

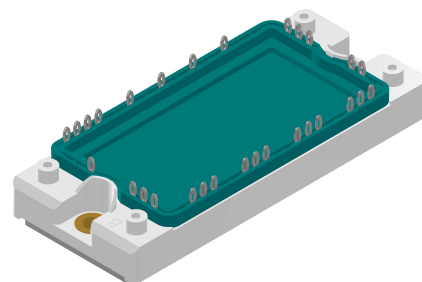
# High Voltage Thyristor Module

| 3~ Rectifier               | Brake Chopper                 |
|----------------------------|-------------------------------|
| $V_{RRM} = 2200 \text{ V}$ | $V_{CES} = 1700 \text{ V}$    |
| $I_{DAV} = 120 \text{ A}$  | $I_{C25} = 113 \text{ A}$     |
| $I_{FSM} = 500 \text{ A}$  | $V_{CE(sat)} = 2.5 \text{ V}$ |

3~ Rectifier Bridge, half-controlled (high-side) + Brake Unit

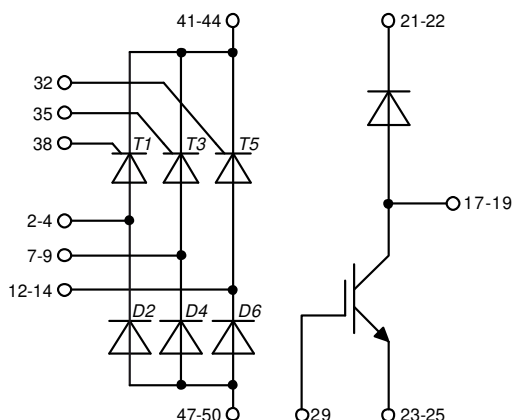
Part number

**MCNA120UI2200PED**



Backside: isolated

 E72873



## Features / Advantages:

- Thyristor/Standard Rectifier for line frequency
- Planar passivated chips
- Long-term stability
- Low forward voltage drop
- Copper base plate with Direct Copper Bonded Al<sub>2</sub>O<sub>3</sub>-ceramic
- Improved temperature and power cycling

## Applications:

- 3~ Rectifier with brake unit for drive inverters

## Package: E2-Pack

- Isolation Voltage: 3600 V~
- Industry standard outline
- RoHS compliant
- PressFit-Pins for PCB mounting
- Height: 17 mm
- Base plate: Copper internally DCB isolated
- Advanced power cycling
- Phase Change Material available

