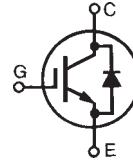


## HiPerFAST™ IGBT with Diode B2-Class High Speed IGBTs

**IXGK 50N60B2D1**  
**IXGX 50N60B2D1**

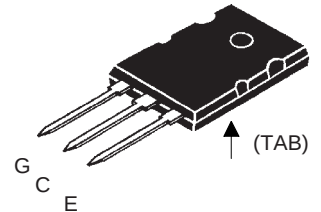
$V_{CES} = 600 \text{ V}$   
 $I_{C25} = 75 \text{ A}$   
 $V_{CE(sat)} = 2.0 \text{ V}$   
 $t_{fi(typ)} = 65 \text{ ns}$



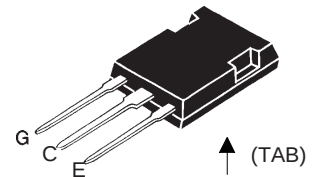
| Symbol                                                                          | Test Conditions                                                                                                              | Maximum Ratings   |                  |
|---------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|-------------------|------------------|
| $V_{CES}$                                                                       | $T_J = 25^\circ\text{C to } 150^\circ\text{C}$                                                                               | 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                |
| $I_{C25}$                                                                       | $T_C = 25^\circ\text{C}$ (limited by leads)                                                                                  | 75                | A                |
| $I_{C110}$                                                                      | $T_C = 110^\circ\text{C}$                                                                                                    | 50                | A                |
| $I_{F110}$                                                                      | $T_C = 110^\circ\text{C}$ (50N60B2D1 Diode)                                                                                  | 38                | A                |
| $I_{CM}$                                                                        | $T_C = 25^\circ\text{C}, 1 \text{ ms}$                                                                                       | 200               | A                |
| <b>SSOA</b><br><b>(RBSOA)</b>                                                   | $V_{GE} = 15 \text{ V}, T_{VJ} = 125^\circ\text{C}, R_G = 10 \Omega$<br>Clamped inductive load @ $V_{CE} \leq 600 \text{ V}$ | $I_{CM} = 80$     | A                |
| $P_c$                                                                           | $T_C = 25^\circ\text{C}$                                                                                                     | 400               | W                |
| $T_J$                                                                           |                                                                                                                              | -55 ... +150      | $^\circ\text{C}$ |
| $T_{JM}$                                                                        |                                                                                                                              | 150               | $^\circ\text{C}$ |
| $T_{stg}$                                                                       |                                                                                                                              | -55 ... +150      | $^\circ\text{C}$ |
| $M_d$                                                                           | Mounting torque, TO-264                                                                                                      | 1.13/10 Nm/lb.in. |                  |
| <b>Weight</b>                                                                   | TO-264                                                                                                                       | 10                | g                |
|                                                                                 | PLUS247                                                                                                                      | 6                 | g                |
| Maximum lead temperature for soldering<br>1.6 mm (0.062 in.) from case for 10 s |                                                                                                                              | 300               | $^\circ\text{C}$ |

| Symbol        | Test Conditions                                   | Characteristic Values<br>( $T_J = 25^\circ\text{C}$ , unless otherwise specified) |      |                      |
|---------------|---------------------------------------------------|-----------------------------------------------------------------------------------|------|----------------------|
|               |                                                   | Min.                                                                              | Typ. | Max.                 |
| $V_{GE(th)}$  | $I_C = 250 \mu\text{A}, V_{CE} = V_{GE}$          | 3.0                                                                               |      | 5.0 V                |
| $I_{CES}$     | $V_{CE} = V_{CES}$                                |                                                                                   |      | 600 $\mu\text{A}$    |
|               | $V_{GE} = 0 \text{ V}$                            |                                                                                   |      | 5 mA                 |
| $I_{GES}$     | $V_{CE} = 0 \text{ V}, V_{GE} = \pm 20 \text{ V}$ |                                                                                   |      | $\pm 100 \text{ nA}$ |
| $V_{CE(sat)}$ | $I_C = 40 \text{ A}, V_{GE} = 15 \text{ V}$       | 1.6                                                                               | 2.0  | V                    |
|               | Note 1                                            | 1.5                                                                               |      | V                    |

**TO-264  
(IXGK)**



**PLUS247  
(IXGX)**



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

### Features

- High frequency IGBT and anti-parallel FRED in one package
- High current handling capability
- MOS Gate turn-on for drive simplicity
- Fast Recovery Epitaxial Diode (FRED) with soft recovery and low  $I_{RM}$

