

# XPT™ IGBT 600V GenX3™ w/ Diode

## IXXH50N60B3D1

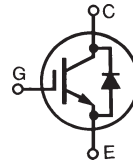
$$V_{CES} = 600V$$

$$I_{C110} = 50A$$

$$V_{CE(sat)} \leq 1.80V$$

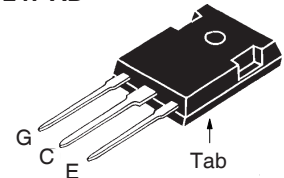
$$t_{fi(typ)} = 135ns$$

Extreme Light Punch Through  
IGBT for 5-30 kHz Switching



| Symbol                        | Test Conditions   | Maximum Ratings                           |            |
|-------------------------------|---|---|------------|
| $V_{CES}$                     | $T_J = 25^\circ C$ to $175^\circ C$   | 600                                       | V          |
| $V_{CGR}$                     | $T_J = 25^\circ C$ to $175^\circ C$ , $R_{GE} = 1M\Omega$                                   | 600                                       | V          |
| $V_{GES}$                     | Continuous  | $\pm 20$                                  | V          |
| $V_{GEM}$                     | Transient   | $\pm 30$                                  | V          |
| $I_{C25}$                     | $T_C = 25^\circ C$  | 120                                       | A          |
| $I_{C110}$                    | $T_C = 110^\circ C$   | 50  | A          |
| $I_{F110}$                    | $T_C = 110^\circ C$   | 30  | A          |
| $I_{CM}$                      | $T_C = 25^\circ C$ , 1ms  | 200                                       | A          |
| $I_A$                         | $T_C = 25^\circ C$  | 25  | A          |
| $E_{AS}$                      | $T_C = 25^\circ C$  | 200                                       | mJ         |
| <b>SSOA</b><br><b>(RBSOA)</b> | $V_{GE} = 15V$ , $T_{VJ} = 150^\circ C$ , $R_G = 5\Omega$<br>Clamped Inductive Load         | $I_{CM} = 100$<br>@ $V_{CE} \leq V_{CES}$ | A          |
| $t_{sc}$<br><b>(SCSOA)</b>    | $V_{GE} = 15V$ , $V_{CE} = 360V$ , $T_J = 150^\circ C$<br>$R_G = 22\Omega$ , Non Repetitive | 10  | $\mu s$    |
| $P_C$                         | $T_C = 25^\circ C$  | 600                                       | W          |
| $T_J$                         |   | -55 ... +175                              | $^\circ C$ |
| $T_{JM}$                      |   | 175                                       | $^\circ C$ |
| $T_{stg}$                     |   | -55 ... +175                              | $^\circ C$ |
| $T_L$                         | 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 AD



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

### Features

- Optimized for 5-30kHz Switching
- Square RBSOA
- Anti-Parallel Ultra Fast Diode
- Avalanche Capability
- Short Circuit Capability
- International Standard Package

### Advantages

- High Power Density
- $175^\circ C$  Rated
- Extremely Rugged
- Low Gate Drive Requirement

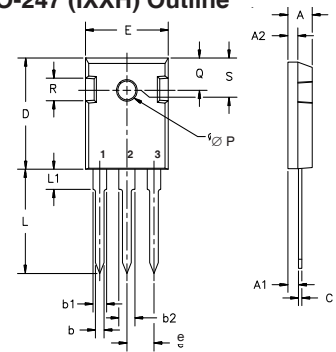
### Applications

- 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.               |
| $BV_{CES}$    | $I_C = 250\mu A$ , $V_{GE} = 0V$                                      | 600                   |      | V                  |
| $V_{GE(th)}$  | $I_C = 250\mu A$ , $V_{CE} = V_{GE}$                                  | 3.0                   |      | 5.5 V              |
| $I_{CES}$     | $V_{CE} = V_{CES}$ , $V_{GE} = 0V$<br>$T_J = 150^\circ C$             |                       |      | 25 $\mu A$<br>3 mA |
| $I_{GES}$     | $V_{CE} = 0V$ , $V_{GE} = \pm 20V$                                    |                       |      | $\pm 100$ nA       |
| $V_{CE(sat)}$ | $I_C = 36A$ , $V_{GE} = 15V$ , Note 1<br>$T_J = 150^\circ C$          | 1.55                  | 1.80 | V<br>V             |