## Disclaimer Notice

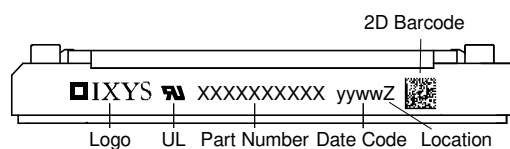
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| Rectifier      |                                                      |                                                                                                                                                                        |                                | 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                       | $V_{R/D} = 2200\text{ V}$                                                                                                                                              | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 50   | $\mu\text{A}$     |
|                |                                                      | $V_{R/D} = 2200\text{ V}$                                                                                                                                              | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 10   | mA                |
| $V_T$          | forward voltage drop                                 | $I_T = 40\text{ A}$                                                                                                                                                    | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 1.33 | V                 |
|                |                                                      | $I_T = 120\text{ A}$                                                                                                                                                   |                                |         |      | 2.05 | V                 |
|                |                                                      | $I_T = 40\text{ A}$                                                                                                                                                    | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 1.36 | V                 |
|                |                                                      | $I_T = 120\text{ A}$                                                                                                                                                   |                                |         |      | 2.38 | V                 |
| $I_{DAV}$      | bridge output current                                | $T_C = 80^{\circ}\text{C}$<br>rectangular $d = \frac{1}{3}$                                                                                                            | $T_{VJ} = 150^{\circ}\text{C}$ |         |      | 120  | A                 |
| $V_{T0}$       | threshold voltage                                    | } for power loss calculation only                                                                                                                                      | $T_{VJ} = 150^{\circ}\text{C}$ |         |      | 0.83 | V                 |
| $r_T$          | slope resistance                                     |                                                                                                                                                                        |                                |         |      | 13.6 | m $\Omega$        |
| $R_{thJC}$     | thermal resistance junction to case                  |                                                                                                                                                                        |                                |         |      | 0.65 | K/W               |
| $R_{thCH}$     | thermal resistance case to heatsink                  |                                                                                                                                                                        |                                |         | 0.1  |      | K/W               |
| $P_{tot}$      | total power dissipation                              |                                                                                                                                                                        | $T_C = 25^{\circ}\text{C}$     |         |      | 190  | W                 |
| $I_{TSM}$      | max. forward surge current                           | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                       | $T_{VJ} = 45^{\circ}\text{C}$  |         |      | 500  | A                 |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                      | $V_R = 0\text{ V}$             |         |      | 540  | A                 |
|                |                                                      | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                       | $T_{VJ} = 150^{\circ}\text{C}$ |         |      | 425  | A                 |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                      | $V_R = 0\text{ V}$             |         |      | 460  | A                 |
| $I^2t$         | value for fusing                                     | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                       | $T_{VJ} = 45^{\circ}\text{C}$  |         |      | 1.25 | kA <sup>2</sup> s |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                      | $V_R = 0\text{ V}$             |         |      | 1.22 | kA <sup>2</sup> s |
|                |                                                      | $t = 10\text{ ms}; (50\text{ Hz}), \text{ sine}$                                                                                                                       | $T_{VJ} = 150^{\circ}\text{C}$ |         |      | 905  | A <sup>2</sup> s  |
|                |                                                      | $t = 8,3\text{ ms}; (60\text{ Hz}), \text{ sine}$                                                                                                                      | $V_R = 0\text{ V}$             |         |      | 880  | A <sup>2</sup> s  |
| $C_J$          | junction capacitance                                 | $V_R = 700\text{ V}$ $f = 1\text{ MHz}$                                                                                                                                | $T_{VJ} = 25^{\circ}\text{C}$  |         | 13   |      | pF                |
| $P_{GM}$       | max. gate power dissipation                          | $t_p = 30\text{ }\mu\text{s}$                                                                                                                                          | $T_C = 150^{\circ}\text{C}$    |         |      | 10   | W                 |
|                |                                                      | $t_p = 300\text{ }\mu\text{s}$                                                                                                                                         |                                |         |      | 5    | W                 |
| $P_{GAV}$      | average gate power dissipation                       |                                                                                                                                                                        |                                |         |      | 0.5  | W                 |
| $(di/dt)_{cr}$ | critical rate of rise of current                     | $T_{VJ} = 150^{\circ}\text{C}; f = 50\text{ Hz}$ repetitive, $I_T = 120\text{ A}$                                                                                      |                                |         |      | 150  | A/ $\mu\text{s}$  |
|                |                                                      | $t_p = 200\text{ }\mu\text{s}; di_G/dt = 0.45\text{ A}/\mu\text{s};$<br>$I_G = 0.45\text{ A}; V = \frac{2}{3} V_{DRM}$ non-repet., $I_T = 40\text{ A}$                 |                                |         |      | 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)                                                                                        | $T_{VJ} = 150^{\circ}\text{C}$ |         |      | 1000 | V/ $\mu\text{s}$  |
| $V_{GT}$       | gate trigger voltage                                 | $V_D = 6\text{ V}$                                                                                                                                                     | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 1.4  | V                 |
|                |                                                      |                                                                                                                                                                        | $T_{VJ} = -40^{\circ}\text{C}$ |         |      | 1.6  | V                 |
| $I_{GT}$       | gate trigger current                                 | $V_D = 6\text{ V}$                                                                                                                                                     | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 70   | mA                |
|                |                                                      |                                                                                                                                                                        | $T_{VJ} = -40^{\circ}\text{C}$ |         |      | 150  | mA                |
| $V_{GD}$       | gate non-trigger voltage                             | $V_D = \frac{2}{3} V_{DRM}$                                                                                                                                            | $T_{VJ} = 150^{\circ}\text{C}$ |         |      | 0.2  | V                 |
| $I_{GD}$       | gate non-trigger current                             |                                                                                                                                                                        |                                |         |      | 5    | mA                |
| $I_L$          | latching current                                     | $t_p = 10\text{ }\mu\text{s}$                                                                                                                                          | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 150  | mA                |
|                |                                                      | $I_G = 0.45\text{ A}; di_G/dt = 0.45\text{ A}/\mu\text{s}$                                                                                                             |                                |         |      |      |                   |
| $I_H$          | holding current                                      | $V_D = 6\text{ V}$ $R_{GK} = \infty$                                                                                                                                   | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 100  | mA                |
| $t_{gd}$       | gate controlled delay time                           | $V_D = \frac{1}{2} V_{DRM}$                                                                                                                                            | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 2    | $\mu\text{s}$     |
|                |                                                      | $I_G = 0.45\text{ A}; di_G/dt = 0.45\text{ A}/\mu\text{s}$                                                                                                             |                                |         |      |      |                   |
| $t_q$          | turn-off time                                        | $V_R = 100\text{ V}; I_T = 40\text{ A}; V = \frac{2}{3} V_{DRM}$<br>$di/dt = 10\text{ A}/\mu\text{s}$ $dv/dt = 20\text{ V}/\mu\text{s}$ $t_p = 200\text{ }\mu\text{s}$ | $T_{VJ} = 125^{\circ}\text{C}$ |         | 500  |      | $\mu\text{s}$     |



