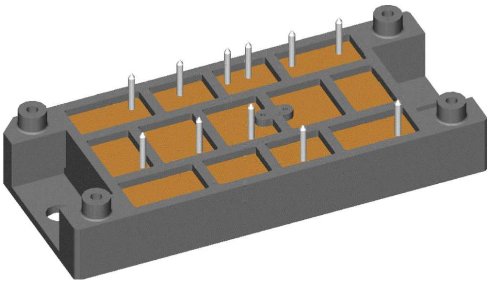
# Thyristor Module

| 3~ Rectifier | | | Brake Chopper | | |
|---|---|---|---|---|---|
| $V_{RRM}$ | = | 1600 V | $V_{CES}$ | = | 1200 V |
| $I_{DAV}$ | = | 180 A | $I_{C25}$ | = | 180 A |
| $I_{FSM}$ | = | 700 A | $V_{CE(sat)}$ | = | 1.7 V |

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

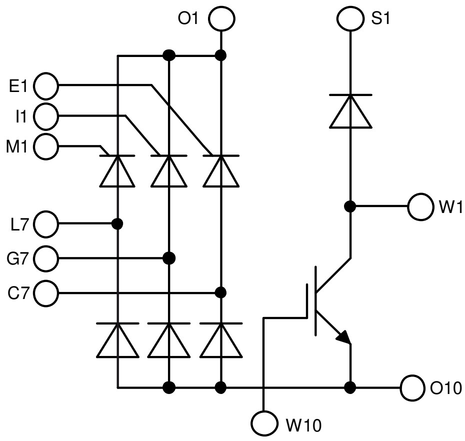
**Part number**

**VVZB120-16ioX**



Backside: isolated

UL E72873




**Features / Advantages:**

- Package with DCB ceramic base plate
- 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 µsec.
  - very low gate charge
  - low EMI
  - square RBSOA @ 2x Ic
- Thin wafer technology combined with X2PT design results in a competitive low VCE(sat) and low thermal resistance

**Applications:**

- 3~ Rectifier with brake unit for drive inverters

**Package:** V2-Pack

- Isolation Voltage: 3600 V~
- Industry standard outline
- RoHS compliant
- Soldering pins for PCB mounting
- Height: 17 mm
- Base plate: DCB ceramic
- Reduced weight
- Advanced power cycling

