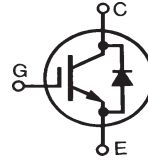


# GenX3™ 600V IGBT w/ Diode

## IXGH56N60B3D1

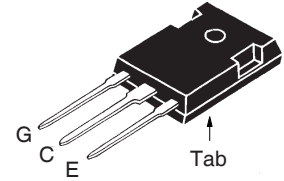
$V_{CES} = 600V$   
 $I_{C110} = 56A$   
 $V_{CE(sat)} \leq 1.80V$

Medium-Speed-Low-Vsat PT  
IGBT 5-40kHz Switching



| Symbol                        | Test Conditions   | Maximum Ratings                           |            |
|-------------------------------|---|---|------------|
| $V_{CES}$                     | $T_J = 25^\circ C$ to $150^\circ C$   | 600                                       | V          |
| $V_{CGR}$                     | $T_J = 25^\circ C$ to $150^\circ C$ , $R_{GE} = 1M\Omega$                           | 600                                       | V          |
| $V_{GES}$                     | Continuous  | $\pm 20$                                  | V          |
| $V_{GEM}$                     | Transient   | $\pm 30$                                  | V          |
| $I_{C110}$                    | $T_C = 110^\circ C$   | 56  | A          |
| $I_{CM}$                      | $T_C = 25^\circ C$ , 1ms  | 350                                       | A          |
| <b>SSOA</b><br><b>(RBSOA)</b> | $V_{GE} = 15V$ , $T_{VJ} = 125^\circ C$ , $R_G = 5\Omega$<br>Clamped Inductive Load | $I_{CM} = 150$<br>@ $V_{CE} \leq V_{CES}$ | A          |
| $P_C$                         | $T_C = 25^\circ C$  | 330                                       | W          |
| $T_J$                         |   | -55 ... +150                              | $^\circ C$ |
| $T_{JM}$                      |   | 150                                       | $^\circ C$ |
| $T_{stg}$                     |   | -55 ... +150                              | $^\circ C$ |
| $T_L$                         | Maximum Lead Temperature for Soldering  | 300                                       | $^\circ C$ |
| $T_{SOLD}$                    | 1.6 mm (0.062in.) from Case for 10s   | 260                                       | $^\circ C$ |
| $M_d$                         | Mounting Torque   | 1.13/10                                   | Nm/lb.in.  |
| <b>Weight</b>                 |   | 6   | g          |

TO-247



G = Gate      C = Collector  
 E = Emitter    Tab = Collector

### Features

- Optimized for Low Conduction and Switching losses
- Square RBSOA
- Anti-Parallel Ultra Fast Diode
- International Standard Package

### Advantages

- High Power Density
- Low Gate Drive Requirement

### Applications

- Power Inverters
- UPS
- Motor Drives
- SMPS
- PFC Circuits
- Battery Chargers
- Welding Machines
- Lamp Ballasts

| Symbol        | Test Conditions<br>( $T_J = 25^\circ C$ , Unless Otherwise Specified) | Characteristic Values |              |                     |
|---------------|---|-----------------------|--------------|---------------------|
|               |   | Min.                  | Typ.         | Max.                |
| $V_{GE(th)}$  | $I_C = 250\mu A$ , $V_{CE} = V_{GE}$                                  | 3.0                   |              | 5.0 V               |
| $I_{CES}$     | $V_{CE} = V_{CES}$ , $V_{GE} = 0V$<br>$T_J = 125^\circ C$             |                       |              | 300 $\mu A$<br>2 mA |
| $I_{GES}$     | $V_{CE} = 0V$ , $V_{GE} = \pm 20V$                                    |                       |              | $\pm 100$ nA        |
| $V_{CE(sat)}$ | $I_C = 44A$ , $V_{GE} = 15V$ , Note 1<br>$T_J = 125^\circ C$          |                       | 1.49<br>1.47 | 1.80 V<br>V         |

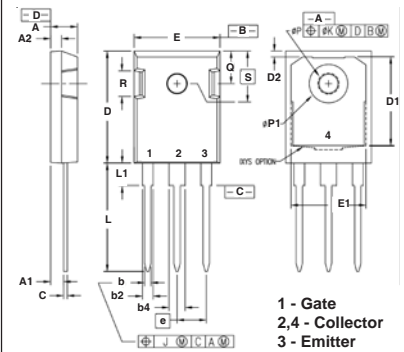
### Symbol Test Conditions

( $T_J = 25^\circ\text{C}$  Unless Otherwise Specified)

