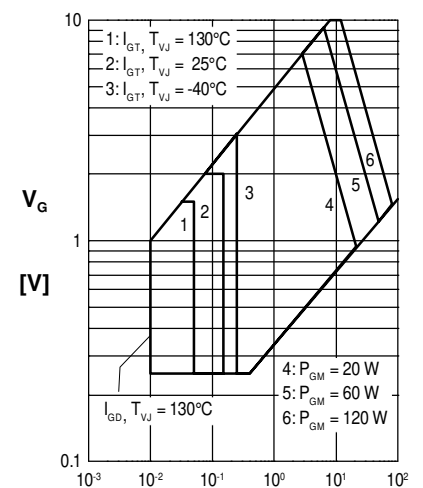


Fig. 5 Gate trigger characteristics

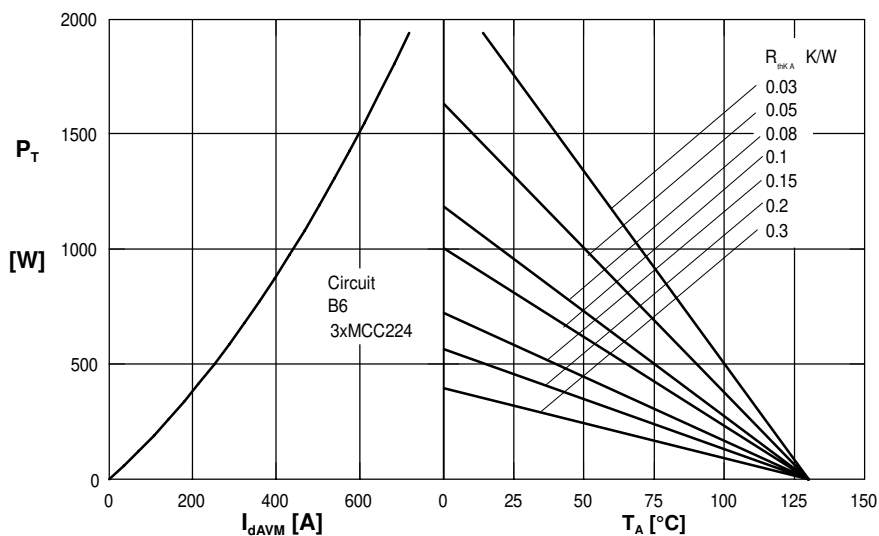


Fig. 6 Three phase rectifier bridge: Power dissipation versus  
 direct output current and ambient temperature

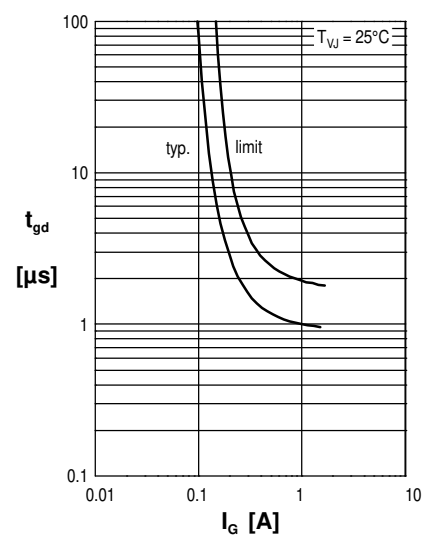


Fig. 7 Gate trigger delay time

## Thyristor

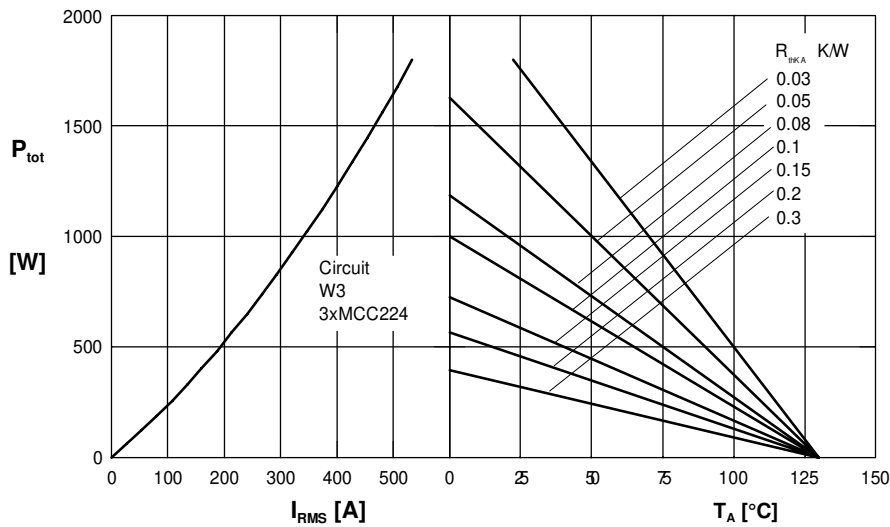


Fig. 7 Three phase AC-controller: Power dissipation versus RMS output current and ambient temperature

