

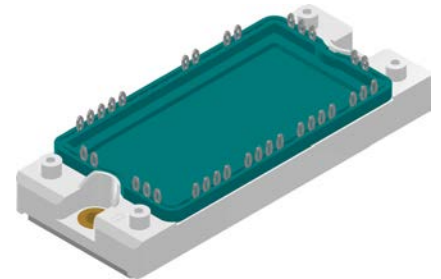
## Standard Rectifier Module

| 3~ Rectifier               | Brake Chopper                 |
|----------------------------|-------------------------------|
| $V_{RRM} = 1600 \text{ V}$ | $V_{CES} = 1200 \text{ V}$    |
| $I_{DAV} = 450 \text{ A}$  | $I_{C25} = 250 \text{ A}$     |
| $I_{FSM} = 2400 \text{ A}$ | $V_{CE(sat)} = 1,7 \text{ V}$ |

3~ Rectifier Bridge + Brake Unit + NTC

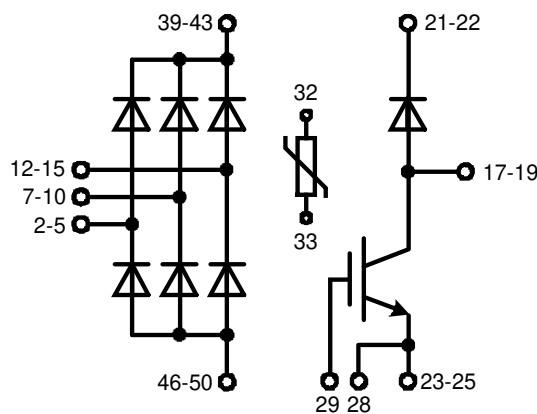
Part number

**MDMA450UB1600PTED**



Backside: isolated

 E72873



### Features / Advantages:

- Package with DCB ceramic
- Improved temperature and power cycling
- Planar passivated chips
- Very low forward voltage drop
- Very low leakage current
- NTC

### X2PT Features:

- very low  $E_{off}$
- reduced  $V_{ce(sat)}$
- $T_{jmax} = 175^{\circ}\text{C}$
- reduced  $R_{th}$
- very low gate charge
- easy paralleling
- square RBSOA @  $3 \times I_{nom}$