### Characteristic Values

|              |   | Min. | Typ. | Max.  |                    |
|--------------|---|------|------|-------|--------------------|
| $g_{fs}$     | $I_C = 44\text{A}, V_{CE} = 10\text{V}, \text{Note 1}$  | 36   | 60   |       | S                  |
| $C_{ies}$    | $V_{CE} = 25\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$  |      | 3950 |       | pF                 |
| $C_{oes}$    |   |      | 220  |       | pF                 |
| $C_{res}$    |   |      | 56   |       | pF                 |
| $Q_{g(on)}$  | $I_C = 40\text{A}, V_{GE} = 15\text{V}, V_{CE} = 0.5 \cdot V_{CES}$   |      | 138  |       | nC                 |
| $Q_{ge}$     |   |      | 25   |       | nC                 |
| $Q_{gc}$     |   |      | 47   |       | nC                 |
| $t_{d(on)}$  | <b>Inductive Load, <math>T_J = 25^\circ\text{C}</math></b><br>$I_C = 44\text{A}, V_{GE} = 15\text{V}$<br>$V_{CE} = 480\text{V}, R_G = 5\Omega$<br>Note 2  |      | 26   |       | ns                 |
| $t_{ri}$     |   |      | 41   |       | ns                 |
| $E_{on}$     |   |      | 1.30 |       | mJ                 |
| $t_{d(off)}$ |   |      | 155  | 335   | ns                 |
| $t_{fi}$     |   |      | 95   | 165   | ns                 |
| $E_{off}$    |   |      | 1.05 | 2.0   | mJ                 |
| $t_{d(on)}$  | <b>Inductive Load, <math>T_J = 125^\circ\text{C}</math></b><br>$I_C = 44\text{A}, V_{GE} = 15\text{V}$<br>$V_{CE} = 480\text{V}, R_G = 5\Omega$<br>Note 2 |      | 26   |       | ns                 |
| $t_{ri}$     |   |      | 37   |       | ns                 |
| $E_{on}$     |   |      | 2.34 |       | mJ                 |
| $t_{d(off)}$ |   |      | 220  |       | ns                 |
| $t_{fi}$     |   |      | 165  |       | ns                 |
| $E_{off}$    |   |      | 2.20 |       | mJ                 |
| $R_{thJC}$   |   |      |      | 0.375 | $^\circ\text{C/W}$ |
| $R_{thCS}$   |   | 0.21 |      |       | $^\circ\text{C/W}$ |

### TO-247 (IXGH) Outline



| Dim. | Millimeter |       | Inches    |       |
|------|------------|-------|-----------|-------|
|      | min        | max   | min       | max   |
| A    | 4.70       | 5.30  | 0.185     | 0.209 |
| A1   | 2.21       | 2.59  | 0.087     | 0.102 |
| A2   | 1.50       | 2.49  | 0.059     | 0.098 |
| b    | 0.99       | 1.40  | 0.039     | 0.055 |
| b2   | 1.65       | 2.39  | 0.065     | 0.094 |
| b4   | 2.59       | 3.43  | 0.102     | 0.135 |
| c    | 0.38       | 0.89  | 0.015     | 0.035 |
| D    | 20.79      | 21.45 | 0.819     | 0.845 |
| D1   | 13.07      | -     | 0.515     | -     |
| D2   | 0.51       | 1.35  | 0.020     | 0.053 |
| E    | 15.48      | 16.24 | 0.610     | 0.640 |
| E1   | 13.45      | -     | 0.53      | -     |
| E2   | 4.31       | 5.48  | 0.170     | 0.216 |
| e    | 5.45 BSC   |       | 0.215 BSC |       |
| L    | 19.80      | 20.30 | 0.078     | 0.800 |
| L1   | -          | 4.49  | -         | 0.177 |
| Ø P  | 3.55       | 3.65  | 0.140     | 0.144 |
| Ø P1 | -          | 7.39  | -         | 0.290 |
| Q    | 5.38       | 6.19  | 0.212     | 0.244 |
| S    | 6.14 BSC   |       | 0.242 BSC |       |

### Reverse Diode (FRED)

### Symbol Test Conditions

( $T_J = 25^\circ\text{C}$  Unless Otherwise Specified)

