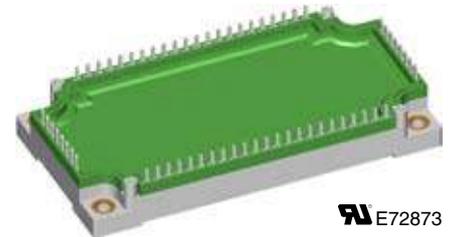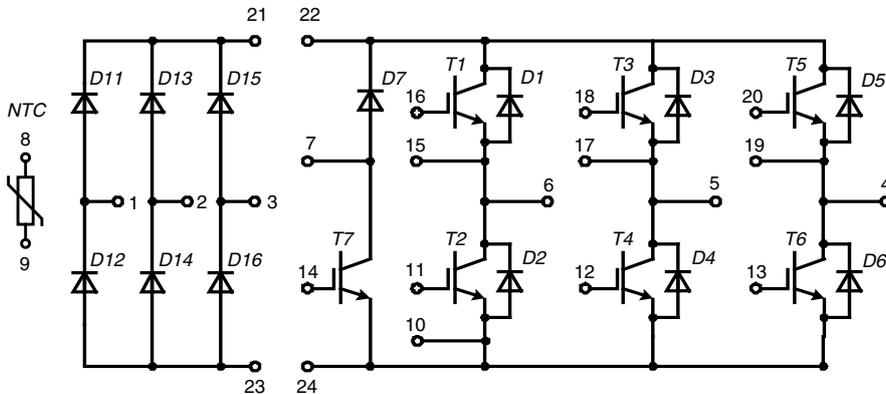# Converter - Brake - Inverter Module (CBI3) with Trench IGBT technology



⎈ E72873

| Three Phase Rectifier | Brake Chopper | Three Phase Inverter |
|---|---|---|
| $V_{RRM}$ = 2200 V | $V_{CES}$ = 1700 V | $V_{CES}$ = 1700 V |
| $I_{FAVM}$ = 70 A | $I_{C25}$ = 48 A | $I_{C25}$ = 113 A |
| $I_{FSM}$ = 700 A | $V_{CE(sat)}$ = 1.8 V | $V_{CE(sat)}$ = 2.0 V |

## Input Rectifier Bridge D11 - D16

| Symbol | Conditions | Maximum Ratings | |
|---|---|---|---|
| $V_{RRM}$ | | 2200 | V |
| $I_{FAV}$ | $T_C$ = 80°C; sine 180° | 50 | A |
| $I_{DAVM}$ | $T_C$ = 80°C; rectangular; d = $^1/_3$; bridge | 155 | A |
| $I_{FSM}$ | $T_C$ = 25°C; t = 10 ms; sine 50 Hz | 700 | A |
| $P_{tot}$ | $T_C$ = 25°C | 130 | W |

| Symbol | Conditions | | Characteristic Values | | | |
|---|---|---|---|---|---|---|
| | | ($T_{VJ}$ = 25°C, unless otherwise specified) | | | | |
| | | | min. | typ. | max. | |
| $V_F$ | $I_F$ = 75 A; | $T_{VJ}$ = 25°C | | 1.4 | 1.5 | V |
| | | $T_{VJ}$ = 125°C | | 1.3 | | V |
| $I_R$ | $V_R$ = $V_{RRM}$; | $T_{VJ}$ = 25°C | | | 0.05 | mA |
| | | $T_{VJ}$ = 125°C | | 1.5 | | mA |
| $R_{thJC}$ | (per diode) | | | | 0.95 | K/W |

### Application: AC motor drives with

- Input from single or three phase grid
- Three phase synchronous or asynchronous motor
- Electric braking operation

### Features

- High level of integration - only one power semiconductor module required for the whole drive
- IGBT technology with low saturation voltage, low switching losses and tail current, high RBSOA and short circuit ruggedness
- Epitaxial free wheeling diodes with Hiperfast and soft reverse recovery
- Industry standard package with insulated copper base plate and soldering pins for PCB mounting
- Temperature sense included

IXYS reserves the right to change limits, test conditions and dimensions.

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## Output Inverter T1 - T6

| Symbol | Conditions | | Maximum Ratings | |
|---|---|---|---|---|
| $V_{CES}$ | $T_{VJ}$ = 25°C to 150°C | | 1700 | V |
| $V_{GES}$ | Continuous | | ± 20 | V |
| $I_{C25}$ | $T_C$ = 25°C | | 113 | A |
| $I_{C80}$ | $T_C$ = 80°C | | 80 | A |
| $I_{CM}$ | $T_C$ = 80°C; $t_p$ = 1 ms | | 150 | A |
| $P_{tot}$ | $T_C$ = 25°C | | 450 | W |