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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°C | | | 1700 | V |
| $V_{RRM/DRM}$ | *max. repetitive reverse/forward blocking voltage* | $T_{VJ}$ = 25°C | | | 1600 | V |
| $I_{R/D}$ | *reverse current, drain current* | $V_{R/D}$ = 1600 V; $T_{VJ}$ = 25°C | | | 50 | µA |
| | | $V_{R/D}$ = 1600 V; $T_{VJ}$ = 150°C | | | 20 | mA |
| $V_T$ | *forward voltage drop* | $I_T$ = 60 A; $T_{VJ}$ = 25°C | | | 1.27 | V |
| | | $I_T$ = 180 A | | | 1.90 | V |
| | | $I_T$ = 60 A; $T_{VJ}$ = 125°C | | | 1.25 | V |
| | | $I_T$ = 180 A | | | 2.04 | V |
| $I_{DAV}$ | *bridge output current* | $T_C$ = 85°C; $T_{VJ}$ = 150°C | | | 180 | A |
| | | rectangular d = ⅓ | | | | |
| $V_{T0}$ | *threshold voltage* } *for power loss calculation only* | $T_{VJ}$ = 150°C | | | 0.83 | V |
| $r_T$ | *slope resistance* | | | | 6.9 | mΩ |
| $R_{thJC}$ | *thermal resistance junction to case* | | | | 0.5 | K/W |
| $R_{thCH}$ | *thermal resistance case to heatsink* | | | 0.1 | | K/W |
| $P_{tot}$ | *total power dissipation* | $T_C$ = 25°C | | | 250 | W |
| $I_{TSM}$ | *max. forward surge current* | t = 10 ms; (50 Hz), sine; $T_{VJ}$ = 45°C | | | 700 | A |
| | | t = 8,3 ms; (60 Hz), sine; $V_R$ = 0 V | | | 755 | A |
| | | t = 10 ms; (50 Hz), sine; $T_{VJ}$ = 150°C | | | 595 | A |
| | | t = 8,3 ms; (60 Hz), sine; $V_R$ = 0 V | | | 645 | A |
| $I^2t$ | *value for fusing* | t = 10 ms; (50 Hz), sine; $T_{VJ}$ = 45°C | | | 2.45 | kA²s |
| | | t = 8,3 ms; (60 Hz), sine; $V_R$ = 0 V | | | 2.37 | kA²s |
| | | t = 10 ms; (50 Hz), sine; $T_{VJ}$ = 150°C | | | 1.77 | kA²s |
| | | t = 8,3 ms; (60 Hz), sine; $V_R$ = 0 V | | | 1.73 | kA²s |
| $C_J$ | *junction capacitance* | $V_R$ = 400 V f = 1 MHz; $T_{VJ}$ = 25°C | | 54 | | pF |
| $P_{GM}$ | *max. gate power dissipation* | $t_P$ = 30 µs; $T_C$ = 150°C | | | 10 | W |
| | | $t_P$ = 300 µs | | | 5 | W |
| $P_{GAV}$ | *average gate power dissipation* | | | | 0.5 | W |
| $(di/dt)_{cr}$ | *critical rate of rise of current* | $T_{VJ}$ = 150°C; f = 50 Hz; repetitive, $I_T$ = 180 A | | | 150 | A/µs |
| | | $t_P$ = 200 µs; $di_G/dt$ = 0.45 A/µs; | | | | |
| | | $I_G$ = 0.45 A; V = ⅔ $V_{DRM}$; non-repet., $I_T$ = 60 A | | | 500 | A/µs |
| $(dv/dt)_{cr}$ | *critical rate of rise of voltage* | V = ⅔ $V_{DRM}$; $T_{VJ}$ = 150°C | | | 1000 | V/µs |
| | | $R_{GK}$ = ∞; method 1 (linear voltage rise) | | | | |
| $V_{GT}$ | *gate trigger voltage* | $V_D$ = 6 V; $T_{VJ}$ = 25°C | | | 1.5 | V |
| | | $T_{VJ}$ = -40°C | | | 1.6 | V |
| $I_{GT}$ | *gate trigger current* | $V_D$ = 6 V; $T_{VJ}$ = 25°C | | | 95 | mA |
| | | $T_{VJ}$ = -40°C | | | 200 | mA |
| $V_{GD}$ | *gate non-trigger voltage* | $V_D$ = ⅔ $V_{DRM}$; $T_{VJ}$ = 150°C | | | 0.2 | V |
| $I_{GD}$ | *gate non-trigger current* | | | | 10 | mA |
| $I_L$ | *latching current* | $t_p$ = 10 µs; $T_{VJ}$ = 25°C | | | 450 | mA |
| | | $I_G$ = 0.45 A; $di_G/dt$ = 0.45 A/µs | | | | |
| $I_H$ | *holding current* | $V_D$ = 6 V $R_{GK}$ = ∞; $T_{VJ}$ = 25°C | | | 200 | mA |
| $t_{gd}$ | *gate controlled delay time* | $V_D$ = ½ $V_{DRM}$; $T_{VJ}$ = 25°C | | | 2 | µs |
| | | $I_G$ = 0.45 A; $di_G/dt$ = 0.45 A/µs | | | | |
| $t_q$ | *turn-off time* | $V_R$ = 100 V; $I_T$ = 60A; V = ⅔ $V_{DRM}$; $T_{VJ}$ = 125 °C | | 150 | | µs |
| | | di/dt = 10 A/µs dv/dt = 20 V/µs $t_p$ = 200 µs | | | | |