### Applications

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

### Advantages

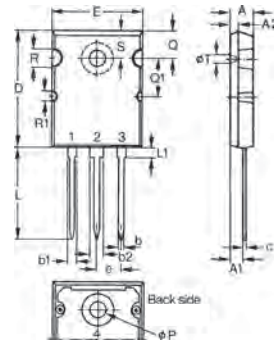
- Space savings (two devices in one package)
- Easy to mount with 1 screw

| Symbol       | Test Conditions                                                                                                                                                        | Characteristic Values<br>( $T_J = 25^\circ\text{C}$ , unless otherwise specified) |      |          |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------|----------|
|              |                                                                                                                                                                        | Min.                                                                              | Typ. | Max.     |
| $g_{fs}$     | $I_C = 40\text{ A}$ ; $V_{CE} = 10\text{ V}$ ,<br>Note 1                                                                                                               | 40                                                                                | 55   | S        |
| $C_{ies}$    | $V_{CE} = 25\text{ V}$ , $V_{GE} = 0\text{ V}$ , $f = 1\text{ MHz}$                                                                                                    |                                                                                   | 3500 | pF       |
| $C_{oes}$    |                                                                                                                                                                        |                                                                                   | 220  | pF       |
| $C_{res}$    |                                                                                                                                                                        |                                                                                   | 50   | pF       |
| $Q_g$        | $I_C = 40\text{ A}$ , $V_{GE} = 15\text{ V}$ , $V_{CE} = 0.5 V_{CES}$                                                                                                  |                                                                                   | 140  | nC       |
| $Q_{ge}$     |                                                                                                                                                                        |                                                                                   | 23   | nC       |
| $Q_{gc}$     |                                                                                                                                                                        |                                                                                   | 44   | nC       |
| $t_{d(on)}$  | <b>Inductive load, <math>T_J = 25^\circ\text{C}</math></b><br>$I_C = 40\text{ A}$ , $V_{GE} = 15\text{ V}$<br>$V_{CE} = 480\text{ V}$ , $R_G = R_{off} = 5.0\ \Omega$  |                                                                                   | 18   | ns       |
| $t_{ri}$     |                                                                                                                                                                        |                                                                                   | 25   | ns       |
| $t_{d(off)}$ |                                                                                                                                                                        |                                                                                   | 190  | 300 ns   |
| $t_{fi}$     |                                                                                                                                                                        |                                                                                   | 65   | ns       |
| $E_{off}$    |                                                                                                                                                                        |                                                                                   | 0.55 | 0.85 mJ  |
| $t_{d(on)}$  | <b>Inductive load, <math>T_J = 125^\circ\text{C}</math></b><br>$I_C = 40\text{ A}$ , $V_{GE} = 15\text{ V}$<br>$V_{CE} = 480\text{ V}$ , $R_G = R_{off} = 5.0\ \Omega$ |                                                                                   | 18   | ns       |
| $t_{ri}$     |                                                                                                                                                                        |                                                                                   | 25   | ns       |
| $E_{on}$     |                                                                                                                                                                        |                                                                                   | 0.9  | mJ       |
| $t_{d(off)}$ |                                                                                                                                                                        |                                                                                   | 290  | ns       |
| $t_{fi}$     |                                                                                                                                                                        |                                                                                   | 140  | ns       |
| $E_{off}$    |                                                                                                                                                                        |                                                                                   | 1.55 | mJ       |
| $R_{thJC}$   |                                                                                                                                                                        |                                                                                   |      | 0.31 K/W |
| $R_{thCK}$   |                                                                                                                                                                        |                                                                                   | 0.15 | K/W      |

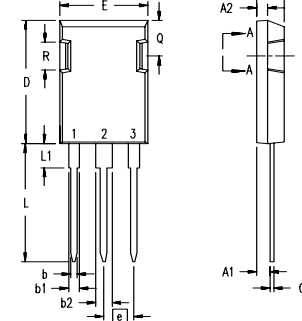
**Reverse Diode (FRED)**

| Symbol     | Test Conditions                                                                                                                         | Characteristic Values<br>( $T_J = 25^\circ\text{C}$ , unless otherwise specified) |      |          |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------|----------|
|            |                                                                                                                                         | min.                                                                              | typ. | max.     |
| $V_F$      | $I_F = 60\text{ A}$ , $V_{GE} = 0\text{ V}$ ,<br>Note 1<br>$T_J = 150^\circ\text{C}$                                                    |                                                                                   |      | 2.1 V    |
| $I_{RM}$   | $I_F = 60\text{ A}$ , $V_{GE} = 0\text{ V}$ , $-di_F/dt = 100\text{ A}/\mu\text{s}$ , $T_J = 100^\circ\text{C}$<br>$V_R = 100\text{ V}$ |                                                                                   |      | 8.3 A    |
| $t_{rr}$   | $I_F = 1\text{ A}$ ; $-di/dt = 200\text{ A/ms}$ ; $V_R = 30\text{ V}$                                                                   |                                                                                   | 35   | ns       |
| $R_{thJC}$ |                                                                                                                                         |                                                                                   |      | 0.65 K/W |

