

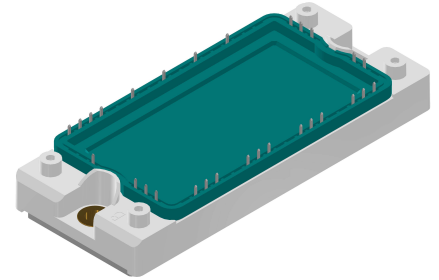
# Thyristor Module

| 3~ Rectifier               | Brake Chopper                 |
|----------------------------|-------------------------------|
| $V_{RRM} = 1600 \text{ V}$ | $V_{CES} = 1200 \text{ V}$    |
| $I_{DAV} = 240 \text{ A}$  | $I_{C25} = 180 \text{ A}$     |
| $I_{FSM} = 1500 \text{ A}$ | $V_{CE(sat)} = 1.7 \text{ V}$ |

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

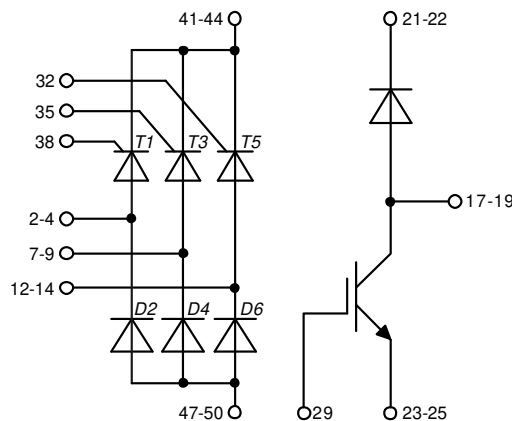
Part number

**MCMA240UI1600ED**



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
- X2PT - 2nd generation Xtreme light Punch Through
- Rugged X2PT design results in:
  - short circuit rated for 10  $\mu\text{sec}$ .
  - very low gate charge
  - low EMI
  - square RBSOA @ 2x  $I_c$
- Thin wafer technology combined with X2PT design results in a competitive low  $V_{CE(sat)}$  and low thermal resistance

