

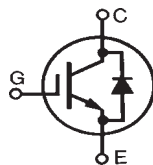
## High Speed IGBT with Diode

**IXSH 30N60B2D1**  
**IXST 30N60B2D1**

$$\begin{aligned} V_{CES} &= 600 \text{ V} \\ I_{C25} &= 48 \text{ A} \\ V_{CE(sat)} &= 2.5 \text{ V} \end{aligned}$$

Short Circuit SOA Capability

Preliminary Data Sheet

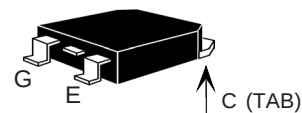


| Symbol                                                                          | Test Conditions                                                                                                | Maximum Ratings                  |                  |
|---------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|----------------------------------|------------------|
| $V_{CES}$                                                                       | $T_J = 25^\circ\text{C to } 150^\circ\text{C}$                                                                 | 600                              | V                |
| $V_{CGR}$                                                                       | $T_J = 25^\circ\text{C to } 150^\circ\text{C}; R_{GE} = 1 \text{ M}\Omega$                                     | 600                              | V                |
| $V_{GES}$                                                                       | Continuous                                                                                                     | $\pm 20$                         | V                |
| $V_{GEM}$                                                                       | Transient                                                                                                      | $\pm 30$                         | V                |
| $I_{C25}$                                                                       | $T_C = 25^\circ\text{C}$                                                                                       | 48                               | A                |
| $I_{C110}$                                                                      | $T_C = 110^\circ\text{C}$                                                                                      | 30                               | A                |
| $I_{F(110)}$                                                                    |                                                                                                                | 28                               | A                |
| $I_{CM}$                                                                        | $T_C = 25^\circ\text{C}, 1 \text{ ms}$                                                                         | 90                               | A                |
| <b>SSOA</b><br><b>(RBSOA)</b>                                                   | $V_{GE} = 15 \text{ V}, T_J = 125^\circ\text{C}, R_G = 10 \Omega$<br>Clamped inductive load                    | $I_{CM} = 48$<br>@ $0.8 V_{CES}$ | A                |
| $t_{SC}$<br><b>(SCSOA)</b>                                                      | $V_{GE} = 15 \text{ V}, V_{CE} = 360 \text{ V}, T_J = 125^\circ\text{C}$<br>$R_G = 10 \Omega$ , non repetitive | 10                               | $\mu\text{s}$    |
| $P_C$                                                                           | $T_C = 25^\circ\text{C}$                                                                                       | 250                              | W                |
| $T_J$                                                                           |                                                                                                                | -55 ... +150                     | $^\circ\text{C}$ |
| $T_{JM}$                                                                        |                                                                                                                | 150                              | $^\circ\text{C}$ |
| $T_{stg}$                                                                       |                                                                                                                | -55 ... +150                     | $^\circ\text{C}$ |
| <b>Weight</b>                                                                   | TO-247                                                                                                         | 6                                | g                |
|                                                                                 | TO-268                                                                                                         | 5                                | g                |
| Maximum lead temperature for soldering<br>1.6 mm (0.062 in.) from case for 10 s |                                                                                                                | 300                              | $^\circ\text{C}$ |
| Maximum tab temperature for soldering for 10s                                   |                                                                                                                | 260                              | $^\circ\text{C}$ |

TO-247 (IXSH)



TO-268 (IXST)



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

### Features

- International standard package
- Guaranteed Short Circuit SOA capability
- Low  $V_{CE(sat)}$ 
  - for low on-state conduction losses
- High current handling capability
- MOS Gate turn-on
  - drive simplicity
- Fast fall time for switching speeds up to 20 kHz

### Applications

- AC motor speed control
- Uninterruptible power supplies (UPS)
- Welding

### Advantages

- High power density

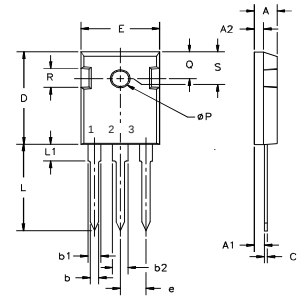
| Symbol        | Test Conditions                                   | Characteristic Values<br>( $T_J = 25^\circ\text{C}$ , unless otherwise specified) |      |                           |
|---------------|---------------------------------------------------|-----------------------------------------------------------------------------------|------|---------------------------|
|               |                                                   | min.                                                                              | typ. | max.                      |
| $V_{GE(th)}$  | $I_C = 750 \mu\text{A}, V_{CE} = V_{GE}$          | 4.0                                                                               |      | 7.0 V                     |
| $I_{CES}$     | $V_{CE} = V_{CES}$<br>$V_{GE} = 0 \text{ V}$      |                                                                                   |      | 150 $\mu\text{A}$<br>1 mA |
| $I_{GES}$     | $V_{CE} = 0 \text{ V}, V_{GE} = \pm 20 \text{ V}$ |                                                                                   |      | $\pm 100 \text{ nA}$      |
| $V_{CE(sat)}$ | $I_C = 24 \text{ A}, V_{GE} = 15 \text{ V}$       |                                                                                   |      | 2.5 V                     |

