

# High Voltage Thyristor Module

$$V_{RRM} = 2 \times 2000 \text{ V}$$

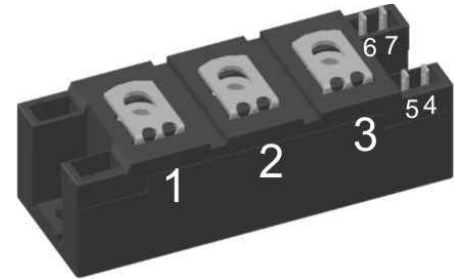
$$I_{TAV} = 165 \text{ A}$$

$$V_T = 1.08 \text{ V}$$

Phase leg

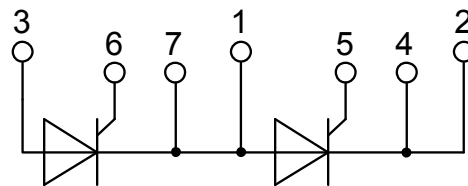
Part number

**MCC161-20io1**



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:

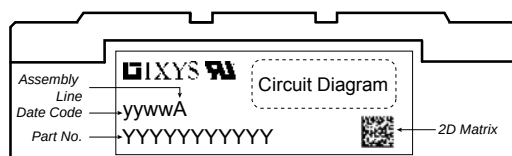
- Line rectifying 50/60 Hz
- Softstart AC motor control
- DC Motor control
- Power converter
- AC power control
- Lighting and temperature control

## 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

| Thyristor      |                                                      |                                                                                                                                                                                                        |                                | Ratings |      |       |                   |
|----------------|------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|---------|------|-------|-------------------|
| Symbol         | Definition                                           | Conditions                                                                                                                                                                                             |                                | min.    | typ. | max.  | Unit              |
| $V_{RSM/DSM}$  | max. non-repetitive reverse/forward blocking voltage | $T_{VJ} = 25^{\circ}\text{C}$                                                                                                                                                                          |                                |         |      | 2100  | V                 |
| $V_{RRM/DRM}$  | max. repetitive reverse/forward blocking voltage     | $T_{VJ} = 25^{\circ}\text{C}$                                                                                                                                                                          |                                |         |      | 2000  | V                 |
| $I_{RD}$       | reverse current, drain current                       | $V_{RD} = 2000\text{ V}$                                                                                                                                                                               | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 400   | $\mu\text{A}$     |
|                |                                                      | $V_{RD} = 2000\text{ V}$                                                                                                                                                                               | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 40    | mA                |
| $V_T$          | forward voltage drop                                 | $I_T = 150\text{ A}$                                                                                                                                                                                   | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 1.14  | V                 |
|                |                                                      | $I_T = 300\text{ A}$                                                                                                                                                                                   |                                |         |      | 1.36  | V                 |
|                |                                                      | $I_T = 150\text{ A}$                                                                                                                                                                                   | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 1.08  | V                 |
|                |                                                      | $I_T = 300\text{ A}$                                                                                                                                                                                   |                                |         |      | 1.36  | V                 |
| $I_{TAV}$      | average forward current                              | $T_C = 85^{\circ}\text{C}$                                                                                                                                                                             | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 165   | A                 |
| $I_{T(RMS)}$   | RMS forward current                                  | 180° sine                                                                                                                                                                                              |                                |         |      | 300   | A                 |
| $V_{T0}$       | threshold voltage                                    | } for power loss calculation only                                                                                                                                                                      | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 0.80  | V                 |
| $r_T$          | slope resistance                                     |                                                                                                                                                                                                        |                                |         |      | 1.6   | 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                                 | $V_R = 700\text{ V}$ $f = 1\text{ MHz}$                                                                                                                                                                | $T_{VJ} = 25^{\circ}\text{C}$  |         | 195  |       | 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, $I_T = 500\text{ A}$                                                                                                                      |                                |         |      | 150   | A/ $\mu\text{s}$  |
|                |                                                      | $t_P = 200\text{ }\mu\text{s}; di_G/dt = 0.5\text{ A}/\mu\text{s};$ non-repet., $I_T = 160\text{ A}$                                                                                                   |                                |         |      | 500   | A/ $\mu\text{s}$  |
| $(dv/dt)_{cr}$ | critical rate of rise of voltage                     | $V_D = \frac{2}{3} V_{DRM}$                                                                                                                                                                            | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 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                 |
|                |                                                      |                                                                                                                                                                                                        | $T_{VJ} = -40^{\circ}\text{C}$ |         |      | 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                             | $V_D = \frac{2}{3} V_{DRM}$                                                                                                                                                                            | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 0.25  | 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                                      | $V_D = 6\text{ V}$ $R_{GK} = \infty$                                                                                                                                                                   | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 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                                        | $V_R = 100\text{ V}; I_T = 160\text{ A}; V_D = \frac{2}{3} V_{DRM}$ $T_{VJ} = 125^{\circ}\text{C}$<br>$di/dt = 10\text{ A}/\mu\text{s}; dv/dt = 20\text{ V}/\mu\text{s}; t_P = 200\text{ }\mu\text{s}$ |                                |         | 150  |       | $\mu\text{s}$     |