| Symbol Test Conditions<br>( $T_J = 25^\circ\text{C}$ Unless Otherwise Specified) |   | Characteristic Values |      |                           |
|--|---|-----------------------|------|---------------------------|
|  |   | Min.                  | Typ. | Max.                      |
| $g_{fs}$   | $I_C = 36\text{A}, V_{CE} = 10\text{V}, \text{Note 1}$  | 12                    | 19   | S                         |
| $C_{ies}$  | $V_{CE} = 25\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$  |                       | 2230 | pF                        |
| $C_{oes}$  |   |                       | 195  | pF                        |
| $C_{res}$  |   |                       | 44   | pF                        |
| $Q_{g(on)}$  | $I_C = 36\text{A}, V_{GE} = 15\text{V}, V_{CE} = 0.5 \cdot V_{CES}$   |                       | 70   | nC                        |
| $Q_{ge}$   |   |                       | 16   | nC                        |
| $Q_{gc}$   |   |                       | 29   | nC                        |
| $t_{d(on)}$  | <b>Inductive load, <math>T_J = 25^\circ\text{C}</math></b><br>$I_C = 36\text{A}, V_{GE} = 15\text{V}$<br>$V_{CE} = 360\text{V}, R_G = 5\Omega$<br>Note 2  |                       | 27   | ns                        |
| $t_{ri}$   |   |                       | 40   | ns                        |
| $E_{on}$   |   |                       | 0.67 | mJ                        |
| $t_{d(off)}$   |   |                       | 100  | 150 ns                    |
| $t_{fi}$   |   |                       | 135  | ns                        |
| $E_{off}$  |   |                       | 0.74 | 1.20 mJ                   |
| $t_{d(on)}$  | <b>Inductive load, <math>T_J = 150^\circ\text{C}</math></b><br>$I_C = 36\text{A}, V_{GE} = 15\text{V}$<br>$V_{CE} = 360\text{V}, R_G = 5\Omega$<br>Note 2 |                       | 30   | ns                        |
| $t_{ri}$   |   |                       | 45   | ns                        |
| $E_{on}$   |   |                       | 1.40 | mJ                        |
| $t_{d(off)}$   |   |                       | 130  | ns                        |
| $t_{fi}$   |   |                       | 190  | ns                        |
| $E_{off}$  |   |                       | 1.20 | mJ                        |
| $R_{thJC}$   |   |                       | 0.25 | $^\circ\text{C}/\text{W}$ |
| $R_{thCS}$   |   | 0.21                  |      | $^\circ\text{C}/\text{W}$ |

TO-247 (IXXH) Outline



Terminals: 1 - Gate 2 - Collector 3 - Emitted

| 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  |
| L1             |            | 4.50  |        | .177  |
| ∅P             | 3.55       | 3.65  | .140   | .144  |
| Q              | 5.89       | 6.40  | 0.232  | 0.252 |
| R              | 4.32       | 5.49  | .170   | .216  |
| S              | 6.15       | BSC   | 242    | BSC   |

### Reverse Diode (FRED)

| Symbol Test Conditions<br>( $T_J = 25^\circ\text{C}$ Unless Otherwise Specified) |   | Characteristic Values     |      |                               |
|--|---|---------------------------|------|-------------------------------|
|  |   | Min.                      | Typ. | Max.                          |
| $V_F$  | $I_F = 24\text{A}, V_{GE} = 0\text{V}, \text{Note 1}$                                       |                           |      | 2.7 V                         |
|  |   | $T_J = 150^\circ\text{C}$ | 1.6  | V                             |
| $I_{RM}$   | $I_F = 30\text{A}, V_{GE} = 0\text{V}, -di_F/dt = 100\text{A}/\mu\text{s},$                 | $T_J = 100^\circ\text{C}$ |      | 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 $^\circ\text{C}/\text{W}$ |

Notes:

