

# High Voltage Thyristor \ Diode Module

$$V_{RRM} = 2 \times 2200 \text{ V}$$

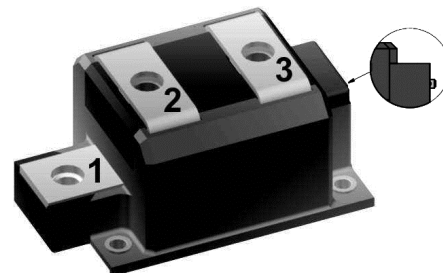
$$I_{TAV} = 650 \text{ A}$$

$$V_T = 1.16 \text{ V}$$

Phase leg

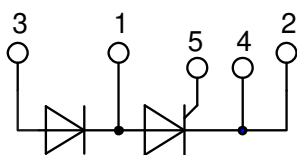
Part number

**MCNA650PD2200CB**



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: ComPack

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

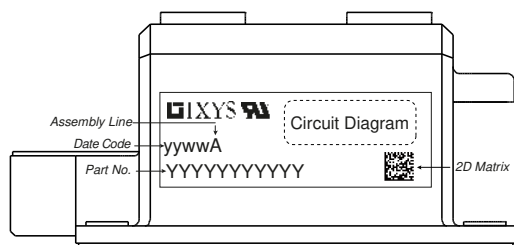
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| Rectifier      |                                                      |                                                                                                                                                                         |                                | Ratings |      |       |                   |
|----------------|------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|---------|------|-------|-------------------|
| Symbol         | Definition                                           | Conditions                                                                                                                                                              |                                | min.    | typ. | max.  | Unit              |
| $V_{RSM/DSM}$  | max. non-repetitive reverse/forward blocking voltage | $T_{VJ} = 25^{\circ}\text{C}$                                                                                                                                           |                                |         |      | 2300  | V                 |
| $V_{RRM/DRM}$  | max. repetitive reverse/forward blocking voltage     | $T_{VJ} = 25^{\circ}\text{C}$                                                                                                                                           |                                |         |      | 2200  | V                 |
| $I_{R/D}$      | reverse current, drain current                       | $V_{R/D} = 2200\text{ V}$                                                                                                                                               | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 2     | mA                |
|                |                                                      | $V_{R/D} = 2200\text{ V}$                                                                                                                                               | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 40    | mA                |
| $V_T$          | forward voltage drop                                 | $I_T = 650\text{ A}$                                                                                                                                                    | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 1.19  | V                 |
|                |                                                      | $I_T = 1300\text{ A}$                                                                                                                                                   |                                |         |      | 1.53  | V                 |
|                |                                                      | $I_T = 650\text{ A}$                                                                                                                                                    | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 1.16  | V                 |
|                |                                                      | $I_T = 1300\text{ A}$                                                                                                                                                   |                                |         |      | 1.59  | V                 |
| $I_{TAV}$      | average forward current                              | $T_C = 85^{\circ}\text{C}$<br>180° sine                                                                                                                                 | $T_{VJ} = 140^{\circ}\text{C}$ |         |      | 650   | A                 |
| $V_{T0}$       | threshold voltage                                    | } for power loss calculation only                                                                                                                                       | $T_{VJ} = 140^{\circ}\text{C}$ |         |      | 0.75  | V                 |
| $r_T$          | slope resistance                                     |                                                                                                                                                                         |                                |         |      | 0.63  | mΩ                |
| $R_{thJC}$     | thermal resistance junction to case                  |                                                                                                                                                                         |                                |         |      | 0.045 | K/W               |
| $R_{thCH}$     | thermal resistance case to heatsink                  |                                                                                                                                                                         |                                |         | 0.02 |       | K/W               |
| $P_{tot}$      | total power dissipation                              |                                                                                                                                                                         | $T_C = 25^{\circ}\text{C}$     |         |      | 2555  | W                 |
| $I_{TSM}$      | max. forward surge current                           | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                        | $T_{VJ} = 45^{\circ}\text{C}$  |         |      | 16.0  | kA                |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                       | $V_R = 0\text{ V}$             |         |      | 17.3  | kA                |
|                |                                                      | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                        | $T_{VJ} = 140^{\circ}\text{C}$ |         |      | 13.6  | kA                |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                       | $V_R = 0\text{ V}$             |         |      | 14.7  | kA                |
| $I^2t$         | value for fusing                                     | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                        | $T_{VJ} = 45^{\circ}\text{C}$  |         |      | 1.28  | MA <sup>2</sup> s |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                       | $V_R = 0\text{ V}$             |         |      | 1.24  | MA <sup>2</sup> s |