| Symbol | Conditions | | | Characteristic Values | | | |
|---|---|---|---|---|---|---|---|
| | | | ($T_{VJ}$ = 25°C, unless otherwise specified) | | | | |
| | | | | min. | typ. | max. | |
| $V_{CE(sat)}$ | $I_C$ = 75 A; $V_{GE}$ = 15 V | $T_{VJ}$ = 25°C | | | 2.0 | 2.4 | V |
| | | $T_{VJ}$ = 125°C | | | 2.4 | | V |
| $V_{GE(th)}$ | $I_C$ = 3 mA; $V_{GE}$ = $V_{CE}$ | | | 5 | | 6.5 | V |
| $I_{CES}$ | $V_{CE}$ = $V_{CES}$; $V_{GE}$ = 0 V | $T_{VJ}$ = 25°C | | | | 0.8 | mA |
| | | $T_{VJ}$ = 125°C | | | 2.0 | | mA |
| $I_{GES}$ | $V_{CE}$ = 0 V; $V_{GE}$ = ± 20 V | | | | | 400 | nA |
| $C_{iss}$ | $V_{CE}$ = 25 V; $V_{GE}$ = 0 V; f = 1 MHz | | | | 6.6 | | nF |
| $Q_{Gon}$ | $V_{CE}$ = 900 V; $V_{GE}$ = 15 V; $I_C$ = 75 A | | | | 850 | | nC |
| $t_{d(on)}$ | Inductive load, $T_{VJ}$ = 125°C $V_{CE}$ = 900 V; $I_C$ = 75 A $V_{GE}$ = ±15 V; $R_G$ = 18 Ω | | | | 300 | | ns |
| $t_r$ | | | | | 60 | | ns |
| $t_{d(off)}$ | | | | | 850 | | ns |
| $t_f$ | | | | | 500 | | ns |
| $E_{on}$ | | | | | 30 | | mJ |
| $E_{off}$ | | | | | 25 | | mJ |
| RBSOA | $I_C$ = $I_{CM}$; $V_{GE}$ = 15 V $R_G$ = 18 Ω; $T_{VJ}$ = 125°C | $V_{CEK} \le V_{CES}$ - $L_S$ di/dt | | | | | V |
| $t_{SC}$ (SCSOA) | $V_{CE}$ = 1000 V; $V_{GE}$ = ±15 V; $R_G$ = 18 Ω $t_P \le$ 10 µs; non-repetitive; $T_{VJ}$ = 125°C | | | | 10 | | µs |
| $R_{thJC}$ | | | | | | 0.28 | K/W |

## Output Inverter D1 - D6

| Symbol | Conditions | Maximum Ratings | |
|---|---|---|---|
| $I_{F25}$ | $T_C$ = 25°C | 92 | A |
| $I_{F80}$ | $T_C$ = 80°C | 63 | A |

| Symbol | Conditions | | Characteristic Values | | | |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| $V_F$ | $I_F$ = 75 A; | $T_{VJ}$ = 25°C | | 2.2 | 2.9 | V |
| | | $T_{VJ}$ = 125°C | | 2.3 | | V |
| $I_{RM}$ | $I_F$ = 75 A; $di_F$/dt = -1400 A/µs; $T_{VJ}$ = 125°C; $V_R$ = 900 V; $V_{GE}$ = 0 V | | | 95 | | A |
| $Q_{rr}$ | | | | 20 | | µC |
| $t_{rr}$ | | | | 800 | | ns |
| $E_{rec}$ | | | | 10 | | mJ |
| $R_{thJC}$ | (per diode) | | | | 0.4 | K/W |

### Equivalent Circuits for Simulation

**Conduction**
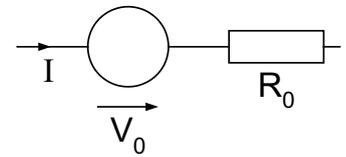


**IGBT** (typ. at $V_{GE}$ = 15 V; $T_J$ = 125°C)

*T1-T6*
$V_0$ = 1.0 V; $R_0$ = 17 mΩ

*T7*
$V_0$ = 1.0 V; $R_0$ = 28 mΩ

**Diode** (typ. at $T_J$ = 125°C)

*D1-D6*
$V_0$ = 1.4 V; $R_0$ = 11 mΩ

*D7*
$V_0$ = 1.65 V; $R_0$ = 37 mΩ

*D11-D16*
$V_0$ = 0.85 V; $R_0$ = 2.8 mΩ

IXYS reserves the right to change limits, test conditions and dimensions.

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### Brake Chopper T7

| Symbol | Conditions | Maximum Ratings | |
|---|---|---:|---|
| $V_{CES}$ | $T_{VJ}$ = 25°C to 150°C | 1700 | V |
| $V_{GES}$ | Continuous | ± 20 | V |
| $I_{C25}$ | $T_C$ = 25°C | 48 | A |
| $I_{C80}$ | $T_C$ = 80°C | 34 | A |
| $I_{CM}$ | $T_C$ = 80°C; $t_p$ = 1 ms | 60 | A |
| $P_{tot}$ | $T_C$ = 25°C | 200 | W |

| Symbol | Conditions | | Characteristic Values | | | |
|---|---|---|---|---|---|---|
| | | | ($T_{VJ}$ = 25°C, unless otherwise specified) | | | |
| | | | min. | typ. | max. | |
| $V_{CE(sat)}$ | $I_C$ = 30 A; $V_{GE}$ = 15 V | $T_{VJ}$ = 25°C | | 1.9 | 2.2 | V |
| | | $T_{VJ}$ = 125°C | | 2.1 | | V |
| $V_{GE(th)}$ | $I_C$ = 2 mA; $V_{GE}$ = $V_{CE}$ | | 5 | | 6.5 | V |
| $I_{CES}$ | $V_{CE}$ = $V_{CES}$; $V_{GE}$ = 0 V | $T_{VJ}$ = 25°C | | | 0.3 | mA |
| | | $T_{VJ}$ = 125°C | | 0.6 | | mA |
| $I_{GES}$ | $V_{CE}$ = 0 V; $V_{GE}$ = ± 20 V | | | | 400 | nA |
| $C_{ies}$ | $V_{CE}$ = 25 V; $V_{GE}$ = 0 V; f = 1 MHz | | | 4.4 | | nF |
| $Q_{Gon}$ | $V_{CE}$ = 900 V; $V_{GE}$ = 15 V; $I_C$ = 30 A | | | 600 | | nC |
| $t_{d(on)}$ | | | | 190 | | ns |
| $t_r$ | Inductive load, $T_{VJ}$ = 125°C | | | 45 | | ns |
| $t_{d(off)}$ | $V_{CE}$ = 900 V; $I_C$ = 30 A | | | 970 | | ns |
| $t_f$ | $V_{GE}$ = ±15 V; $R_G$ = 45 Ω | | | 340 | | ns |
| $E_{off}$ | | | | 7.5 | | mJ |
| $E_{on}$ | | | | 8.5 | | mJ |
| RBSOA | $I_C$ = $I_{CM}$; $V_{GE}$ = 15 V | $V_{CEK} \leq V_{CES}$ - $L_S$ di/dt | | | | V |
| | $R_G$ = 27 Ω; $T_{VJ}$ = 125°C | | | | | |
| $t_{SC}$ (SCSOA) | $V_{CE}$ = 900 V; $V_{GE}$ = ±15 V; $R_G$ = 45 Ω $t_P \leq$ 10 μs; non-repetitive; $T_{VJ}$ = 125°C | | | 10 | | μs |
| $R_{thJC}$ | | | | | 0.62 | K/W |