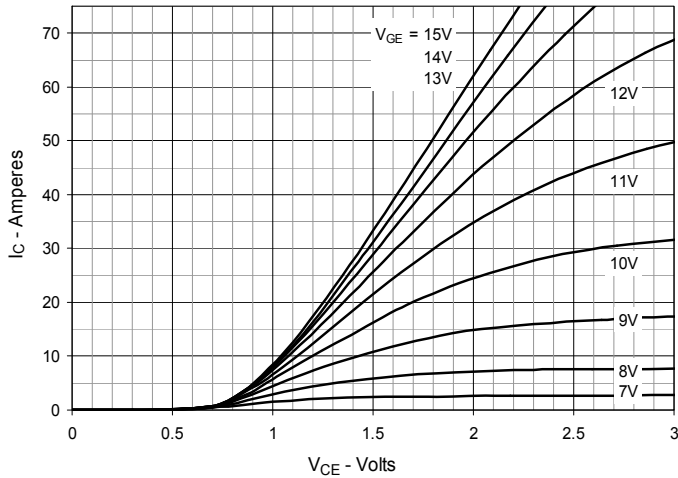
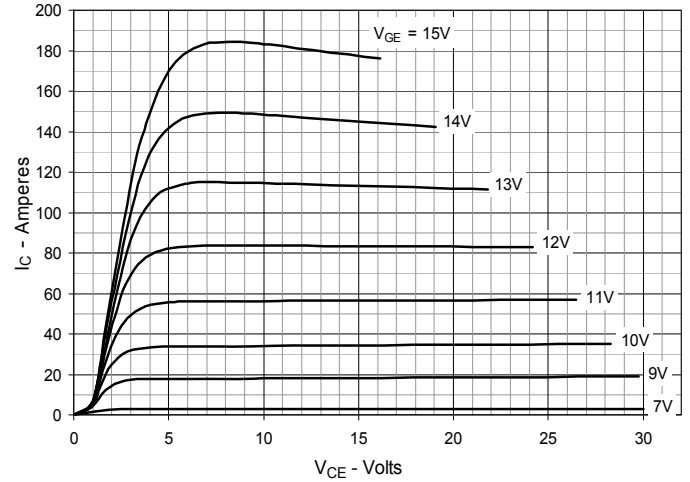
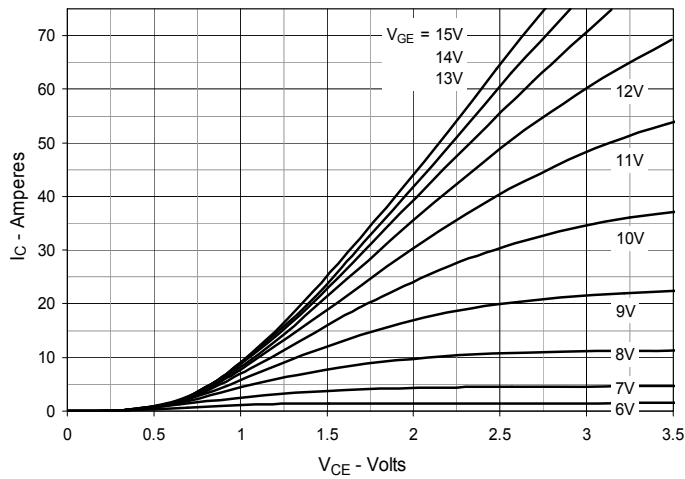
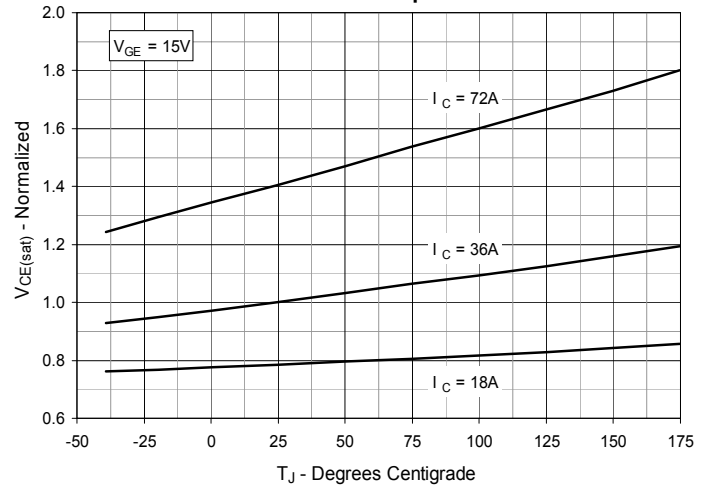
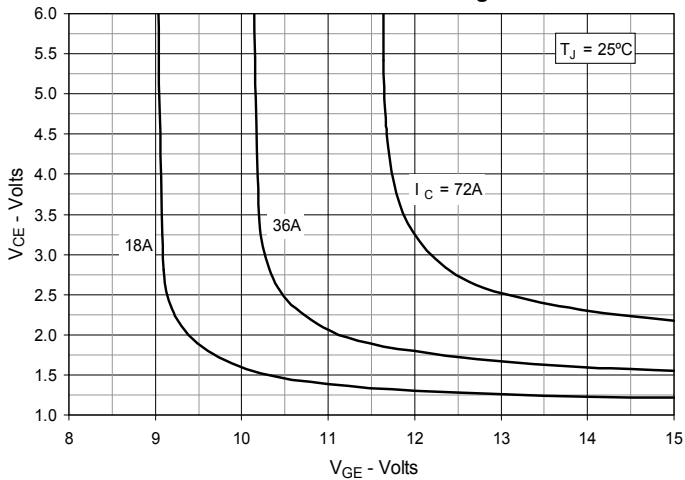
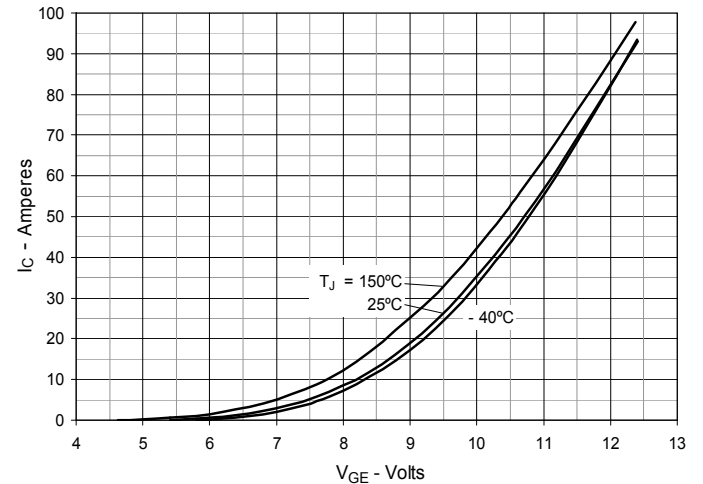
1. Pulse test,  $t \leq 300\mu\text{s}$ , duty cycle,  $d \leq 2\%$ .
2. Switching times & energy losses may increase for higher  $V_{CE}(\text{clamp})$ ,  $T_J$  or  $R_G$ .