| Symbol       | Test Conditions                                                                                                                                                                                                                                                         | Characteristic Values<br>( $T_J = 25^\circ\text{C}$ , unless otherwise specified) |      |          |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------|----------|
|              |                                                                                                                                                                                                                                                                         | min.                                                                              | typ. | max.     |
| $g_{fs}$     | $I_C = 24\text{A}; V_{CE} = 10\text{ V}$ , Note 1                                                                                                                                                                                                                       | 7.0                                                                               | 12.0 | S        |
| $C_{ies}$    | $V_{CE} = 25\text{ V}, V_{GE} = 0\text{ V}$<br>$f = 1\text{ MHz}$<br>20N60B2D1                                                                                                                                                                                          |                                                                                   | 1220 | pF       |
| $C_{oes}$    |                                                                                                                                                                                                                                                                         |                                                                                   | 110  | pF       |
| $C_{res}$    |                                                                                                                                                                                                                                                                         |                                                                                   | 140  | pF       |
|              |                                                                                                                                                                                                                                                                         |                                                                                   | 42   | pF       |
| $Q_g$        | $I_C = 24\text{A}, V_{GE} = 15\text{ V}, V_{CE} = 0.5 V_{CES}$                                                                                                                                                                                                          |                                                                                   | 50   | nC       |
| $Q_{ge}$     |                                                                                                                                                                                                                                                                         |                                                                                   | 23   | nC       |
| $Q_{gc}$     |                                                                                                                                                                                                                                                                         |                                                                                   | 15   | nC       |
| $t_{d(on)}$  | <b>Inductive load, <math>T_J = 25^\circ\text{C}</math></b><br>$I_C = 24\text{A}, V_{GE} = 15\text{ V}$<br>$V_{CE} = 400\text{ V}, R_G = 5\ \Omega$<br>Switching times may increase for $V_{CE}$<br>(Clamp) $> 0.8 \cdot V_{CES}$ , higher $T_J$ or<br>increased $R_G$   |                                                                                   | 30   | ns       |
| $t_{ri}$     |                                                                                                                                                                                                                                                                         |                                                                                   | 30   | ns       |
| $t_{d(off)}$ |                                                                                                                                                                                                                                                                         |                                                                                   | 130  | 280 ns   |
| $t_{fi}$     |                                                                                                                                                                                                                                                                         |                                                                                   | 140  | 300 ns   |
| $E_{off}$    |                                                                                                                                                                                                                                                                         |                                                                                   | 0.55 | 1.0 mJ   |
|              |                                                                                                                                                                                                                                                                         |                                                                                   |      |          |
| $t_{d(on)}$  | <b>Inductive load, <math>T_J = 125^\circ\text{C}</math></b><br>$I_C = 24\text{ A}, V_{GE} = 15\text{ V}$<br>$V_{CE} = 400\text{ V}, R_G = 5\ \Omega$<br>Switching times may increase for<br>$V_{CE}$ (Clamp) $> 0.8 \cdot V_{CES}$ , higher $T_J$<br>or increased $R_G$ |                                                                                   | 30   | ns       |
| $t_{ri}$     |                                                                                                                                                                                                                                                                         |                                                                                   | 50   | ns       |
| $E_{on}$     |                                                                                                                                                                                                                                                                         |                                                                                   | 0.32 | mJ       |
|              |                                                                                                                                                                                                                                                                         |                                                                                   | 0.82 | mJ       |
| $t_{d(off)}$ |                                                                                                                                                                                                                                                                         |                                                                                   | 202  | ns       |
| $t_{fi}$     |                                                                                                                                                                                                                                                                         |                                                                                   | 234  | ns       |
| $E_{off}$    |                                                                                                                                                                                                                                                                         |                                                                                   | 1.18 | mJ       |
| $R_{thJC}$   |                                                                                                                                                                                                                                                                         |                                                                                   |      | 0.50 K/W |
| $R_{thCS}$   |                                                                                                                                                                                                                                                                         |                                                                                   | 0.21 | K/W      |

| Symbol     | Test Conditions                                                                                           | Characteristic Values<br>( $T_J = 25^\circ\text{C}$ , unless otherwise specified) |      |                |
|------------|-----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------|----------------|
|            |                                                                                                           | min.                                                                              | typ. | max.           |
| $V_F$      | $I_F = 30\text{A}, V_{GE} = 0\text{ V}$<br>$T_J = 150^\circ\text{C}$                                      |                                                                                   |      | 1.6 V<br>2.5 V |
| $I_{RM}$   | $I_F = 50\text{A}, V_{GE} = 0\text{ V}, -di_F/dt = 100\text{ A}/\mu\text{s}$<br>$T_J = 100^\circ\text{C}$ |                                                                                   | 2.0  | 2.5 A          |
| $t_{rr}$   | $V_R = 100\text{ V}$<br>$T_J = 100^\circ\text{C}$                                                         |                                                                                   | 150  | ns             |
| $t_{rr}$   | $I_F = 1\text{ A}; -di/dt = 100\text{ A}/\mu\text{s}; V_R = 30\text{ V}$                                  |                                                                                   | 30   | ns             |
| $R_{thJC}$ |                                                                                                           |                                                                                   |      | 0.9 K/W        |

