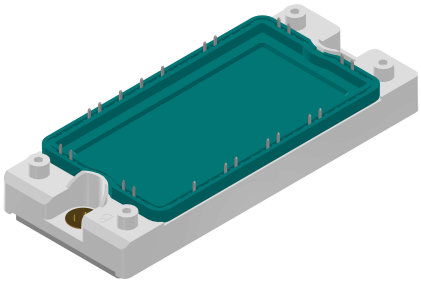
# High Voltage Thyristor Module

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

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

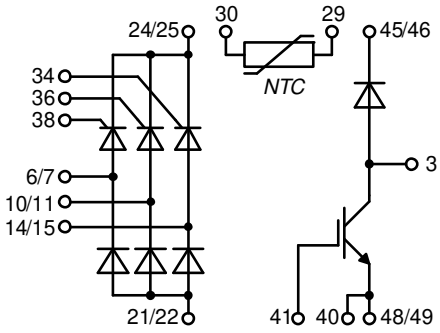
**Part number**

**MCNA120UI2200TED**



Backside: isolated

E72873




**Features / Advantages:**

- Thyristor/Standard Rectifier for line frequency
- Planar passivated chips
- Long-term stability
- Low forward voltage drop
- Leads suitable for PC board soldering
- Copper base plate with Direct Copper Bonded Al2O3-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
- Soldering pins for PCB mounting
- Height: 17 mm
- Base plate: Copper internally DCB isolated
- Advanced power cycling
- Phase Change Material available

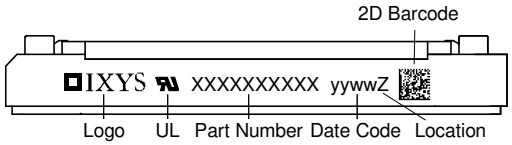
## Rectifier

| Symbol | Definition | Conditions | | Ratings min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|---|
| $V_{RSM/DSM}$ | *max. non-repetitive reverse/forward blocking voltage* | | $T_{VJ}$ = 25°C | | | 2300 | V |
| $V_{RRM/DRM}$ | *max. repetitive reverse/forward blocking voltage* | | $T_{VJ}$ = 25°C | | | 2200 | V |
| $I_{R/D}$ | *reverse current, drain current* | $V_{R/D}$ = 2200 V | $T_{VJ}$ = 25°C | | | 50 | µA |
| | | $V_{R/D}$ = 2200 V | $T_{VJ}$ = 125°C | | | 10 | mA |
| $V_T$ | *forward voltage drop* | $I_T$ = 40 A | $T_{VJ}$ = 25°C | | | 1.33 | V |
| | | $I_T$ = 120 A | | | | 2.05 | V |
| | | $I_T$ = 40 A | $T_{VJ}$ = 125°C | | | 1.36 | V |
| | | $I_T$ = 120 A | | | | 2.38 | V |
| $I_{DAV}$ | *bridge output current* | $T_C$ = 80°C | $T_{VJ}$ = 150°C | | | 120 | A |
| | | rectangular d = ⅓ | | | | | |
| $V_{T0}$ | *threshold voltage* } *for power loss calculation only* | | $T_{VJ}$ = 150°C | | | 0.83 | V |
| $r_T$ | *slope resistance* } | | | | | 13.6 | mΩ |
| $R_{thJC}$ | *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°C | | | 190 | W |
| $I_{TSM}$ | *max. forward surge current* | t = 10 ms; (50 Hz), sine | $T_{VJ}$ = 45°C | | | 500 | A |
| | | t = 8,3 ms; (60 Hz), sine | $V_R$ = 0 V | | | 540 | A |
| | | t = 10 ms; (50 Hz), sine | $T_{VJ}$ = 150°C | | | 425 | A |
| | | t = 8,3 ms; (60 Hz), sine | $V_R$ = 0 V | | | 460 | A |
| $I^2t$ | *value for fusing* | t = 10 ms; (50 Hz), sine | $T_{VJ}$ = 45°C | | | 1.25 | kA²s |
| | | t = 8,3 ms; (60 Hz), sine | $V_R$ = 0 V | | | 1.22 | kA²s |
| | | t = 10 ms; (50 Hz), sine | $T_{VJ}$ = 150°C | | | 905 | A²s |
| | | t = 8,3 ms; (60 Hz), sine | $V_R$ = 0 V | | | 880 | A²s |
| $C_J$ | *junction capacitance* | $V_R$ = 700 V f = 1 MHz | $T_{VJ}$ = 25°C | | 13 | | 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, $I_T$ = 120 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., $I_T$ = 40 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 | | | 1.4 | V |
| | | | $T_{VJ}$ = -40°C | | | 1.6 | V |
| $I_{GT}$ | *gate trigger current* | $V_D$ = 6 V | $T_{VJ}$ = 25°C | | | 70 | mA |
| | | | $T_{VJ}$ = -40°C | | | 150 | 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* | | | | | 5 | mA |
| $I_L$ | *latching current* | $t_p$ = 10 µs | $T_{VJ}$ = 25°C | | | 150 | 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 | | | 100 | 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; $I_T$ = 40A; V = ⅔ $V_{DRM}$ | $T_{VJ}$ = 125 °C | | 500 | | µs |
| | | di/dt = 10 A/µs dv/dt = 20 V/µs $t_p$ = 200 µs | | | | | |