### Characteristic Values

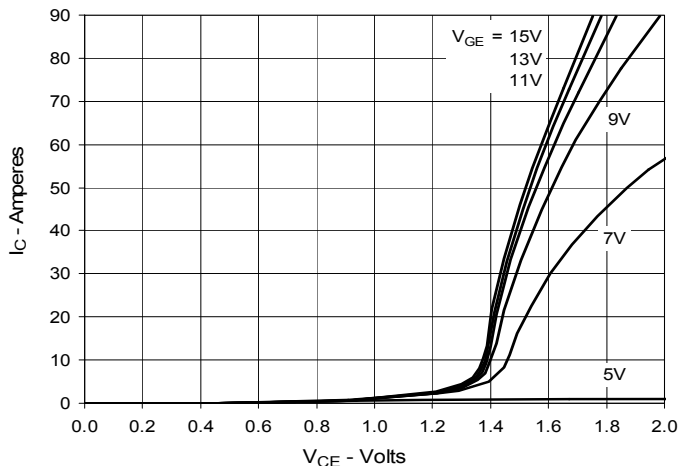
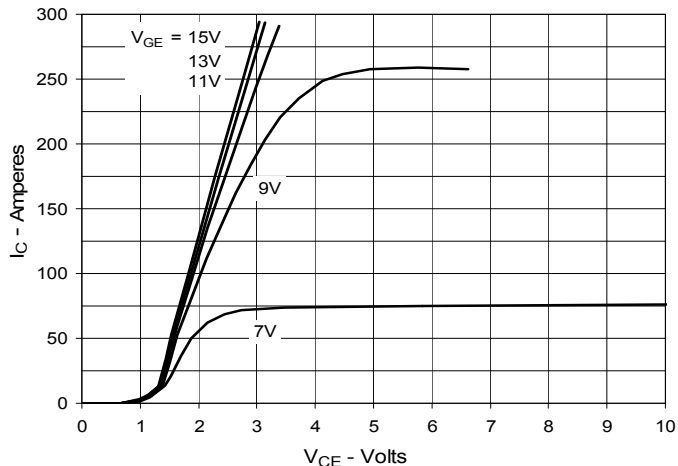
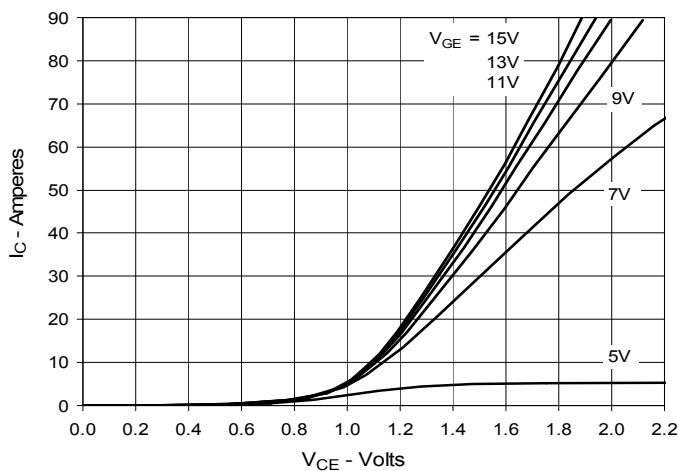
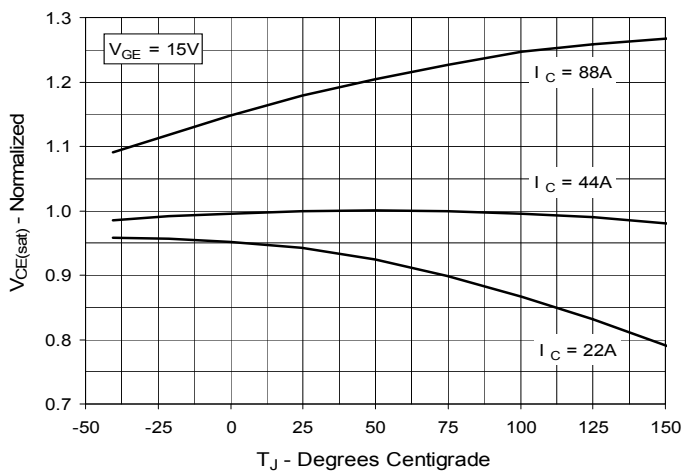
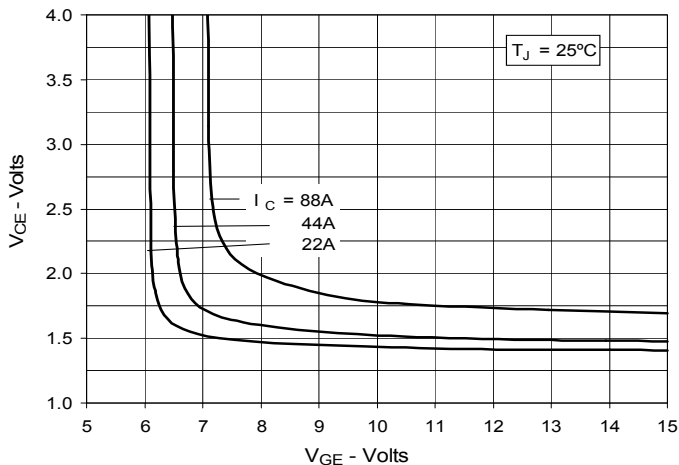
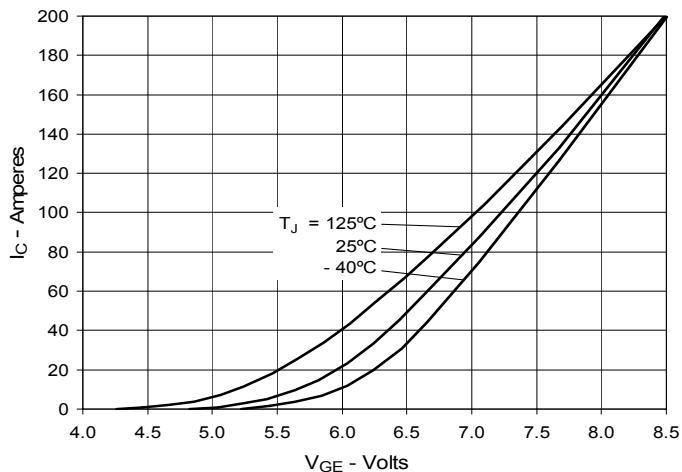
|            |   | Min. | Typ. | Max. |                    |
|------------|---|------|------|------|--------------------|
| $V_F$      | $I_F = 30\text{A}, V_{GE} = 0\text{V}, \text{Note 1}$   |      |      | 2.7  | V                  |
|            |   |      |      |      | V                  |
| $I_{RM}$   | $I_F = 30\text{A}, V_{GE} = 0\text{V}, -di_F/dt = 100\text{A}/\mu\text{s}, T_J = 100^\circ\text{C}$ |      | 1.6  | 4    | A                  |
| $t_{rr}$   | $V_R = 100\text{V}, T_J = 100^\circ\text{C}$  |      | 100  |      | ns                 |
|            | $I_F = 1\text{A}, V_{GE} = 0\text{V}, -di_F/dt = 100\text{A}/\mu\text{s}, V_R = 30\text{V}$         |      | 25   |      | ns                 |
| $R_{thJC}$ |   |      |      | 0.9  | $^\circ\text{C/W}$ |

