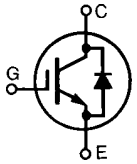
# IXYS

# IGBT with Diode

**IXSK 50N60BD1**
**IXSX 50N60BD1**

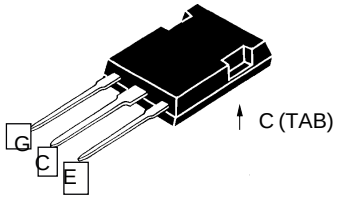
$V_{CES}$ = 600 V
$I_{C25}$ = 75 A
$V_{CE(sat)}$ = 2.5 V

## Short Circuit SOA Capability

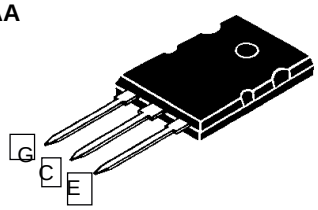



| Symbol | Test Conditions | Maximum Ratings | |
|---|---|---|---|
| $V_{CES}$ | $T_J$ = 25°C to 150°C | 600 | V |
| $V_{CGR}$ | $T_J$ = 25°C to 150°C; $R_{GE}$ = 1 MΩ | 600 | V |
| $V_{GES}$ | Continuous | ±20 | V |
| $V_{GEM}$ | Transient | ±30 | V |
| $I_{C25}$ | $T_C$ = 25°C, limited by leads | 75 | A |
| $I_{C90}$ | $T_C$ = 90°C | 50 | A |
| $I_{CM}$ | $T_C$ = 25°C, 1 ms | 200 | A |
| **SSOA (RBSOA)** | $V_{GE}$ = 15 V, $T_{VJ}$ = 125°C, $R_G$ = 22 Ω<br>Clamped inductive load, L = 30 μH | $I_{CM}$ = 100<br>@ 0.8 $V_{CES}$ | A |
| $t_{SC}$ **(SCSOA)** | $V_{GE}$ = 15 V, $V_{CE}$ = 360 V, $T_J$ = 125°C<br>$R_G$ = 22 Ω, non repetitive | 10 | μs |
| $P_C$ | $T_C$ = 25°C | 300 | W |
| $T_J$ | | -55 ... +150 | °C |
| $T_{JM}$ | | 150 | °C |
| $T_{stg}$ | | -55 ... +150 | °C |
| $M_d$ | Mounting torque | 0.9/6 | Nm/lb.in. |
| **Weight** | | 10 | g |
| Maximum lead temperature for soldering 1.6 mm (0.062 in.) from case for 10 s | | 300 | °C |

**PLUS247 (IXSX)**




**TO-264 AA (IXSK)**




G = Gate, C = Collector,
E = Emitter, TAB = Collector

### Features

- International standard package JEDEC TO-264 AA, and hole-less TO-247 package for clip mounting
- Guaranteed Short Circuit SOA capability
- High frequency IGBT and anti-parallel FRED in one package
- Latest generation HDMOS™ process
- Low $V_{CE(sat)}$
  - for minimum on-state conduction losses
- MOS Gate turn-on
  - drive simplicity
- Fast Recovery Epitaxial Diode (FRED)
  - soft recovery with low $I_{RM}$

### Applications

- AC motor speed control
- DC servo and robot drives
- DC choppers
- Uninterruptible power supplies (UPS)
- Switch-mode and resonant-mode power supplies

### Advantages

- Space savings (two devices in one package)
- Easy to mount with 1 screw (isolated mounting screw hole)
- Reduces assembly time and cost

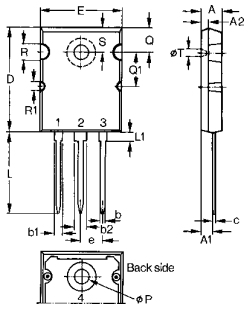
| Symbol | Test Conditions | | Characteristic Values ($T_J$ = 25°C, unless otherwise specified) min. | typ. | max. | |
|---|---|---|---|---|---|---|
| $BV_{CES}$ | $I_C$ = 3 mA, $V_{GE}$ = 0 V | | 600 | | | V |
| $V_{GE(th)}$ | $I_C$ = 4 mA, $V_{CE}$ = $V_{GE}$ | | 4 | | 8 | V |
| $I_{CES}$ | $V_{CE}$ = 0.8 • $V_{CES}$<br>$V_{GE}$ = 0 V | $T_J$ = 25°C<br>$T_J$ = 125°C | | | 350<br>5 | μA<br>mA |
| $I_{GES}$ | $V_{CE}$ = 0 V, $V_{GE}$ = ±20 V | | | | ±100 | nA |
| $V_{CE(sat)}$ | $I_C$ = $I_{C90}$; $V_{GE}$ = 15 V | | | 2.2 | 2.5 | V |