## Applications:

- 3~ Rectifier with brake unit for drive inverters

## Package: E2-Pack

- Isolation Voltage: 3600 V~
- Industry standard outline
- RoHS compliant
- Soldering 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 | $T_{VJ} = 25^{\circ}C$   |                         |      | 1700 | V                 |
| $V_{RRM/DRM}$  | max. repetitive reverse/forward blocking voltage     | $T_{VJ} = 25^{\circ}C$   |                         |      | 1600 | V                 |
| $I_{RD}$       | reverse current, drain current                       | $V_{R/D} = 1600 V$   | $T_{VJ} = 25^{\circ}C$  |      | 100  | $\mu A$           |
|                |  | $V_{R/D} = 1600 V$   | $T_{VJ} = 150^{\circ}C$ |      | 20   | mA                |
| $V_T$          | forward voltage drop                                 | $I_T = 80 A$   | $T_{VJ} = 25^{\circ}C$  |      | 1.27 | V                 |
|                |  | $I_T = 240 A$  |                         |      | 1.89 | V                 |
|                |  | $I_T = 80 A$   | $T_{VJ} = 125^{\circ}C$ |      | 1.26 | V                 |
|                |  | $I_T = 240 A$  |                         |      | 2.05 | V                 |
| $I_{DAV}$      | bridge output current                                | $T_C = 80^{\circ}C$<br>rectangular $d = 120^{\circ}$   | $T_{VJ} = 150^{\circ}C$ |      | 240  | A                 |
| $V_{T0}$       | threshold voltage                                    | } for power loss calculation only  | $T_{VJ} = 150^{\circ}C$ |      | 0.83 | V                 |
| $r_T$          | slope resistance                                     |  |                         |      | 5.3  | m $\Omega$        |
| $R_{thJC}$     | thermal resistance junction to case                  |  |                         |      | 0.4  | K/W               |
| $R_{thCH}$     | thermal resistance case to heatsink                  |  |                         | 0.1  |      | K/W               |
| $P_{tot}$      | total power dissipation                              |  | $T_C = 25^{\circ}C$     |      | 312  | W                 |
| $I_{TSM}$      | max. forward surge current                           | $t = 10 ms; (50 Hz), sine$   | $T_{VJ} = 45^{\circ}C$  |      | 1.50 | kA                |
|                |  | $t = 8,3 ms; (60 Hz), sine$  | $V_R = 0 V$             |      | 1.62 | kA                |
|                |  | $t = 10 ms; (50 Hz), sine$   | $T_{VJ} = 150^{\circ}C$ |      | 1.28 | kA                |
|                |  | $t = 8,3 ms; (60 Hz), sine$  | $V_R = 0 V$             |      | 1.38 | kA                |
| $I^2t$         | value for fusing                                     | $t = 10 ms; (50 Hz), sine$   | $T_{VJ} = 45^{\circ}C$  |      | 11.3 | kA <sup>2</sup> s |
|                |  | $t = 8,3 ms; (60 Hz), sine$  | $V_R = 0 V$             |      | 10.9 | kA <sup>2</sup> s |
|                |  | $t = 10 ms; (50 Hz), sine$   | $T_{VJ} = 150^{\circ}C$ |      | 8.13 | kA <sup>2</sup> s |
|                |  | $t = 8,3 ms; (60 Hz), sine$  | $V_R = 0 V$             |      | 7.87 | kA <sup>2</sup> s |
| $C_J$          | junction capacitance                                 | $V_R = 400 V f = 1 MHz$  | $T_{VJ} = 25^{\circ}C$  |      | 74   | pF                |
| $P_{GM}$       | max. gate power dissipation                          | $t_p = 30 \mu s$   | $T_C = 150^{\circ}C$    |      | 10   | W                 |
|                |  | $t_p = 300 \mu s$  |                         |      | 5    | W                 |
| $P_{GAV}$      | average gate power dissipation                       |  |                         |      | 0.5  | W                 |
| $(di/dt)_{cr}$ | critical rate of rise of current                     | $T_{VJ} = 150^{\circ}C; f = 50 Hz$ repetitive, $I_T = 240 A$   |                         |      | 150  | A/ $\mu s$        |
|                |  | $t_p = 200 \mu s; di_G/dt = 0.45 A/\mu s;$<br>$I_G = 0.45 A; V = \frac{2}{3} V_{DRM}$ non-repet., $I_T = 80 A$ |                         |      | 500  | A/ $\mu s$        |
| $(dv/dt)_{cr}$ | critical rate of rise of voltage                     | $V = \frac{2}{3} V_{DRM}$<br>$R_{GK} = \infty; \text{method 1 (linear voltage rise)}$                          | $T_{VJ} = 150^{\circ}C$ |      | 1000 | V/ $\mu s$        |
| $V_{GT}$       | gate trigger voltage                                 | $V_D = 6 V$  | $T_{VJ} = 25^{\circ}C$  |      | 1.5  | V                 |
|                |  |  | $T_{VJ} = -40^{\circ}C$ |      | 1.6  | V                 |
| $I_{GT}$       | gate trigger current                                 | $V_D = 6 V$  | $T_{VJ} = 25^{\circ}C$  |      | 95   | mA                |
|                |  |  | $T_{VJ} = -40^{\circ}C$ |      | 200  | mA                |
| $V_{GD}$       | gate non-trigger voltage                             | $V_D = \frac{2}{3} V_{DRM}$  | $T_{VJ} = 150^{\circ}C$ |      | 0.2  | V                 |
| $I_{GD}$       | gate non-trigger current                             |  |                         |      | 10   | mA                |
| $I_L$          | latching current                                     | $t_p = 10 \mu s$   | $T_{VJ} = 25^{\circ}C$  |      | 450  | mA                |
|                |  | $I_G = 0.45 A; di_G/dt = 0.45 A/\mu s$   |                         |      |      |                   |
| $I_H$          | holding current                                      | $V_D = 6 V R_{GK} = \infty$  | $T_{VJ} = 25^{\circ}C$  |      | 200  | mA                |
| $t_{gd}$       | gate controlled delay time                           | $V_D = \frac{1}{2} V_{DRM}$  | $T_{VJ} = 25^{\circ}C$  |      | 2    | $\mu s$           |
|                |  | $I_G = 0.45 A; di_G/dt = 0.45 A/\mu s$   |                         |      |      |                   |
| $t_q$          | turn-off time  | $V_R = 100 V; I_T = 80 A; V = \frac{2}{3} V_{DRM}$<br>$di/dt = 10 A/\mu s dv/dt = 20 V/\mu s t_p = 200 \mu s$  | $T_{VJ} = 125^{\circ}C$ |      | 150  | $\mu s$           |