### Applications:

- 3~ Rectifier with brake unit for drive inverters

### Package: E2-Pack

- Isolation Voltage: 4300 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

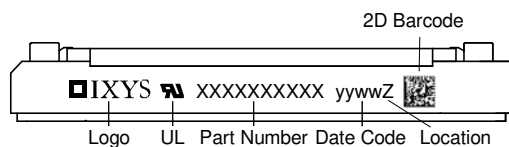
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| Rectifier  |                                              |                                         |                                | Ratings                        |      |      |                   |
|------------|----------------------------------------------|-----------------------------------------|--------------------------------|--------------------------------|------|------|-------------------|
| Symbol     | Definition                                   | Conditions                              |                                | min.                           | typ. | max. | Unit              |
| $V_{RSM}$  | max. non-repetitive reverse blocking voltage | $T_{VJ} = 25^{\circ}\text{C}$           |                                |                                |      | 1700 | V                 |
| $V_{RRM}$  | max. repetitive reverse blocking voltage     | $T_{VJ} = 25^{\circ}\text{C}$           |                                |                                |      | 1600 | V                 |
| $I_R$      | reverse current                              | $V_R = 1600\text{ V}$                   | $T_{VJ} = 25^{\circ}\text{C}$  |                                |      | 100  | $\mu\text{A}$     |
|            |                                              | $V_R = 1600\text{ V}$                   | $T_{VJ} = 150^{\circ}\text{C}$ |                                |      | 3    | mA                |
| $V_F$      | forward voltage drop                         | $I_F = 150\text{ A}$                    | $T_{VJ} = 25^{\circ}\text{C}$  |                                |      | 1,26 | V                 |
|            |                                              | $I_F = 450\text{ A}$                    |                                |                                |      | 1,81 | V                 |
|            |                                              | $I_F = 150\text{ A}$                    | $T_{VJ} = 125^{\circ}\text{C}$ |                                |      | 1,23 | V                 |
|            |                                              | $I_F = 450\text{ A}$                    |                                |                                |      | 1,99 | V                 |
| $I_{DAV}$  | bridge output current                        | $T_C = 85^{\circ}\text{C}$              | $T_{VJ} = 150^{\circ}\text{C}$ |                                |      | 450  | A                 |
|            |                                              | rectangular $d = \frac{1}{3}$           |                                |                                |      |      |                   |
| $V_{F0}$   | threshold voltage                            | } for power loss calculation only       |                                | $T_{VJ} = 150^{\circ}\text{C}$ |      | 0,82 | V                 |
| $r_F$      | slope resistance                             |                                         |                                |                                |      | 2,7  | m $\Omega$        |
| $R_{thJC}$ | thermal resistance junction to case          |                                         |                                |                                |      | 0,2  | K/W               |
| $R_{thCH}$ | thermal resistance case to heatsink          |                                         |                                |                                | 0,1  |      | K/W               |
| $P_{tot}$  | total power dissipation                      | $T_C = 25^{\circ}\text{C}$              |                                |                                |      | 625  | W                 |
| $I_{FSM}$  | max. forward surge current                   | $t = 10\text{ ms; (50 Hz), sine}$       | $T_{VJ} = 45^{\circ}\text{C}$  |                                |      | 2,40 | kA                |
|            |                                              | $t = 8,3\text{ ms; (60 Hz), sine}$      | $V_R = 0\text{ V}$             |                                |      | 2,59 | kA                |
|            |                                              | $t = 10\text{ ms; (50 Hz), sine}$       | $T_{VJ} = 150^{\circ}\text{C}$ |                                |      | 2,04 | kA                |
|            |                                              | $t = 8,3\text{ ms; (60 Hz), sine}$      | $V_R = 0\text{ V}$             |                                |      | 2,21 | kA                |
| $I^2t$     | value for fusing                             | $t = 10\text{ ms; (50 Hz), sine}$       | $T_{VJ} = 45^{\circ}\text{C}$  |                                |      | 28,8 | kA <sup>2</sup> s |
|            |                                              | $t = 8,3\text{ ms; (60 Hz), sine}$      | $V_R = 0\text{ V}$             |                                |      | 27,9 | kA <sup>2</sup> s |
|            |                                              | $t = 10\text{ ms; (50 Hz), sine}$       | $T_{VJ} = 150^{\circ}\text{C}$ |                                |      | 20,8 | kA <sup>2</sup> s |
|            |                                              | $t = 8,3\text{ ms; (60 Hz), sine}$      | $V_R = 0\text{ V}$             |                                |      | 20,2 | kA <sup>2</sup> s |
| $C_J$      | junction capacitance                         | $V_R = 400\text{ V; } f = 1\text{ MHz}$ |                                | $T_{VJ} = 25^{\circ}\text{C}$  | 91   |      | pF                |