| Brake IGBT + Diode |                                      |                                                                                                              |                                | Ratings |      |          |               |
|--------------------|--------------------------------------|--------------------------------------------------------------------------------------------------------------|--------------------------------|---------|------|----------|---------------|
| Symbol             | Definition                           | Conditions                                                                                                   |                                | min.    | typ. | max.     | Unit          |
| $V_{CES}$          | collector emitter voltage            | $T_{VJ} = 25^{\circ}\text{C}$                                                                                |                                |         |      | 1700     | V             |
| $V_{GES}$          | max. DC gate voltage                 |                                                                                                              |                                |         |      | $\pm 20$ | V             |
| $V_{GEM}$          | max. transient gate emitter voltage  |                                                                                                              |                                |         |      | $\pm 30$ | V             |
| $I_{C25}$          | collector current                    | $T_C = 25^{\circ}\text{C}$                                                                                   |                                |         |      | 113      | A             |
| $I_{C80}$          |                                      | $T_C = 80^{\circ}\text{C}$                                                                                   |                                |         |      | 80       | A             |
| $P_{tot}$          | total power dissipation              | $T_C = 25^{\circ}\text{C}$                                                                                   |                                |         |      | 445      | W             |
| $V_{CE(sat)}$      | collector emitter saturation voltage | $I_C = 75\text{ A}; V_{GE} = 15\text{ V}$                                                                    | $T_{VJ} = 25^{\circ}\text{C}$  |         | 2.5  | 2.93     | V             |
|                    |                                      |                                                                                                              | $T_{VJ} = 125^{\circ}\text{C}$ |         | 3    |          | V             |
| $V_{GE(th)}$       | gate emitter threshold voltage       | $I_C = 3\text{ mA}; V_{GE} = V_{CE}$                                                                         | $T_{VJ} = 25^{\circ}\text{C}$  | 5.2     | 5.8  | 6.4      | V             |
| $I_{CES}$          | collector emitter leakage current    | $V_{CE} = V_{CES}; V_{GE} = 0\text{ V}$                                                                      | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 0.6      | mA            |
|                    |                                      |                                                                                                              | $T_{VJ} = 125^{\circ}\text{C}$ |         | 5    |          | mA            |
| $I_{GES}$          | gate emitter leakage current         | $V_{GE} = \pm 20\text{ V}$                                                                                   |                                |         |      | 400      | nA            |
| $Q_{G(on)}$        | total gate charge                    | $V_{CE} = 900\text{ V}; V_{GE} = 15\text{ V}; I_C = 75\text{ A}$                                             |                                |         | 850  |          | nC            |
| $t_{d(on)}$        | turn-on delay time                   | inductive load<br>$V_{CE} = 900\text{ V}; I_C = 75\text{ A}$<br>$V_{GE} = \pm 15\text{ V}; R_G = 18\ \Omega$ | $T_{VJ} = 125^{\circ}\text{C}$ |         | 270  |          | ns            |
| $t_r$              | current rise time                    |                                                                                                              |                                |         | 100  |          | ns            |
| $t_{d(off)}$       | turn-off delay time                  |                                                                                                              |                                |         | 700  |          | ns            |
| $t_f$              | current fall time                    |                                                                                                              |                                |         | 430  |          | ns            |
| $E_{on}$           | turn-on energy per pulse             |                                                                                                              |                                |         | 34   |          | mJ            |
| $E_{off}$          | turn-off energy per pulse            |                                                                                                              |                                |         | 17.5 |          | mJ            |
| <b>RBSOA</b>       | reverse bias safe operating area     | $V_{GE} = \pm 15\text{ V}; R_G = 18\ \Omega$                                                                 | $T_{VJ} = 125^{\circ}\text{C}$ |         |      |          |               |
| $I_{CM}$           |                                      | $V_{CEK} = 1700\text{ V}$                                                                                    |                                |         |      | 150      | A             |
| <b>SCSOA</b>       | short circuit safe operating area    | $V_{CEK} = 1700\text{ V}$                                                                                    |                                |         |      |          |               |
| $t_{SC}$           | short circuit duration               | $V_{CE} = 720\text{ V}; V_{GE} = \pm 15$                                                                     | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 10       | $\mu\text{s}$ |
| $I_{SC}$           | short circuit current                | $R_G = 18\ \Omega$ ; non-repetitive                                                                          |                                |         | 280  |          | A             |
| $R_{thJC}$         | thermal resistance junction to case  |                                                                                                              |                                |         |      | 0.28     | K/W           |
| $R_{thCH}$         | thermal resistance case to heatsink  |                                                                                                              |                                |         | 0.1  |          | K/W           |
| Brake Diode        |                                      |                                                                                                              |                                |         |      |          |               |
| $V_{RRM}$          | max. repetitive reverse voltage      |                                                                                                              | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 1700     | V             |
| $I_{F25}$          | forward current                      |                                                                                                              | $T_C = 25^{\circ}\text{C}$     |         |      | 75       | A             |
| $I_{F80}$          |                                      |                                                                                                              | $T_C = 80^{\circ}\text{C}$     |         |      | 50       | A             |
| $V_F$              | forward voltage                      | $I_F = 60\text{ A}$                                                                                          | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 2.45     | V             |
|                    |                                      |                                                                                                              | $T_{VJ} = 125^{\circ}\text{C}$ |         | 2.20 |          | V             |
| $I_R$              | reverse current                      | $V_R = V_{RRM}$                                                                                              | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 0.1      | mA            |
|                    |                                      |                                                                                                              | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 1        | mA            |
| $Q_{rr}$           | reverse recovery charge              | $V_R = 900\text{ V}$<br>$-di_F/dt = 600\text{ A}/\mu\text{s}$<br>$I_F = 60\text{ A}; V_{GE} = 0\text{ V}$    | $T_{VJ} = 125^{\circ}\text{C}$ |         | 20   |          | $\mu\text{C}$ |
| $I_{RM}$           | max. reverse recovery current        |                                                                                                              |                                |         | 46   |          | A             |
| $t_{rr}$           | reverse recovery time                |                                                                                                              |                                |         | 1300 |          | ns            |
| $E_{rec}$          | reverse recovery energy              |                                                                                                              |                                |         | 10.5 |          | mJ            |
| $R_{thJC}$         | thermal resistance junction to case  |                                                                                                              |                                |         |      | 0.65     | K/W           |
| $R_{thCH}$         | thermal resistance case to heatsink  |                                                                                                              |                                |         | 0.1  |          | K/W           |