### Notes:

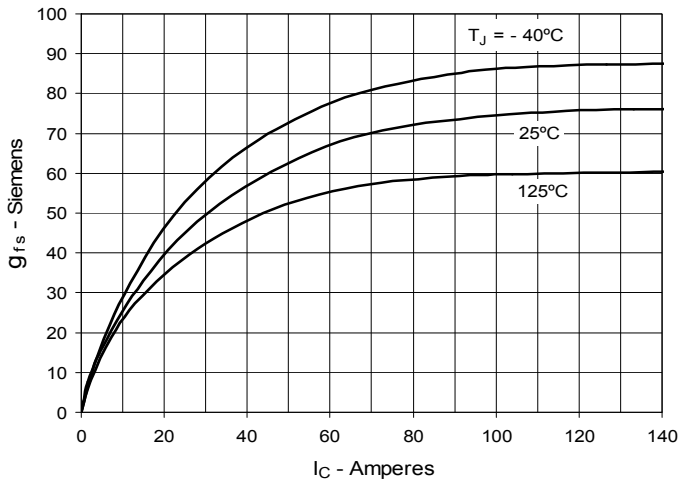
1. Pulse test,  $t \leq 300\mu\text{s}$ , duty cycle,  $d \leq 2\%$ .
2. Switching times & energy losses may increase for higher  $V_{CE}$  (clamp),  $T_J$  or  $R_G$ .

IXYS Reserves the Right to Change Limits, Test Conditions and Dimensions.

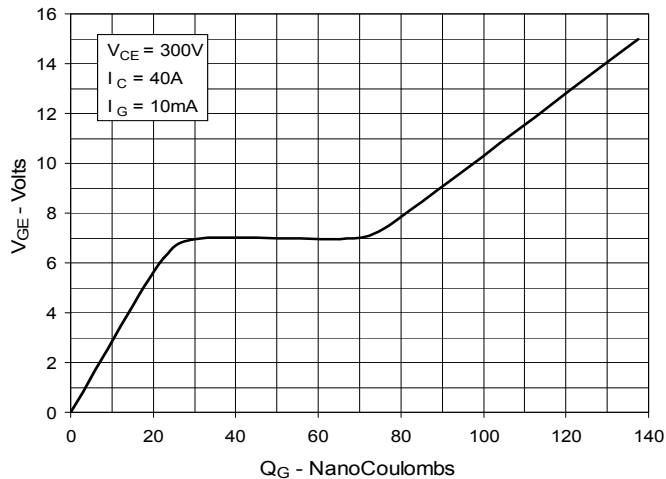
|  |           |           |           |           |              |              |              |              |              |             |
|--|-----------|-----------|-----------|-----------|--------------|--------------|--------------|--------------|--------------|-------------|
| IXYS MOSFETs and IGBTs are covered by one or more of the following U.S. patents: | 4,835,592 | 4,931,844 | 5,049,961 | 5,237,481 | 6,162,665    | 6,404,065 B1 | 6,683,344    | 6,727,585    | 7,005,734 B2 | 7,157,338B2 |
|  | 4,860,072 | 5,017,508 | 5,063,307 | 5,381,025 | 6,259,123 B1 | 6,534,343    | 6,710,405 B2 | 6,759,692    | 7,063,975 B2 |             |
|  | 4,881,106 | 5,034,796 | 5,187,117 | 5,486,715 | 6,306,728 B1 | 6,583,505    | 6,710,463    | 6,771,478 B2 | 7,071,537    |             |