| Brake IGBT + Diode |                                      |  |      | Ratings |          |               |  |
|--------------------|--------------------------------------|--|------|---------|----------|---------------|--|
| Symbol             | Definition                           | Conditions   | min. | typ.    | max.     | Unit          |  |
| $V_{CES}$          | collector emitter voltage            |  |      |         | 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                    |  |      |         | 180      | A             |  |
| $I_{C80}$          |                                      |  |      |         | 140      | A             |  |
| $P_{tot}$          | total power dissipation              |  |      |         | 500      | W             |  |
| $V_{CE(sat)}$      | collector emitter saturation voltage | $I_C = 100 \text{ A}; V_{GE} = 15 \text{ V}$   |      |         | 1.7      | V             |  |
|                    |                                      |  |      |         | 1.9      | V             |  |
| $V_{GE(th)}$       | gate emitter threshold voltage       | $I_C = 4 \text{ mA}; V_{GE} = V_{CE}$  | 6    | 6.8     | 7.5      | V             |  |
| $I_{CES}$          | collector emitter leakage current    | $V_{CE} = V_{CES}; V_{GE} = 0 \text{ V}$   |      |         | 0.1      | mA            |  |
|                    |                                      |  |      |         | 0.1      | mA            |  |
| $I_{GES}$          | gate emitter leakage current         | $V_{GE} = \pm 20 \text{ V}$  |      |         | 500      | nA            |  |
| $Q_{G(on)}$        | total gate charge                    | $V_{CE} = 600 \text{ V}; V_{GE} = 15 \text{ V}; I_C = 100 \text{ A}$   |      | 340     |          | nC            |  |
| $t_{d(on)}$        | turn-on delay time                   | inductive load<br>$V_{CE} = 600 \text{ V}; I_C = 100 \text{ A}$<br>$V_{GE} = \pm 15 \text{ V}; R_G = 6.8 \Omega$ |      | 230     |          | ns            |  |
| $t_r$              | current rise time                    |  |      | 70      |          | ns            |  |
| $t_{d(off)}$       | turn-off delay time                  |  |      | 380     |          | ns            |  |
| $t_f$              | current fall time                    |  |      | 230     |          | ns            |  |
| $E_{on}$           | turn-on energy per pulse             |  |      | 12.5    |          | mJ            |  |
| $E_{off}$          | turn-off energy per pulse            |  |      | 11.5    |          | mJ            |  |
| <b>RBSOA</b>       | reverse bias safe operating area     | $V_{GE} = \pm 15 \text{ V}; R_G = 6.8 \Omega$  |      |         |          |               |  |
| $I_{CM}$           |                                      | $V_{CEK} = 1200 \text{ V}$   |      |         | 300      | A             |  |
| <b>SCSOA</b>       | short circuit safe operating area    | $V_{CEK} = 1200 \text{ V}$   |      |         |          |               |  |
| $t_{SC}$           | short circuit duration               | $V_{CE} = 720 \text{ V}; V_{GE} = \pm 15$  |      |         | 10       | $\mu\text{s}$ |  |
| $I_{SC}$           | short circuit current                | $R_G = 6.8 \Omega$ ; non-repetitive  |      | 450     |          | A             |  |
| $R_{thJC}$         | thermal resistance junction to case  |  |      |         | 0.25     | K/W           |  |
| $R_{thCH}$         | thermal resistance case to heatsink  |  |      | 0.10    |          | K/W           |  |
| <b>Brake Diode</b> |                                      |  |      |         |          |               |  |
| $V_{RRM}$          | max. repetitive reverse voltage      |  |      |         | 1200     | V             |  |
| $I_{F25}$          | forward current                      |  |      |         | 88       | A             |  |
| $I_{F80}$          |                                      |  |      |         | 59       | A             |  |
| $V_F$              | forward voltage                      | $I_F = 60 \text{ A}$   |      |         | 2.20     | V             |  |
|                    |                                      |  |      |         | 1.95     | V             |  |
| $I_R$              | reverse current                      | $V_R = V_{RRM}$  |      |         | 0.1      | mA            |  |
|                    |                                      |  |      |         | 1.2      | mA            |  |
| $Q_{rr}$           | reverse recovery charge              | $V_R = 600 \text{ V}$<br>$-di_f/dt = 900 \text{ A}/\mu\text{s}$<br>$I_F = 60 \text{ A}; V_{GE} = 0 \text{ V}$    |      | 9.6     |          | $\mu\text{C}$ |  |
| $I_{RM}$           | max. reverse recovery current        |  |      | 47      |          | A             |  |
| $t_{rr}$           | reverse recovery time                |  |      | 450     |          | ns            |  |
| $E_{rec}$          | reverse recovery energy              |  |      | 3       |          | mJ            |  |
| $R_{thJC}$         | thermal resistance junction to case  |  |      |         | 0.6      | K/W           |  |
| $R_{thCH}$         | thermal resistance case to heatsink  |  |      | 0.1     |          | K/W           |  |