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

**TO-264 Outline**


| Dim. | Millimeter |       | Inches   |       |
|------|------------|-------|----------|-------|
|      | Min.       | Max.  | 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 Outline**


Terminals:  
 1 - Gate  
 2 - Drain (Collector)  
 3 - Source (Emitter)  
 4 - Drain (Collector)

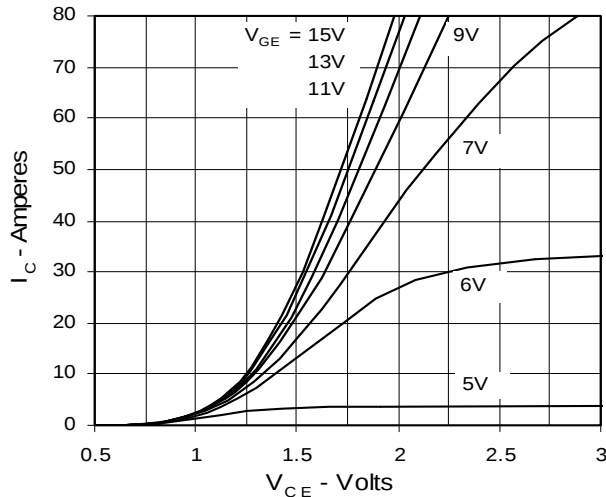
| Dim. | Millimeter |       | Inches   |       |
|------|------------|-------|----------|-------|
|      | Min.       | Max.  | Min.     | Max.  |
| A    | 4.83       | 5.21  | .190     | .205  |
| A1   | 2.29       | 2.54  | .090     | .100  |
| A2   | 1.91       | 2.16  | .075     | .085  |
| b    | 1.14       | 1.40  | .045     | .055  |
| b1   | 1.91       | 2.13  | .075     | .084  |
| b2   | 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     | 0.244 |
| R    | 4.32       | 4.83  | .170     | .190  |

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

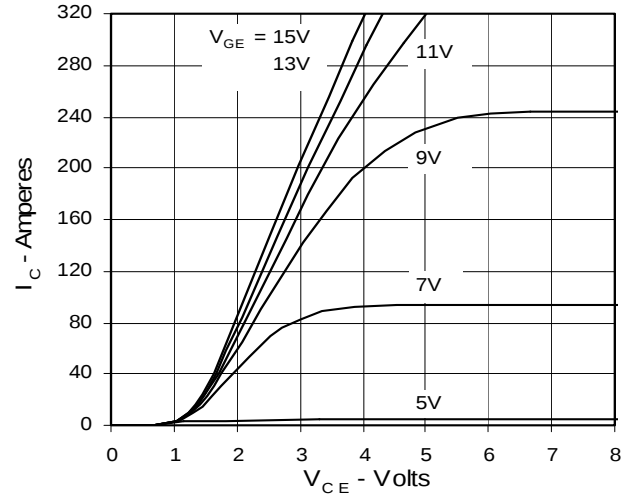
IXYS MOSFETs and IGBTs are covered by one or more of the following U.S. patents:

|           |           |           |           |           |           |             |             |             |           |
|-----------|-----------|-----------|-----------|-----------|-----------|-------------|-------------|-------------|-----------|
| 4,850,072 | 4,931,844 | 5,034,796 | 5,063,307 | 5,237,481 | 5,381,025 | 6,404,065B1 | 6,162,665   | 6,534,343   | 6,583,505 |
| 4,835,592 | 4,881,106 | 5,017,508 | 5,049,961 | 5,187,117 | 5,486,715 | 6,306,728B1 | 6,259,123B1 | 6,306,728B1 | 6,683,344 |

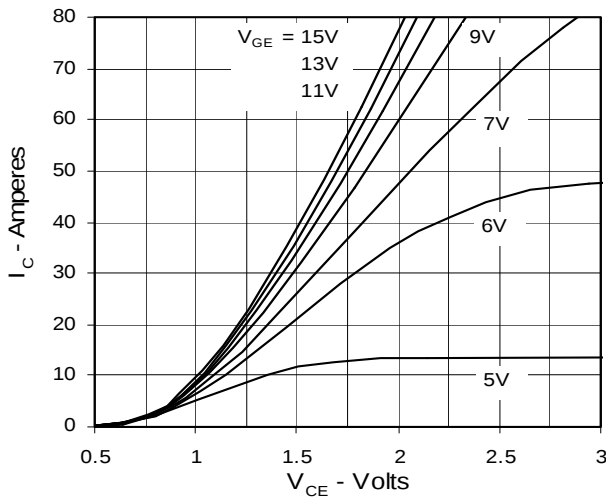
**Fig. 1. Output Characteristics  
@ 25 Deg. C**