**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  
Junction Temperature**

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

**Fig. 6. Input Admittance**


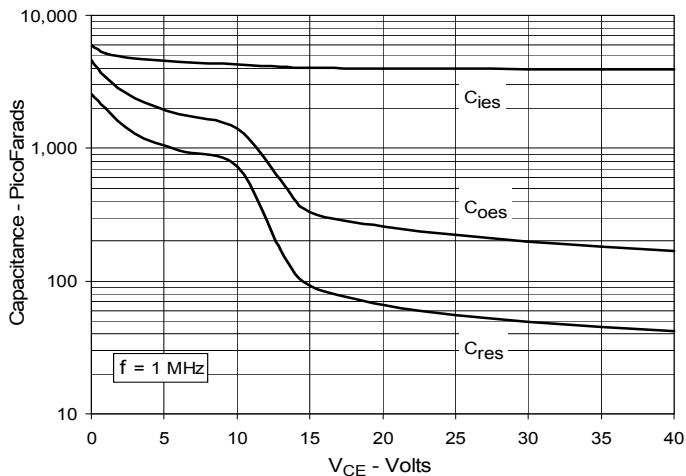
**Fig. 7. Transconductance**



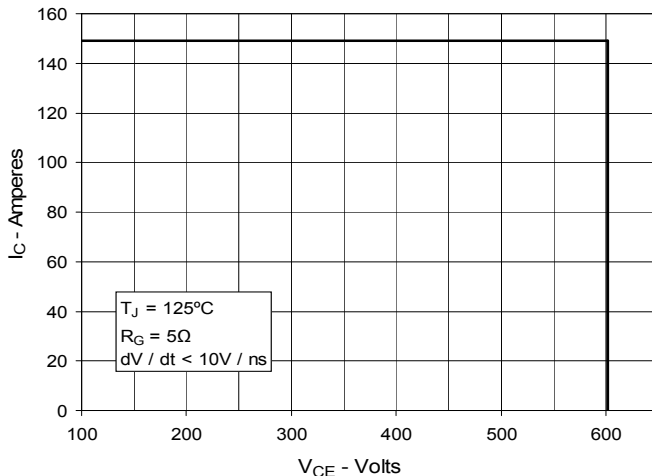