|                |                                                      | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                        | $T_{VJ} = 140^{\circ}\text{C}$ |         |      | 924.8 | kA <sup>2</sup> s |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                       | $V_R = 0\text{ V}$             |         |      | 897.7 | kA <sup>2</sup> s |
| $C_J$          | junction capacitance                                 | $V_R = 700\text{ V}$ $f = 1\text{ MHz}$                                                                                                                                 | $T_{VJ} = 25^{\circ}\text{C}$  |         | 620  |       | pF                |
| $P_{GM}$       | max. gate power dissipation                          | $t_p = 30\text{ }\mu\text{s}$                                                                                                                                           | $T_C = 140^{\circ}\text{C}$    |         |      | 120   | W                 |
|                |                                                      | $t_p = 300\text{ }\mu\text{s}$                                                                                                                                          |                                |         |      | 60    | W                 |
| $P_{GAV}$      | average gate power dissipation                       |                                                                                                                                                                         |                                |         |      | 30    | W                 |
| $(di/dt)_{cr}$ | critical rate of rise of current                     | $T_{VJ} = 140^{\circ}\text{C}; f = 50\text{ Hz}$ repetitive, $I_T = 1950\text{ A}$                                                                                      |                                |         |      | 100   | A/ $\mu\text{s}$  |
|                |                                                      | $t_p = 200\text{ }\mu\text{s}; di_G/dt = 1\text{ A}/\mu\text{s};$<br>$I_G = 1\text{ A}; V = \frac{2}{3} V_{DRM}$ non-repet., $I_T = 650\text{ A}$                       |                                |         |      | 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)                                                                                         | $T_{VJ} = 140^{\circ}\text{C}$ |         |      | 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                                 | $V_D = 6\text{ V}$                                                                                                                                                      | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 300   | mA                |
|                |                                                      |                                                                                                                                                                         | $T_{VJ} = -40^{\circ}\text{C}$ |         |      | 400   | 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                                     | $t_p = 30\text{ }\mu\text{s}$                                                                                                                                           | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 400   | mA                |
|                |                                                      | $I_G = 1\text{ A}; di_G/dt = 1\text{ A}/\mu\text{s}$                                                                                                                    |                                |         |      |       |                   |
| $I_H$          | holding current                                      | $V_D = 6\text{ V}$ $R_{GK} = \infty$                                                                                                                                    | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 300   | 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                                        | $V_R = 100\text{ V}; I_T = 650\text{ A}; V = \frac{2}{3} V_{DRM}$<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 ComPack      |                                                              |                      |                                         | Ratings |      |      |      |
|----------------------|--------------------------------------------------------------|----------------------|-----------------------------------------|---------|------|------|------|
| Symbol               | Definition                                                   | Conditions           |                                         | min.    | typ. | max. | Unit |
| I <sub>RMS</sub>     | RMS current                                                  | per terminal         |                                         |         |      | 1200 | A    |
| T <sub>VJ</sub>      | virtual junction temperature                                 |                      |                                         | -40     |      | 140  | °C   |
| T <sub>op</sub>      | operation temperature                                        |                      |                                         | -40     |      | 125  | °C   |
| T <sub>stg</sub>     | storage temperature                                          |                      |                                         | -40     |      | 125  | °C   |
| Weight               |                                                              |                      |                                         |         | 500  |      | g    |
| M <sub>D</sub>       | mounting torque                                              |                      |                                         | 3       |      | 5    | Nm   |
| M <sub>T</sub>       | terminal torque                                              |                      |                                         | 12      |      | 14   | Nm   |
| d <sub>Spp/App</sub> | creepage distance on surface   striking distance through air | terminal to terminal |                                         | 21.0    |      |      | mm   |
| d <sub>Spb/Apb</sub> |                                                              | terminal to backside |                                         | 18.0    |      |      | mm   |
| V <sub>ISOL</sub>    | isolation voltage                                            | t = 1 second         | 50/60 Hz, RMS; I <sub>ISOL</sub> ≤ 1 mA | 4800    |      |      | V    |
|                      |                                                              | t = 1 minute         |                                         | 4000    |      |      | V    |