| Brake IGBT + Diode | | | | Ratings | | | |
|---|---|---|---|---|---|---|---|
| **Symbol** | **Definition** | **Conditions** | | **min.** | **typ.** | **max.** | **Unit** |
| $V_{CES}$ | *collector emitter voltage* | | $T_{VJ}$ = 25°C | | | 1700 | 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 | | | 113 | A |
| $I_{C80}$ | | | $T_C$ = 80°C | | | 80 | A |
| $P_{tot}$ | *total power dissipation* | | $T_C$ = 25°C | | | 445 | W |
| $V_{CE(sat)}$ | *collector emitter saturation voltage* | $I_C$ = 75 A; $V_{GE}$ = 15 V | $T_{VJ}$ = 25°C | | 2.5 | 2.93 | V |
| | | | $T_{VJ}$ = 125°C | | 3 | | V |
| $V_{GE(th)}$ | *gate emitter threshold voltage* | $I_C$ = 3 mA; $V_{GE}$ = $V_{CE}$ | $T_{VJ}$ = 25°C | 5.2 | 5.8 | 6.4 | V |
| $I_{CES}$ | *collector emitter leakage current* | $V_{CE}$ = $V_{CES}$; $V_{GE}$ = 0 V | $T_{VJ}$ = 25°C | | | 0.6 | mA |
| | | | $T_{VJ}$ = 125°C | | 5 | | mA |
| $I_{GES}$ | *gate emitter leakage current* | $V_{GE}$ = ±20 V | | | | 400 | nA |
| $Q_{G(on)}$ | *total gate charge* | $V_{CE}$ = 900 V; $V_{GE}$ = 15 V; $I_C$ = 75 A | | | 850 | | nC |
| $t_{d(on)}$ | *turn-on delay time* | inductive load<br>$V_{CE}$ = 900 V; $I_C$ = 75 A<br>$V_{GE}$ = ±15 V; $R_G$ = 18 Ω | $T_{VJ}$ = 125°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 |
| **RBSOA** | *reverse bias safe operating area* | $V_{GE}$ = ±15 V; $R_G$ = 18 Ω | $T_{VJ}$ = 125°C | | | | |
| $I_{CM}$ | | $V_{CEK}$ = 1700 V | | | | 150 | A |
| **SCSOA** | *short circuit safe operating area* | $V_{CEK}$ = 1700 V | | | | | |
| $t_{SC}$ | *short circuit duration* | $V_{CE}$ = 720 V; $V_{GE}$ = ±15 | $T_{VJ}$ = 125°C | | | 10 | µs |
| $I_{SC}$ | *short circuit current* | $R_G$ = 18 Ω; 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°C | | | 1700 | V |
| $I_{F25}$ | *forward current* | | $T_C$ = 25°C | | | 75 | A |
| $I_{F80}$ | | | $T_C$ = 80°C | | | 50 | A |
| $V_F$ | *forward voltage* | $I_F$ = 60 A | $T_{VJ}$ = 25°C | | | 2.45 | V |
| | | | $T_{VJ}$ = 125°C | | 2.20 | | V |
| $I_R$ | *reverse current* | $V_R$ = $V_{RRM}$ | $T_{VJ}$ = 25°C | | | 0.1 | mA |
| | | | $T_{VJ}$ = 125°C | | | 1 | mA |
| $Q_{rr}$ | *reverse recovery charge* | $V_R$ = 900 V<br>$-di_F/dt$ = 600 A/µs<br>$I_F$ = 60 A; $V_{GE}$ = 0 V | $T_{VJ}$ = 125°C | | 20 | | µC |
| $I_{RM}$ | *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** |
| $I_{RMS}$ | *RMS current* | per terminal | | | | 40 | A |
| $T_{VJ}$ | *virtual junction temperature* | | | -40 | | 150 | °C |
| $T_{op}$ | *operation temperature* | | | -40 | | 125 | °C |
| $T_{stg}$ | *storage temperature* | | | -40 | | 125 | °C |
| **Weight** | | | | | 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 |
| $d_{Spb/Apb}$ | | | *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 |