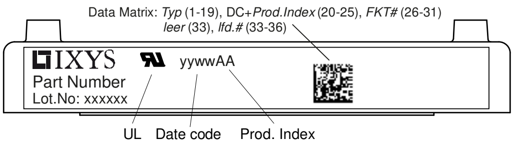
## Brake IGBT + Diode

| Symbol | Definition | Conditions | | Ratings min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|---|
| $V_{CES}$ | *collector emitter voltage* | | $T_{VJ}$ = 25°C | | | 1200 | V |
| $V_{GES}$ | *max. DC gate voltage* | | | | | ±20 | V |
| $V_{GEM}$ | *max. transient gate emitter voltage* | | | | | ±30 | V |
| $I_{C25}$ | *collector current* | | $T_C$ = 25°C | | | 180 | A |
| $I_{C80}$ | | | $T_C$ = 80°C | | | 140 | A |
| $P_{tot}$ | *total power dissipation* | | $T_C$ = 25°C | | | 500 | W |
| $V_{CE(sat)}$ | *collector emitter saturation voltage* | $I_C$ = 100 A; $V_{GE}$ = 15 V | $T_{VJ}$ = 25°C | | 1.7 | 2.1 | V |
| | | | $T_{VJ}$ = 125°C | | 1.9 | | V |
| $V_{GE(th)}$ | *gate emitter threshold voltage* | $I_C$ = 4 mA; $V_{GE}$ = $V_{CE}$ | $T_{VJ}$ = 25°C | 6 | 6.8 | 7.5 | V |
| $I_{CES}$ | *collector emitter leakage current* | $V_{CE}$ = $V_{CES}$; $V_{GE}$ = 0 V | $T_{VJ}$ = 25°C | | | 0.1 | mA |
| | | | $T_{VJ}$ = 125°C | | 0.1 | | mA |
| $I_{GES}$ | *gate emitter leakage current* | $V_{GE}$ = ±20 V | | | | 500 | nA |
| $Q_{G(on)}$ | *total gate charge* | $V_{CE}$ = 600 V; $V_{GE}$ = 15 V; $I_C$ = 100 A | | | 340 | | nC |
| $t_{d(on)}$ | *turn-on delay time* | inductive load | $T_{VJ}$ = 125°C | | 230 | | ns |
| $t_r$ | *current rise time* | $V_{CE}$ = 600 V; $I_C$ = 100 A | | | 70 | | ns |
| $t_{d(off)}$ | *turn-off delay time* | $V_{GE}$ = ±15 V; $R_G$ = 6.8 Ω | | | 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 |
| **RBSOA** | *reverse bias safe operating area* | $V_{GE}$ = ±15 V; $R_G$ = 6.8 Ω | $T_{VJ}$ = 125°C | | | | |
| $I_{CM}$ | | $V_{CEK}$ = 1200 V | | | | 300 | A |
| **SCSOA** | *short circuit safe operating area* | $V_{CEK}$ = 1200 V | | | | | |
| $t_{SC}$ | *short circuit duration* | $V_{CE}$ = 720 V; $V_{GE}$ = ±15 | $T_{VJ}$ = 125°C | | | 10 | µs |
| $I_{SC}$ | *short circuit current* | $R_G$ = 6.8 Ω; 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 |

## Brake Diode

| Symbol | Definition | Conditions | | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|---|
| $V_{RRM}$ | *max. repetitive reverse voltage* | | $T_{VJ}$ = 25°C | | | 1200 | V |
| $I_{F25}$ | *forward current* | | $T_C$ = 25°C | | | 48 | A |
| $I_{F80}$ | | | $T_C$ = 80°C | | | 32 | A |
| $V_F$ | *forward voltage* | $I_F$ = 30 A | $T_{VJ}$ = 25°C | | | 2.75 | V |
| | | | $T_{VJ}$ = 125°C | | 1.60 | | V |
| $I_R$ | *reverse current* | $V_R$ = $V_{RRM}$ | $T_{VJ}$ = 25°C | | | 0.25 | mA |
| | | | $T_{VJ}$ = 125°C | | | 1 | mA |
| $Q_{rr}$ | *reverse recovery charge* | $V_R$ = 600 V | | | 5.2 | | µC |
| $I_{RM}$ | *max. reverse recovery current* | $-di_F/dt$ = 1000 A/µs | $T_{VJ}$ = 125°C | | 50 | | A |
| $t_{rr}$ | *reverse recovery time* | $I_F$ = 30 A; $V_{GE}$ = 0 V | | | 300 | | ns |
| $E_{rec}$ | *reverse recovery energy* | | | | 1.9 | | mJ |
| $R_{thJC}$ | *thermal resistance junction to case* | | | | | 0.9 | K/W |
| $R_{thCH}$ | *thermal resistance case to heatsink* | | | | 0.3 | | K/W |