| Brake IGBT + Diode |                                      |                                                                                                                  |                                | Ratings |      |          |               |
|--------------------|--------------------------------------|------------------------------------------------------------------------------------------------------------------|--------------------------------|---------|------|----------|---------------|
| Symbol             | Definition                           | Conditions                                                                                                       |                                | min.    | typ. | max.     | Unit          |
| $V_{CES}$          | collector emitter voltage            | $T_{VJ} = 25^{\circ}\text{C}$                                                                                    |                                |         |      | 1200     | V             |
| $V_{GES}$          | max. DC gate voltage                 |                                                                                                                  |                                |         |      | $\pm 20$ | V             |
| $V_{GEM}$          | max. transient gate emitter voltage  |                                                                                                                  |                                |         |      | $\pm 30$ | V             |
| $I_{C25}$          | collector current                    | $T_C = 25^{\circ}\text{C}$                                                                                       |                                |         |      | 250      | A             |
| $I_{C80}$          |                                      | $T_C = 80^{\circ}\text{C}$                                                                                       |                                |         |      | 175      | A             |
| $P_{tot}$          | total power dissipation              | $T_C = 25^{\circ}\text{C}$                                                                                       |                                |         |      | 780      | W             |
| $V_{CE(sat)}$      | collector emitter saturation voltage | $I_C = 150 \text{ A}; V_{GE} = 15 \text{ V}$                                                                     | $T_{VJ} = 25^{\circ}\text{C}$  |         | 1,7  | 2,1      | V             |
|                    |                                      |                                                                                                                  | $T_{VJ} = 125^{\circ}\text{C}$ |         | 1,9  |          | V             |
| $V_{GE(th)}$       | gate emitter threshold voltage       | $I_C = 6 \text{ mA}; V_{GE} = V_{CE}$                                                                            | $T_{VJ} = 25^{\circ}\text{C}$  | 6       | 6,8  | 7,5      | V             |
| $I_{CES}$          | collector emitter leakage current    | $V_{CE} = V_{CES}; V_{GE} = 0 \text{ V}$                                                                         | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 0,1      | mA            |
|                    |                                      |                                                                                                                  | $T_{VJ} = 125^{\circ}\text{C}$ |         | 1    |          | mA            |
| $I_{GES}$          | gate emitter leakage current         | $V_{GE} = \pm 20 \text{ V}$                                                                                      |                                |         |      | 500      | nA            |
| $Q_{G(on)}$        | total gate charge                    | $V_{CE} = 600 \text{ V}; V_{GE} = 15 \text{ V}; I_C = 150 \text{ A}$                                             |                                |         | 510  |          | nC            |
| $t_{d(on)}$        | turn-on delay time                   | inductive load<br>$V_{CE} = 600 \text{ V}; I_C = 150 \text{ A}$<br>$V_{GE} = \pm 15 \text{ V}; R_G = 4,7 \Omega$ | $T_{VJ} = 125^{\circ}\text{C}$ |         | 280  |          | ns            |
| $t_r$              | current rise time                    |                                                                                                                  |                                |         | 80   |          | ns            |
| $t_{d(off)}$       | turn-off delay time                  |                                                                                                                  |                                |         | 440  |          | ns            |
| $t_f$              | current fall time                    |                                                                                                                  |                                |         | 230  |          | ns            |
| $E_{on}$           | turn-on energy per pulse             |                                                                                                                  |                                |         | 26   |          | mJ            |
| $E_{off}$          | turn-off energy per pulse            |                                                                                                                  |                                |         | 15   |          | mJ            |
| <b>RBSOA</b>       | reverse bias safe operating area     | $V_{GE} = \pm 15 \text{ V}; R_G = 4,7 \Omega$                                                                    | $T_{VJ} = 125^{\circ}\text{C}$ |         |      |          |               |
| $I_{CM}$           |                                      | $V_{CEK} = 1200 \text{ V}$                                                                                       |                                |         |      | 450      | A             |
| <b>SCSOA</b>       | short circuit safe operating area    | $V_{CEK} = 1200 \text{ V}$                                                                                       |                                |         |      |          |               |
| $t_{SC}$           | short circuit duration               | $V_{CE} = 900 \text{ V}; V_{GE} = \pm 15$                                                                        | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 10       | $\mu\text{s}$ |
| $I_{SC}$           | short circuit current                | $R_G = 4,7 \Omega$ ; non-repetitive                                                                              |                                |         | 600  |          | A             |
| $R_{thJC}$         | thermal resistance junction to case  |                                                                                                                  |                                |         |      | 0,16     | K/W           |
| $R_{thCH}$         | thermal resistance case to heatsink  |                                                                                                                  |                                |         | 0,10 |          | K/W           |
| Brake Diode        |                                      |                                                                                                                  |                                |         |      |          |               |
| $V_{RRM}$          | max. repetitive reverse voltage      |                                                                                                                  | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 1200     | V             |
| $I_{F25}$          | forward current                      |                                                                                                                  | $T_C = 25^{\circ}\text{C}$     |         |      | 135      | A             |
| $I_{F80}$          |                                      |                                                                                                                  | $T_C = 80^{\circ}\text{C}$     |         |      | 90       | A             |
| $V_F$              | forward voltage                      | $I_F = 100 \text{ A}$                                                                                            | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 2,20     | V             |
|                    |                                      |                                                                                                                  | $T_{VJ} = 125^{\circ}\text{C}$ |         | 1,95 |          | V             |
| $I_R$              | reverse current                      | $V_R = V_{RRM}$                                                                                                  | $T_{VJ} = 25^{\circ}\text{C}$  |         |      | 0,1      | mA            |
|                    |                                      |                                                                                                                  | $T_{VJ} = 125^{\circ}\text{C}$ |         |      | 1,2      | mA            |
| $Q_{rr}$           | reverse recovery charge              | $V_R = 600 \text{ V}$<br>$-di_F/dt = 1600 \text{ A}/\mu\text{s}$<br>$I_F = 100 \text{ A}; V_{GE} = 0 \text{ V}$  | $T_{VJ} = 125^{\circ}\text{C}$ |         | 12,5 |          | $\mu\text{C}$ |
| $I_{RM}$           | max. reverse recovery current        |                                                                                                                  |                                |         | 100  |          | A             |
| $t_{rr}$           | reverse recovery time                |                                                                                                                  |                                |         | 350  |          | ns            |
| $E_{rec}$          | reverse recovery energy              |                                                                                                                  |                                |         | 4    |          | mJ            |
| $R_{thJC}$         | thermal resistance junction to case  |                                                                                                                  |                                |         |      | 0,4      | 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         |                                         |         |      | 30   | 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 | 4300    |      |      | V    |
|                      |                                                              | t = 1 minute         |                                         | 3600    |      |      | V    |