| Package E2-Pack      |                                                              |                      |                                         | Ratings |      |      |      |
|----------------------|--------------------------------------------------------------|----------------------|-----------------------------------------|---------|------|------|------|
| Symbol               | Definition                                                   | Conditions           |                                         | min.    | typ. | max. | Unit |
| I <sub>RMS</sub>     | RMS current                                                  | per terminal         |                                         |         |      | 40   | A    |
| T <sub>VJ</sub>      | virtual junction temperature                                 |                      |                                         | -40     |      | 150  | °C   |
| T <sub>op</sub>      | operation temperature                                        |                      |                                         | -40     |      | 125  | °C   |
| T <sub>stg</sub>     | storage temperature                                          |                      |                                         | -40     |      | 125  | °C   |
| Weight               |                                                              |                      |                                         |         | 176  |      | g    |
| M <sub>D</sub>       | mounting torque                                              |                      |                                         | 3       |      | 6    | Nm   |
| d <sub>Spp/App</sub> | creepage distance on surface   striking distance through air | terminal to terminal |                                         | 6.0     |      |      | mm   |
| d <sub>Spb/Apb</sub> |                                                              | terminal to backside |                                         | 12.0    |      |      | mm   |
| V <sub>ISOL</sub>    | isolation voltage                                            | t = 1 second         | 50/60 Hz, RMS; I <sub>ISOL</sub> ≤ 1 mA | 3600    |      |      | V    |
|                      |                                                              | t = 1 minute         |                                         | 3000    |      |      | V    |



### Part description

M = Module  
 C = Thyristor (SCR)  
 N = High Voltage Thyristor  
 A = ( $\geq 2000V$ )  
 120 = Current Rating [A]  
 UI = 3~ Rectifier Bridge, half-controlled (high-side) + Brake Unit  
 2200 = Reverse Voltage [V]  
 P = PressFit-Pin  
 ED = E2-Pack  
 - = Hyphen  
 PC = Phase Change Material

| Ordering    | Ordering Number     | Marking on Product | Delivery Mode | Quantity | Code No. |
|-------------|---------------------|--------------------|---------------|----------|----------|
| Standard    | MCNA120UI2200PED    | MCNA120UI2200PED   | Blister       | 28       | 521435   |
| Alternative | MCNA120UI2200PED-PC | MCNA120UI2200PED   | Blister       | 28       | 521428   |