| Package E2-Pack |  | Ratings                             |              |      |      |        |
|-----------------|--|-------------------------------------|--------------|------|------|--------|
| Symbol          | Definition   | Conditions                          | min.         | typ. | max. | Unit   |
| $I_{RMS}$       | RMS current  | per terminal                        |              |      | 50   | A      |
| $T_{VJ}$        | virtual junction temperature                                 |                                     | -40          |      | 150  | °C     |
| $T_{op}$        | operation temperature  |                                     | -40          |      | 125  | °C     |
| $T_{stg}$       | storage temperature  |                                     | -40          |      | 125  | °C     |
| <b>Weight</b>   |  |                                     |              | 176  |      | g      |
| $M_D$           | mounting torque  |                                     | 3            |      | 6    | Nm     |
| $d_{Spp/App}$   | creepage distance on surface / striking distance through air | terminal to terminal                | 6.0          |      |      | mm     |
| $d_{Spb/Appb}$  |  | terminal to backside                | 12.0         |      |      | mm     |
| $V_{ISOL}$      | isolation voltage  | t = 1 second<br>t = 1 minute        | 3600<br>3000 |      |      | V<br>V |
|                 |  | 50/60 Hz, RMS; $I_{ISOL} \leq 1$ mA |              |      |      |        |


**Part description**

M = Module  
 C = Thyristor (SCR)  
 M = Thyristor  
 A = (up to 1800V)  
 240 = Current Rating [A]  
 UI = 3- Rectifier Bridge, half-controlled (high-side) + Brake Unit  
 1600 = Reverse Voltage [V]  
 ED = E2-Pack