### Part description

M = Module  
 D = Diode  
 M = Standard Rectifier  
 A = (up to 1800V)  
 450 = Current Rating [A]  
 UB = 3~ Rectifier Bridge + Brake Unit  
 1600 = Reverse Voltage [V]  
 PT = PressFit-Pin, Thermistor  
 ED = E2-Pack  
 - = Hyphen  
 PC = Phase Change Material

| Ordering    | Ordering Number      | Marking on Product | Delivery Mode | Quantity | Code No. |
|-------------|----------------------|--------------------|---------------|----------|----------|
| Standard    | MDMA450UB1600PTED    | MDMA450UB1600PTED  | Blister       | 28       | 517598   |
| Alternative | MDMA450UB1600PTED-PC | MDMA450UB1600PTED  | Blister       | 28       | 517605   |

### Temperature Sensor NTC

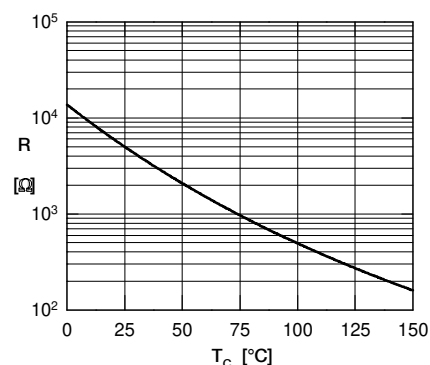
| Symbol      | Definition              | Conditions          | min. | typ. | max. | Unit |
|-------------|-------------------------|---------------------|------|------|------|------|
| $R_{25}$    | resistance              | $T_{VJ} = 25^\circ$ | 4,85 | 5    | 5,15 | kΩ   |
| $B_{25/50}$ | temperature coefficient |                     |      | 3375 |      | K    |