### Brake Chopper D7

| Symbol | Conditions | Maximum Ratings | |
|---|---|---:|---|
| $V_{RRM}$ | $T_{VJ}$ = 25°C to 150°C | 1700 | V |
| $I_{F25}$ | $T_C$ = 25°C | 30 | A |
| $I_{F80}$ | $T_C$ = 80°C | 21 | A |

| Symbol | Conditions | | Characteristic Values | | | |
|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | |
| $V_F$ | $I_F$ = 30 A; | $T_{VJ}$ = 25°C | | 2.5 | 3.3 | V |
| | | $T_{VJ}$ = 125°C | | 2.6 | | V |
| $I_R$ | $V_R$ = $V_{RRM}$; | $T_{VJ}$ = 25°C | | | 0.05 | mA |
| | | $T_{VJ}$ = 125°C | | 0.2 | | mA |
| $I_{RM}$ | $I_F$ = 30 A; $di_F$/dt = -700 A/μs; $T_{VJ}$ = 125°C | | | 38 | | A |
| $t_{rr}$ | $V_R$ = 900 V | | | 670 | | ns |
| $R_{thJC}$ | (per diode) | | | | 0.9 | K/W |

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## Temperature Sensor NTC

| Symbol | Conditions | Characteristic Values | | | |
|---|---|---|---|---|---|
| | | min. | typ. | max. | |
| $R_{25}$ | T = 25°C | 4.75 | 5.0 | 5.25 | kΩ |
| $B_{25/50}$ | | | 3375 | | K |

## Module

| Symbol | Conditions | Maximum Ratings | |
|---|---|---|---|
| $T_{VJ}$ | operating | -40...+125 | °C |
| $T_{JM}$ | | +150 | °C |
| $T_{stg}$ | | -40...+125 | °C |
| $V_{ISO}$ | $I_{ISOL} \leq 1$ mA; 50/60 Hz; 1 min. | 3400 | V~ |
| $M_d$ | Mounting torque (M5) | 3 - 6 | Nm |

| Symbol | Conditions | Characteristic Values | | | |
|---|---|---|---|---|---|
| | | min. | typ. | max. | |
| $R_{therm-chip}$ | Resistance terminal to chip | | 7 | | mΩ |
| $d_S$ | Creepage distance on surface | 12.7 | | | mm |
| $d_A$ | Strike distance in air | 9.6 | | | mm |
| $R_{thCH}$ | with heatsink compound | | 0.01 | | K/W |
| Weight | | | 300 | | g |

