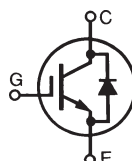


# XPT™ 650V IGBT GenX3™ w/ Sonic Diode

## IXYH40N65C3H1

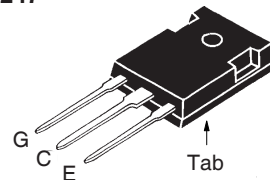
Extreme Light Punch Through  
IGBT for 20-60 kHz Switching



$V_{CES} = 650V$   
 $I_{C110} = 40A$   
 $V_{CE(sat)} \leq 2.35V$   
 $t_{fi(typ)} = 52ns$

| Symbol                        | Test Conditions                                                                             | Maximum Ratings                        |            |
|-------------------------------|---------------------------------------------------------------------------------------------|----------------------------------------|------------|
| $V_{CES}$                     | $T_J = 25^\circ C$ to $175^\circ C$                                                         | 650                                    | V          |
| $V_{CGR}$                     | $T_J = 25^\circ C$ to $175^\circ C$ , $R_{GE} = 1M\Omega$                                   | 650                                    | V          |
| $V_{GES}$                     | Continuous                                                                                  | $\pm 20$                               | V          |
| $V_{GEM}$                     | Transient                                                                                   | $\pm 30$                               | V          |
| $I_{C25}$                     | $T_C = 25^\circ C$                                                                          | 80                                     | A          |
| $I_{C110}$                    | $T_C = 110^\circ C$                                                                         | 40                                     | A          |
| $I_{F110}$                    | $T_C = 110^\circ C$                                                                         | 40                                     | A          |
| $I_{CM}$                      | $T_C = 25^\circ C$ , 1ms                                                                    | 180                                    | A          |
| $I_A$                         | $T_C = 25^\circ C$                                                                          | 20                                     | A          |
| $E_{AS}$                      | $T_C = 25^\circ C$                                                                          | 300                                    | mJ         |
| <b>SSOA</b><br><b>(RBSOA)</b> | $V_{GE} = 15V$ , $T_{VJ} = 150^\circ C$ , $R_G = 10\Omega$<br>Clamped Inductive Load        | $I_{CM} = 80$<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>$R_G = 82\Omega$ , Non Repetitive | 5                                      | $\mu s$    |
| $P_C$                         | $T_C = 25^\circ C$                                                                          | 300                                    | 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



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

### Features

- Optimized for 20-60kHz Switching
- Square RBSOA
- Anti-Parallel Sonic Diode
- Avalanche Rated
- Short Circuit Capability
- International Standard Package

### Advantages

- High Power Density
- Extremely Rugged
- Low Gate Drive Requirement

### Applications

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

| Symbol        | Test Conditions<br>( $T_J = 25^\circ C$ , Unless Otherwise Specified) | Characteristic Values |              |                    |
|---------------|-----------------------------------------------------------------------|-----------------------|--------------|--------------------|
|               |                                                                       | Min.                  | Typ.         | Max.               |
| $BV_{CES}$    | $I_C = 250\mu A$ , $V_{GE} = 0V$                                      | 650                   |              | V                  |
| $V_{GE(th)}$  | $I_C = 250\mu A$ , $V_{CE} = V_{GE}$                                  | 3.5                   |              | 6.0 V              |
| $I_{CES}$     | $V_{CE} = V_{CES}$ , $V_{GE} = 0V$<br>$T_J = 150^\circ C$             |                       |              | 50 $\mu A$<br>3 mA |
| $I_{GES}$     | $V_{CE} = 0V$ , $V_{GE} = \pm 20V$                                    |                       |              | $\pm 100$ nA       |
| $V_{CE(sat)}$ | $I_C = 40A$ , $V_{GE} = 15V$ , Note 1<br>$T_J = 150^\circ C$          |                       | 2.00<br>2.40 | 2.35 V<br>V        |