### Equivalent Circuits for Simulation

\* on die level

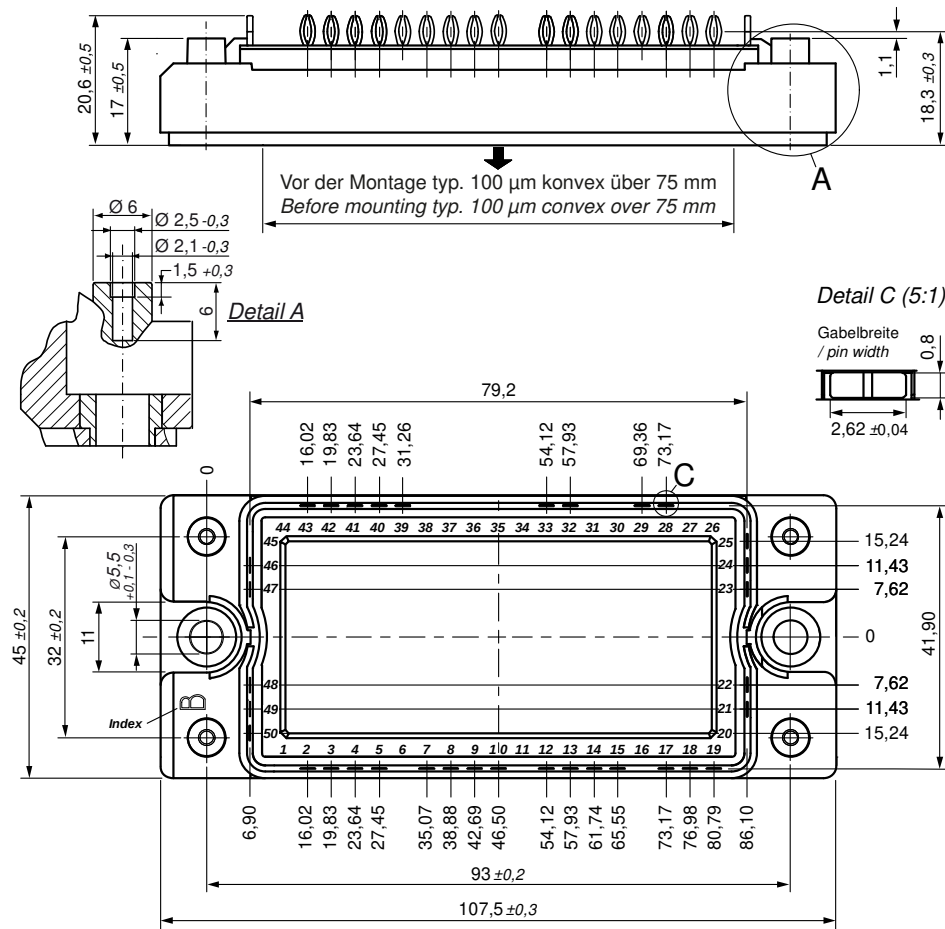
$T_{VJ} = 150^\circ\text{C}$

|       |                    | Rectifier | Brake IGBT + | Brake Diode |    |
|-------|--------------------|-----------|--------------|-------------|----|
| $V_0$ | threshold voltage  | 0,82      | 1,1          | 1,25        | V  |
| $R_0$ | slope resistance * | 1,2       | 9,2          | 8,5         | mΩ |





**Outlines E2-Pack**

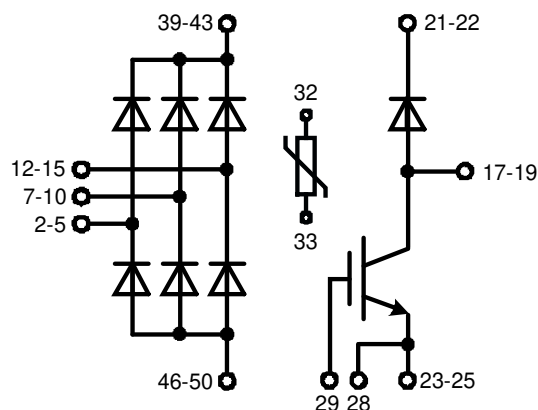


**Bemerkung / Note:**

- 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:  $\pm 0,1$
- 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