**Dimensions in mm (1 mm = 0.0394")**
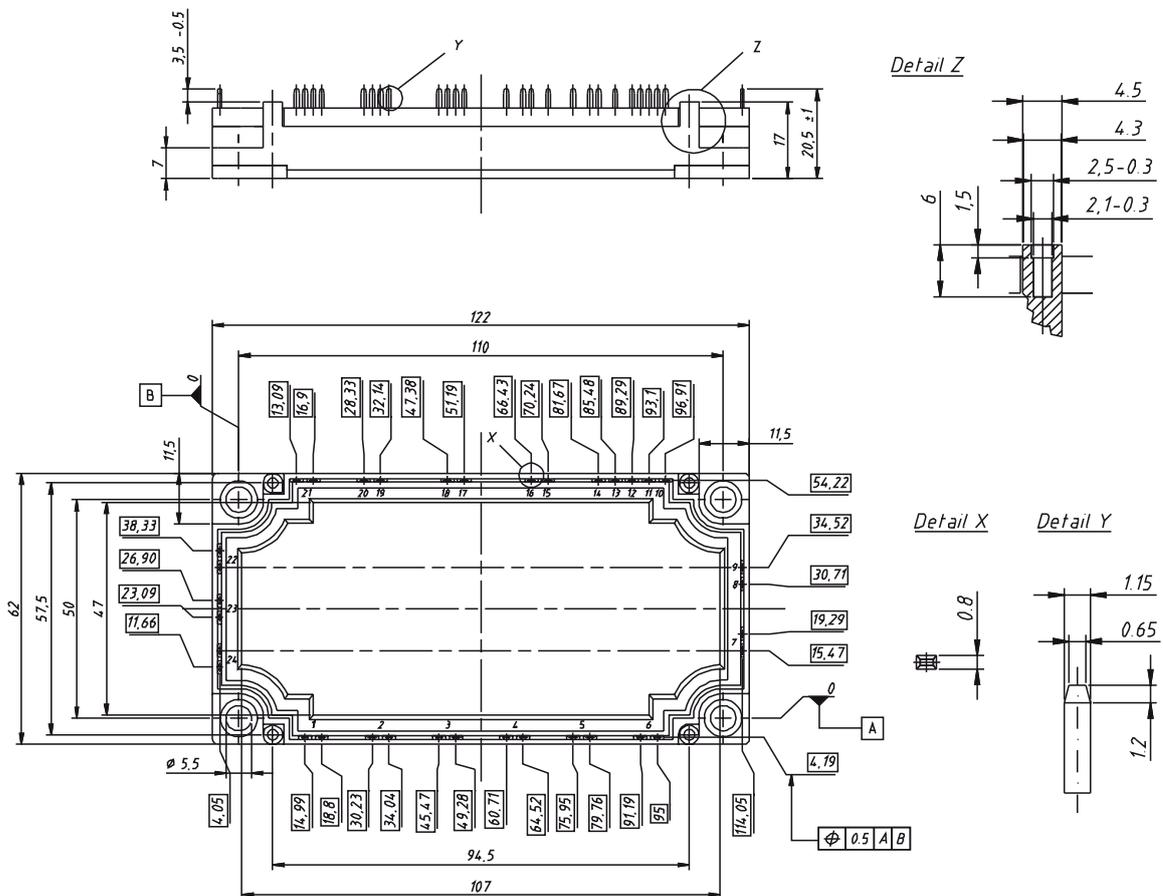
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## Input Rectifier Bridge D11 - D16
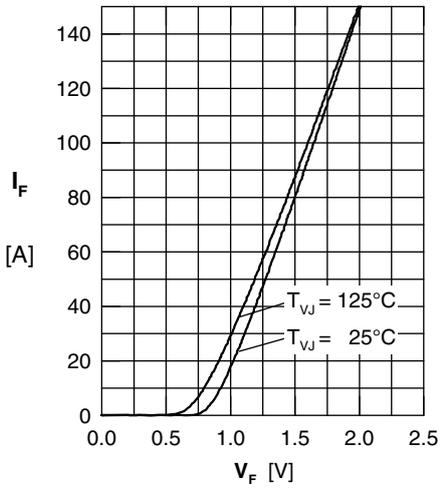


Fig. 1  Typ. forward current vs. voltage drop per diode
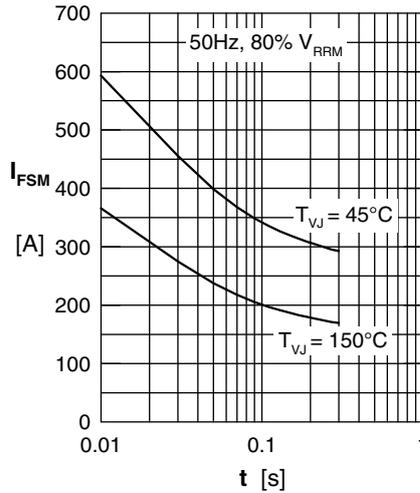


Fig. 2  Surge overload current
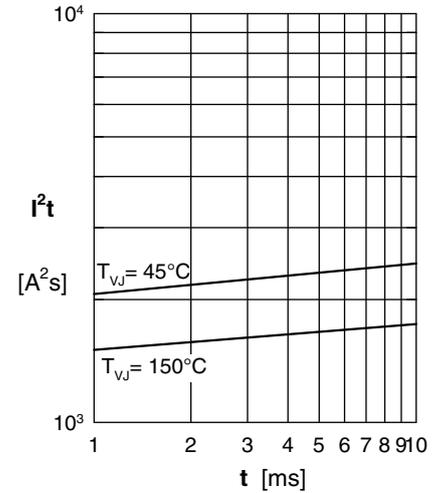


Fig. 3  $I^2t$ versus time per diode
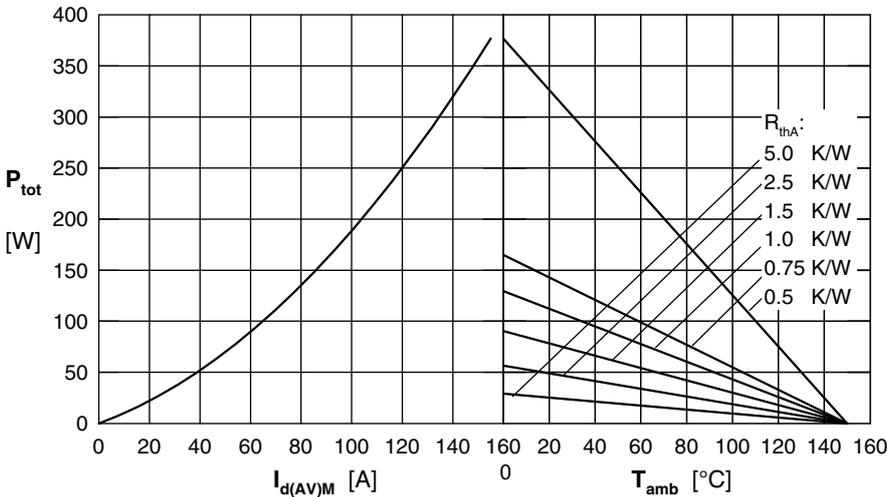


Fig. 4 Power dissipation vs. direct output current & amb. temperature, sin 180°
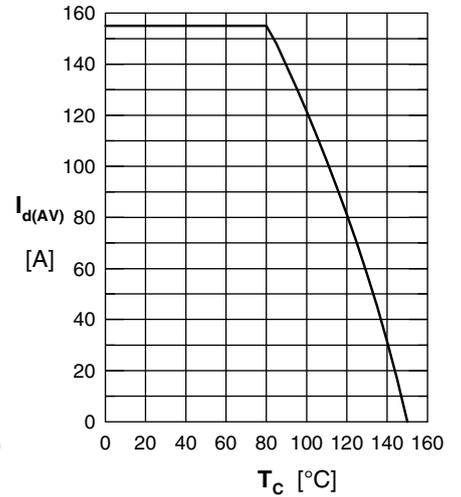