**Part description**

M = Module
C = Thyristor (SCR)
N = High Voltage Thyristor
A = (>= 2000V)
120 = Current Rating [A]
UI = 3~ Rectifier Bridge, half-controlled (high-side) + Brake Unit
2200 = Reverse Voltage [V]
T = Thermistor \ Temperature sensor
ED = E2-Pack

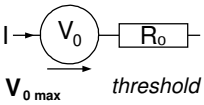
| Ordering | Ordering Number | Marking on Product | Delivery Mode | Quantity | Code No. |
|---|---|---|---|---|---|
| Standard | MCNA120UI2200TED | MCNA120UI2200TED | Box | 36 | 510374 |

## Temperature Sensor NTC

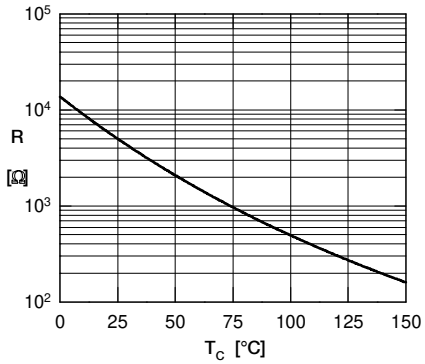
| Symbol | Definition | Conditions | min. | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| $R_{25}$ | *resistance* | $T_{VJ}$ = 25° | 4.75 | 5 | 5.25 | kΩ |
| $B_{25/50}$ | *temperature coefficient* | | | 3375 | | K |