| Symbol | Test Conditions ($T_J$ = 25°C, unless otherwise specified) | Characteristic Values min. | typ. | max. | |
|---|---|---|---|---|---|
| $g_{fs}$ | $I_C = I_{C90}$; $V_{CE}$ = 10 V, Pulse test, t ≤ 300 µs, duty cycle ≤ 2 % | 16 | 23 | | S |
| $I_{C(on)}$ | $V_{GE}$ = 15 V, $V_{CE}$ = 10 V | | 160 | | A |
| $C_{ies}$ | $V_{CE}$ = 25 V, $V_{GE}$ = 0 V, f = 1 MHz | | 3850 | | pF |
| $C_{oes}$ | | | 440 | | pF |
| $C_{res}$ | | | 50 | | pF |
| $Q_g$ | $I_C = I_{C90}$, $V_{GE}$ = 15 V, $V_{CE}$ = 0.5 $V_{CES}$ | | 167 | | nC |
| $Q_{ge}$ | | | 45 | | nC |
| $Q_{gc}$ | | | 88 | | nC |
| $t_{d(on)}$ | **Inductive load, $T_J$ = 25°C** | | 70 | | ns |
| $t_{ri}$ | $I_C = I_{C90}$, $V_{GE}$ = 15 V, L = 100 µH, | | 70 | | ns |
| $t_{d(off)}$ | $V_{CE}$ = 0.8 $V_{CES}$, $R_G$ = 2.7 Ω | | 150 | 300 | ns |
| $t_{fi}$ | Remarks: Switching times may increase | | 150 | 300 | ns |
| $E_{off}$ | for $V_{CE}$ (Clamp) > 0.8 • $V_{CES}$, higher $T_J$ or increased $R_G$ | | 3.3 | 6.0 | mJ |
| $t_{d(on)}$ | **Inductive load, $T_J$ = 125°C** | | 70 | | ns |
| $t_{ri}$ | $I_C = I_{C90}$, $V_{GE}$ = 15 V, L = 100 µH | | 70 | | ns |
| $E_{on}$ | $V_{CE}$ = 0.8 $V_{CES}$, $R_G$ = 2.7 Ω | | 2.5 | | mJ |
| $t_{d(off)}$ | Remarks: Switching times may increase | | 230 | | ns |
| $t_{fi}$ | for $V_{CE}$ (Clamp) > 0.8 • $V_{CES}$, higher $T_J$ or increased $R_G$ | | 230 | | ns |
| $E_{off}$ | | | 4.8 | | mJ |
| $R_{thJC}$ | | | | 0.42 | K/W |
| $R_{thCK}$ | | | 0.15 | | K/W |

**Reverse Diode (FRED)**

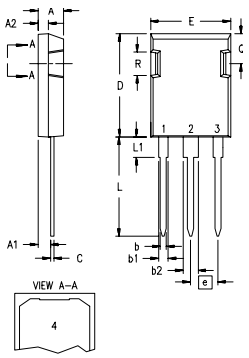
| Symbol | Test Conditions ($T_J$ = 25°C, unless otherwise specified) | Characteristic Values min. | typ. | max. | |
|---|---|---|---|---|---|
| $V_F$ | $I_F = I_{C90}$, $V_{GE}$ = 0 V, Pulse test, t ≤ 300 µs, duty cycle d ≤ 2 % | | | 2.5 | V |
| $I_{RM}$ | $I_F = I_{C90}$, $V_{GE}$ = 0 V, -$di_F$/dt = 100 A/µs | | 2 | 2.5 | A |
| $t_{rr}$ | $V_R$ = 100 V | | | | |
| | $I_F$ = 1 A; -di/dt = 200 A/µs; $V_R$ = 30 V $T_J$ = 25°C | | 35 | | ns |
| $R_{thJC}$ | | | | 0.75 | K/W |