Fig. 5  Max. forward current vs. case temperature
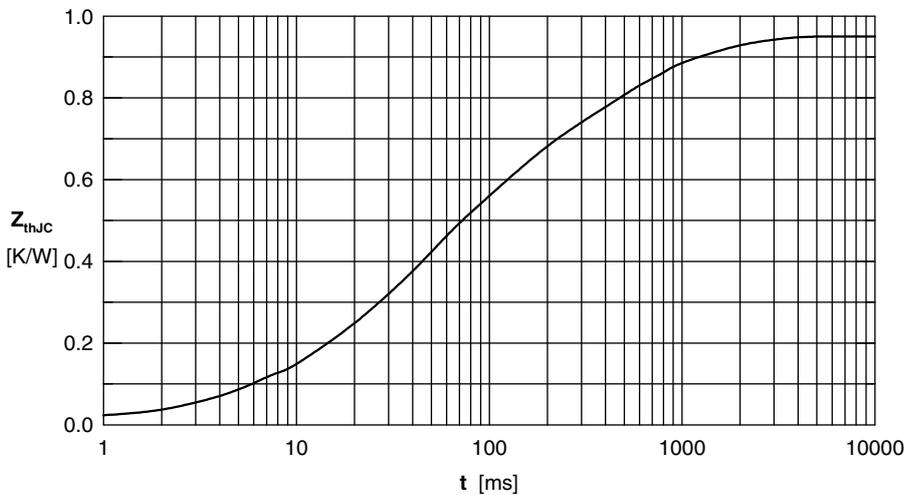


Fig. 6  Transient thermal impedance junction to case
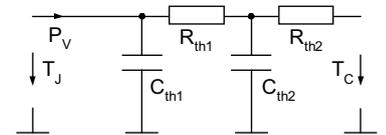
| | $R_i$ | $\tau_i$ |
|---|---|---|
| 1 | 0.049 | 0.0085 |
| 2 | 0.012 | 0.0017 |
| 3 | 0.465 | 0.045 |
| 4 | 0.105 | 0.85 |
| 5 | 0.32 | 0.33 |

IXYS reserves the right to change limits, test conditions and dimensions.

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**Output Inverter T1 - T6 / D1 - D6**
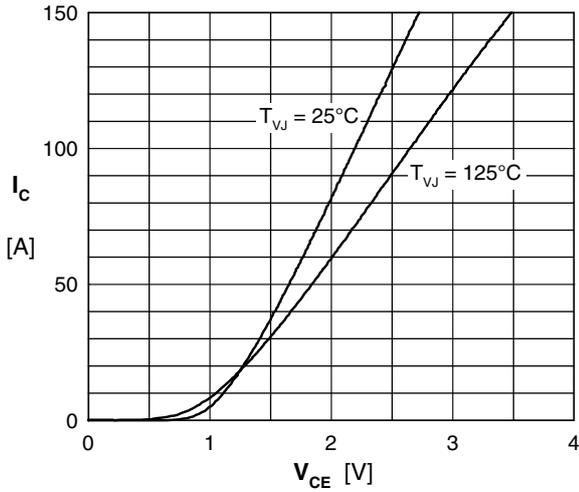