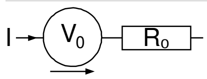
| Package V2-Pack | | | | Ratings | | | |
|---|---|---|---|---|---|---|---|
| **Symbol** | **Definition** | **Conditions** | | **min.** | **typ.** | **max.** | **Unit** |
| $I_{RMS}$ | *RMS current* | per terminal | | | | 100 | A |
| $T_{VJ}$ | *virtual junction temperature* | | | -40 | | 150 | °C |
| $T_{op}$ | *operation temperature* | | | -40 | | 125 | °C |
| $T_{stg}$ | *storage temperature* | | | -40 | | 125 | °C |
| **Weight** | | | | | 76 | | g |
| $M_D$ | *mounting torque* | | | 2 | | 2.5 | Nm |
| $d_{Spp/App}$ | *creepage distance on surface \| striking distance through air* | | *terminal to terminal* | 6.0 | | | mm |
| $d_{Spb/Apb}$ | | | *terminal to backside* | 12.0 | | | mm |
| $V_{ISOL}$ | *isolation voltage* | t = 1 second | 50/60 Hz, RMS; $I_{ISOL}$ ≤ 1 mA | 3600 | | | V |
| | | t = 1 minute | | 3000 | | | V |




| Ordering | Ordering Number | Marking on Product | Delivery Mode | Quantity | Code No. |
|---|---|---|---|---|---|
| Standard | VVZB120-16ioX | VVZB120-16ioX | Box | 6 | 511152 |