**TO-264 AA Outline**




| Dim. | Millimeter Min. | Max. | Inches Min. | Max. |
|---|---|---|---|---|
| A | 4.82 | 5.13 | .190 | .202 |
| A1 | 2.54 | 2.89 | .100 | .114 |
| A2 | 2.00 | 2.10 | .079 | .083 |
| b | 1.12 | 1.42 | .044 | .056 |
| b1 | 2.39 | 2.69 | .094 | .106 |
| b2 | 2.90 | 3.09 | .114 | .122 |
| c | 0.53 | 0.83 | .021 | .033 |
| D | 25.91 | 26.16 | 1.020 | 1.030 |
| E | 19.81 | 19.96 | .780 | .786 |
| e | 5.46 BSC | | .215 BSC | |
| J | 0.00 | 0.25 | .000 | .010 |
| K | 0.00 | 0.25 | .000 | .010 |
| L | 20.32 | 20.83 | .800 | .820 |
| L1 | 2.29 | 2.59 | .090 | .102 |
| P | 3.17 | 3.66 | .125 | .144 |
| Q | 6.07 | 6.27 | .239 | .247 |
| Q1 | 8.38 | 8.69 | .330 | .342 |
| R | 3.81 | 4.32 | .150 | .170 |
| R1 | 1.78 | 2.29 | .070 | .090 |
| S | 6.04 | 6.30 | .238 | .248 |
| T | 1.57 | 1.83 | .062 | .072 |

**PLUS247™ (IXSX)**




| Dim. | Millimeter Min. | Max. | Inches Min. | Max. |
|---|---|---|---|---|
| A | 4.83 | 5.21 | .190 | .205 |
| $A_1$ | 2.29 | 2.54 | .090 | .100 |
| $A_2$ | 1.91 | 2.16 | .075 | .085 |
| b | 1.14 | 1.40 | .045 | .055 |
| $b_1$ | 1.91 | 2.13 | .075 | .084 |
| $b_2$ | 2.92 | 3.12 | .115 | .123 |
| C | 0.61 | 0.80 | .024 | .031 |
| D | 20.80 | 21.34 | .819 | .840 |
| E | 15.75 | 16.13 | .620 | .635 |
| e | 5.45 BSC | | .215 BSC | |
| L | 19.81 | 20.32 | .780 | .800 |
| L1 | 3.81 | 4.32 | .150 | .170 |
| Q | 5.59 | 6.20 | .220 | .244 |
| R | 4.32 | 4.83 | .170 | .190 |