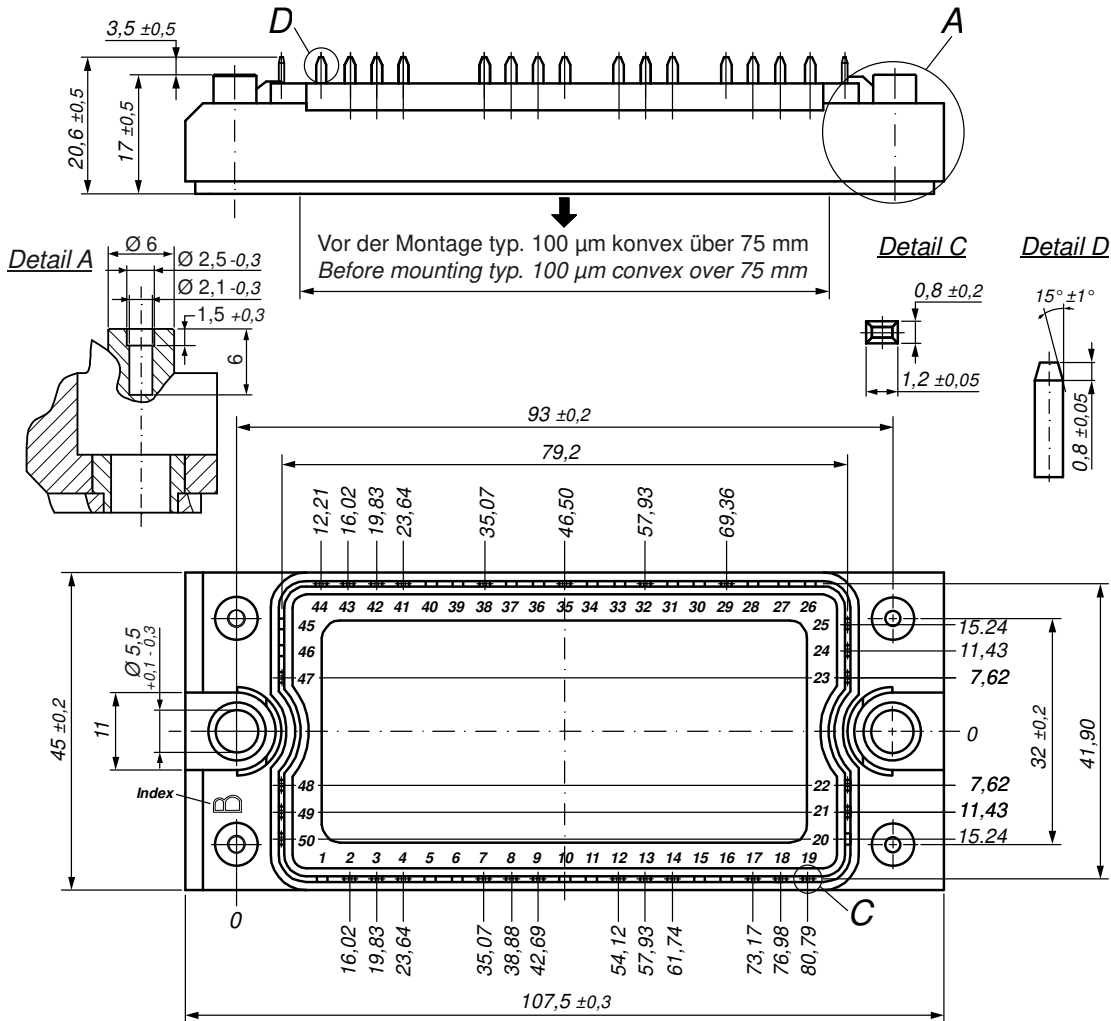
| Ordering | Ordering Number | Marking on Product | Delivery Mode | Quantity | Code No. |
|----------|-----------------|--------------------|---------------|----------|----------|
| Standard | MCMA240UI1600ED | MCMA240UI1600ED    | Box           | 6        | 520454   |

**Equivalent Circuits for Simulation**
*\* on die level*
 $T_{VJ} = 150^{\circ}\text{C}$ 

|       |                    | Thyristor | Brake IGBT + | Brake Diode |    |
|-------|--------------------|-----------|--------------|-------------|----|
| $V_0$ | threshold voltage  | 0.83      | 1.2          | 1.25        | V  |
| $R_0$ | slope resistance * | 2.7       | 11.6         | 8.5         | mΩ |



**Outlines E2-Pack**

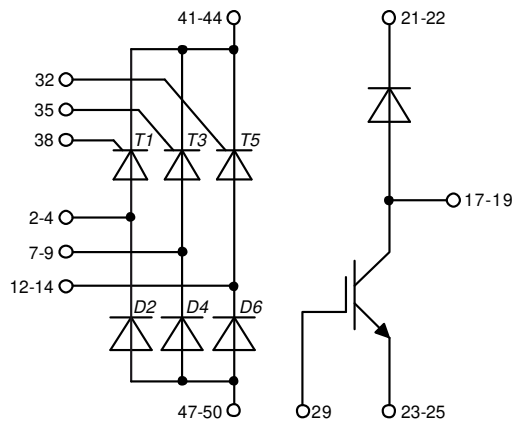


**Bemerkung / Note:**

- Nichttolerierte 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:  $\oplus 0.1$*
- Montageanleitung / *Mounting instruction: 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*