**Fig. 8. Gate Charge**



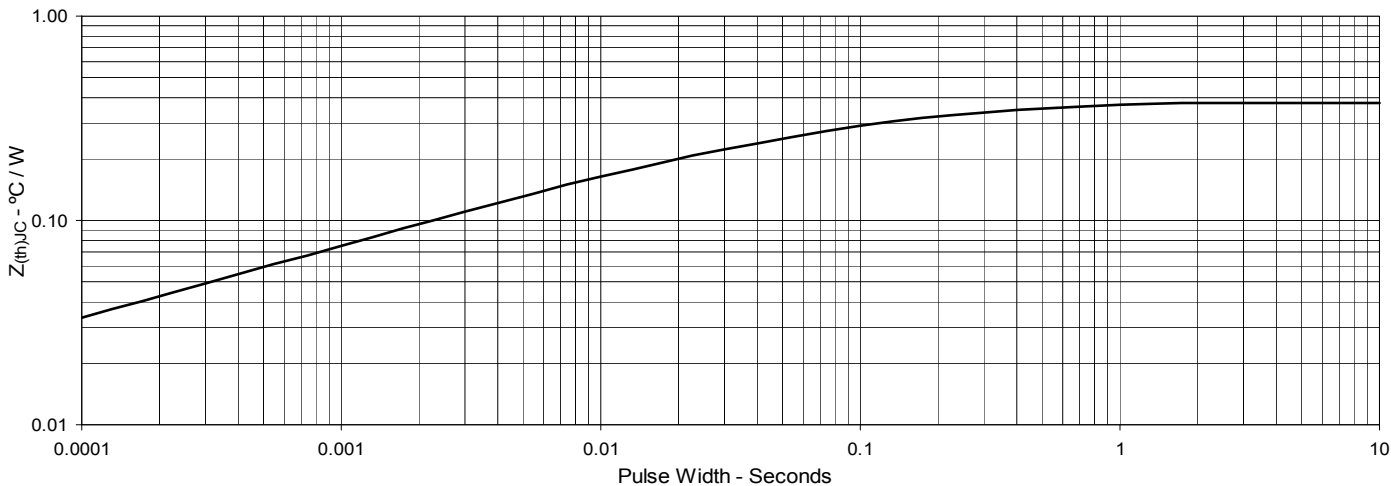
**Fig. 9. Capacitance**

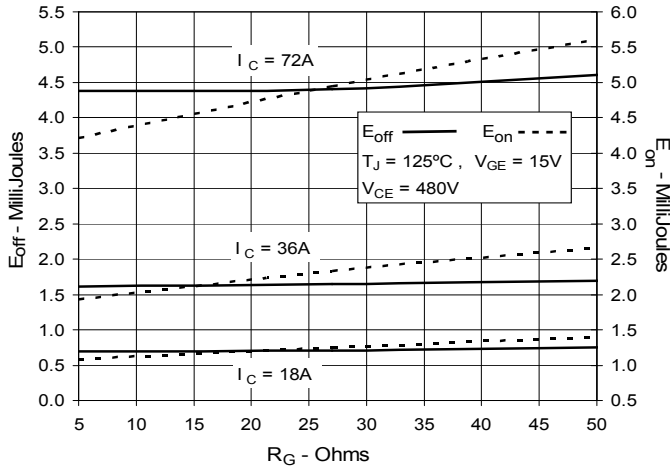
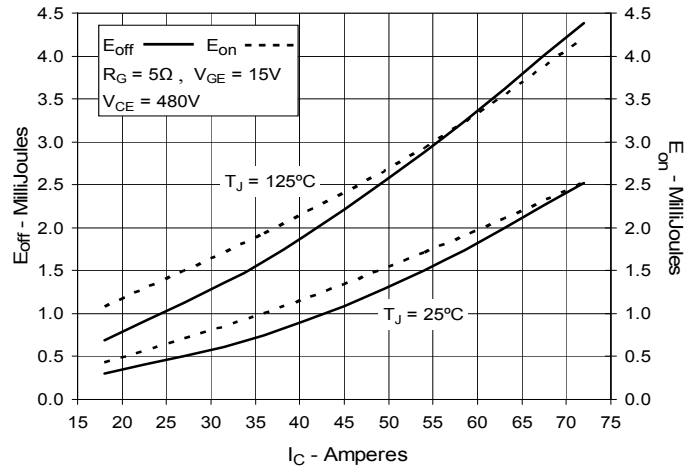
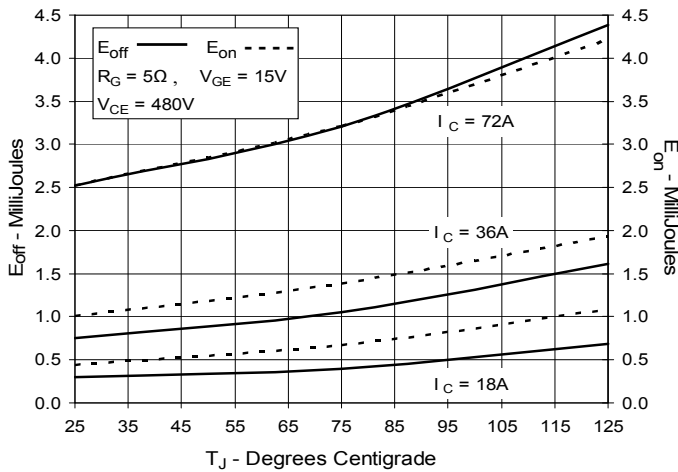
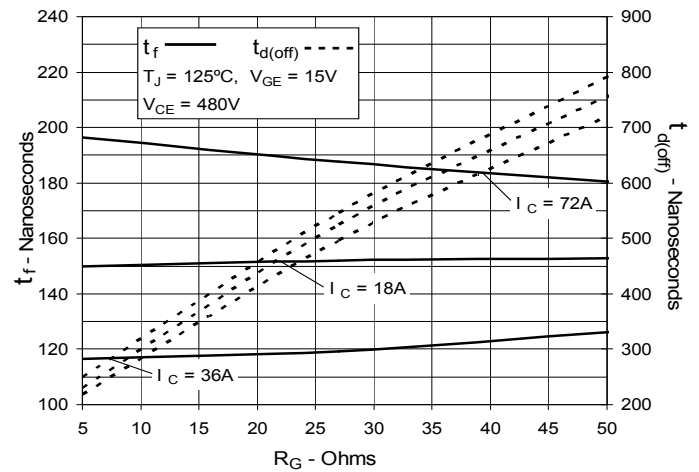
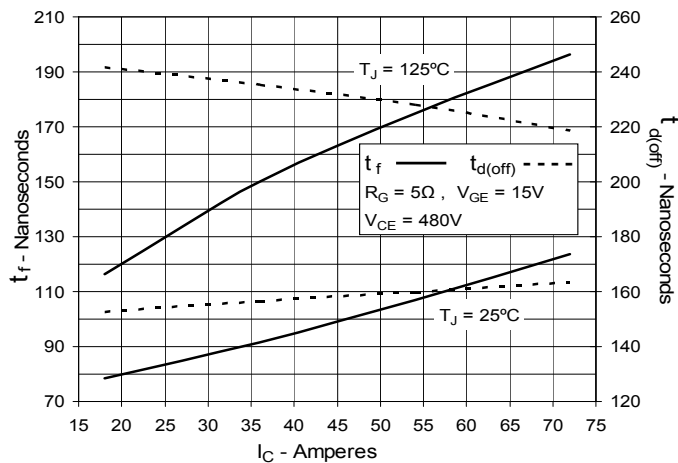
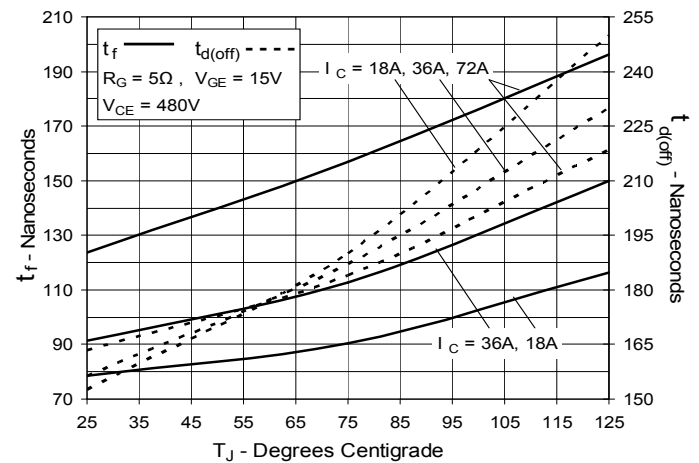