## Equivalent Circuits for Simulation

** on die level* $T_{VJ}$ = 150°C

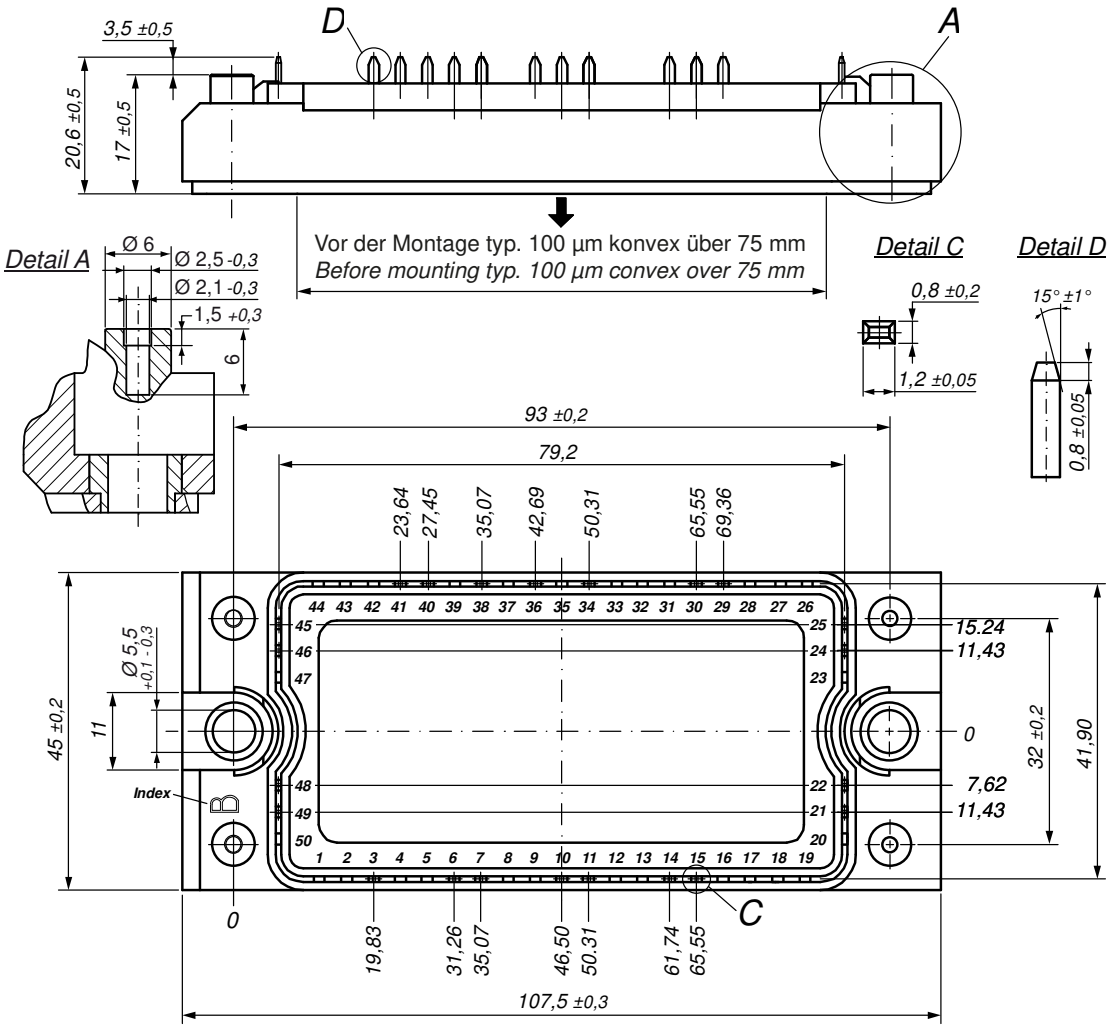



| | | Thyristor | Brake IGBT + | Brake Diode | |
|---|---|---|---|---|---|
| $V_{0\ max}$ | *threshold voltage* | 0.83 | 1.17 | 1.34 | V |
| $R_{0\ max}$ | *slope resistance ** | 10.5 | 25 | 15.2 | mΩ |




Typ. NTC resistance vs. temperature

## Outlines E2-Pack

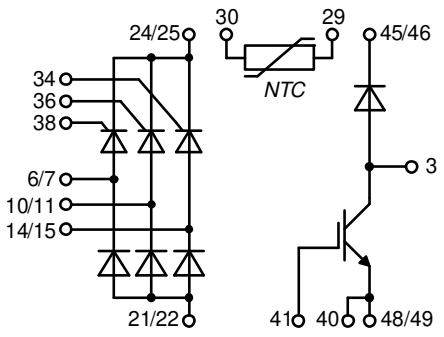



**Bemerkung** / ***Note:***

- 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:* ⌖ **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