### Part description

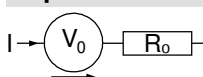
M = Module  
 C = Thyristor (SCR)  
 N = High Voltage Thyristor  
 A = ( $\geq 2000V$ )  
 650 = Current Rating [A]  
 PD = Phase leg  
 2200 = Reverse Voltage [V]  
 CB = ComPack

| Ordering | Ordering Number | Marking on Product | Delivery Mode | Quantity | Code No. |
|----------|-----------------|--------------------|---------------|----------|----------|
| Standard | MCNA650PD2200CB | MCNA650PD2200CB    | Box           | 3        | 516103   |

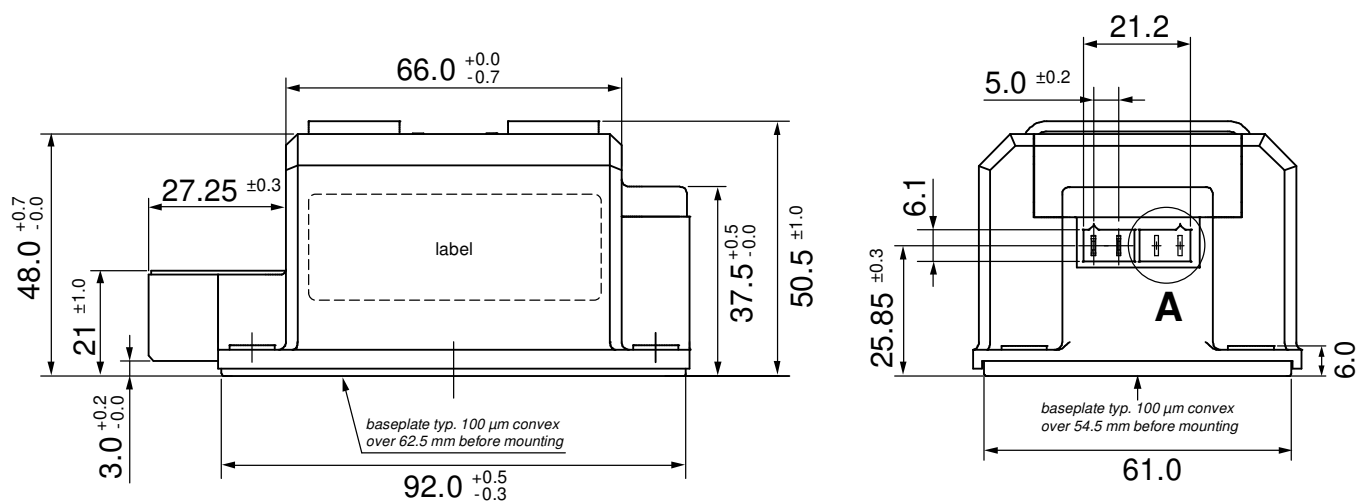
### Equivalent Circuits for Simulation

\* on die level

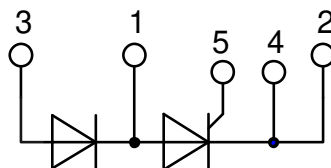
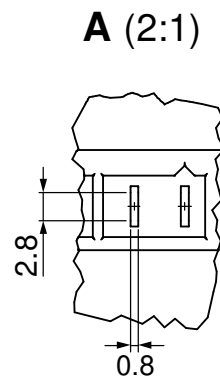
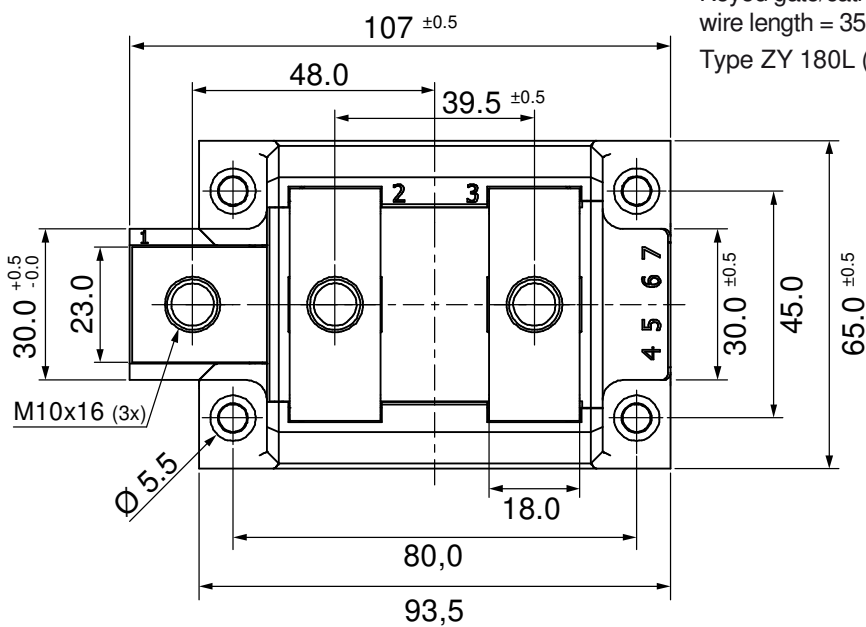