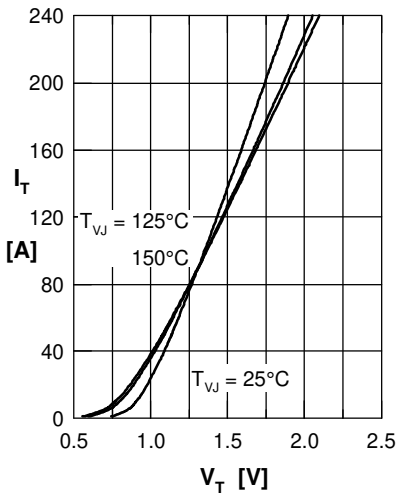
**Thyristor**


Fig. 1 Forward characteristics

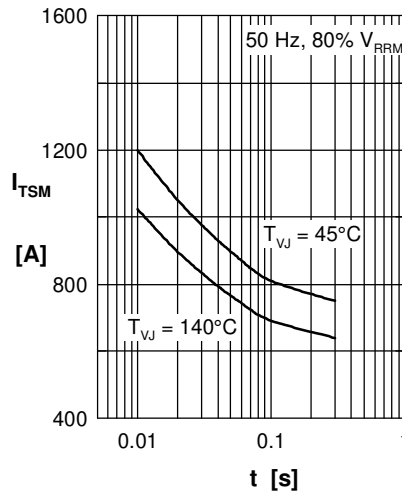
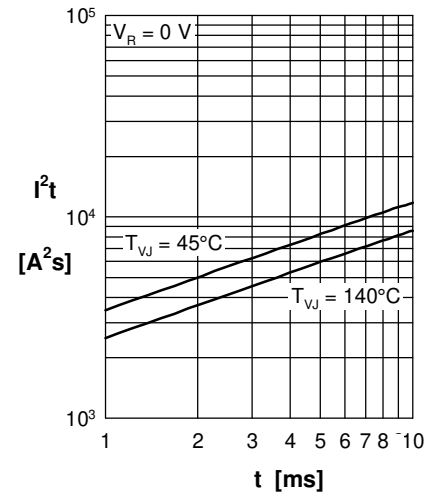
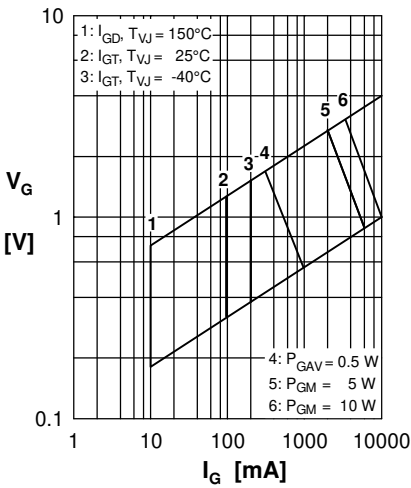

 Fig. 2 Surge overload current  
 $I_{TSM}$ : crest value,  $t$ : duration

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


Fig. 4 Gate voltage &amp; gate current

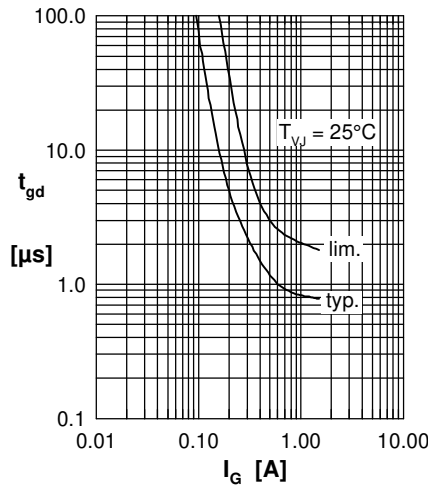
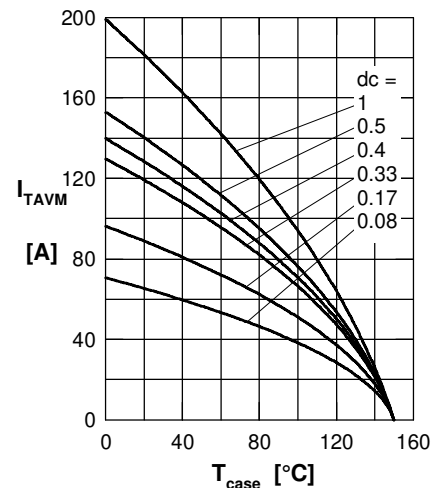