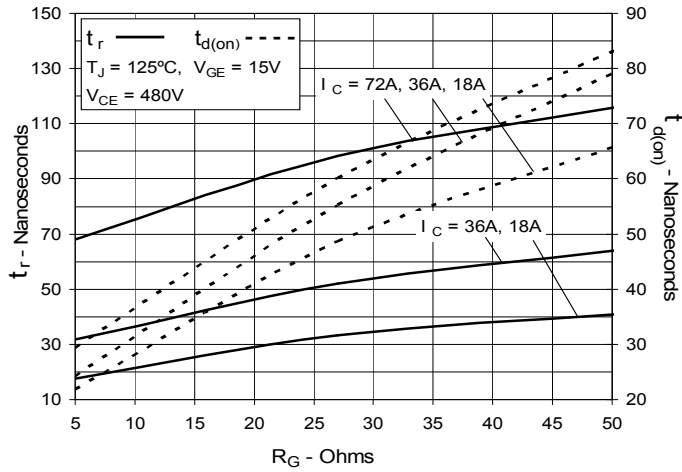
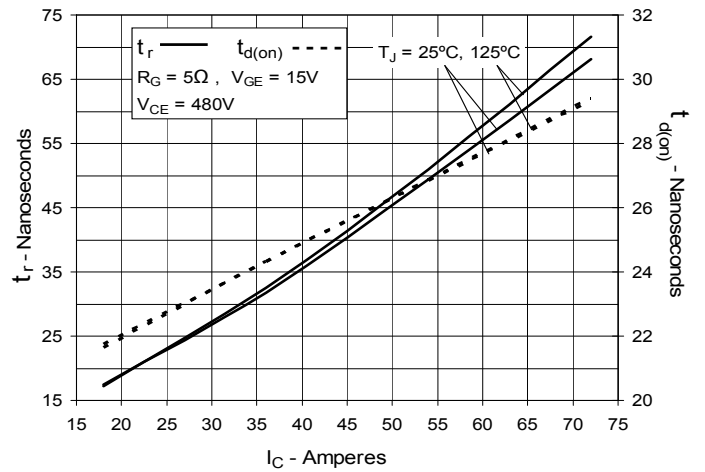
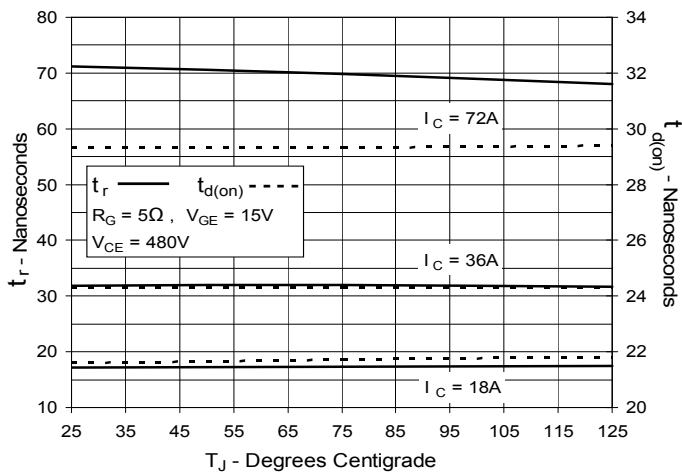
**Fig. 10. Reverse-Bias Safe Operating Area**