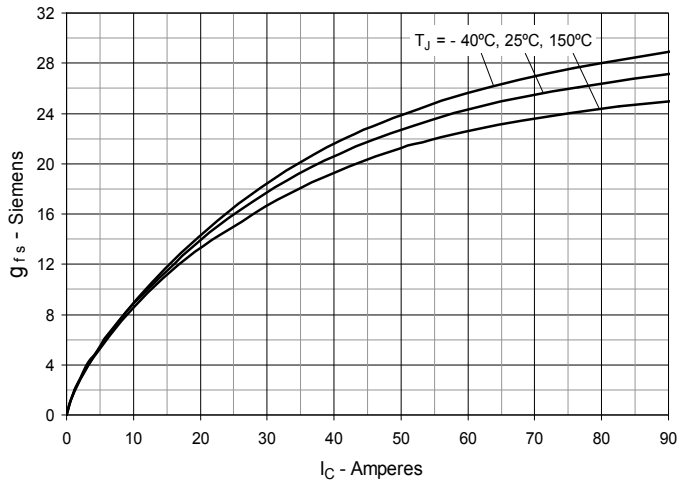
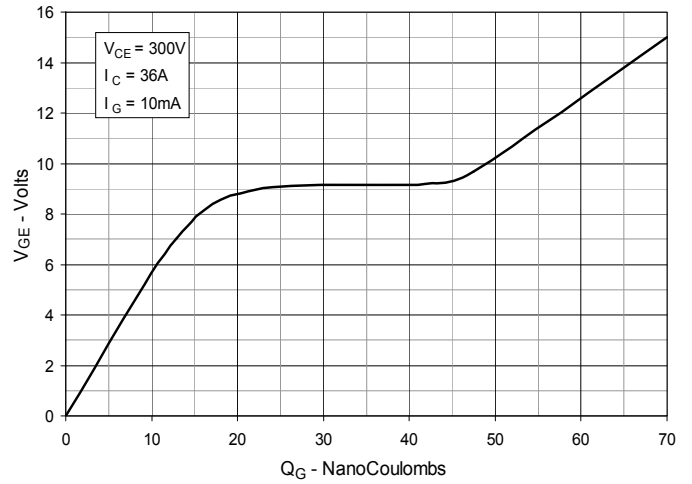
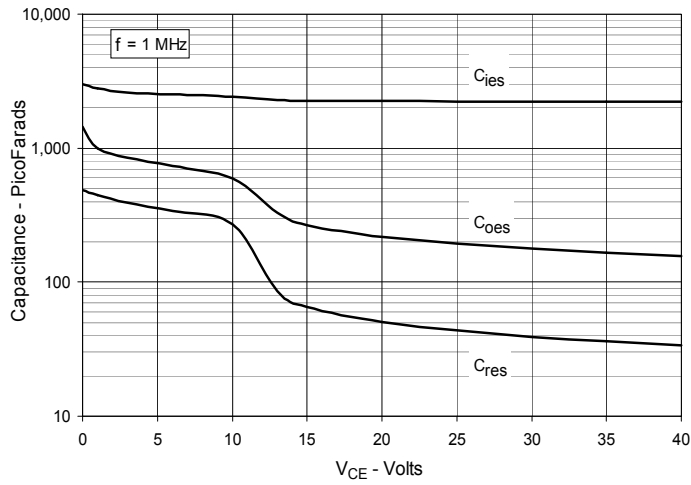
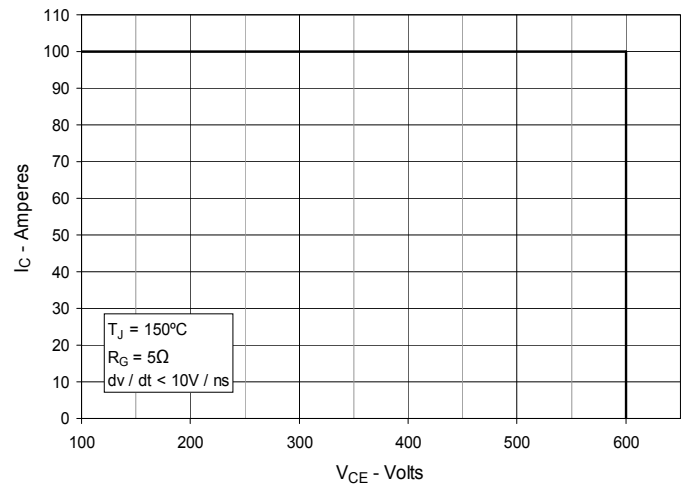
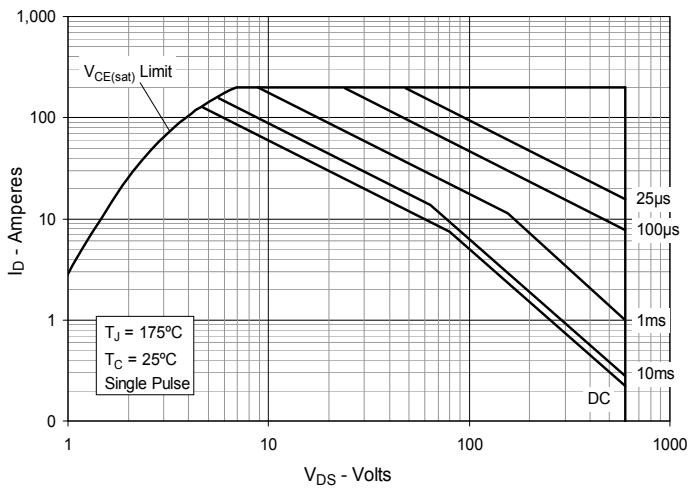
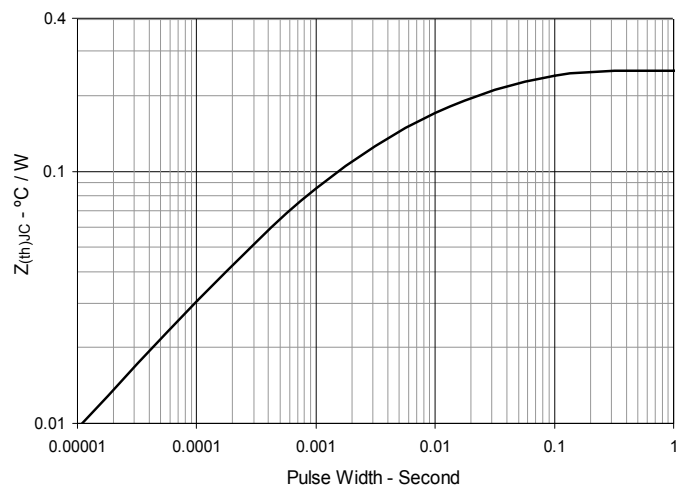
### ADVANCE TECHNICAL INFORMATION