Note 1: Pulse test,  $t \leq 300\ \mu\text{s}$ , duty cycle  $d \leq 2\%$

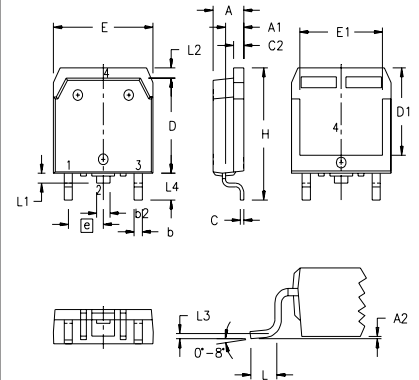
### TO-247 (IXSH) Outline



Terminals: 1 - Gate 2 - Drain

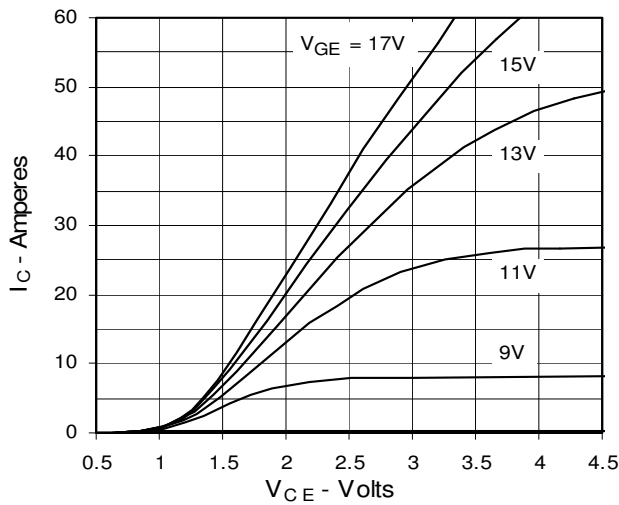
| Dim.           | Millimeter  | Inches      |
|----------------|-------------|-------------|
|                | Min. Max.   | Min. Max.   |
| A              | 4.7 5.3     | .185 .209   |
| A <sub>1</sub> | 2.2 2.54    | .087 .102   |
| A <sub>2</sub> | 2.2 2.6     | .059 .098   |
| b              | 1.0 1.4     | .040 .055   |
| b <sub>1</sub> | 1.65 2.13   | .065 .084   |
| b <sub>2</sub> | 2.87 3.12   | .113 .123   |
| C              | .4 .8       | .016 .031   |
| D              | 20.80 21.46 | .819 .845   |
| E              | 15.75 16.26 | .610 .640   |
| e              | 5.20 5.72   | 0.205 0.225 |
| L              | 19.81 20.32 | .780 .800   |
| L <sub>1</sub> | 4.50        | .177        |
| ØP             | 3.55 3.65   | .140 .144   |
| Q              | 5.89 6.40   | 0.232 0.252 |