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



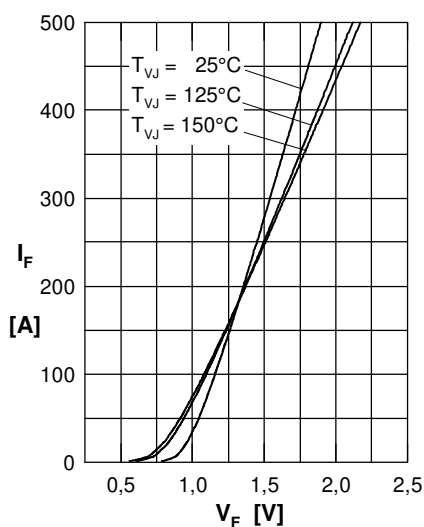
**Rectifier**


Fig. 1 Forward current versus voltage drop per diode

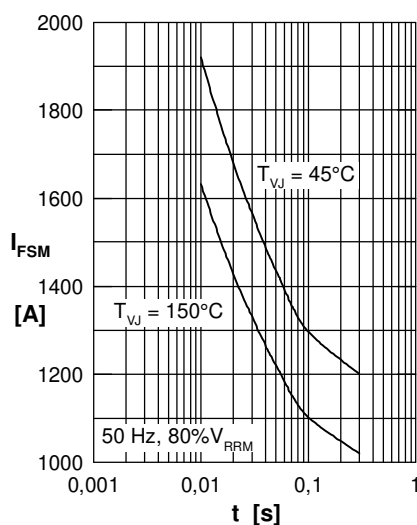


Fig. 2 Surge overload current vs. time per diode

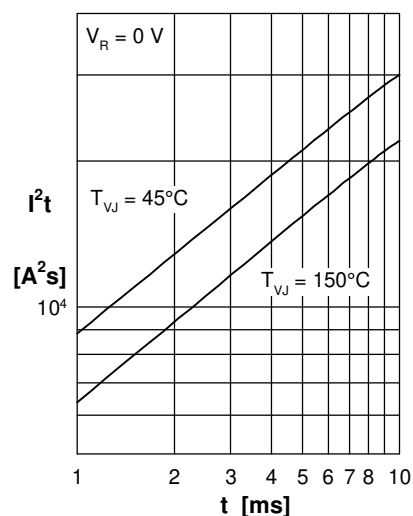
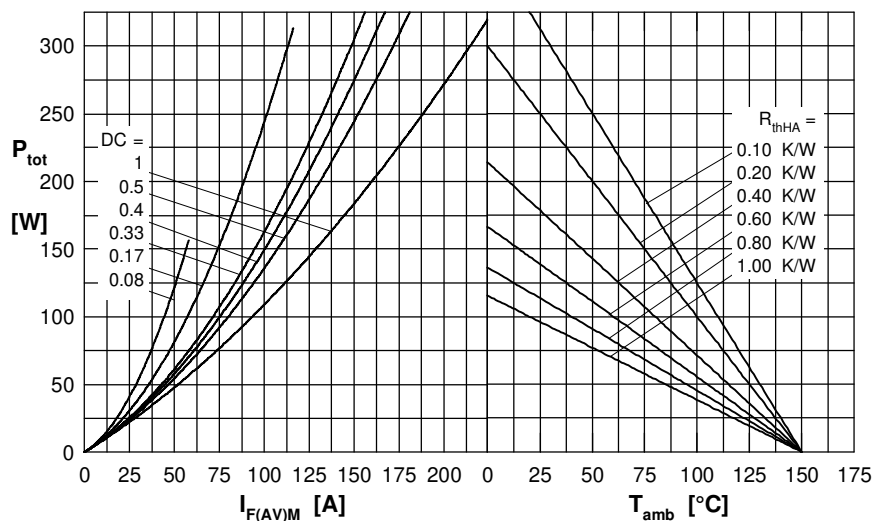