| Package Y4    |                                                              |                      |                                     | Ratings |      |      |      |
|---------------|--------------------------------------------------------------|----------------------|-------------------------------------|---------|------|------|------|
| Symbol        | Definition                                                   | Conditions           |                                     | min.    | typ. | max. | Unit |
| $I_{RMS}$     | RMS current                                                  | per terminal         |                                     |         |      | 300  | A    |
| $T_{VJ}$      | virtual junction temperature                                 |                      |                                     | -40     |      | 125  | °C   |
| $T_{op}$      | operation temperature                                        |                      |                                     | -40     |      | 100  | °C   |
| $T_{stg}$     | storage temperature                                          |                      |                                     | -40     |      | 125  | °C   |
| Weight        |                                                              |                      |                                     |         | 150  |      | g    |
| $M_D$         | mounting torque                                              |                      |                                     | 2.25    |      | 2.75 | Nm   |
| $M_T$         | terminal torque                                              |                      |                                     | 4.5     |      | 5.5  | Nm   |
| $d_{Spp/App}$ | creepage distance on surface   striking distance through air | terminal to terminal | 14.0                                | 10.0    |      |      | mm   |
| $d_{Spb/Apb}$ |                                                              | terminal to backside | 16.0                                | 16.0    |      |      | mm   |
| $V_{ISOL}$    | isolation voltage                                            | t = 1 second         | 50/60 Hz, RMS; $I_{ISOL} \leq 1$ mA | 3600    |      |      | V    |
|               |                                                              | t = 1 minute         |                                     | 3000    |      |      | V    |



| Ordering | Part Number  | Marking on Product | Delivery Mode | Quantity | Code No. |
|----------|--------------|--------------------|---------------|----------|----------|
| Standard | MCC161-20io1 | MCC161-20io1       | Box           | 6        | 463507   |