The product presented herein is under development. The Technical Specifications offered are derived from a subjective evaluation of the design, based upon prior knowledge and experience, and constitute a "considered reflection" of the anticipated result. IXYS reserves the right to change limits, test conditions, and dimensions without notice.

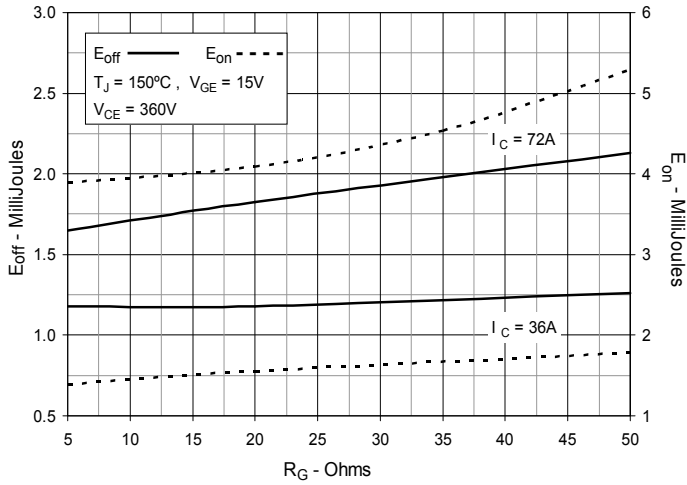
IXYS Reserves the Right to Change Limits, Test Conditions, and Dimensions.

|  |           |           |           |           |              |              |              |              |              |             |
|--|-----------|-----------|-----------|-----------|--------------|--------------|--------------|--------------|--------------|-------------|
| 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 |
|  | 4,850,072 | 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    |             |

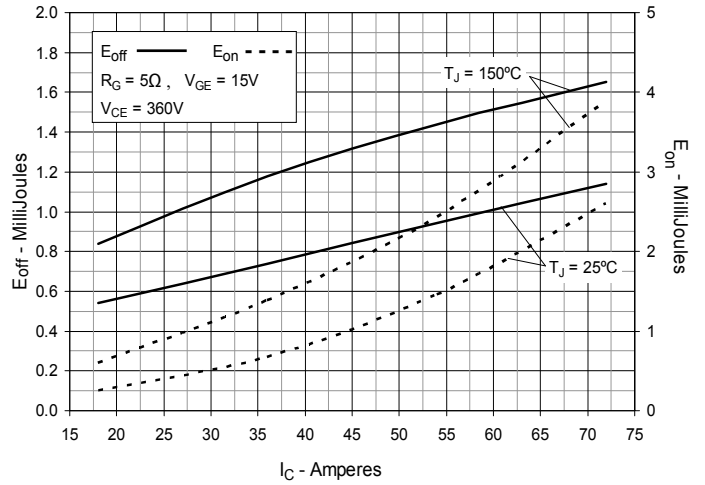
**Fig. 1. Output Characteristics @  $T_J = 25^\circ\text{C}$** 