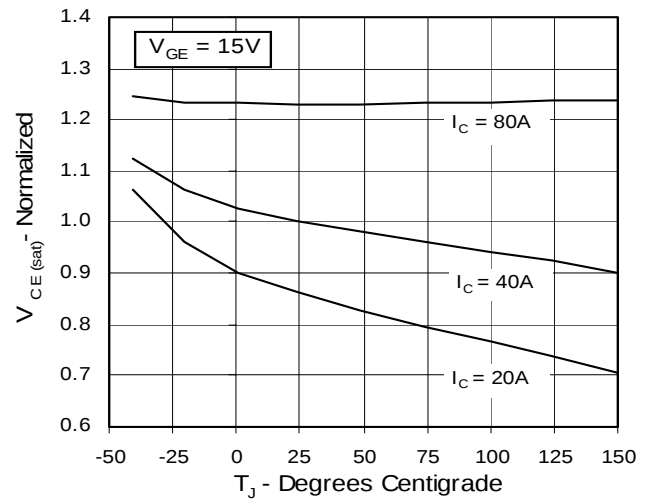
**Fig. 2. Extended Output Characteristics  
@ 25 deg. C**



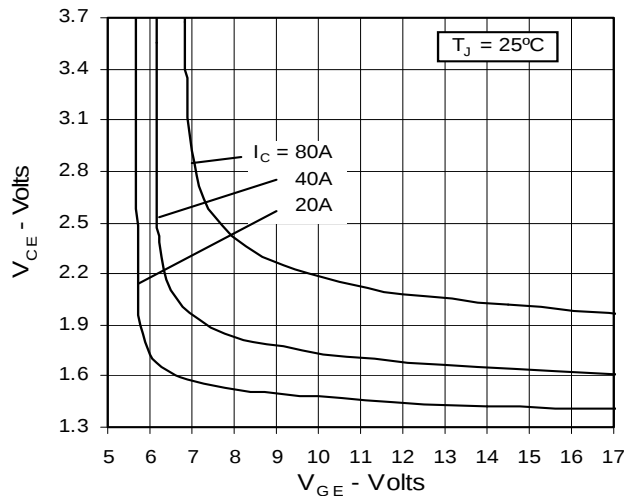
**Fig. 3. Output Characteristics  
@ 125 Deg. C**



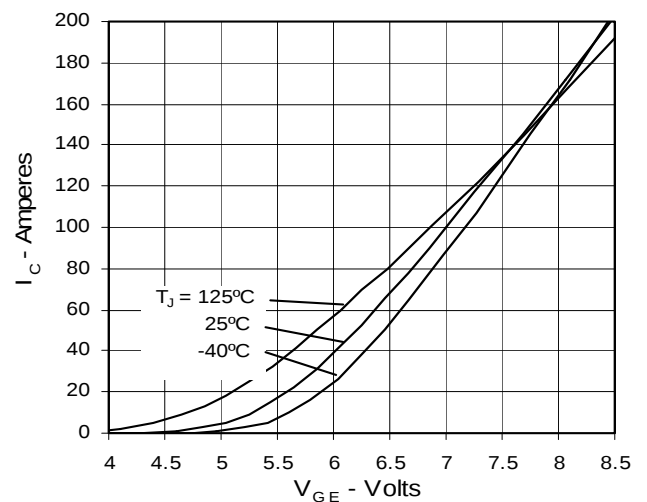
**Fig. 4. Dependence of  $V_{CE(sat)}$  on  
Temperature**