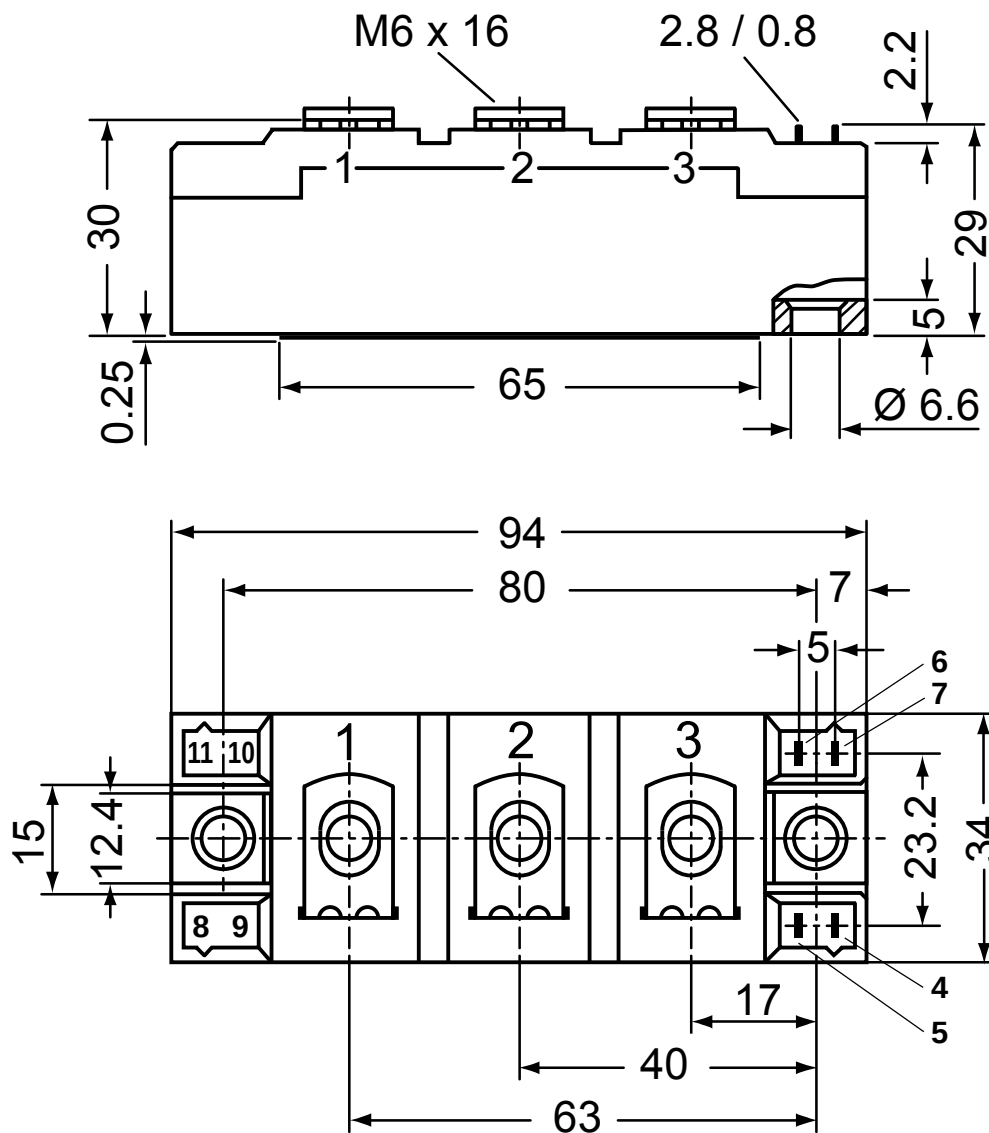
### Equivalent Circuits for Simulation

\* on die level

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

|             |                    |           |    |
|-------------|--------------------|-----------|----|
|             |                    | Thyristor |    |
| $V_{0\max}$ | threshold voltage  | 0.8       | V  |
| $R_{0\max}$ | slope resistance * | 0.9       | mΩ |

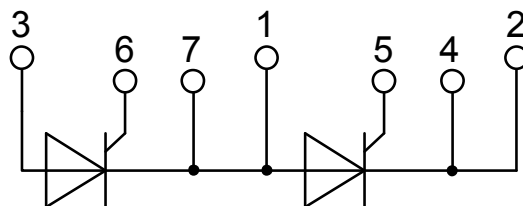
## Outlines Y4



### 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  
 Type ZY 180R (R = Right for pin pair 6/7)



## Thyristor

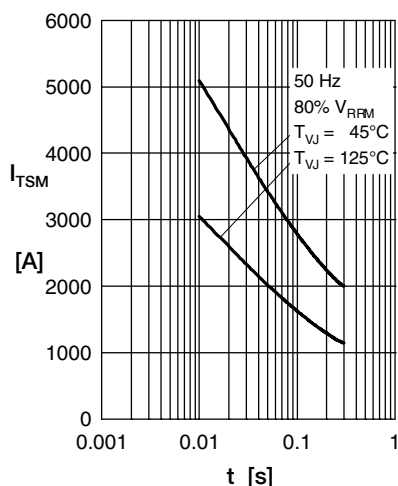


Fig. 1 Surge overload current  $I_{TSM}$ ,  
 $I_{FSM}$ : Crest value,  $t$ : duration