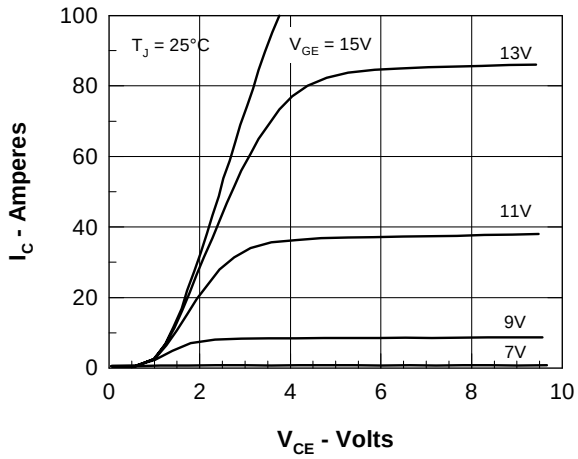



Figure 1. Saturation Voltage Characteristics

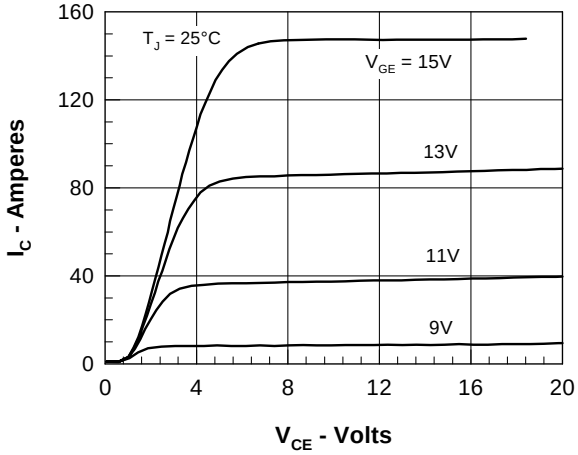



Figure 2. Extended Output Characteristics

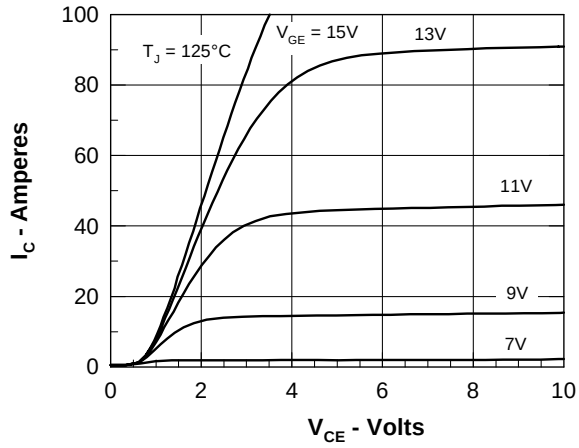



Figure 3. Saturation Voltage Characteristics

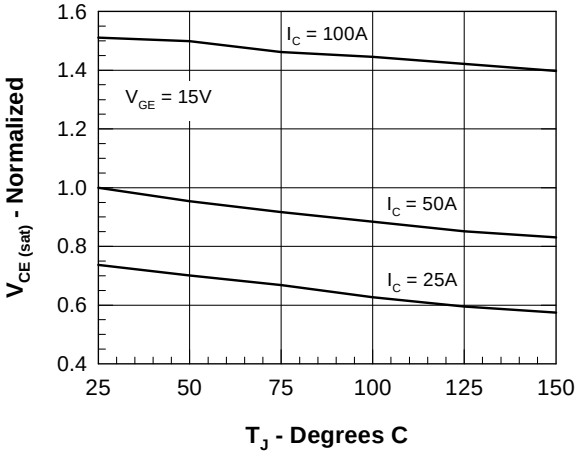



Figure 4. Temperature Dependence of $V_{CE(sat)}$