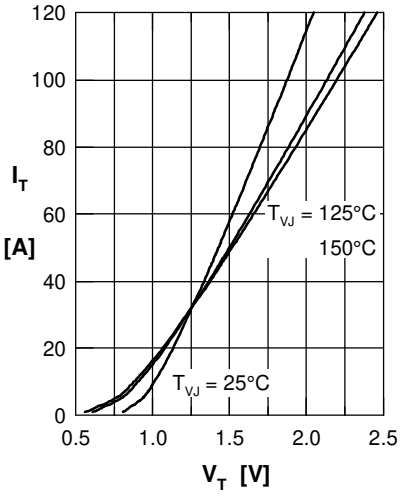



Fig. 1 Forward characteristics

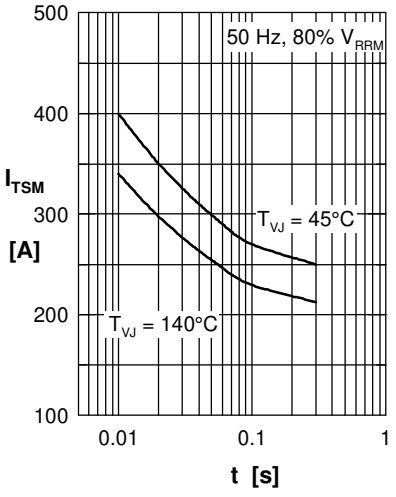



Fig. 2 Surge overload current
$I_{TSM}$: crest value, t: duration

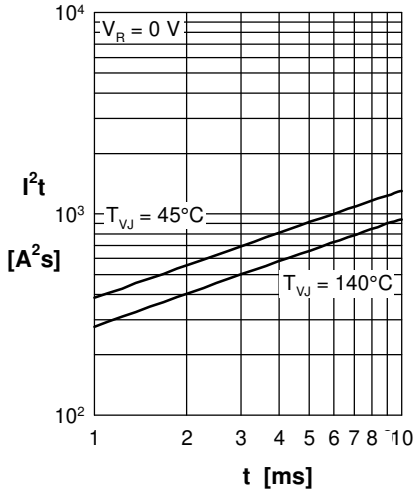



Fig. 3 $I^2t$ versus time (1-10 s)

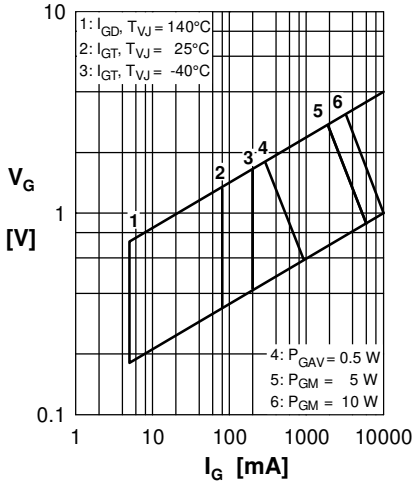



Fig. 4 Gate voltage & gate current

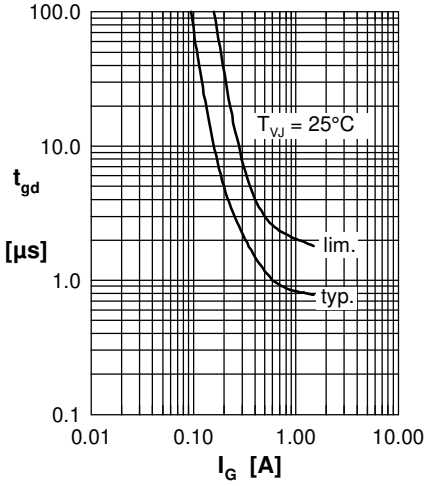



Fig. 5 Gate controlled delay time $t_{gd}$

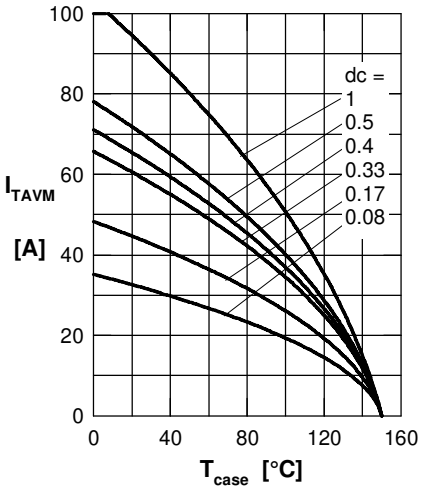



Fig. 6 Max. forward current at case temperature

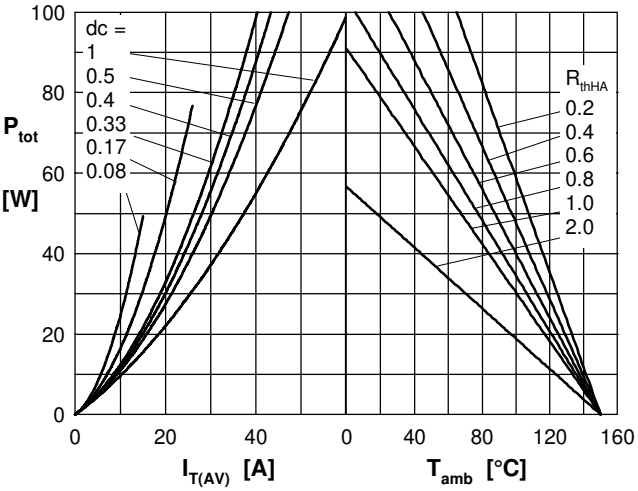
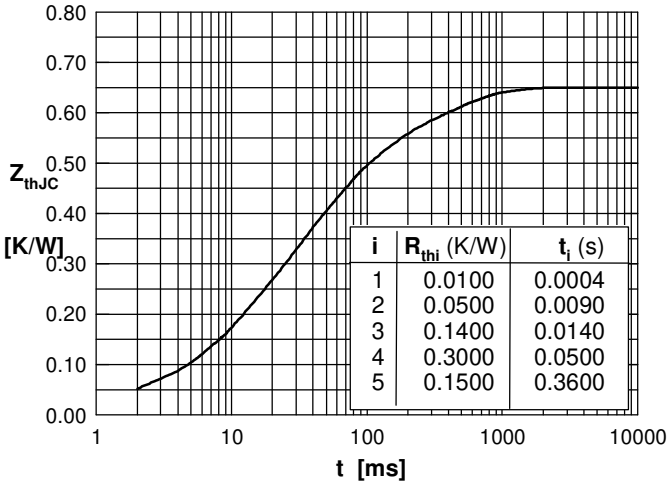