Fig. 7  Typical output characteristic
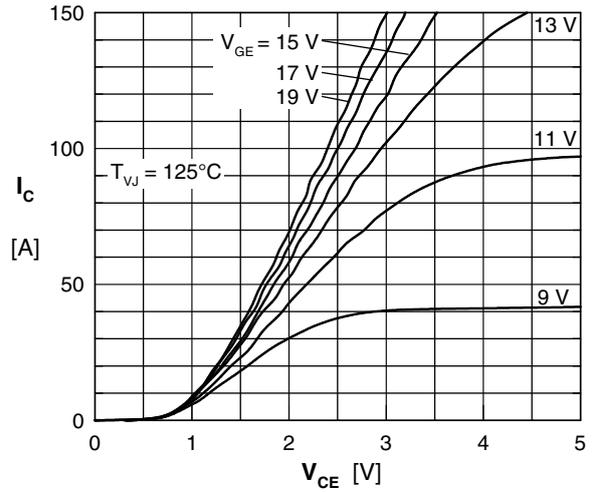

Fig. 8  Typical output characteristic
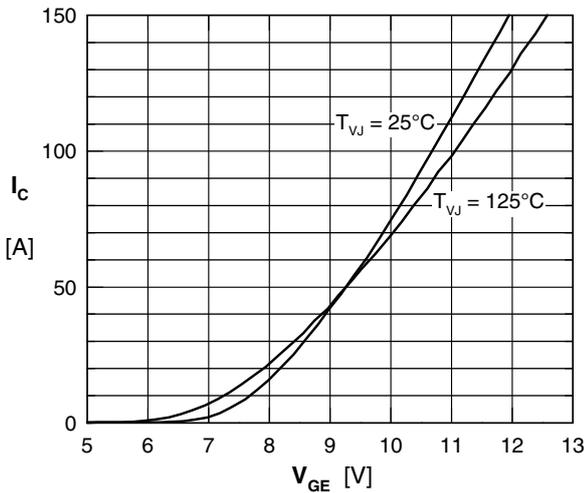

Fig. 9  Typical transfer characteristic
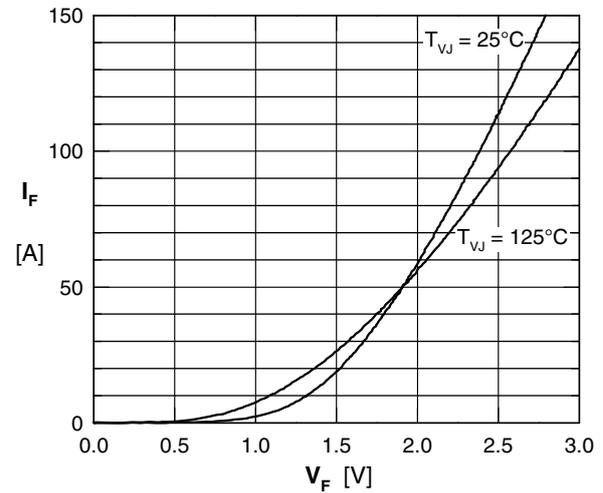

Fig. 10  Typical forward characteristic
of free wheeling diode
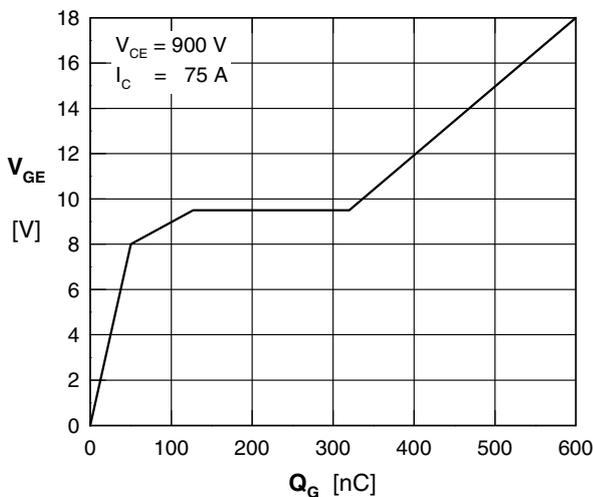

Fig. 11 Typical turn on gate charge
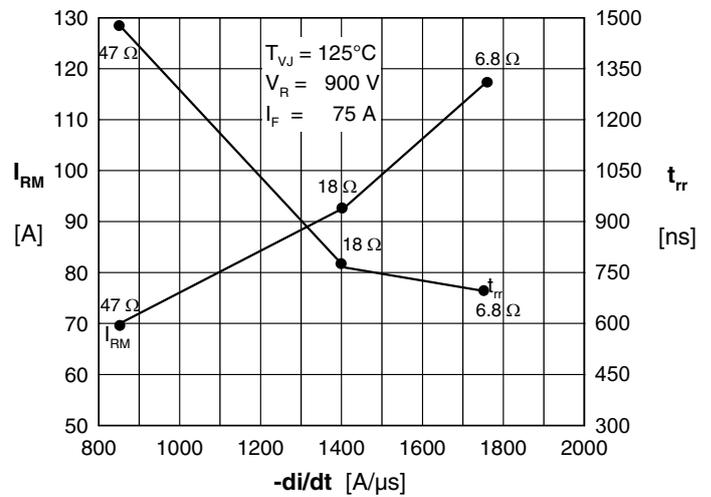

Fig. 12  Typ. turn-off characteristics
of free wheeling diode

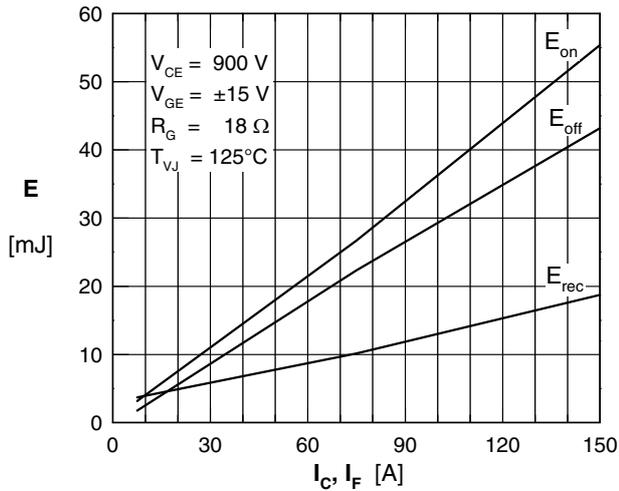IXYS reserves the right to change limits, test conditions and dimensions.

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**Output Inverter T1 - T6 / D1 - D6**



Fig. 13  Typ. turn on energy & switching times
versus collector current

$V_{CE} = 900 \text{ V}$
$V_{GE} = \pm 15 \text{ V}$
$R_G = 18 \text{ }\Omega$
$T_{VJ} = 125°C$