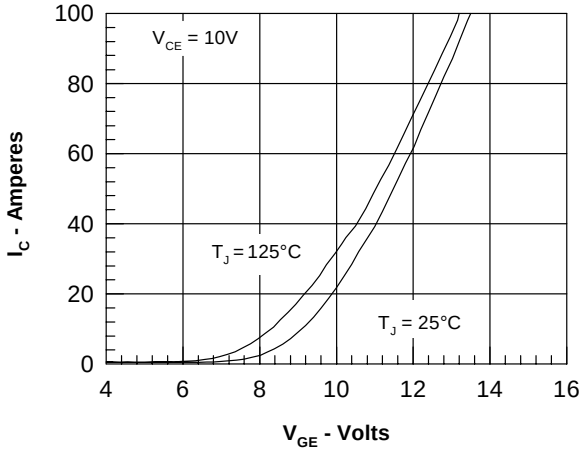



Figure 5. Admittance Curves

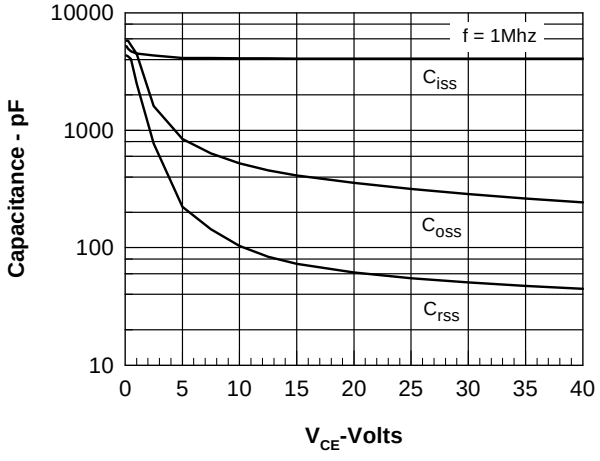



Figure 6. Capacitance Curves

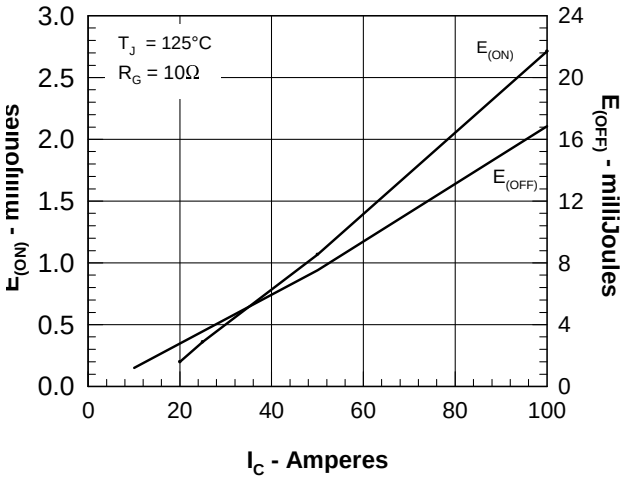



Figure 7. Dependence of $E_{ON}$ and $E_{OFF}$ on $I_C$.

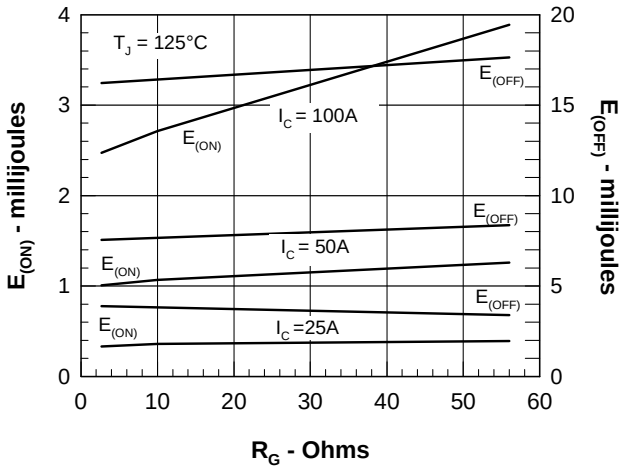



Figure 8. Dependence of $E_{ON}$ and $E_{OFF}$ on $R_G$.