### Equivalent Circuits for Simulation

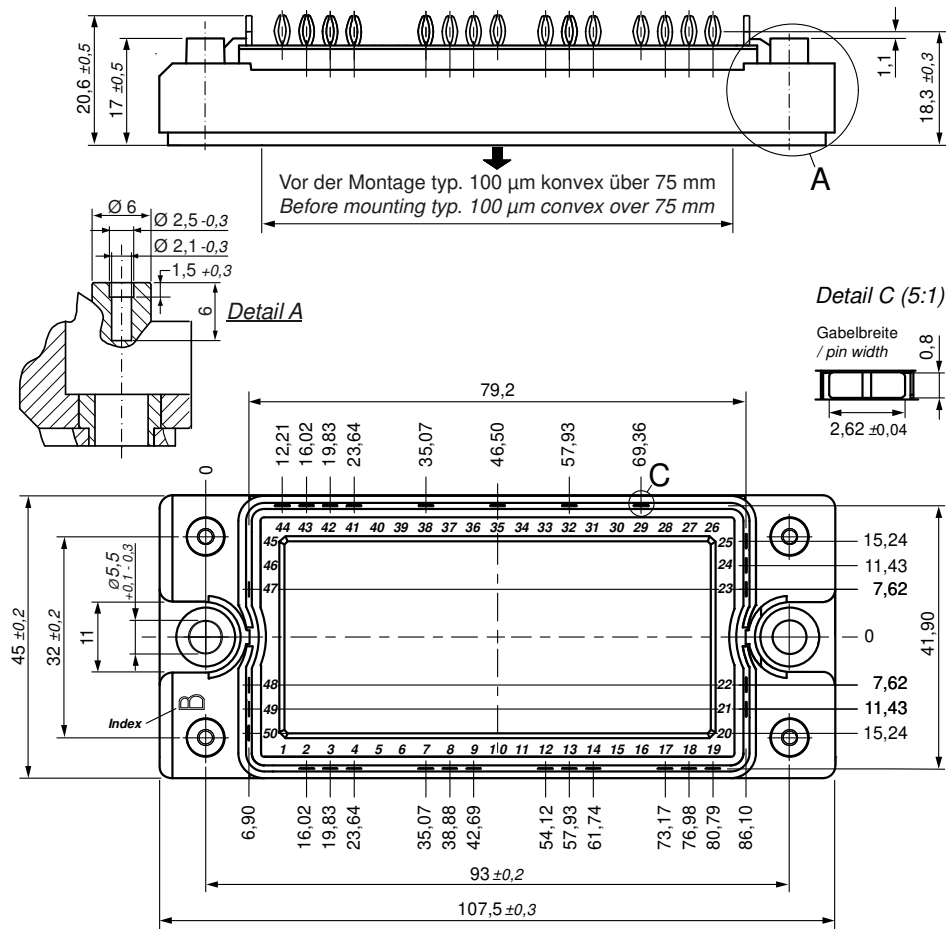
\* on die level

$T_{VJ} = 150^{\circ}C$

|                                                                                     |                    |           |              |             |    |
|-------------------------------------------------------------------------------------|--------------------|-----------|--------------|-------------|----|
|  |                    | Thyristor | Brake IGBT + | Brake Diode |    |
| $V_{0\ max}$                                                                        | threshold voltage  | 0.83      | 1.17         | 1.34        | V  |
| $R_{0\ max}$                                                                        | slope resistance * | 10.5      | 25           | 15.2        | mΩ |



**Outlines E2-Pack**

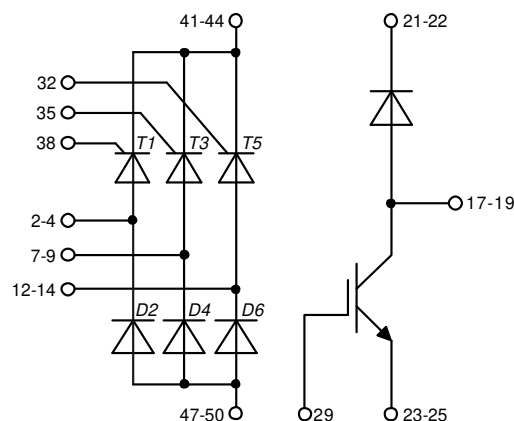


**Bemerkung / Note:**

- Nicht tolerierte Maße nach / Measure without tolerances according DIN ISO 2768-T1-m
- PCB-Lochmuster / PCB hole pattern: **see pin position**
- Toleranz Pin-Position und PCB-Lochmuster / Tolerance of pin position and PCB hole pattern:  $\oplus 0.1$
- Bohrlochdurchmesser / Diameter of drill: **Ø 2.35 mm**
- Endlochdurchmesser / Diameter of plated holes: **Ø 2.14 - 2.29 mm** (Cu thickness in via typ. 50 µm)
- Beschichtung / Plating: **chem. Sn max. 15 µm**
- Einpresskraft / Insert Force: per terminal with a typ. insert speed of 7 mm/s: **typ. 90 N**
- Weitere Angaben / Further information: [www.ixys.com](http://www.ixys.com) **Application note IXAN0077**
- Montageanleitung / Mounting instruction: [www.ixys.com](http://www.ixys.com) **Application note IXAN0024**

**Detail A:** PCB-Montage / Mounting on PCB<sup>1</sup>

- Empfohlene, selbstschneidende Schraube / Recommended, self-tapping screw: **EJOT PT®** (Größe / size: **K25**)<sup>L</sup>
- Max. Schraubenlänge / Max. screw length: **PCB-Dicke / thickness + 6 mm** (max. Lochtiefe / hole depth)<sup>L</sup>
- Empfohlenes Drehmoment / Recommended mounting torque: **1.5 Nm**