**Fig. 2. Extended Output Characteristics @  $T_J = 25^\circ\text{C}$** 

**Fig. 3. Output Characteristics @  $T_J = 150^\circ\text{C}$** 

**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. Forward-Bias Safe Operating Area**

**Fig. 12. Maximum Transient Thermal Impedance**


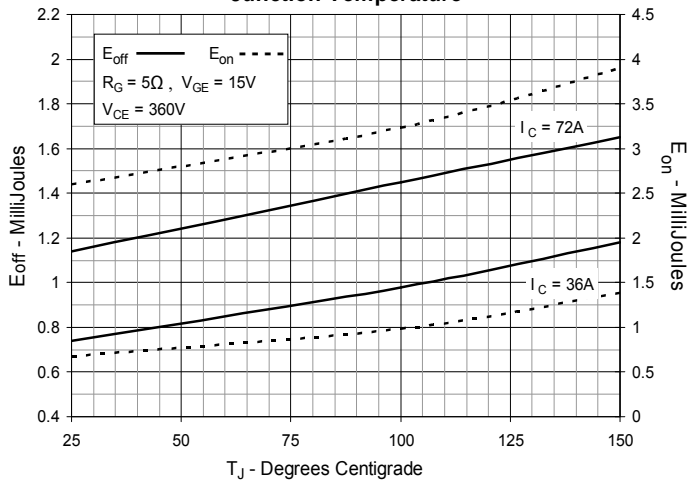
**Fig. 13. Inductive Switching Energy Loss vs. Gate Resistance**



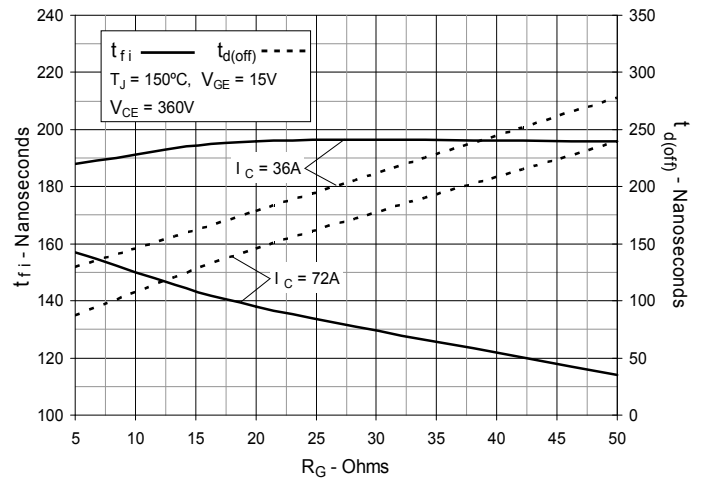
**Fig. 14. Inductive Switching Energy Loss vs. Collector Current**



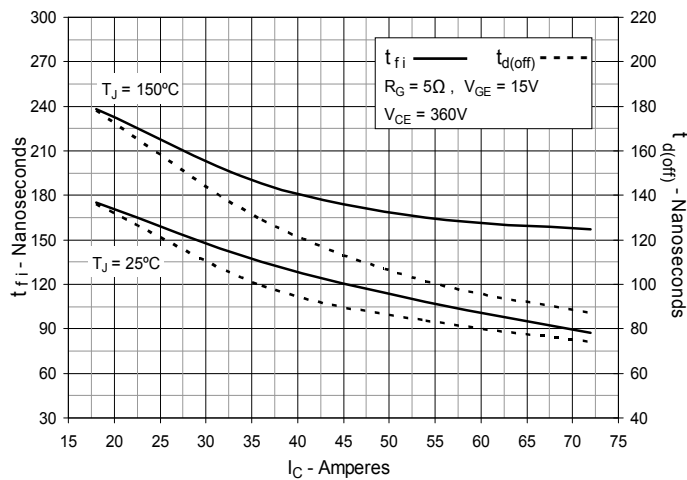
**Fig. 15. Inductive Switching Energy Loss vs. Junction Temperature**



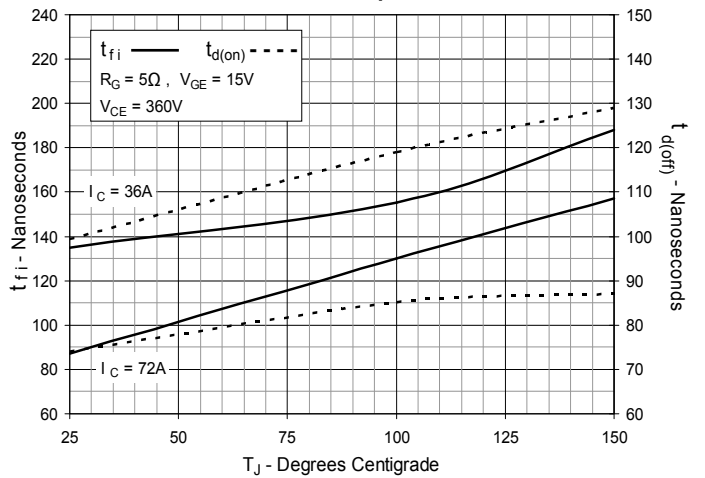
**Fig. 16. Inductive Turn-off Switching Times vs. Gate Resistance**