### TO-268 (IXST) Outline

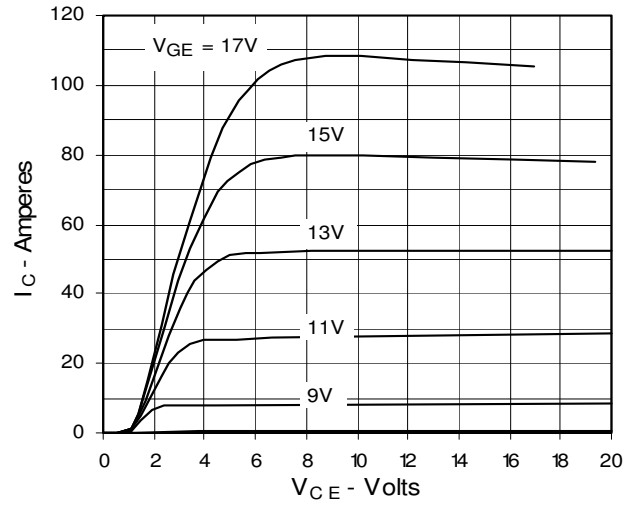


| SYM            | INCHES   |      | MILLIMETERS |       |
|----------------|----------|------|-------------|-------|
|                | MIN      | MAX  | MIN         | MAX   |
| A              | .193     | .201 | 4.90        | 5.10  |
| A <sub>1</sub> | .106     | .114 | 2.70        | 2.90  |
| A <sub>2</sub> | .001     | .010 | 0.02        | 0.25  |
| b              | .045     | .057 | 1.15        | 1.45  |
| b <sub>2</sub> | .075     | .083 | 1.90        | 2.10  |
| C              | .016     | .026 | 0.40        | 0.65  |
| C <sub>2</sub> | .057     | .063 | 1.45        | 1.60  |
| D              | .543     | .551 | 13.80       | 14.00 |
| D <sub>1</sub> | .488     | .500 | 12.40       | 12.70 |
| E              | .624     | .632 | 15.85       | 16.05 |
| E <sub>1</sub> | .524     | .535 | 13.30       | 13.60 |
| e              | .215 BSC |      | 5.45 BSC    |       |
| H              | .736     | .752 | 18.70       | 19.10 |
| L              | .094     | .106 | 2.40        | 2.70  |
| L <sub>1</sub> | .047     | .055 | 1.20        | 1.40  |
| L <sub>2</sub> | .039     | .045 | 1.00        | 1.15  |
| L <sub>3</sub> | .010 BSC |      | 0.25 BSC    |       |
| L <sub>4</sub> | .150     | .161 | 3.80        | 4.10  |

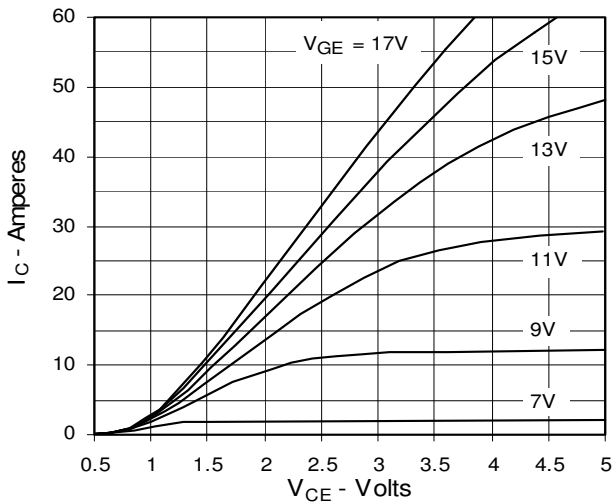
**Fig. 1. Output Characteristics**  
**@ 25 °C**



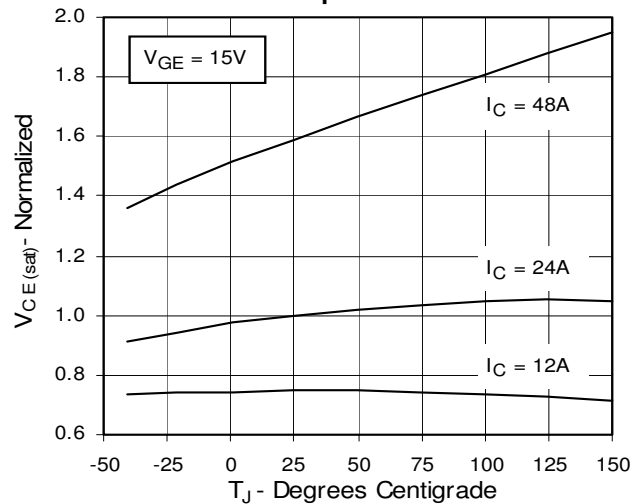
**Fig. 2. Extended Output Characteristics**  
**@ 25 °C**



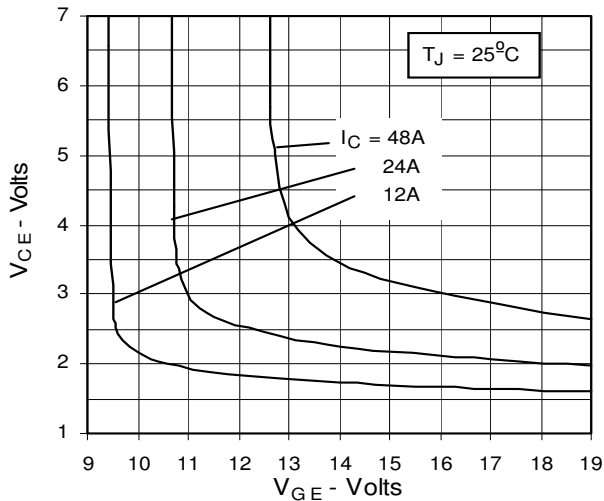
**Fig. 3. Output Characteristics**  
**@ 125 °C**