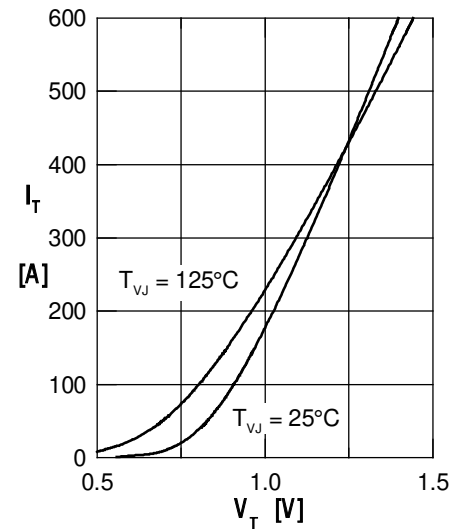


Fig. 10 Forward characteristics

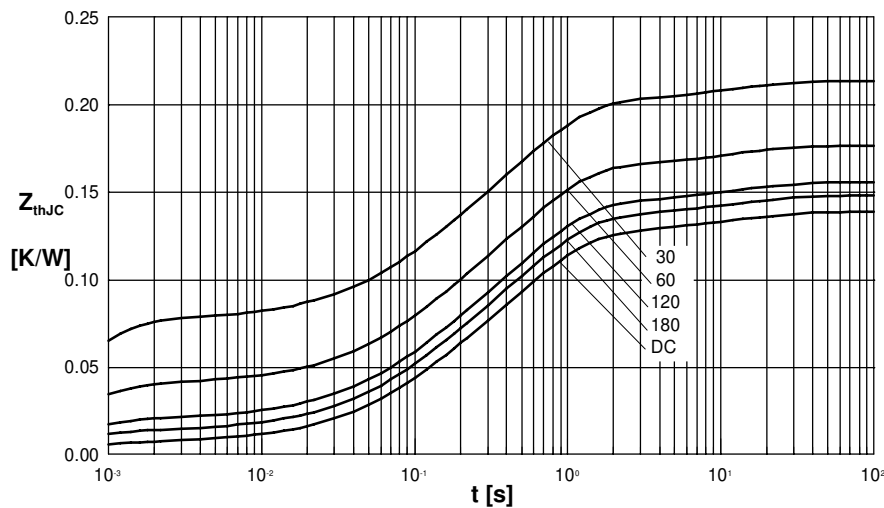


Fig. 8 Transient thermal impedance junction to case (per thyristor/diode)

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

| $d$   | $R_{thJC}$ [K/W] |
|-------|------------------|
| DC    | 0.139            |
| 180°C | 0.148            |
| 120°C | 0.156            |
| 60°C  | 0.176            |
| 30°C  | 0.214            |

Constants for  $Z_{thJC}$  calculation:

| $i$ | $R_{thi}$ [K/W] | $t_i$ [s] |
|-----|-----------------|-----------|
| 1   | 0.0067          | 0.00054   |
| 2   | 0.0358          | 0.098     |
| 3   | 0.0832          | 0.540     |
| 4   | 0.0129          | 12.00     |

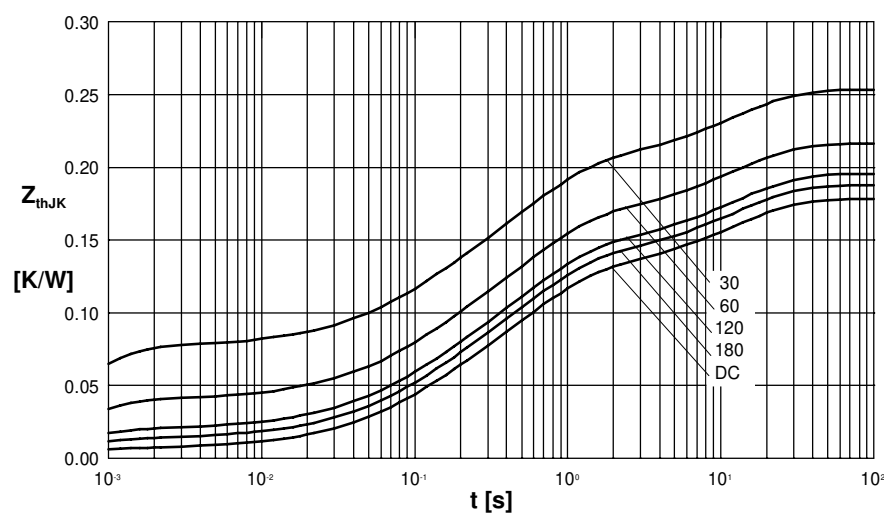


Fig. 9 Transient thermal impedance junction to heatsink (per thyristor/diode)

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

| $d$   | $R_{thJK}$ [K/W] |
|-------|------------------|
| DC    | 0.179            |
| 180°C | 0.188            |
| 120°C | 0.196            |
| 60°C  | 0.216            |
| 30°C  | 0.256            |

Constants for  $Z_{thJK}$  calculation:

| $i$ | $R_{thi}$ [K/W] | $t_i$ [s] |
|-----|-----------------|-----------|
| 1   | 0.0067          | 0.001     |
| 2   | 0.0358          | 0.080     |
| 3   | 0.0832          | 0.200     |
| 4   | 0.0129          | 1.000     |