## Equivalent Circuits for Simulation

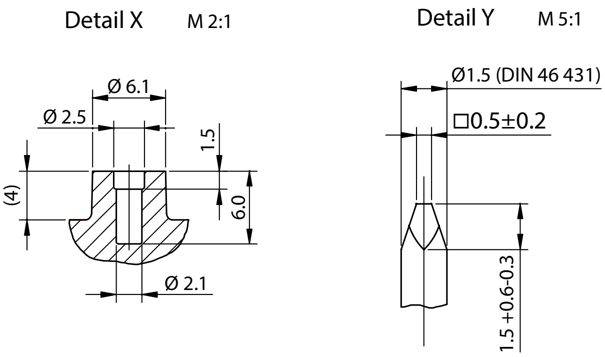
** on die level* $T_{VJ} = 150°C$

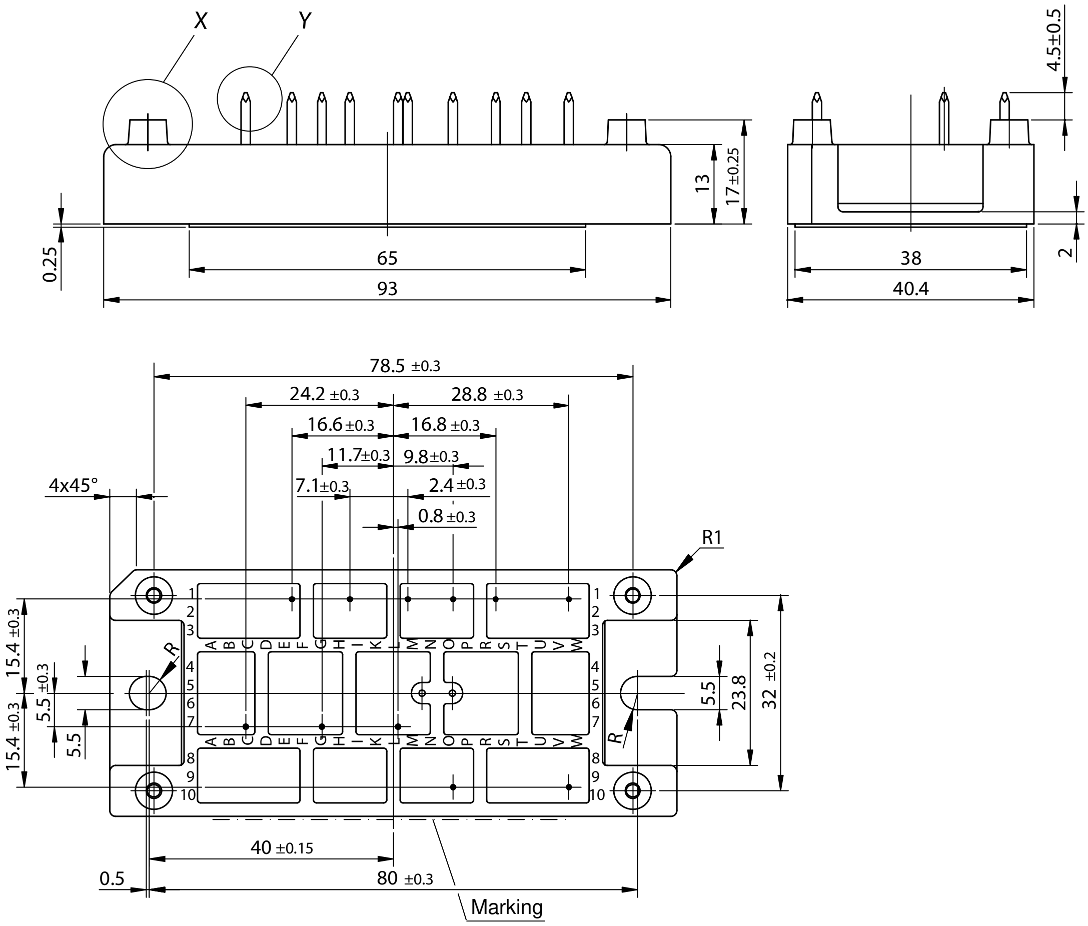


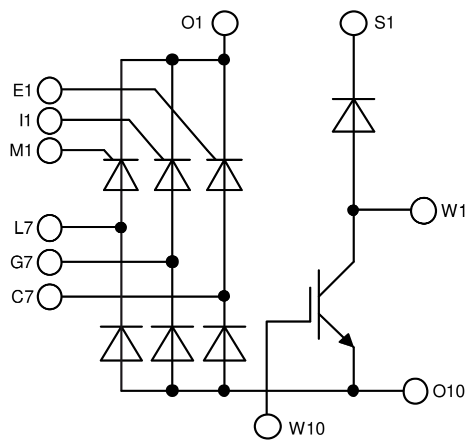

| | | Thyristor | Brake Diode | |
|---|---|---|---|---|
| $V_{0\,max}$ | *threshold voltage* | 0.83 | 1.31 | V |
| $R_{0\,max}$ | *slope resistance ** | 3.7 | 8 | mΩ |

## Outlines V2-Pack

**Remarks:**
EJOT PT® self-tapping screws of the dimension K25 are recommended for the mechanical connection between module and PCB. Choose the right length according to your board thickness at a maximum depth of 6 mm of the module holes.
The recommended mounting torque is 1.5 Nm.