**Fig. 4. Dependence of  $V_{CE(sat)}$  on Temperature**



**Fig. 5. Collector-to-Emitter Voltage vs. Gate-to-Emitter voltage**



**Fig. 6. Input Admittance**

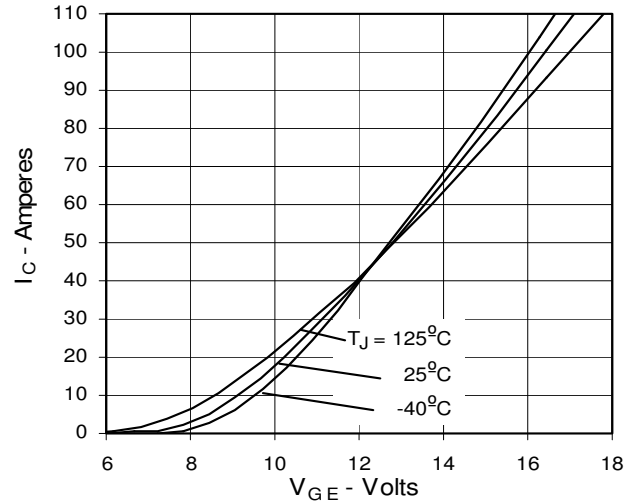


Fig. 7. Transconductance

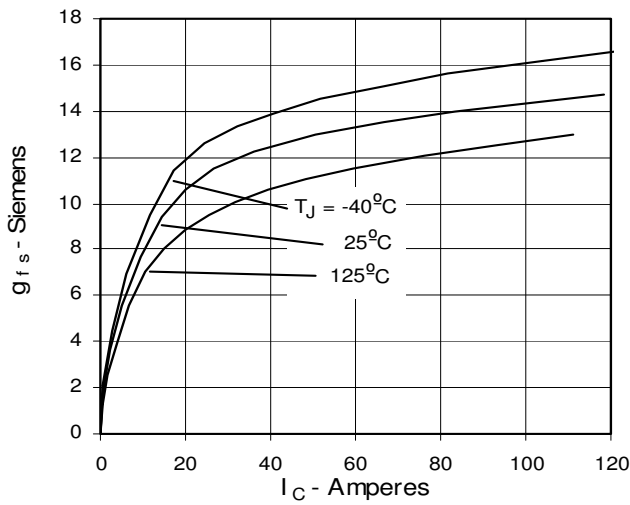


Fig. 8. Dependence of Turn-off Energy Loss on  $R_G$

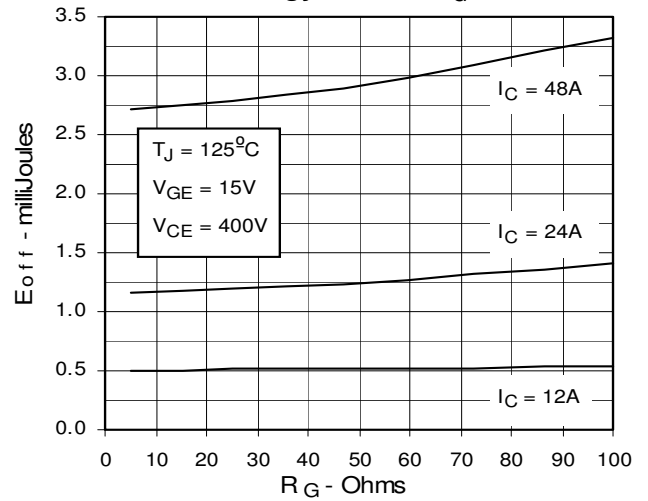


Fig. 9. Dependence of Turn-Off Energy Loss on  $I_C$

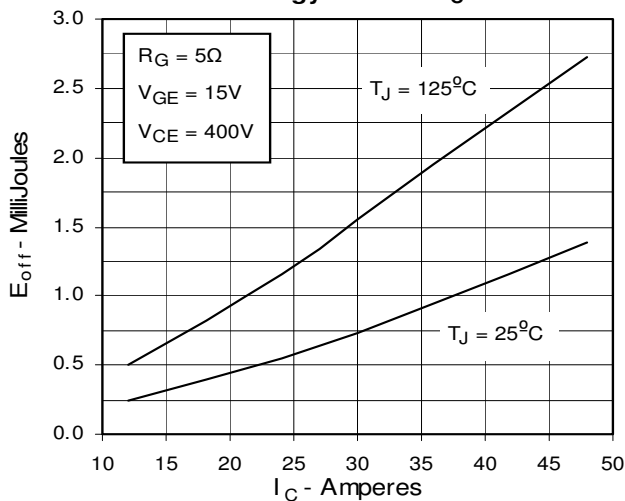