Fig. 7a Power dissipation versus direct output current
Fig. 7b and ambient temperature




| i | $R_{thi}$ (K/W) | $t_i$ (s) |
|---|---|---|
| 1 | 0.0100 | 0.0004 |
| 2 | 0.0500 | 0.0090 |
| 3 | 0.1400 | 0.0140 |
| 4 | 0.3000 | 0.0500 |
| 5 | 0.1500 | 0.3600 |

Fig. 8 Transient thermal impedance junction to case

## Brake IGBT + Diode

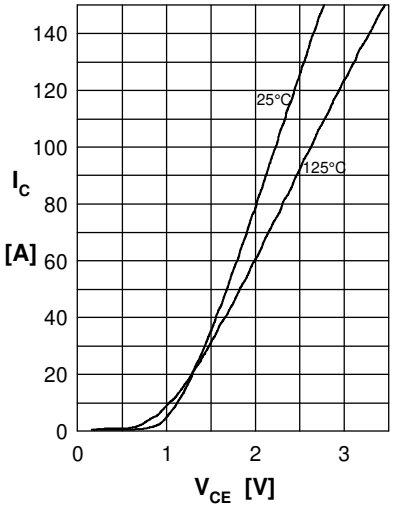



Fig.1 Output characteristics IGBT

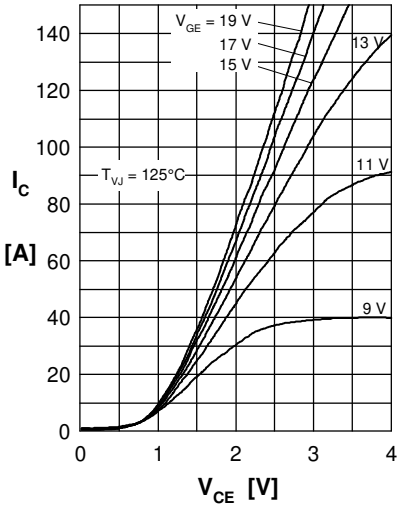



Fig.2 Typ. output characteristics IGBT

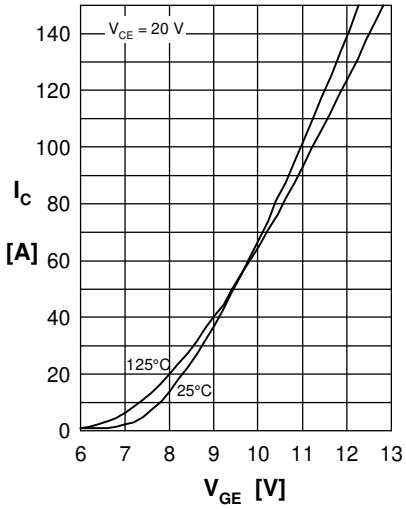



Fig. 3 Typ. transfer charact. IGBT