**Fig. 11. Maximum Transient Thermal Impedance**



**Fig. 12. Inductive Switching Energy Loss vs. Gate Resistance**

**Fig. 13. Inductive Switching Energy Loss vs. Collector Current**

**Fig. 14. Inductive Switching Energy Loss vs. Junction Temperature**

**Fig. 15. Inductive Turn-off Switching Times vs. Gate Resistance**

**Fig. 16. Inductive Turn-off Switching Times vs. Collector Current**

**Fig. 17. Inductive Turn-off Switching Times vs. Junction Temperature**


**Fig. 18. Inductive Turn-on Switching Times vs. Gate Resistance**

**Fig. 19. Inductive Turn-on Switching Times vs. Collector Current**

**Fig. 20. Inductive Turn-on Switching Times vs. Junction Temperature**


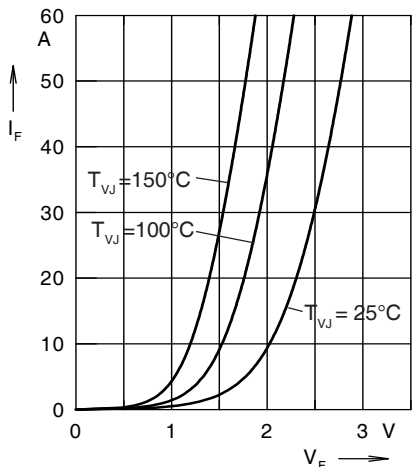


Fig. 21. Forward Current  $I_F$  Versus  $V_F$

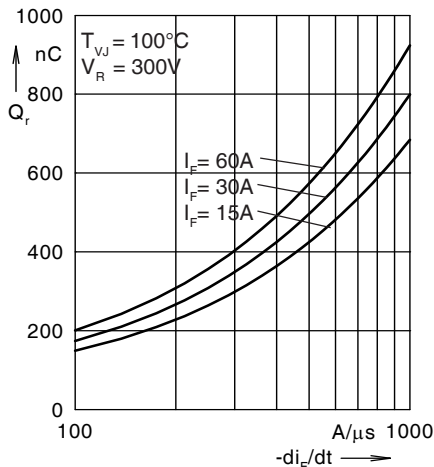


Fig. 22. Reverse Recovery Charge  $Q_r$  Versus  $-di_F/dt$

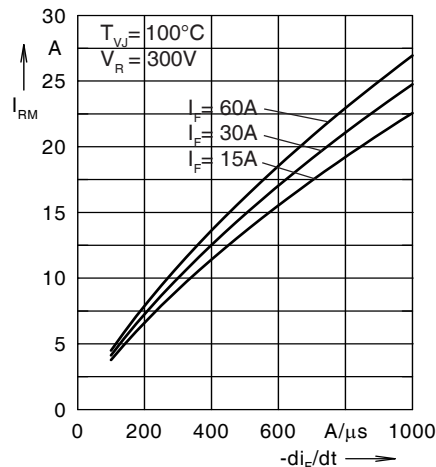


Fig. 23. Peak Reverse Current  $I_{RM}$  Versus  $-di_F/dt$

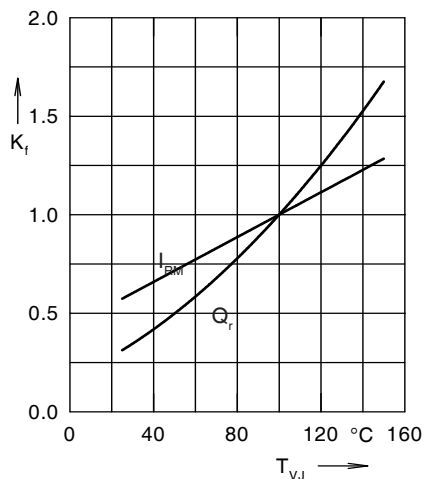


Fig. 24. Dynamic Parameters  $Q_r$ ,  $I_{RM}$  Versus  $T_{VJ}$

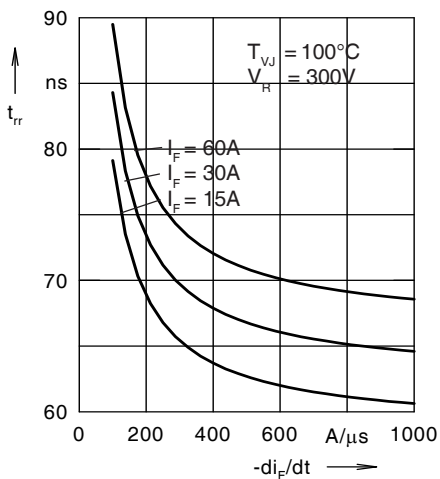


Fig. 25. Recovery Time  $t_{rr}$  Versus  $-di_F/dt$

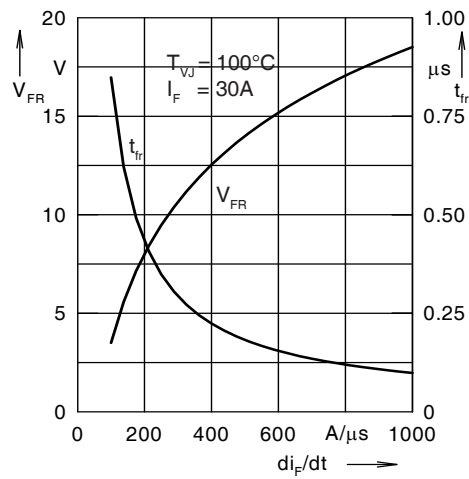


Fig. 26. Peak Forward Voltage  $V_{FR}$  and  $t_{rr}$  Versus  $di_F/dt$

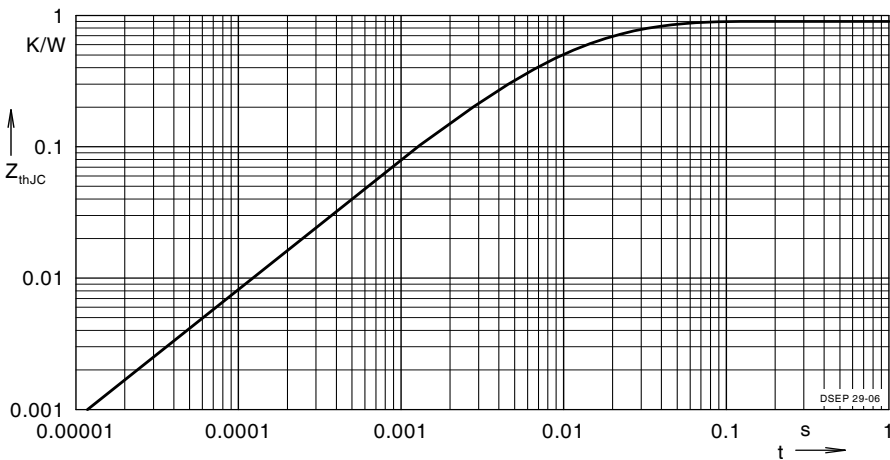


Fig. 27. Transient Thermal Resistance Junction to Case

Constants for  $Z_{thJC}$  calculation:

| i | $R_{thi}$ (K/W) | $t_i$ (s) |
|---|-----------------|-----------|
| 1 | 0.502           | 0.0052    |
| 2 | 0.193           | 0.0003    |
| 3 | 0.205           | 0.0162    |