## Thyristor

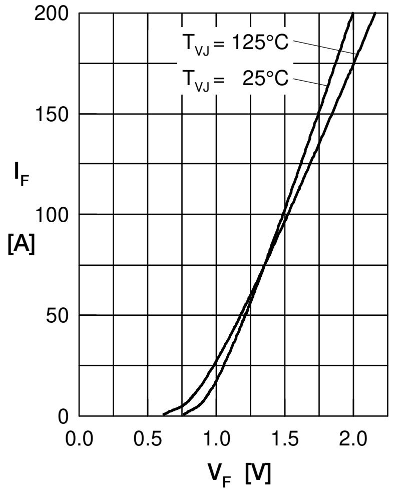



Fig. 1 Forward current vs. voltage drop per thyristor

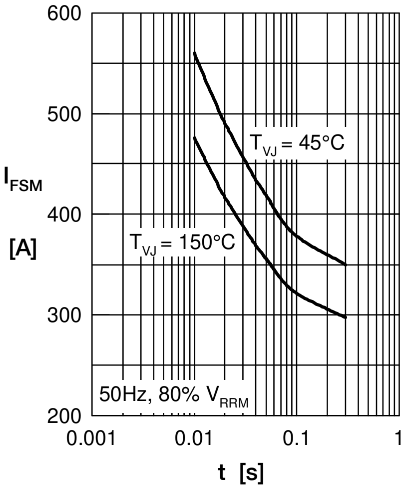



Fig. 2 Surge overload current vs. time per thyristor

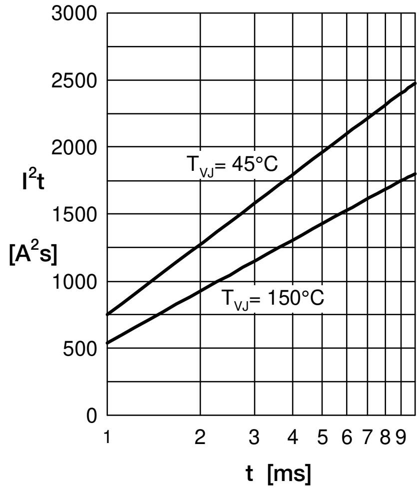



Fig. 3 $I^2t$ vs. time per thyristor

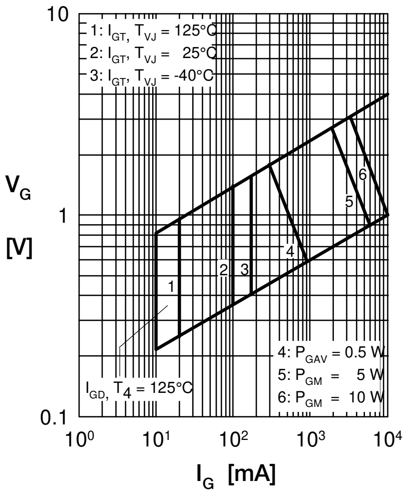



Fig. 4 Gate trigger characteristics

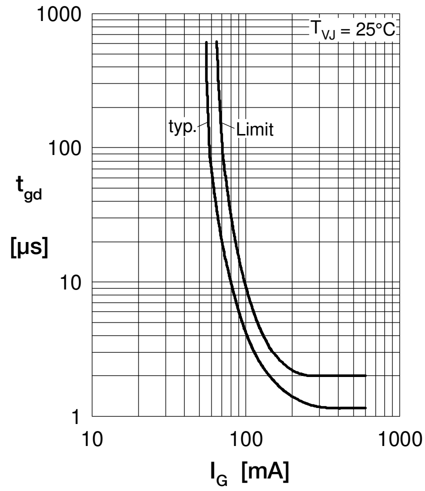



Fig. 5 Gate trigger delay time

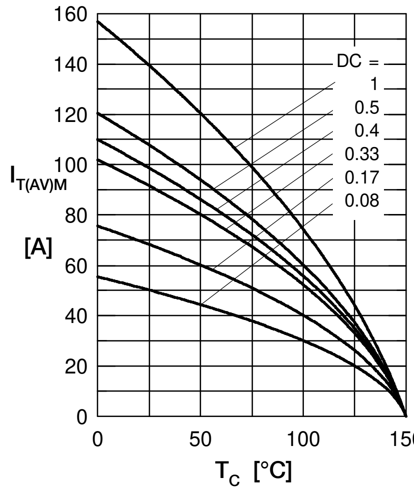



Fig. 5 Max. forward current vs. case temperature per thyristor

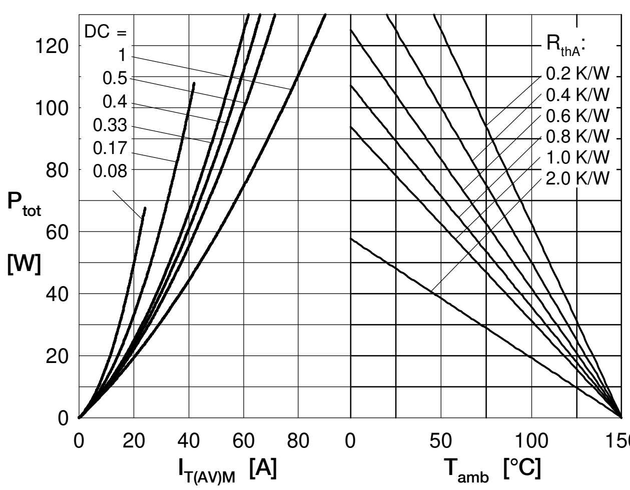
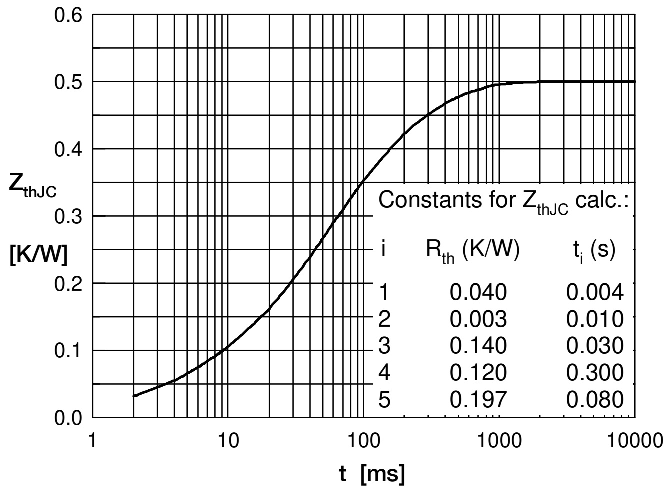