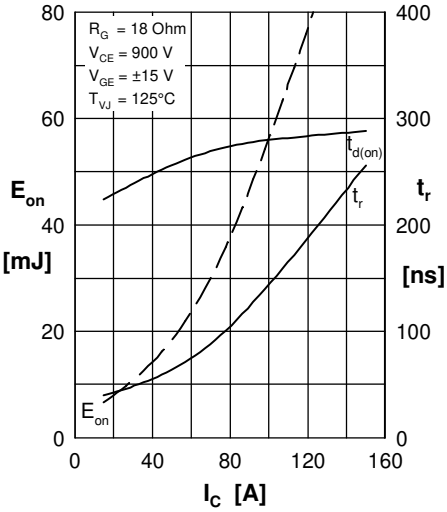



Fig. 4 Typ. turn-on energy & switch. times vs. collector current

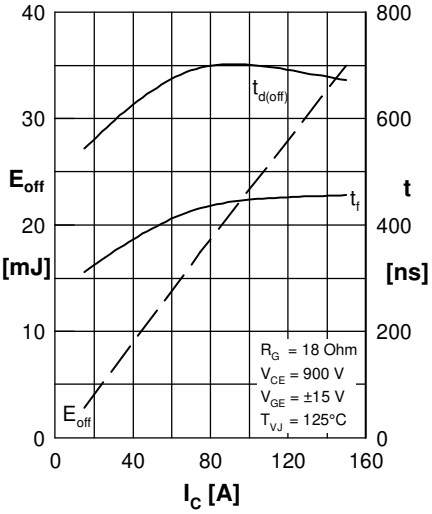



Fig. 5 Typ. turn-off energy & switch. times vs. collector current

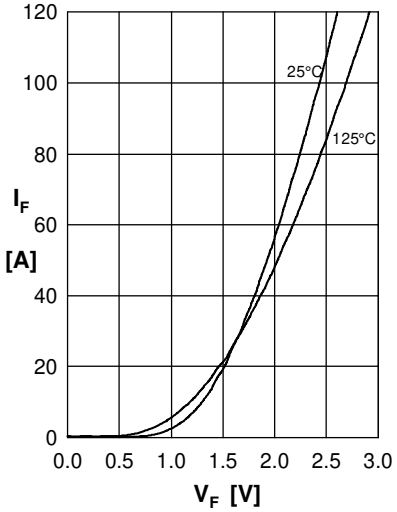



Fig. 6 Typ. forward characteristics Diode

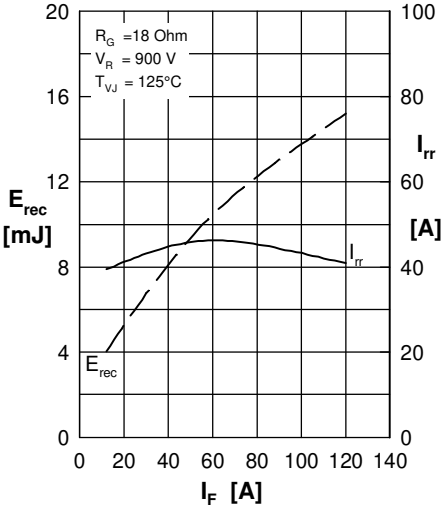



Fig. 7 Typ. reverse recovery characteristics Diode

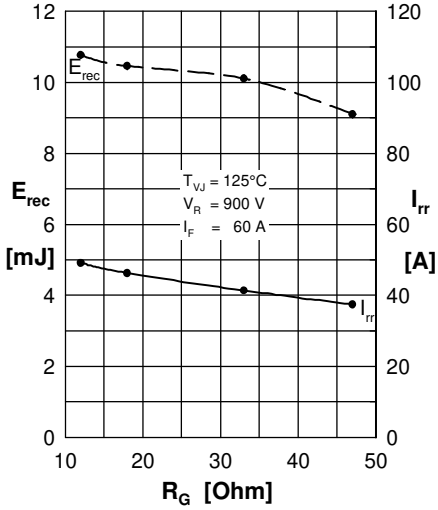



Fig. 8 Typ. reverse recovery characteristics Diode

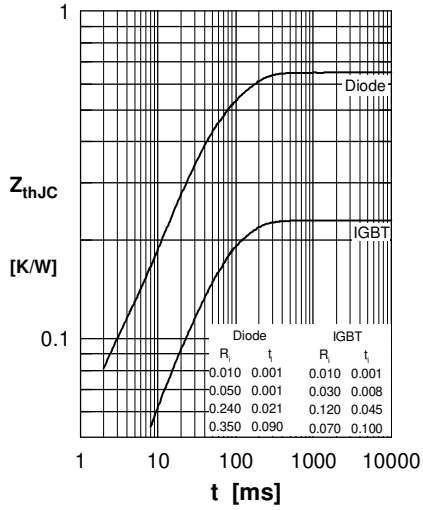



Fig. 9 Transient thermal resistance junction to case