 Fig. 5 Gate controlled delay time  $t_{gd}$ 


Fig. 6 Max. forward current at case temperature

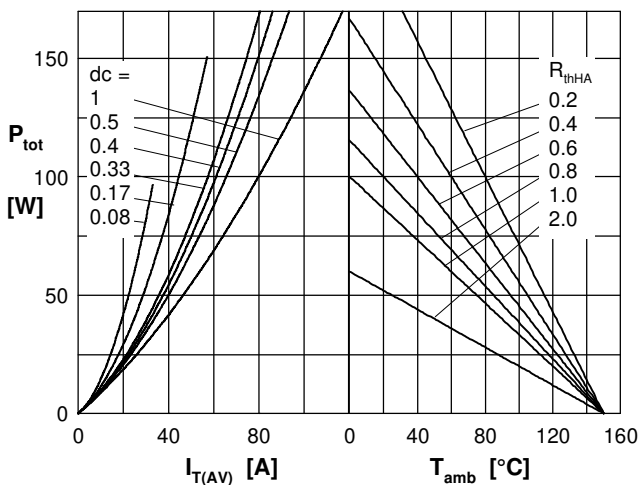
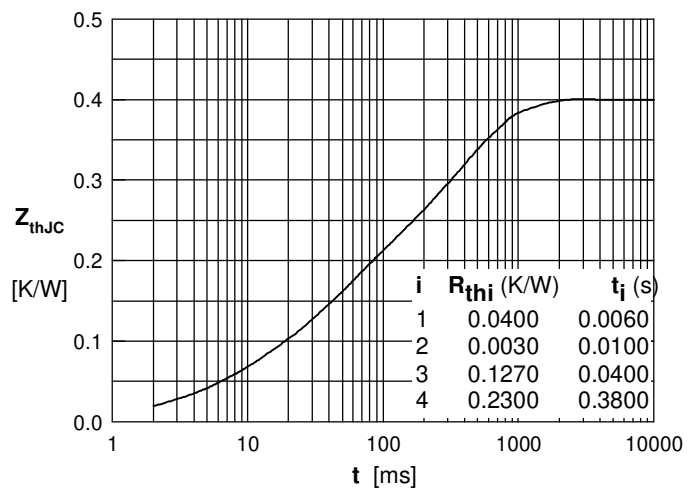

 Fig. 7a Power dissipation versus direct output current  
 Fig. 7b and ambient temperature