## Thyristor

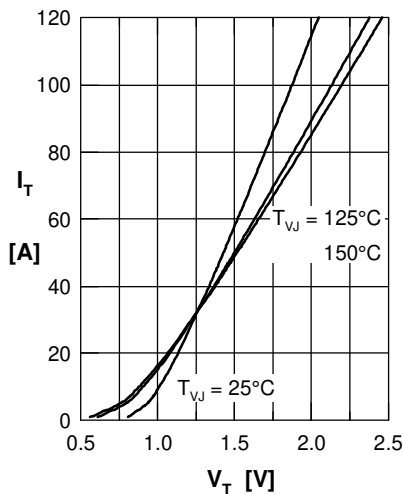


Fig. 1 Forward characteristics

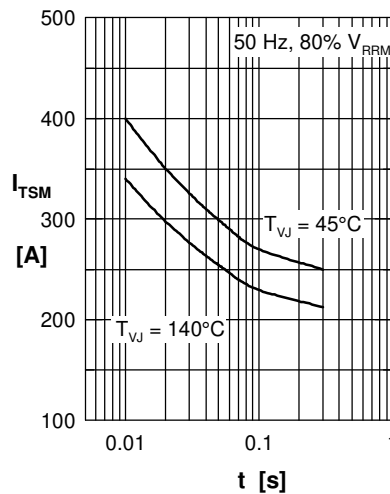


Fig. 2 Surge overload current  
 $I_{TSM}$ : crest value,  $t$ : duration

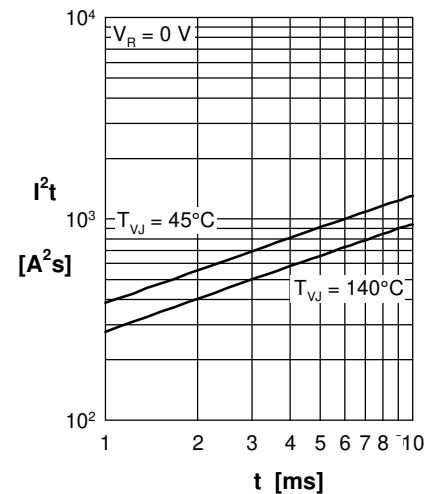


Fig. 3  $I^2t$  versus time (1-10 s)