Fig. 14  Typ. turn off energy and switching times
versus collector current

$V_{CE} = 900 \text{ V}$
$V_{GE} = \pm 15 \text{ V}$
$I_C, I_F = 75 \text{ A}$
$T_{VJ} = 125°C$
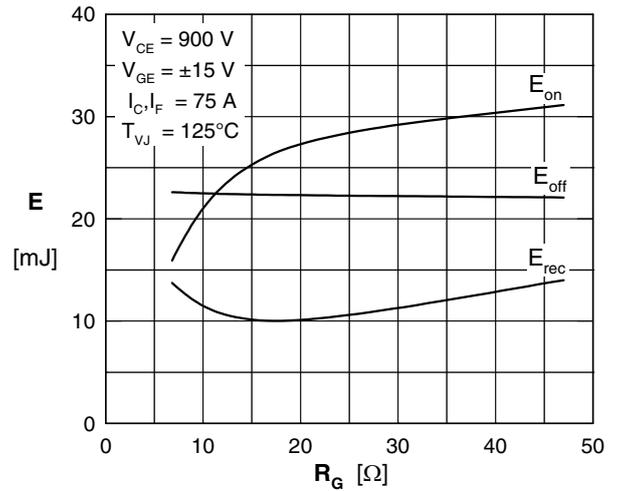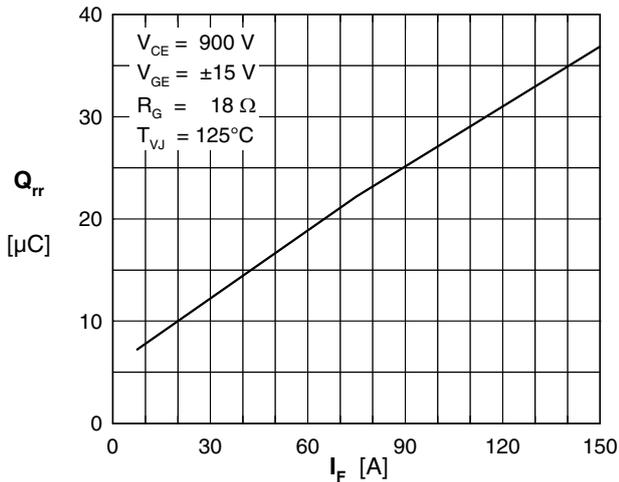


Fig. 15  Typical turn-off characteristics
of free wheeling diode

$V_{CE} = 900 \text{ V}$
$V_{GE} = \pm 15 \text{ V}$
$R_G = 18 \text{ }\Omega$
$T_{VJ} = 125°C$
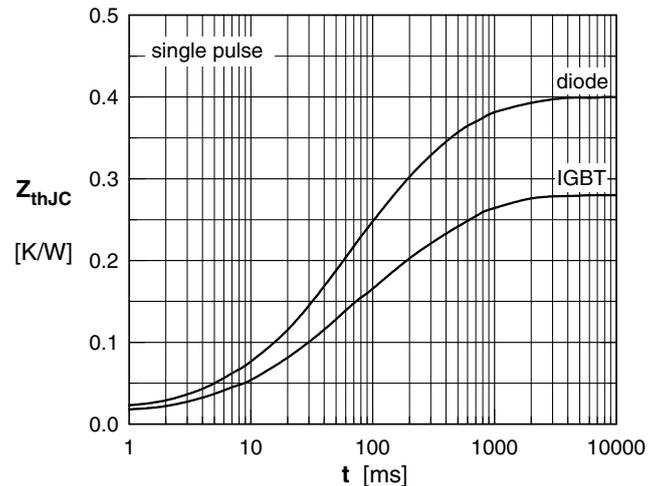


Fig. 16  Transient thermal impedance
junction to case

### Temperature Sensor NTC
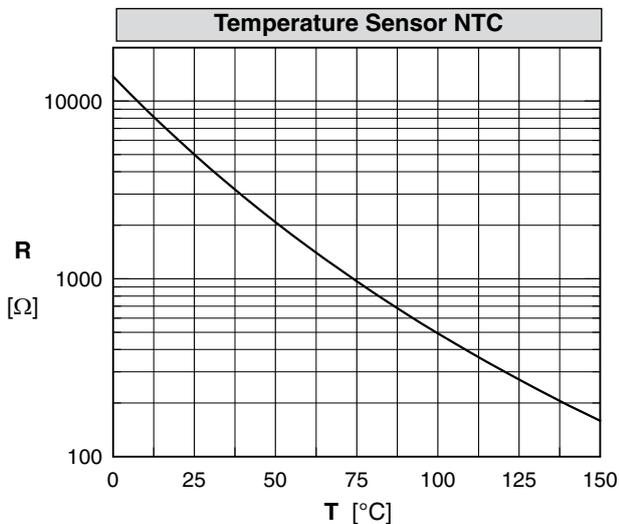


Fig. 17 Typ. transient thermal impedance

| | IGBT | | Diode | |
|---|---|---|---|---|
| | $R_i$ | $\tau_i$ | $R_i$ | $\tau_i$ |
| 1 | 0.0175 | 0.0015 | 0.0265 | 0.0020 |
| 2 | 0.0860 | 0.0276 | 0.1443 | 0.0318 |
| 3 | 0.0920 | 0.1311 | 0.1655 | 0.1618 |
| 4 | 0.0832 | 0.6329 | 0.0636 | 0.8218 |



IXYS reserves the right to change limits, test conditions and dimensions.

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**IXYS**
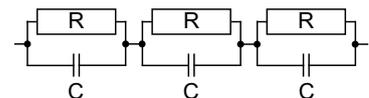
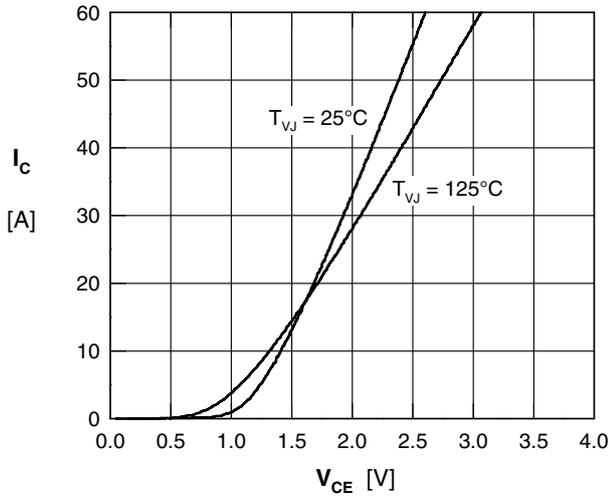**Brake Chopper T7 / D7**