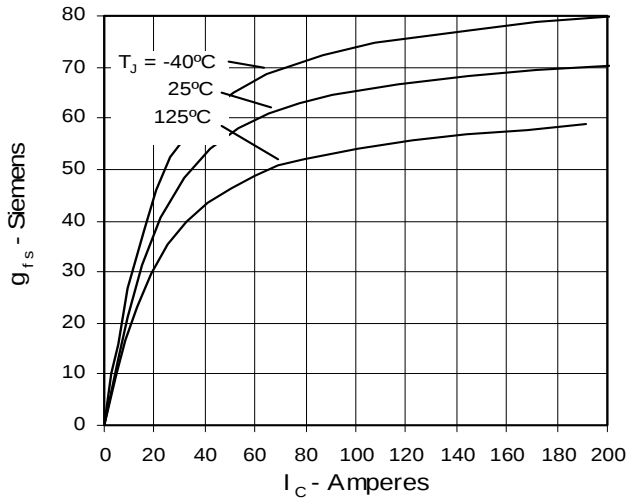
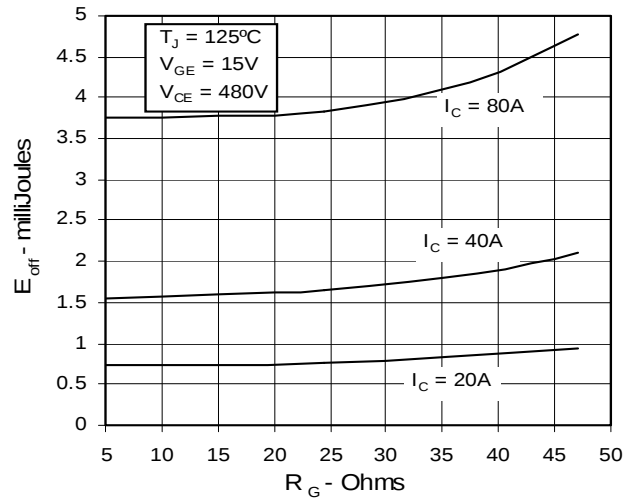
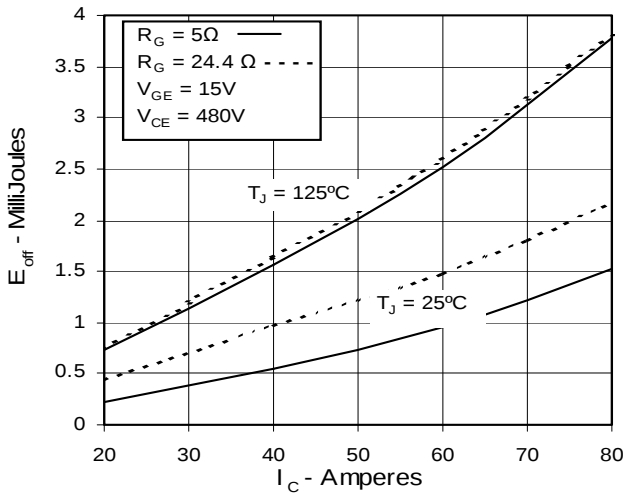
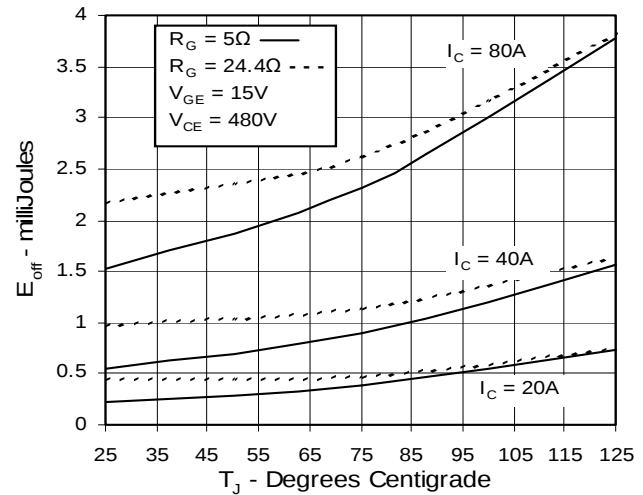
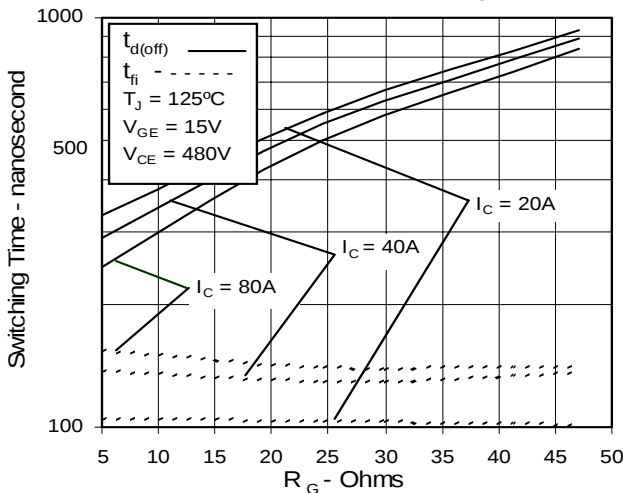
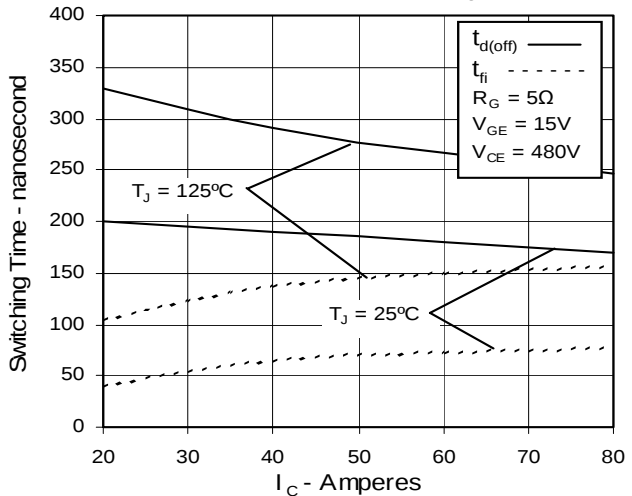