Fig. 4 Power dissipation vs. forward current and ambient temperature per thyristor




Constants for $Z_{thJC}$ calc.:

| i | $R_{th}$ (K/W) | $t_i$ (s) |
|---|---|---|
| 1 | 0.040 | 0.004 |
| 2 | 0.003 | 0.010 |
| 3 | 0.140 | 0.030 |
| 4 | 0.120 | 0.300 |
| 5 | 0.197 | 0.080 |

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

## Brake IGBT + Diode

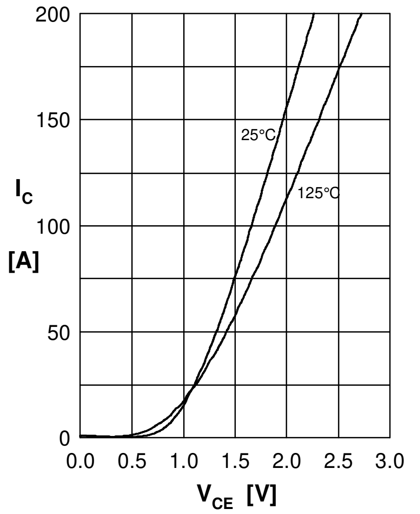



Fig.1 Output characteristics IGBT

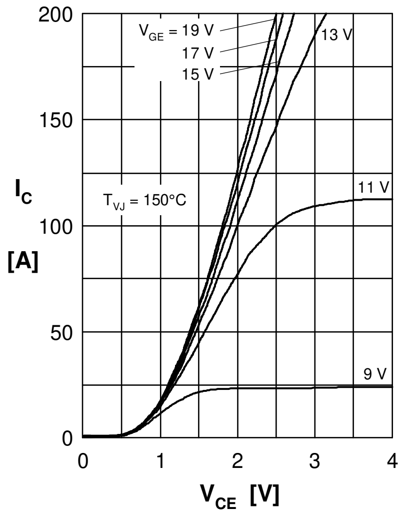



Fig.2 Typ. output characteristics IGBT

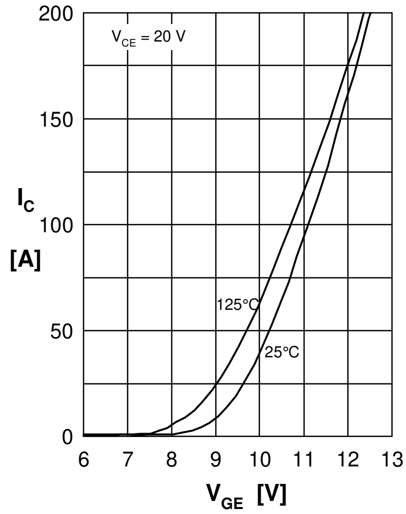



Fig. 3 Typ. transfer charact. IGBT

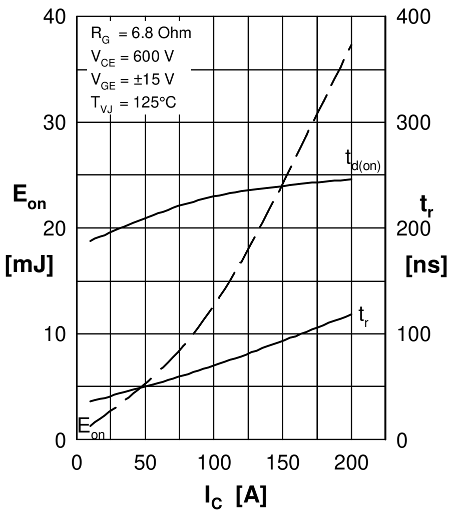



Fig. 4 Typ. turn-on energy & switch. times vs. collector current