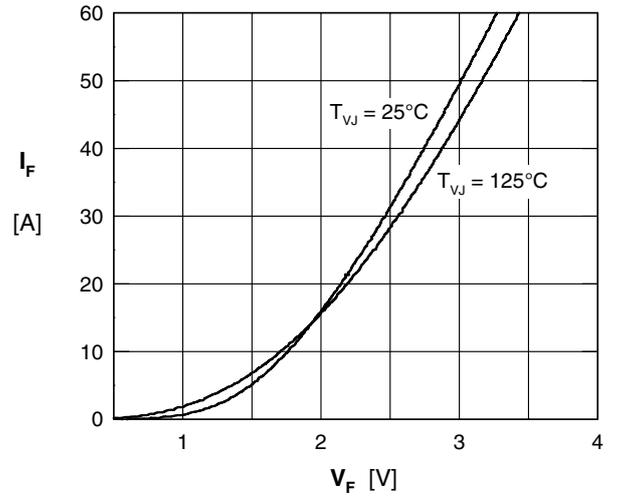Fig. 18  Typical output characteristic



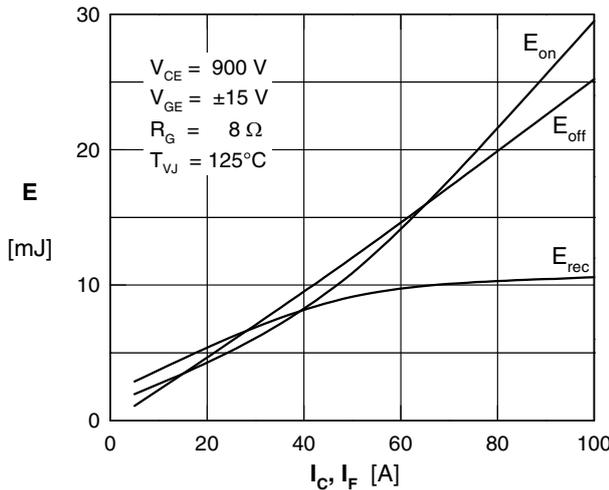Fig. 19  Typ. forward characteristics of brake diode



Fig. 20  Typ. turn on energy & switching times
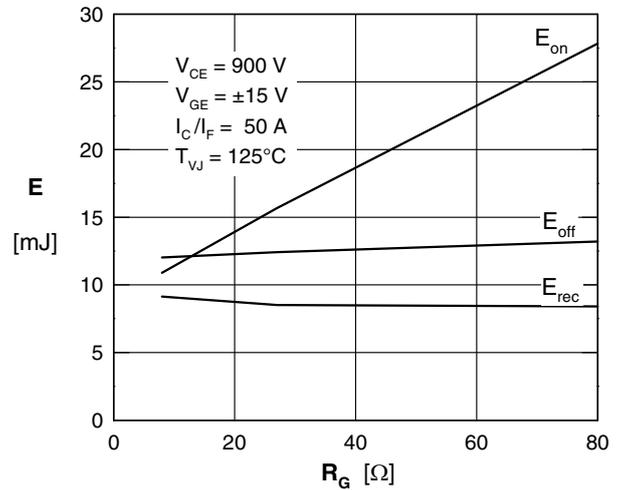versus collector current



Fig. 21  Typ. turn off energy and switching times
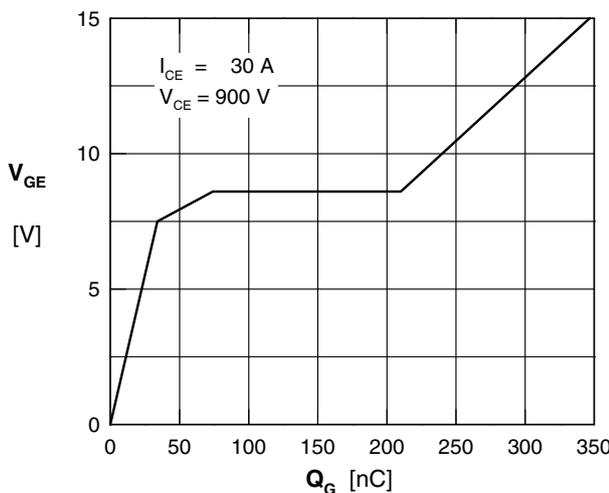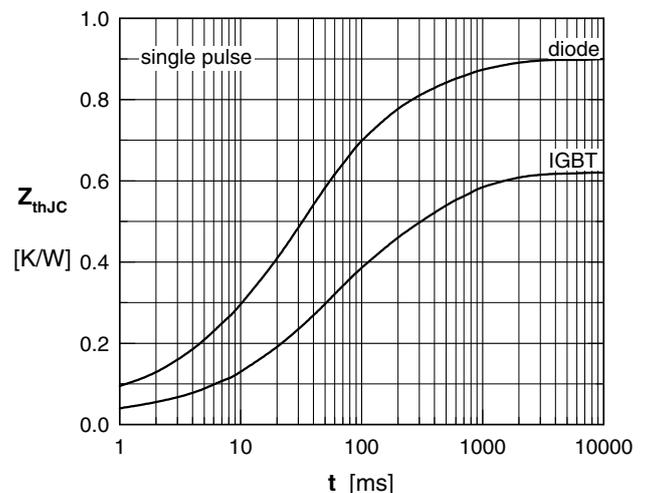versus collector current



Fig. 22  Typ. turn on gate charge



Fig. 23  Typ. NTC resistance versus temperature

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