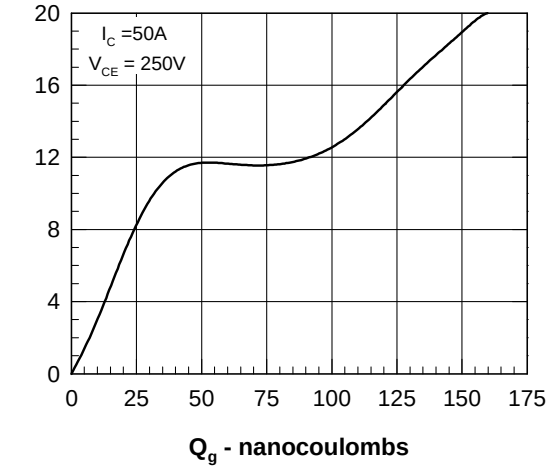



Figure 9. Gate Charge

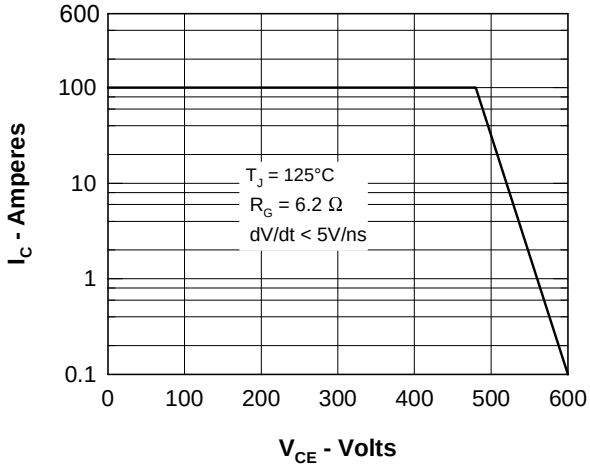



Figure 10. Turn-off Safe Operating Area

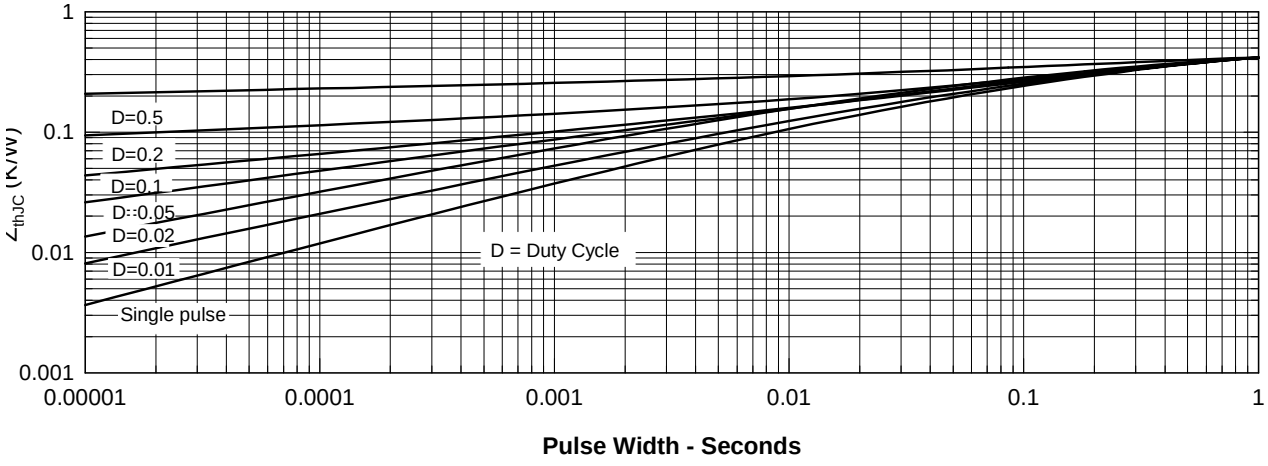



Figure 11. Transient Thermal Resistance

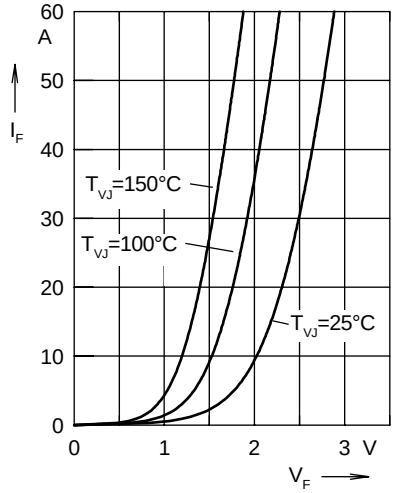



Fig. 12 Forward current $I_F$ versus $V_F$

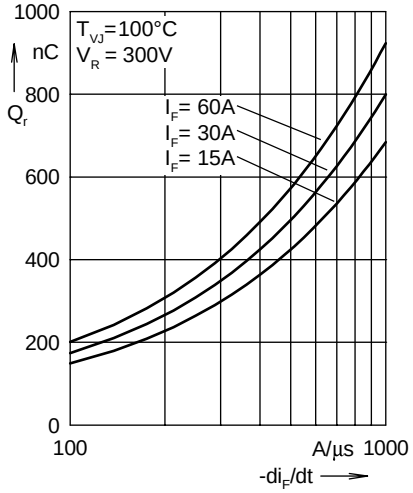



Fig. 13 Reverse recovery charge $Q_r$ versus $-di_F/dt$

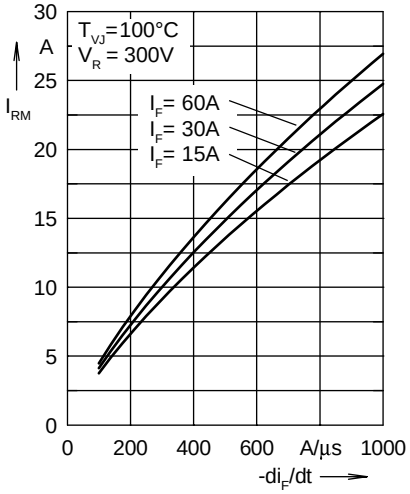



Fig. 14 Peak reverse current $I_{RM}$ versus $-di_F/dt$