**Fig. 5. Collector-to-Emitter Voltage  
vs. Gate-to-Emitter voltage**



**Fig. 6. Input Admittance**



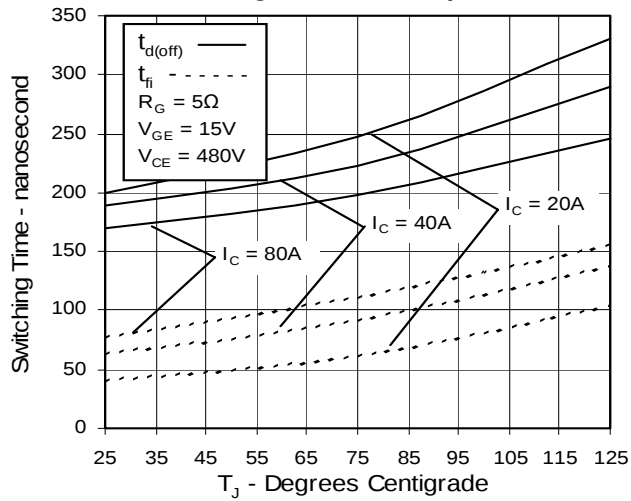
**Fig. 7. Transconductance**

**Fig. 8. Dependence of Turn-Off Energy on  $R_G$** 

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

**Fig. 10. Dependence of Turn-Off Energy on Temperature**

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

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


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

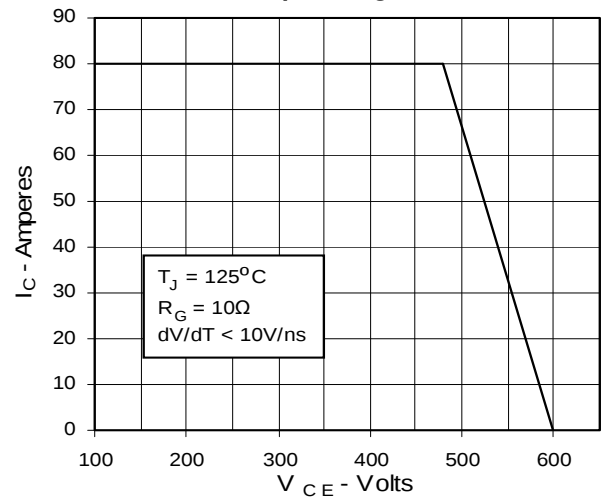
IXYS MOSFETs and IGBTs are covered by one or more of the following U.S. patents:

|           |           |           |           |           |           |             |             |             |           |
|-----------|-----------|-----------|-----------|-----------|-----------|-------------|-------------|-------------|-----------|
| 4,850,072 | 4,931,844 | 5,034,796 | 5,063,307 | 5,237,481 | 5,381,025 | 6,404,065B1 | 6,162,665   | 6,534,343   | 6,583,505 |
| 4,835,592 | 4,881,106 | 5,017,508 | 5,049,961 | 5,187,117 | 5,486,715 | 6,306,728B1 | 6,259,123B1 | 6,306,728B1 | 6,683,344 |

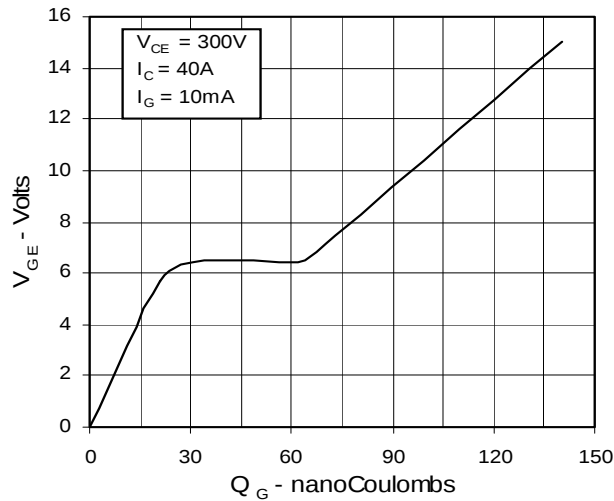
**Fig. 13. Dependence of Turn-Off Switching Time on Temperature**



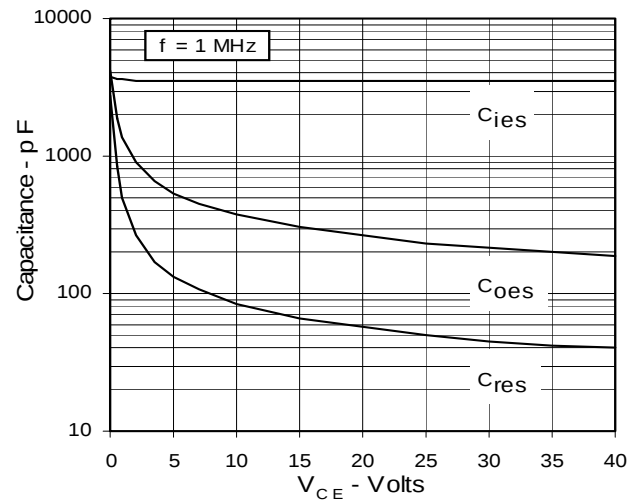
**Fig. 14. Reverse-Bias Safe Operating Area**