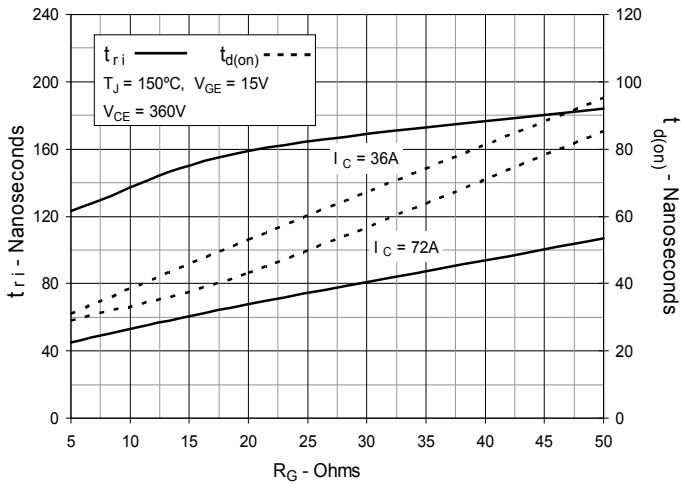
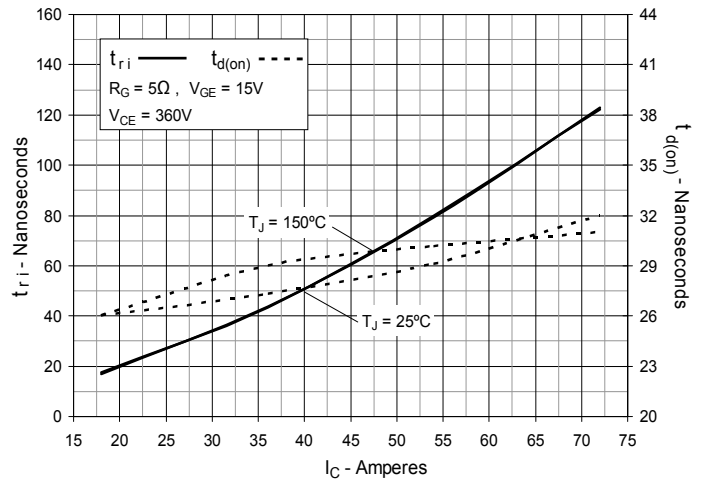
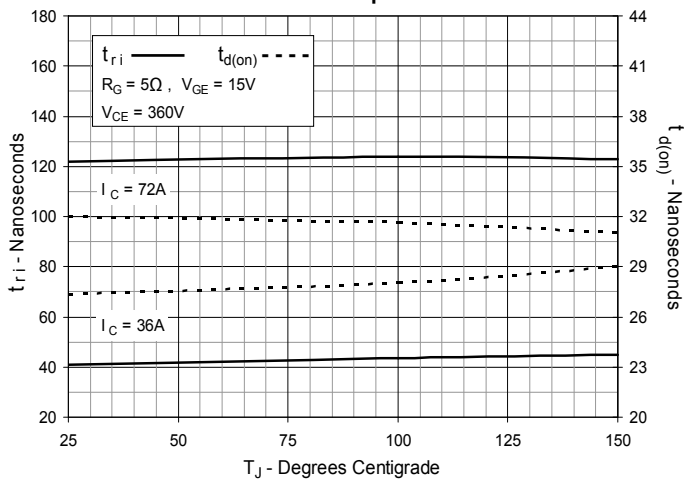