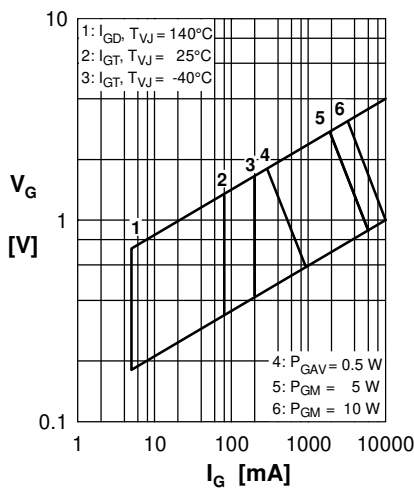


Fig. 4 Gate voltage & gate current

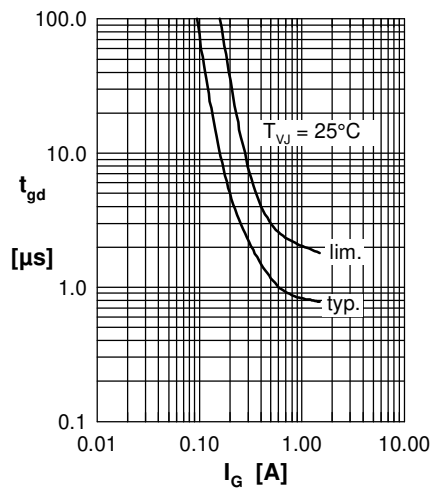


Fig. 5 Gate controlled delay time  $t_{gd}$

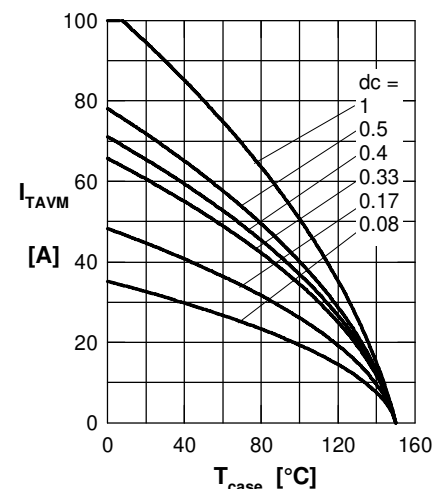


Fig. 6 Max. forward current at case temperature

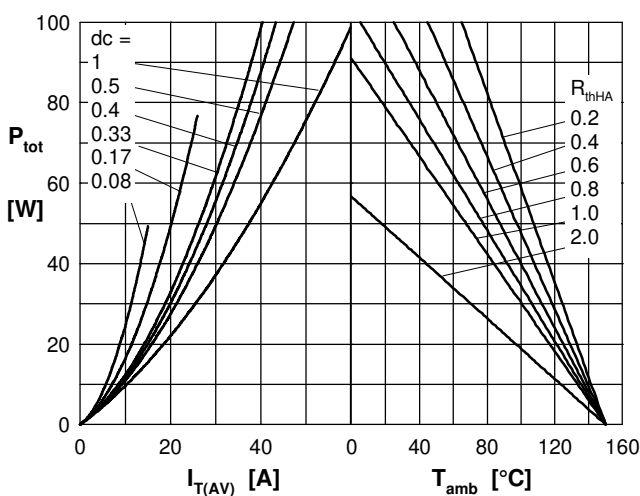


Fig. 7a Power dissipation versus direct output current  
 Fig. 7b and ambient temperature