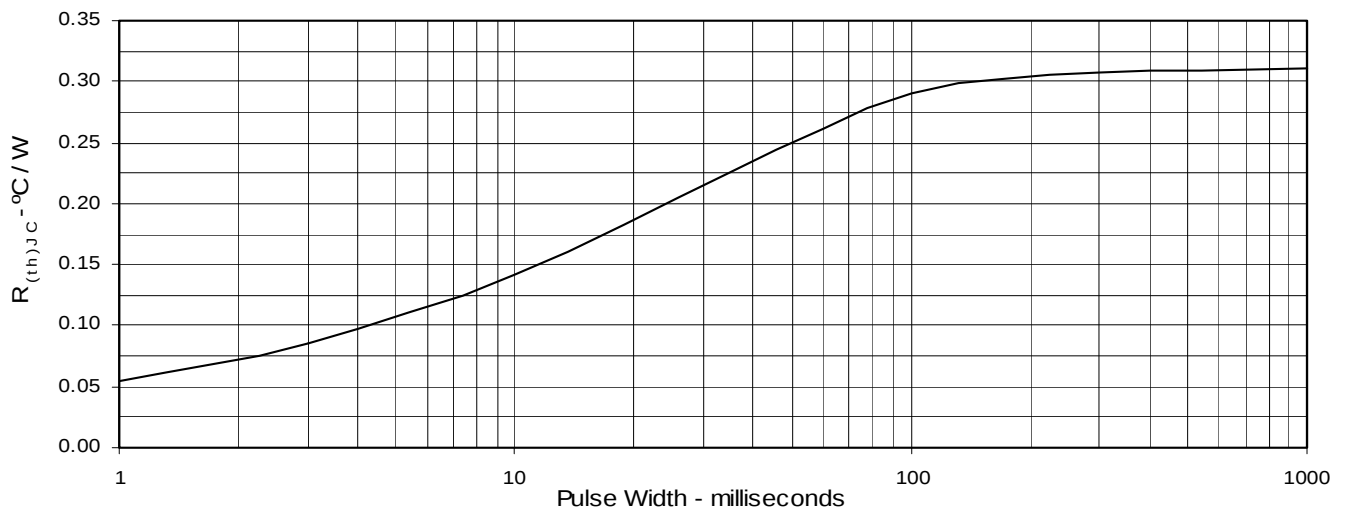
**Fig. 15. Gate Charge**



**Fig. 16. Capacitance**



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



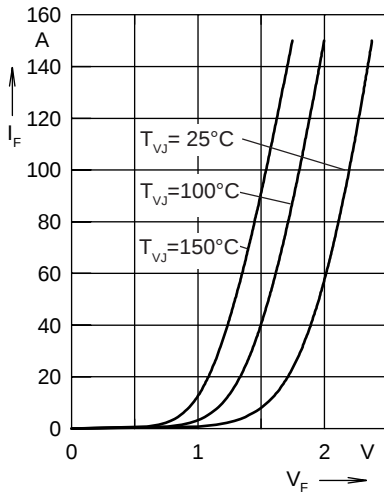


Fig. 18. Forward current  $I_F$  versus  $V_F$

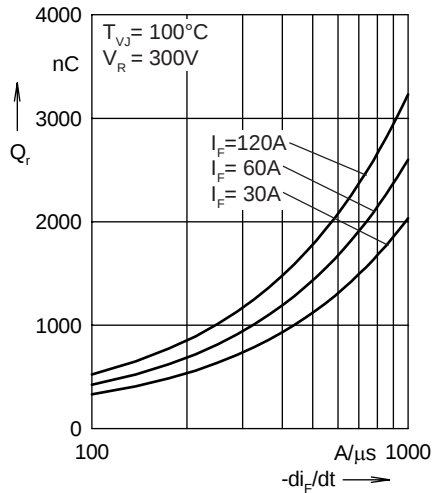


Fig. 19. Reverse recovery charge  $Q_r$  versus  $-di_F/dt$

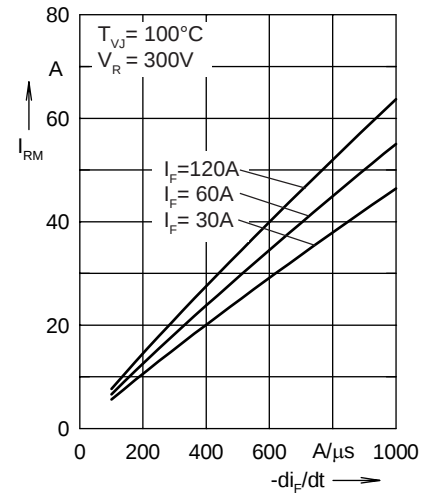


Fig. 20. Peak reverse current  $I_{RM}$  versus  $-di_F/dt$

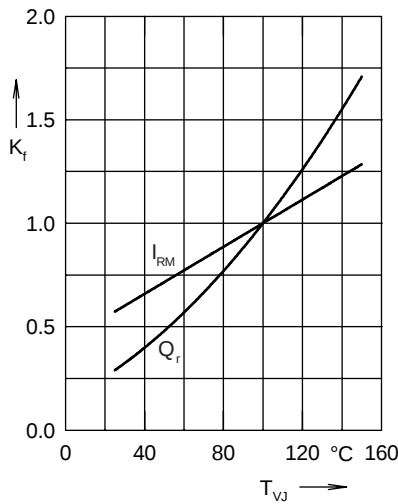


Fig. 21. Dynamic parameters  $Q_r$ ,  $I_{RM}$  versus  $T_{VJ}$

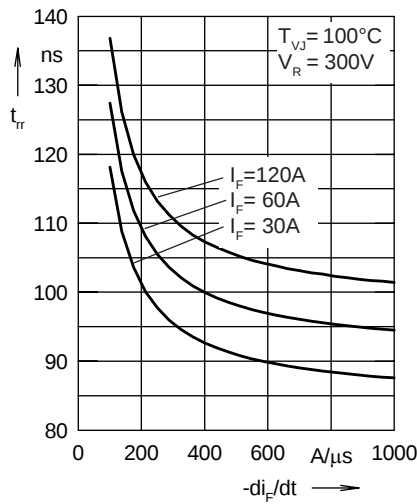


Fig. 22. Recovery time  $t_{rr}$  versus  $-di_F/dt$

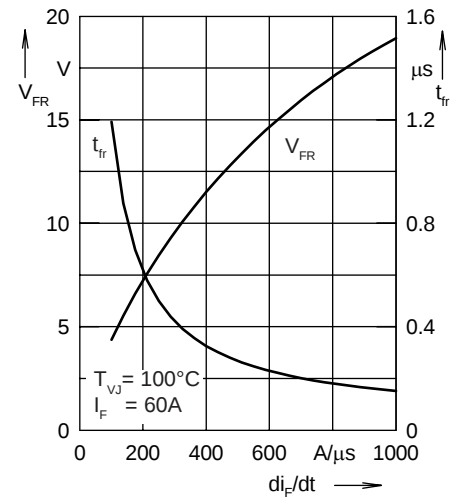


Fig. 23. Peak forward voltage  $V_{FR}$  and  $t_{fr}$  versus  $di_F/dt$