Fig. 10. Dependence of Turn-off Energy Loss on Temperature

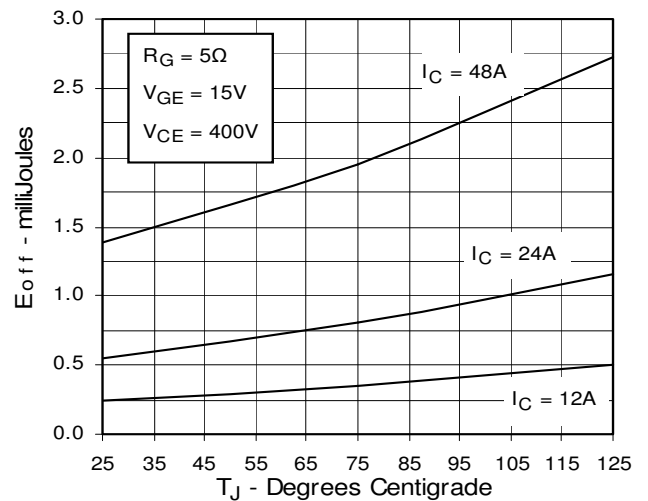


Fig. 11. Dependence of Turn-off Switching Time on  $R_G$

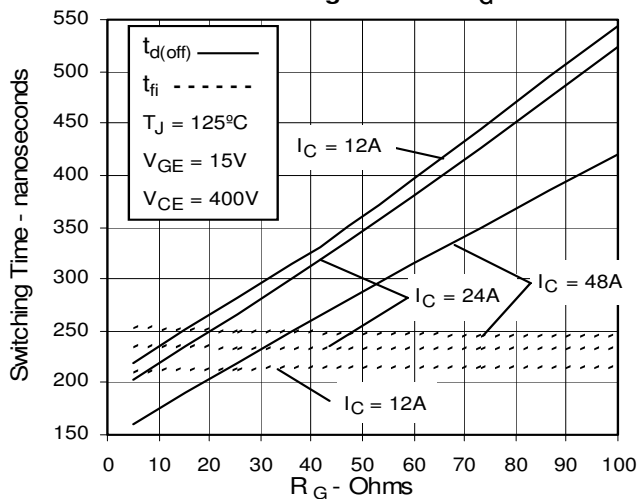
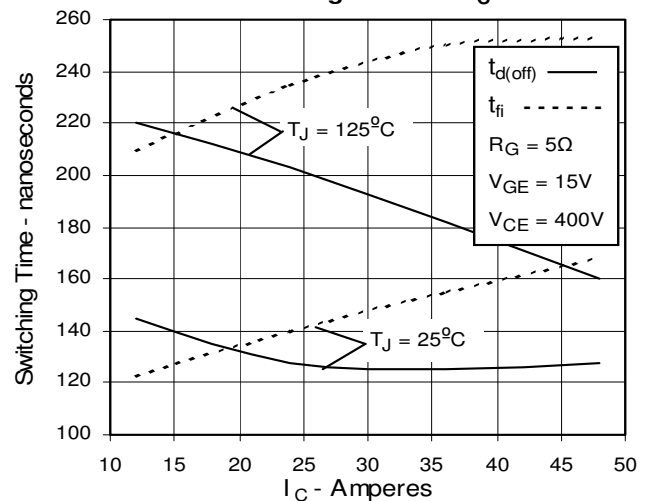
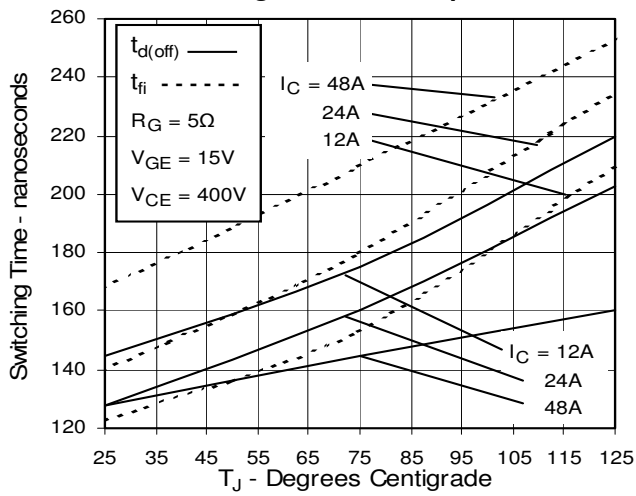


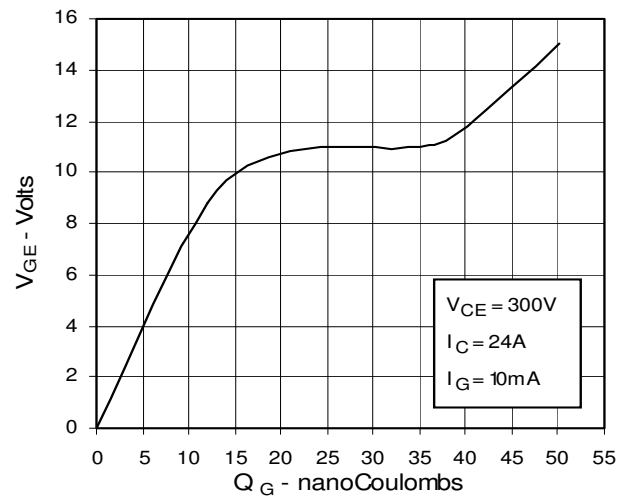
Fig. 12. Dependence of Turn-off Switching Time on  $I_C$



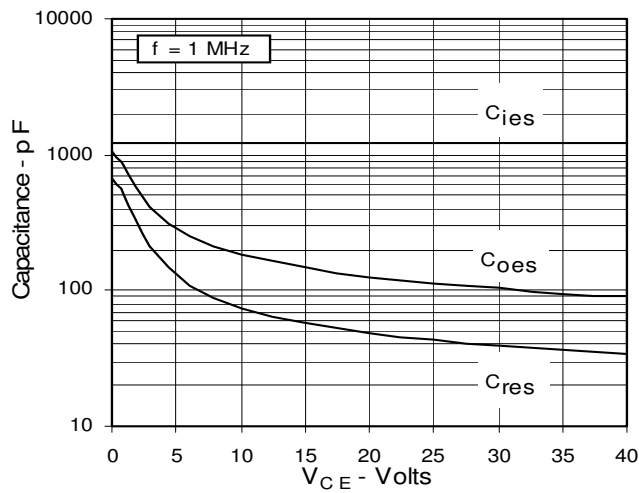
**Fig. 13. Dependence of Turn-off Switching Time on Temperature**