$T_{VJ} = 140^{\circ}C$



|              |                    |      |    |
|--------------|--------------------|------|----|
| $V_{0\ max}$ | threshold voltage  | 0.75 | V  |
| $R_{0\ max}$ | slope resistance * | 0.44 | mΩ |

**Outlines ComPack**


Optional accessories for modules  
 Keyed gate/cathode twin plug with  
 wire length = 350 mm, gate = white, cathode = red  
 Type ZY 180L (L = Left for pin pair 4/5) UL 758, style 3751



## Thyristor

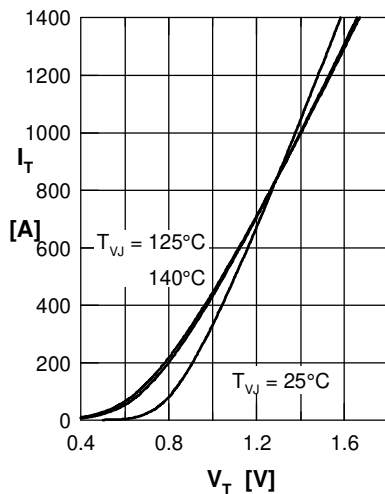


Fig. 1 Forward characteristics

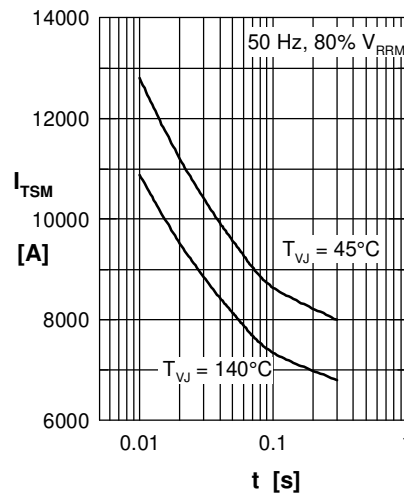


Fig. 2 Surge overload current  
 $I_{TSM}$ : crest value,  $t$ : duration

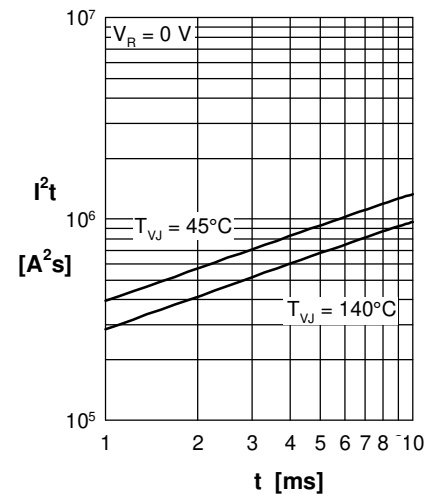


Fig. 3  $I^2t$  versus time (1-10 s)