Constants for  $Z_{thJC}$  calculation:

| i | $R_{thi}$ (K/W) | $t_i$ (s) |
|---|-----------------|-----------|
| 1 | 0.324           | 0.0052    |
| 2 | 0.125           | 0.0003    |
| 3 | 0.201           | 0.0385    |

Note: Fig. 18 through Fig. 23 show typical values

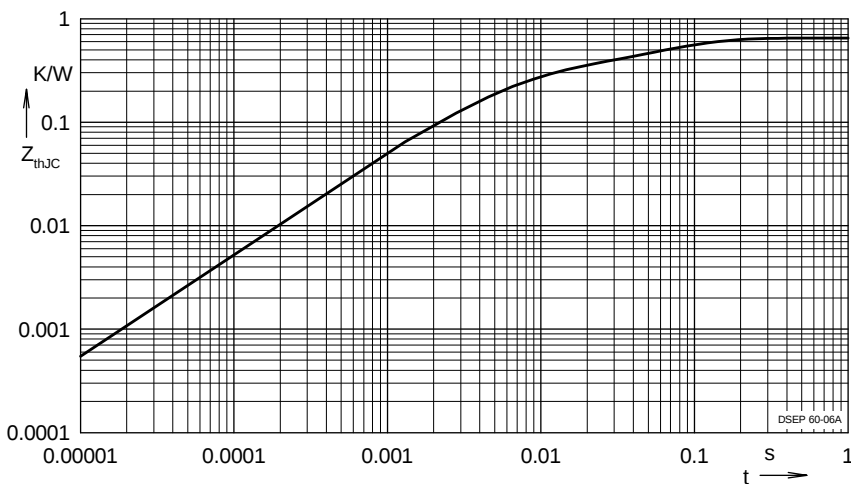


Fig. 24. Transient thermal resistance junction to case

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|           |           |           |           |           |           |             |             |             |           |
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| 4,835,592 | 4,881,106 | 5,017,508 | 5,049,961 | 5,187,117 | 5,486,715 | 6,306,728B1 | 6,259,123B1 | 6,306,728B1 | 6,683,344 |