Fig. 8 Transient thermal impedance junction to case

## Brake IGBT + Diode

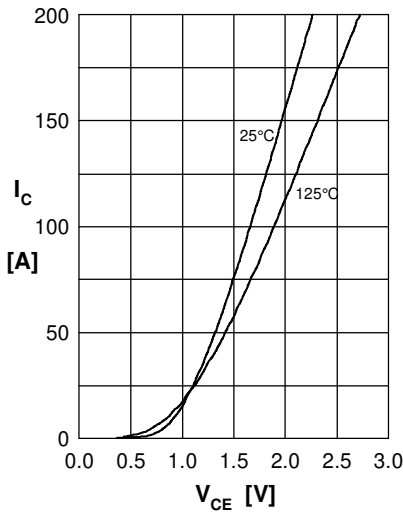


Fig.1 Output characteristics IGBT



Fig.2 Typ. output characteristics IGBT

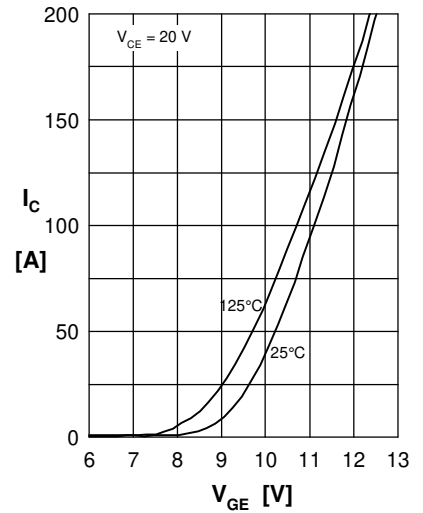


Fig. 3 Typ. transfer charact. IGBT

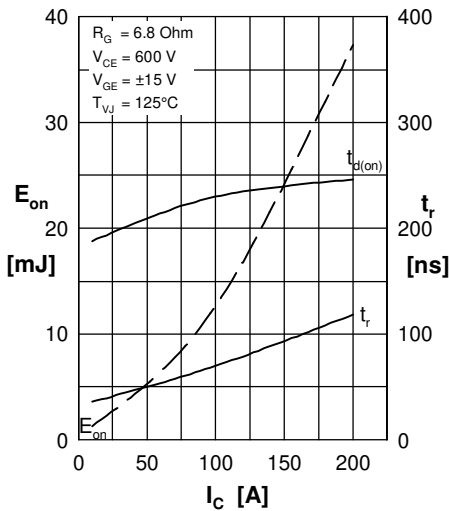


Fig. 4 Typ. turn-on energy & switch. times vs. collector current

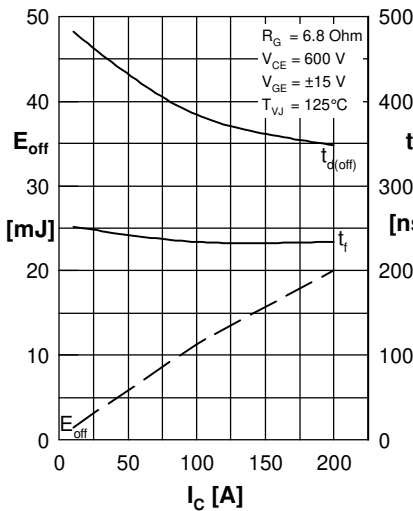


Fig. 5 Typ. turn-off energy & switch. times vs. collector current

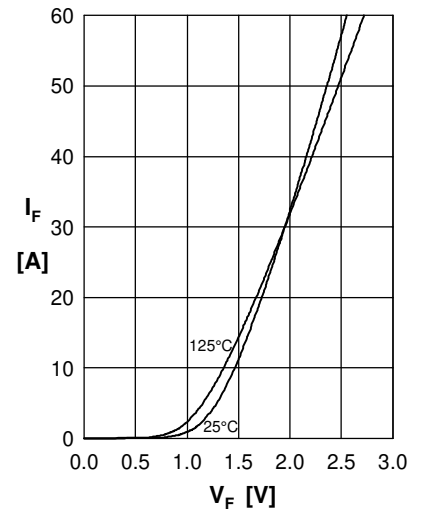


Fig. 6 Typ. forward current versus  $V_F$

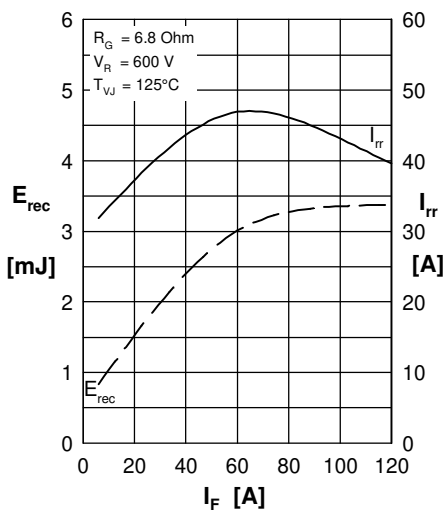


Fig. 7 Typ. reverse recovery characteristics Diode

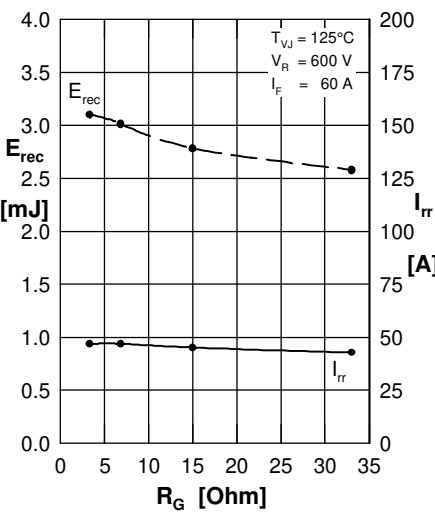


Fig. 8 Typ. reverse recovery characteristics Diode

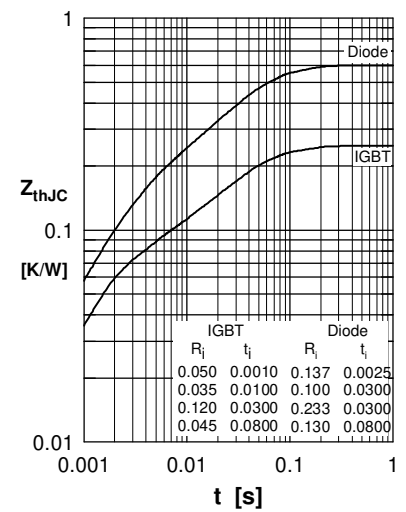


Fig. 9 Transient thermal resistance junction to case