**Fig. 17. Inductive Turn-off Switching Times vs. Collector Current**



**Fig. 18. Inductive Turn-off Switching Times vs. Junction Temperature**



**Fig. 19. Inductive Turn-on Switching Times vs. Gate Resistance**

**Fig. 20. Inductive Turn-on Switching Times vs. Collector Current**

**Fig. 21. Inductive Turn-on Switching Times vs. Junction Temperature**


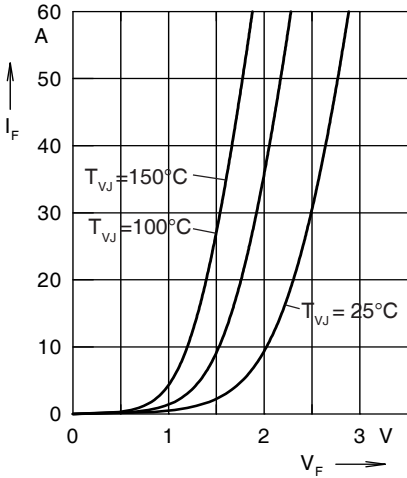
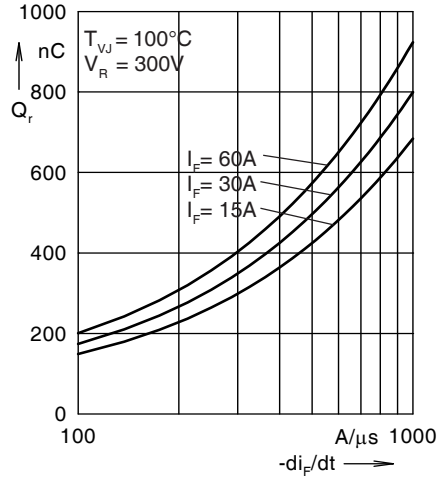
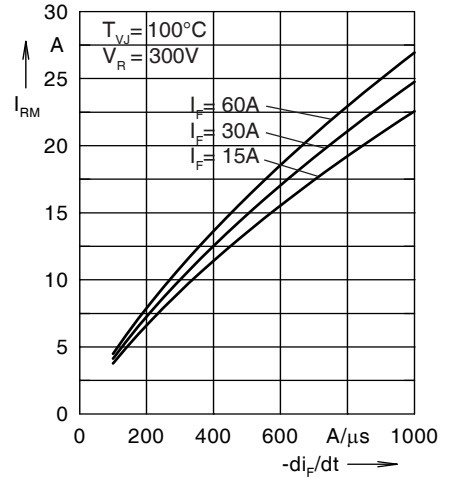
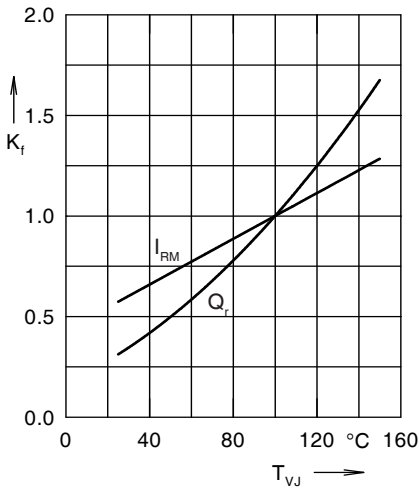
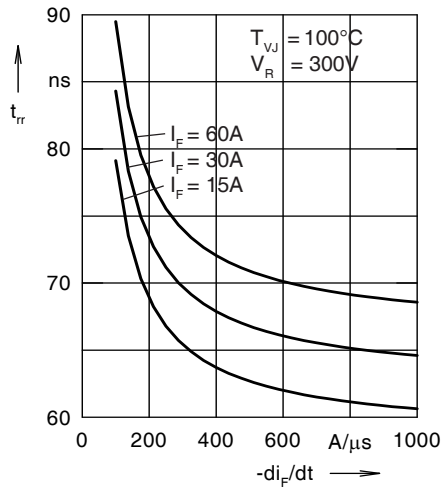
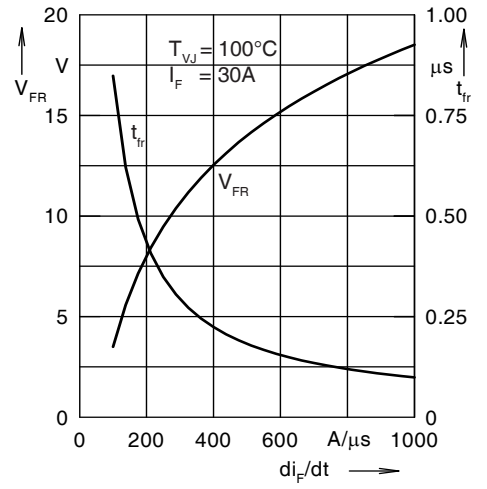
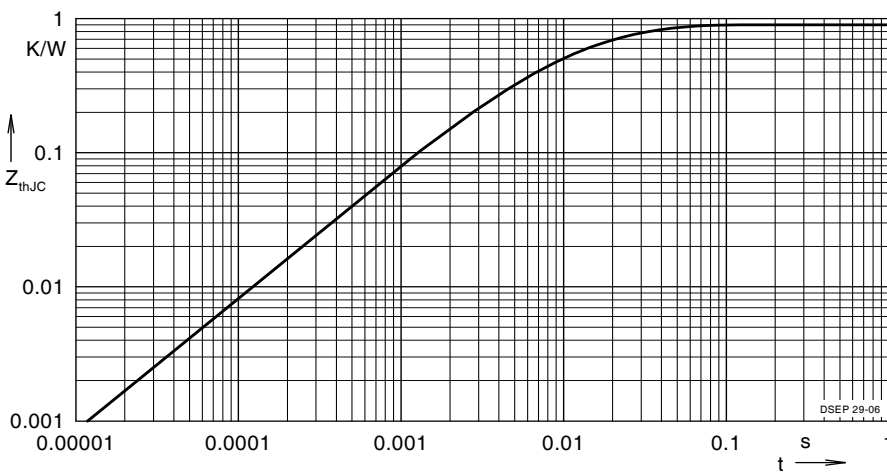

 Fig. 22. Forward Current  $I_F$  Versus  $V_F$ 

 Fig. 23. Reverse Recovery Charge  $Q_r$  Versus  $-di_F/dt$ 

 Fig. 24. Peak Reverse Current  $I_{RM}$  Versus  $-di_F/dt$ 

 Fig. 25. Dynamic Parameters  $Q_r$ ,  $I_{RM}$  Versus  $T_{VJ}$ 

 Fig. 26. Recovery Time  $t_{rr}$  Versus  $-di_F/dt$ 

 Fig. 27. Peak Forward Voltage  $V_{FR}$  and  $t_{fr}$  Versus  $di_F/dt$ 


Fig. 28. 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    |