 Fig. 3  $I^2t$  versus time per diode


Fig. 4 Power dissipation vs. forward current and ambient temperature per diode

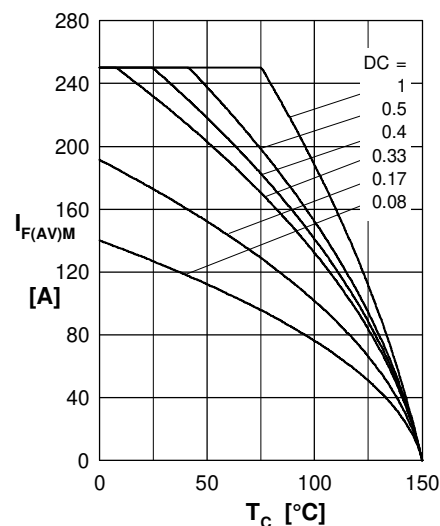


Fig. 5 Max. forward current vs. case temperature per diode

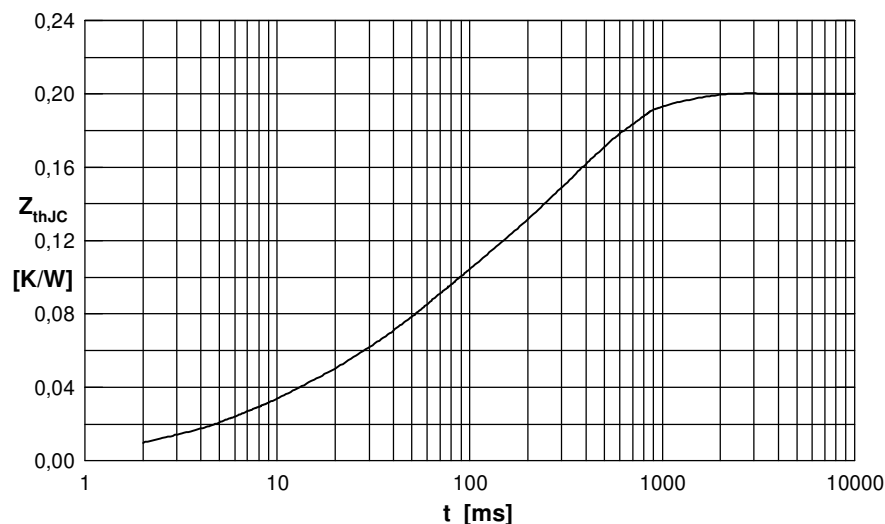


Fig. 6 Transient thermal impedance junction to case vs. time per diode

 Constants for  $Z_{thJC}$  calculation:

| i | $R_{thi}$ (K/W) | $t_i$ (s) |
|---|-----------------|-----------|
| 1 | 0.020           | 0.006     |
| 2 | 0.003           | 0.007     |
| 3 | 0.057           | 0.042     |
| 4 | 0.120           | 0.350     |