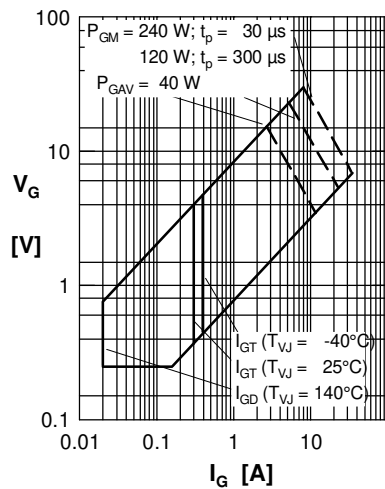


Fig. 4 Gate voltage & gate current

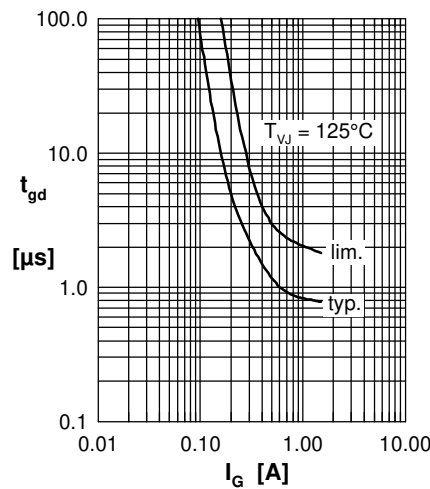


Fig. 5 Gate controlled delay time  $t_{gd}$

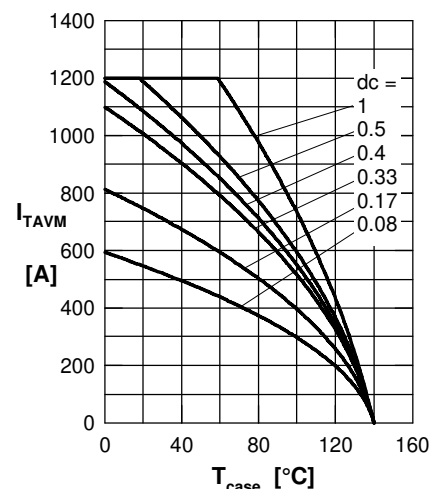


Fig. 6 Max. forward current at case temperature

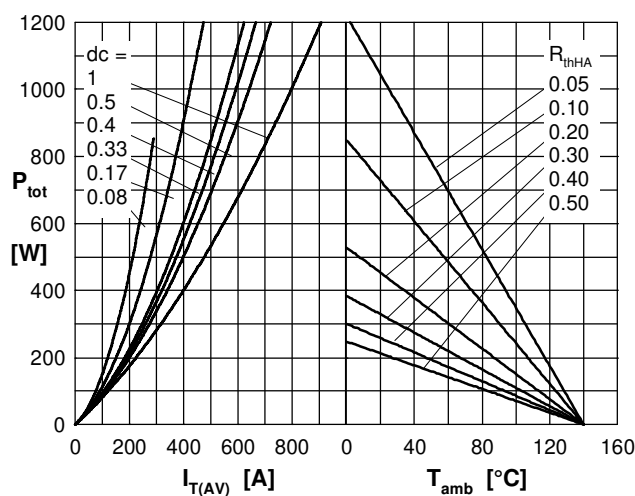


Fig. 7a Power dissipation versus direct output current  
 Fig. 7b and ambient temperature

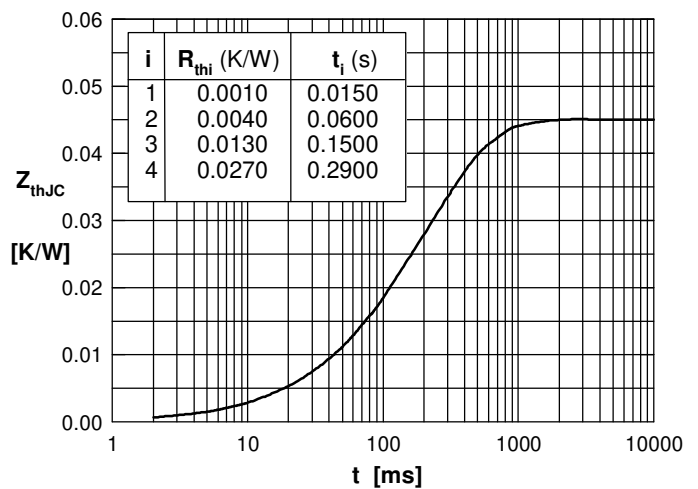


Fig. 8 Transient thermal impedance junction to case