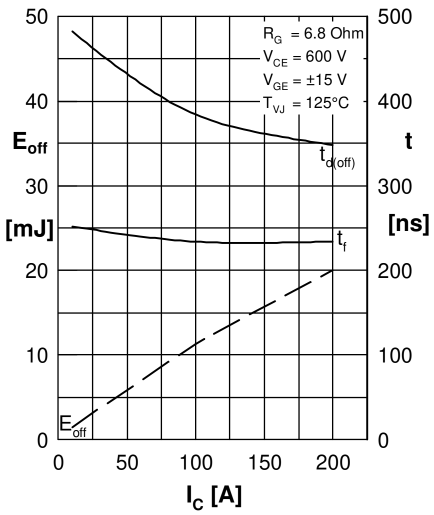



Fig. 5 Typ. turn-off energy & switch. times vs. collector current

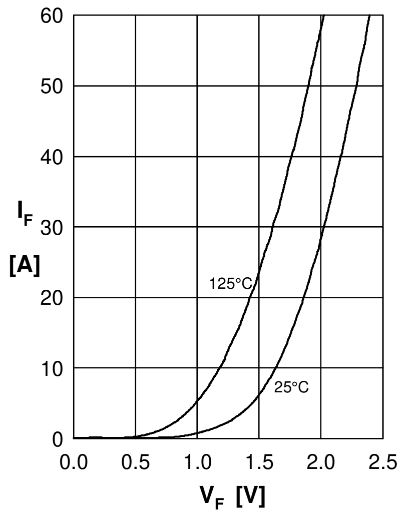



Fig. 6 Typ. forward characteristics Diode

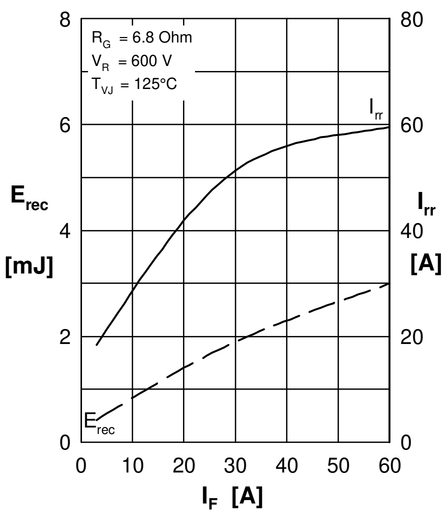



Fig. 7 Typ. reverse recovery characteristics Diode

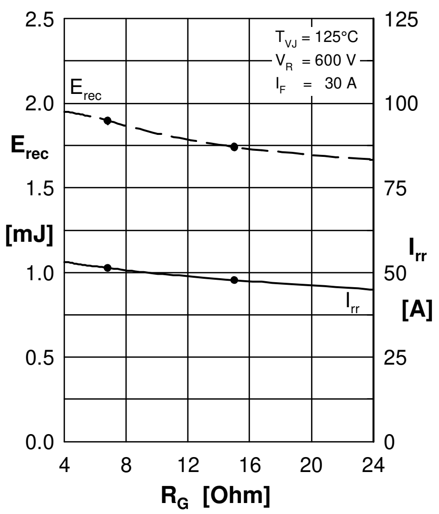
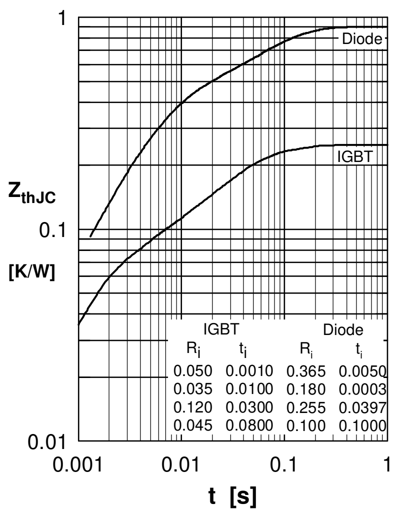



Fig. 8 Typ. reverse recovery characteristics Diode




| IGBT $R_i$ | IGBT $t_i$ | Diode $R_i$ | Diode $t_i$ |
|---|---|---|---|
| 0.050 | 0.0010 | 0.365 | 0.0050 |
| 0.035 | 0.0100 | 0.180 | 0.0003 |
| 0.120 | 0.0300 | 0.255 | 0.0397 |
| 0.045 | 0.0800 | 0.100 | 0.1000 |

Fig. 9 Transient thermal resistance junction to case