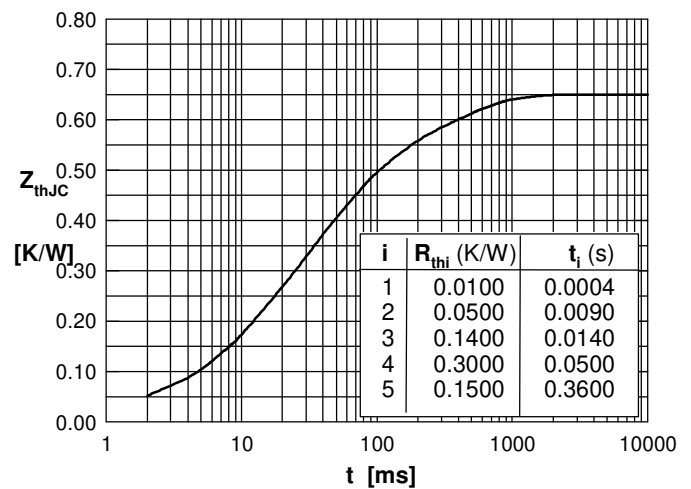


Fig. 8 Transient thermal impedance junction to case

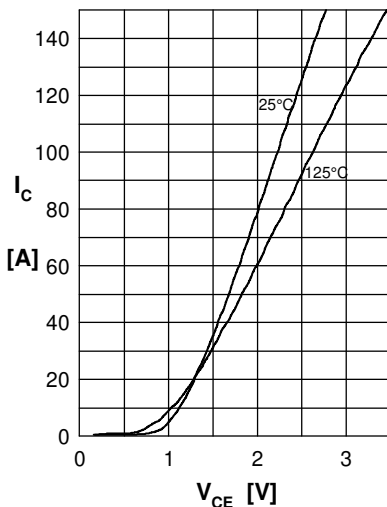
**Brake IGBT + Diode**


Fig.1 Output characteristics IGBT

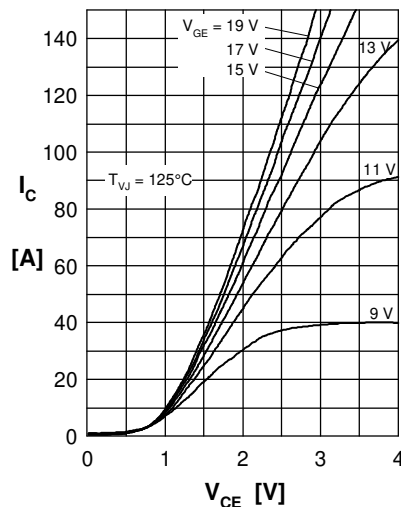


Fig.2 Typ. output characteristics IGBT

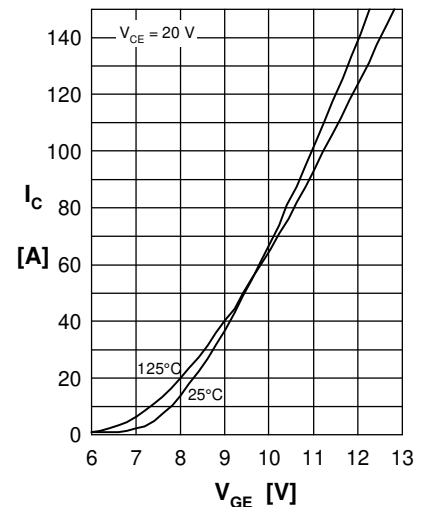


Fig.3 Typ. transfer charact. IGBT

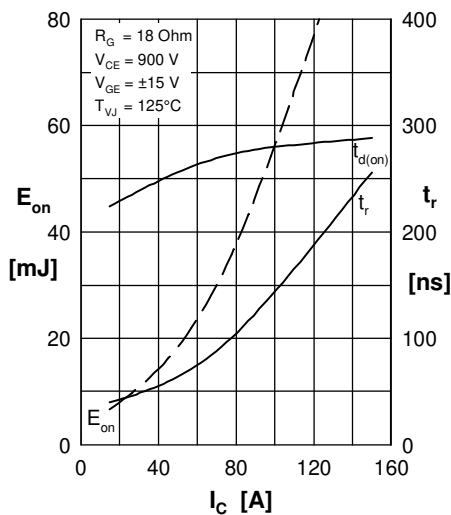


Fig.4 Typ. turn-on energy &amp; switch. times vs. collector current

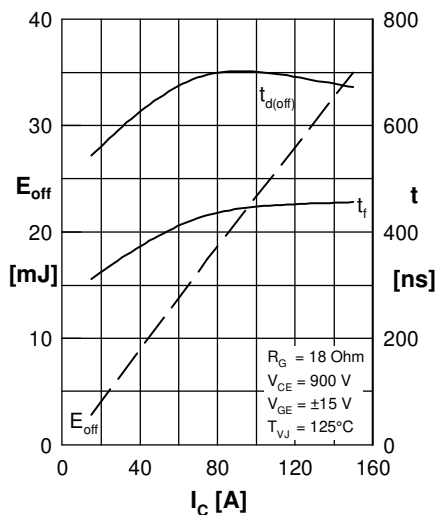


Fig.5 Typ. turn-off energy &amp; switch. times vs. collector current

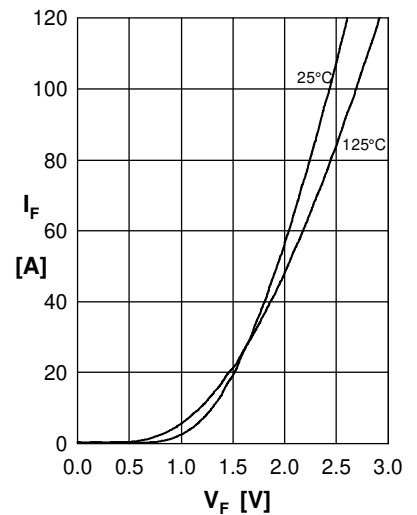


Fig.6 Typ. forward characteristics Diode

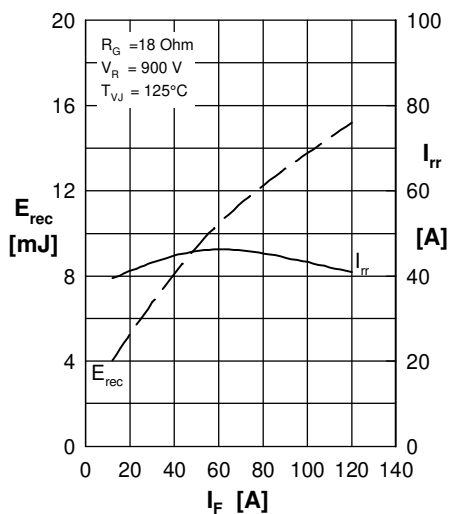


Fig.7 Typ. reverse recovery characteristics Diode

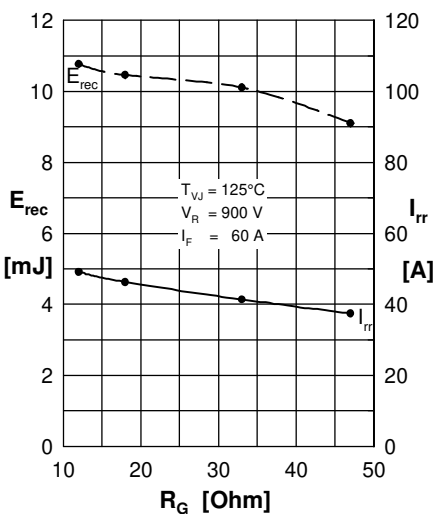


Fig.8 Typ. reverse recovery characteristics Diode

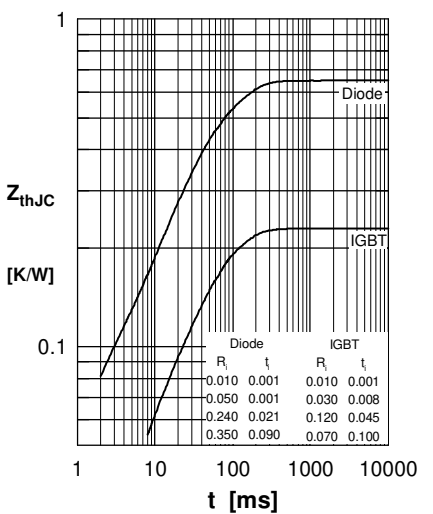


Fig.9 Transient thermal resistance junction to case