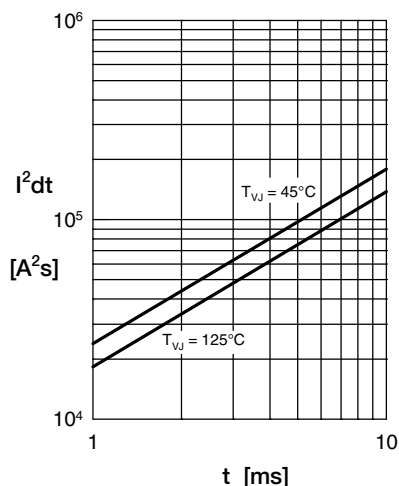


Fig. 2  $I^2t$  versus time (1-10 ms)

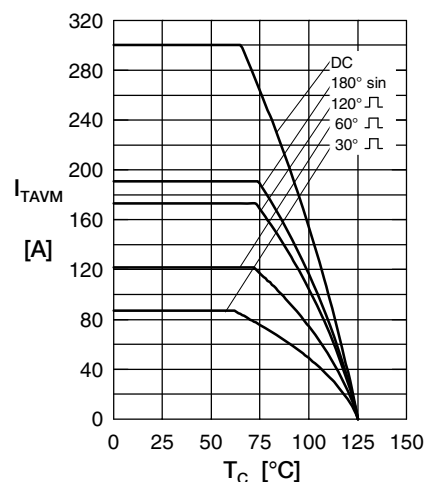


Fig. 3 Max. forward current  
at case temperature

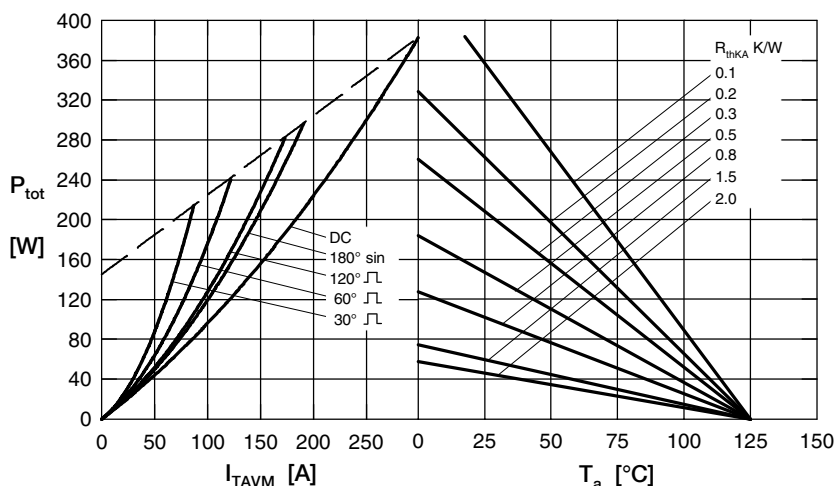


Fig. 4 Power dissipation vs. on-state current & ambient temperature  
(per thyristor or diode)