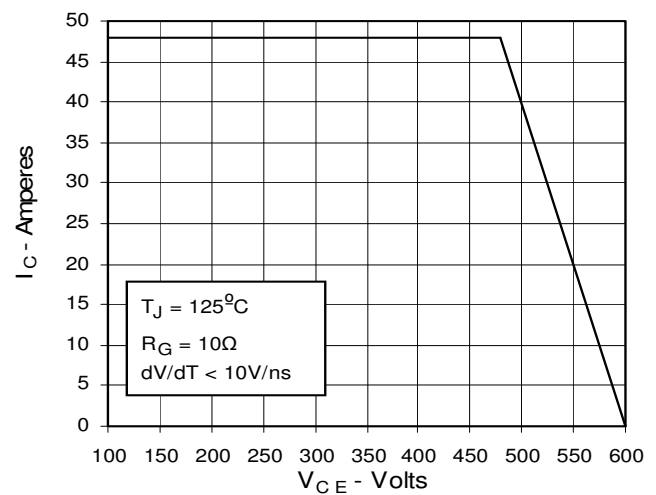
**Fig. 14. Gate Charge**



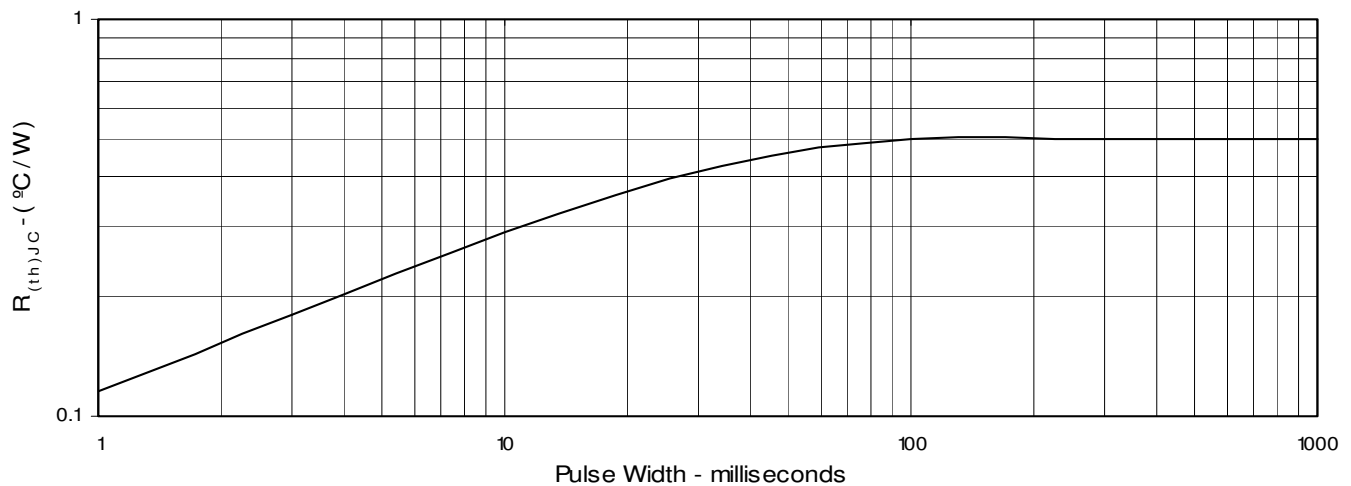
**Fig. 15. Capacitance**



**Fig. 16. Reverse-Bias Safe Operating Area**



**Fig. 17. Maximum Transient Thermal Resistance**



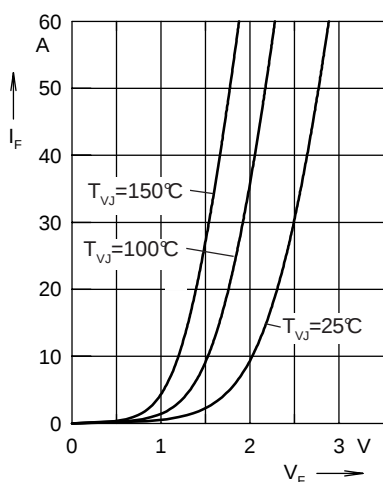


Fig. 18. Forward current  $I_F$  versus  $V_F$

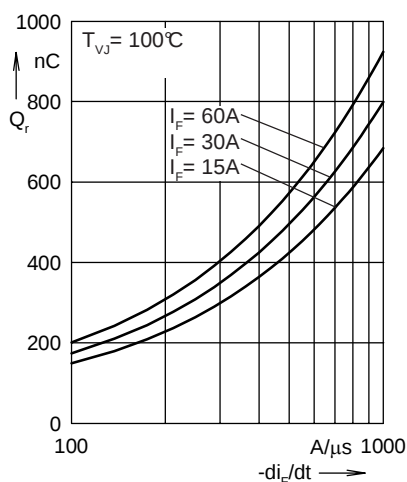


Fig. 19. Reverse recovery charge

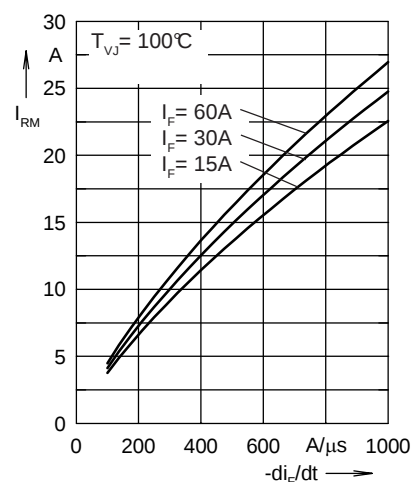


Fig. 20. Peak reverse current  $I_{RM}$

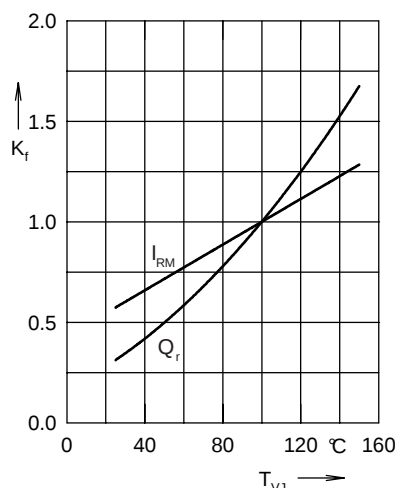