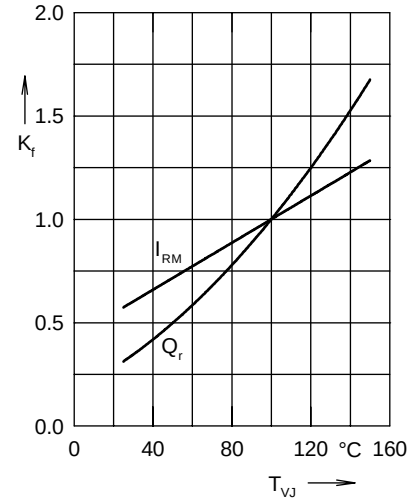



Fig. 15 Dynamic parameters $Q_r$, $I_{RM}$ versus $T_{VJ}$

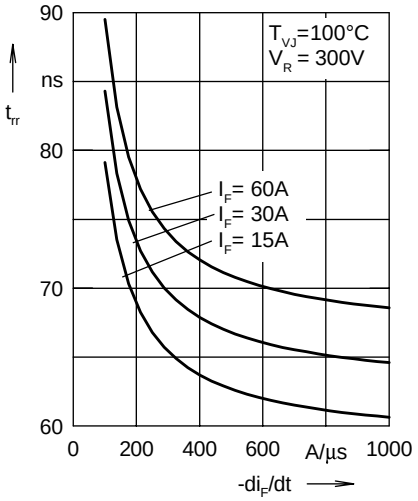



Fig. 16 Recovery time $t_{rr}$ versus $-di_F/dt$

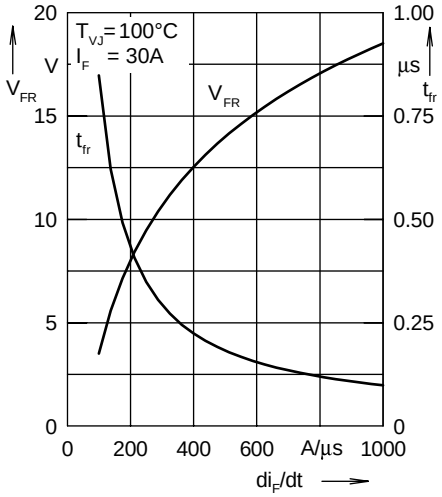



Fig. 17 Peak forward voltage $V_{FR}$ and $t_{fr}$ versus $di_F/dt$

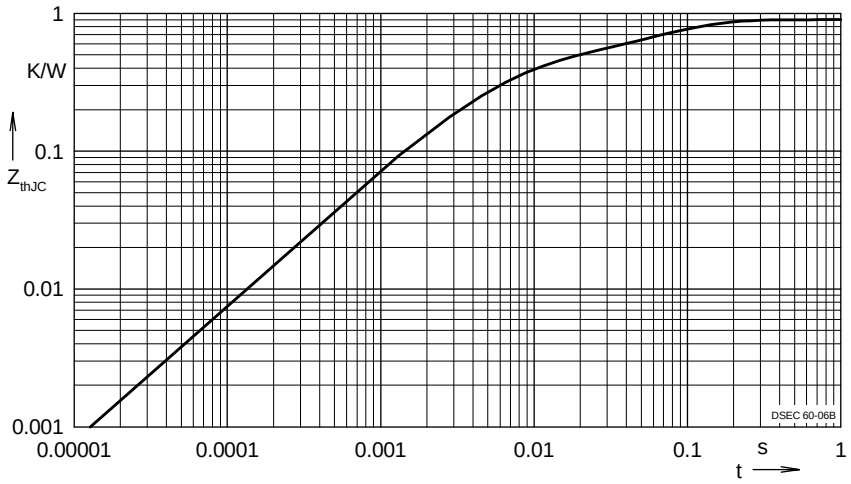



Fig. 18 Transient thermal resistance junction to case

Constants for $Z_{thJC}$ calculation:

| i | $R_{thi}$ (K/W) | $t_i$ (s) |
|---|---|---|
| 1 | 0.465 | 0.0052 |
| 2 | 0.179 | 0.0003 |
| 3 | 0.256 | 0.0396 |