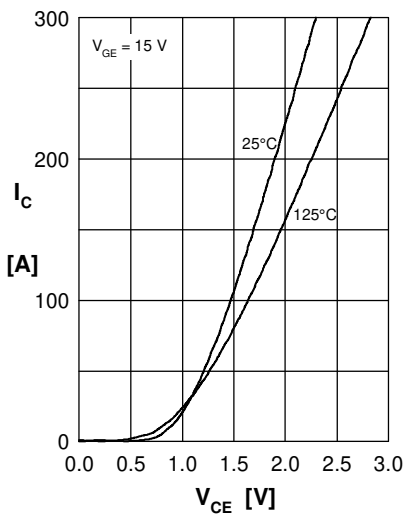
**Brake IGBT + Diode**


Fig.1 Output characteristics IGBT

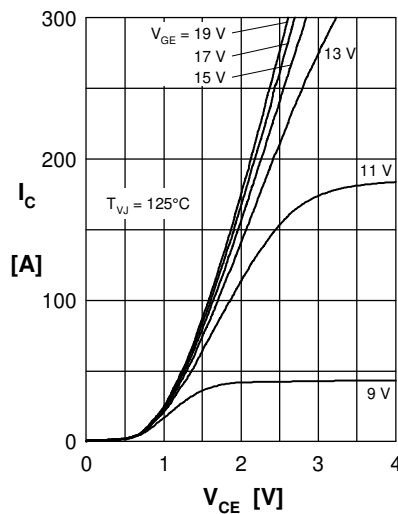


Fig.2 Typ. output characteristics IGBT

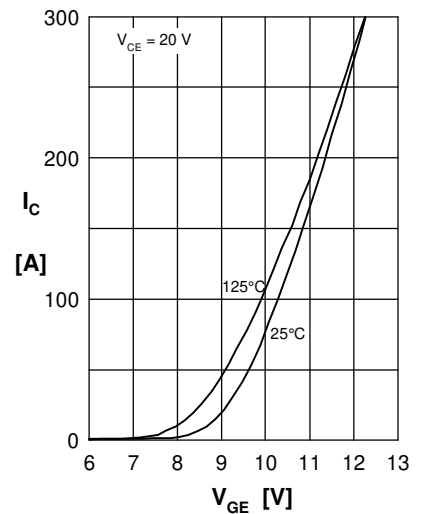


Fig.3 Typ. transfer charact. IGBT

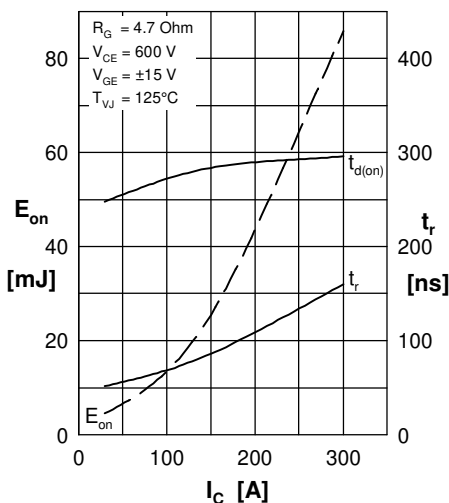


Fig.4 Typ. turn-on energy &amp; switch. times vs. collector current

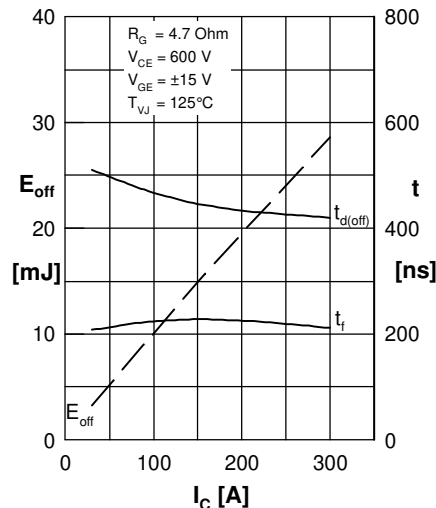


Fig.5 Typ. turn-off energy &amp; switch. times vs. collector current

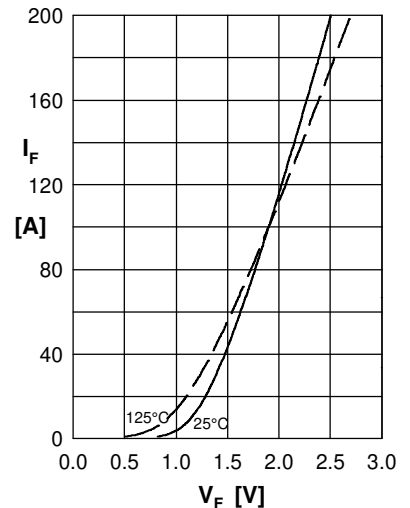


Fig.6 Typ. forward characteristics Diode

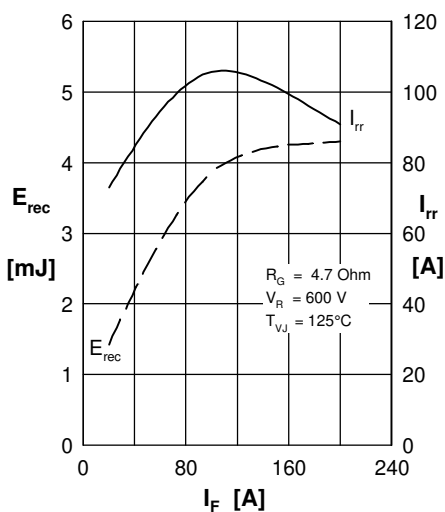


Fig.7 Typ. reverse recovery characteristics Diode

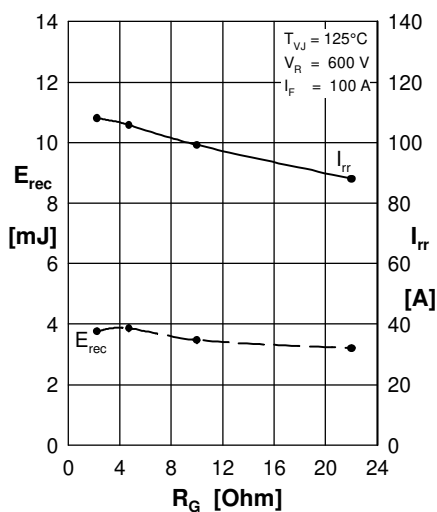


Fig.8 Typ. reverse recovery characteristics Diode

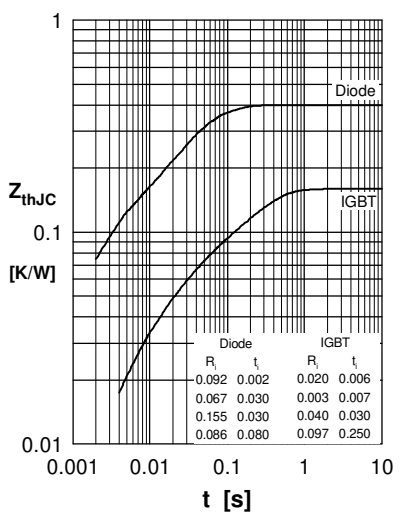


Fig.9 Transient thermal resistance junction to case