Fig. 21. Dynamic parameters  $Q_r$ ,  $I_{RM}$

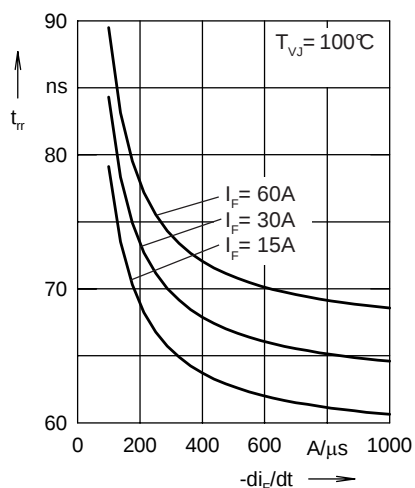


Fig. 22. Recovery time  $t_{rr}$  versus

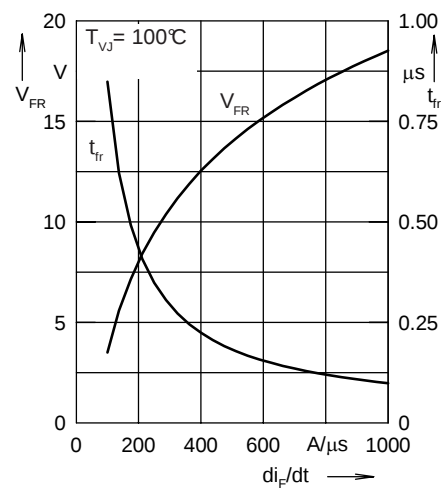


Fig. 23. Peak forward voltage  $V_{FR}$

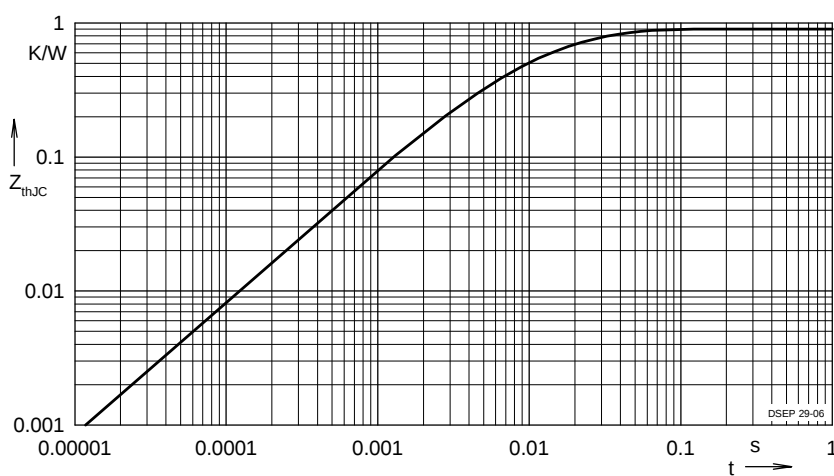


Fig. 24. Transient thermal resistance junction to case

Constants for  $Z_{thJC}$  calculation:

| i | $R_{thi}$ (K/W) | $t_i$ (s) |
|---|-----------------|-----------|
| 1 | 0.502           | 0.0052    |
| 2 | 0.193           | 0.0003    |