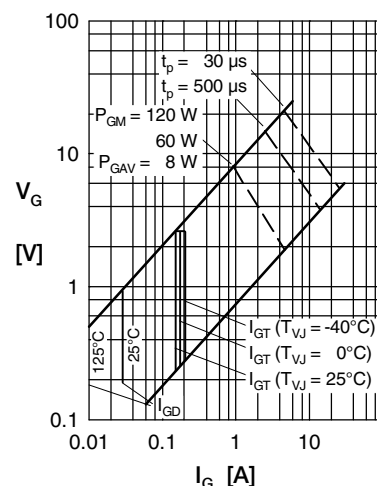


Fig. 5 Gate trigger characteristics

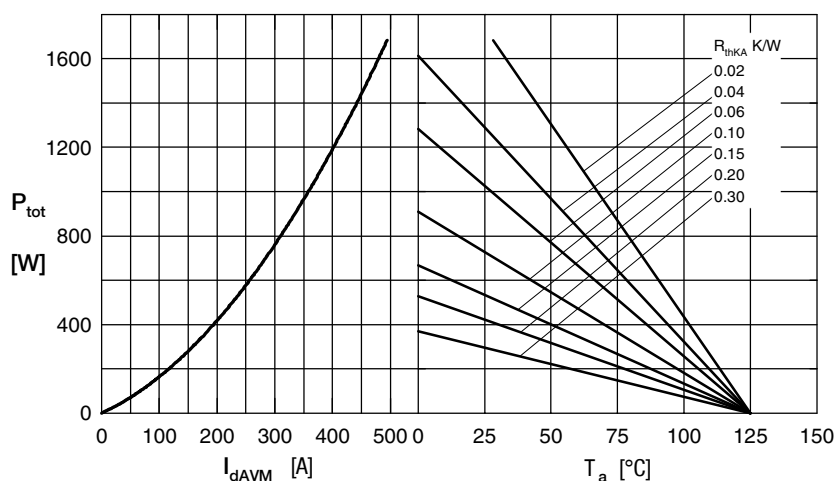


Fig. 6 Three phase rectifier bridge: Power dissipation versus direct  
output current and ambient temperature

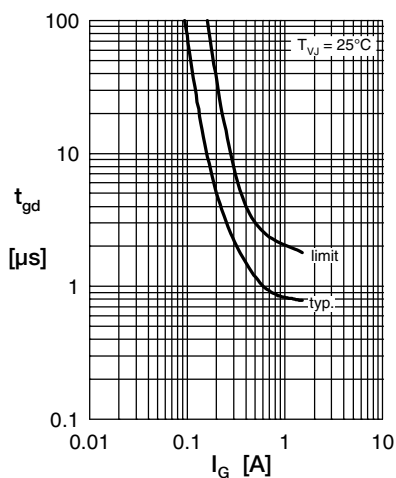


Fig. 7 Gate trigger delay time

# Thyristor

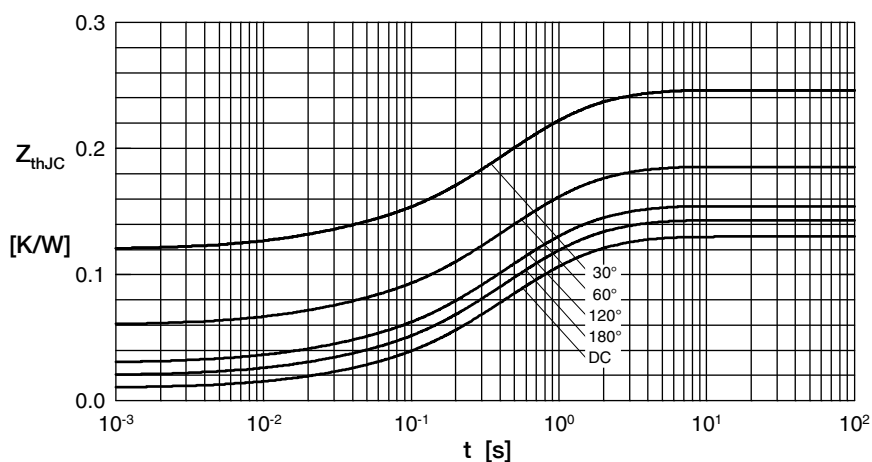


Fig. 8 Transient thermal impedance junction to case at various conduction angles

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

| $d$         | $R_{thJC}$ [K/W] |
|-------------|------------------|
| DC          | 0.155            |
| $180^\circ$ | 0.171            |
| $120^\circ$ | 0.184            |
| $60^\circ$  | 0.222            |
| $30^\circ$  | 0.294            |

Constants for  $Z_{thJC}$  calculation:

| $i$ | $R_{thi}$ [K/W] | $t_i$ [s] |
|-----|-----------------|-----------|
| 1   | 0.012           | 0.00014   |
| 2   | 0.008           | 0.019     |
| 3   | 0.030           | 0.180     |
| 4   | 0.073           | 0.520     |
| 5   | 0.032           | 1.600     |

# AMEYA360

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