## Symbol Test Conditions

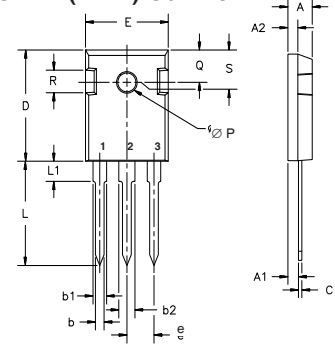
( $T_J = 25^\circ\text{C}$  Unless Otherwise Specified)

## Characteristic Values

Min. Typ. Max.

|              |                                                                                                                                                            |      |      |                         |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|-------------------------|
| $g_{fs}$     | $I_C = 40\text{A}, V_{CE} = 10\text{V}, \text{Note 1}$                                                                                                     | 16   | 27   | S                       |
| $C_{ies}$    | $V_{CE} = 25\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$                                                                                                 |      | 1980 | pF                      |
| $C_{oes}$    |                                                                                                                                                            |      | 215  | pF                      |
| $C_{res}$    |                                                                                                                                                            |      | 40   | pF                      |
| $Q_{g(on)}$  | $I_C = 40\text{A}, V_{GE} = 15\text{V}, V_{CE} = 0.5 \cdot V_{CES}$                                                                                        |      | 70   | nC                      |
| $Q_{ge}$     |                                                                                                                                                            |      | 14   | nC                      |
| $Q_{gc}$     |                                                                                                                                                            |      | 34   | nC                      |
| $t_{d(on)}$  | <b>Inductive load, <math>T_J = 25^\circ\text{C}</math></b><br>$I_C = 30\text{A}, V_{GE} = 15\text{V}$<br>$V_{CE} = 400\text{V}, R_G = 10\Omega$<br>Note 2  |      | 26   | ns                      |
| $t_{ri}$     |                                                                                                                                                            |      | 40   | ns                      |
| $E_{on}$     |                                                                                                                                                            |      | 0.86 | mJ                      |
| $t_{d(off)}$ |                                                                                                                                                            |      | 106  | ns                      |
| $t_{fi}$     |                                                                                                                                                            |      | 52   | ns                      |
| $E_{off}$    |                                                                                                                                                            |      | 0.40 | mJ                      |
| $t_{d(on)}$  | <b>Inductive load, <math>T_J = 150^\circ\text{C}</math></b><br>$I_C = 30\text{A}, V_{GE} = 15\text{V}$<br>$V_{CE} = 400\text{V}, R_G = 10\Omega$<br>Note 2 |      | 25   | ns                      |
| $t_{ri}$     |                                                                                                                                                            |      | 40   | ns                      |
| $E_{on}$     |                                                                                                                                                            |      | 1.33 | mJ                      |
| $t_{d(off)}$ |                                                                                                                                                            |      | 126  | ns                      |
| $t_{fi}$     |                                                                                                                                                            |      | 80   | ns                      |
| $E_{off}$    |                                                                                                                                                            |      | 0.46 | mJ                      |
| $R_{thJC}$   |                                                                                                                                                            |      |      | 0.50 $^\circ\text{C/W}$ |
| $R_{thCS}$   |                                                                                                                                                            | 0.21 |      | $^\circ\text{C/W}$      |

## TO-247 (IXYH) 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        |
| ØP             | 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 Sonic Diode (FRD)

## Symbol Test Conditions

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

## Characteristic Values

Min. Typ. Max.

|            |                                                                                                    |                           |     |                         |
|------------|----------------------------------------------------------------------------------------------------|---------------------------|-----|-------------------------|
| $V_F$      | $I_F = 30\text{A}, V_{GE} = 0\text{V}, \text{Note 1}$                                              | $T_J = 150^\circ\text{C}$ | 2.5 | V                       |
| $I_{RM}$   | $I_F = 30\text{A}, V_{GE} = 0\text{V},$<br>$-di_F/dt = 900\text{A}/\mu\text{s}, V_R = 300\text{V}$ | $T_J = 150^\circ\text{C}$ | 32  | A                       |
| $t_{rr}$   |                                                                                                    | $T_J = 150^\circ\text{C}$ | 78  | ns                      |
| $R_{thJC}$ |                                                                                                    |                           |     | 0.60 $^\circ\text{C/W}$ |

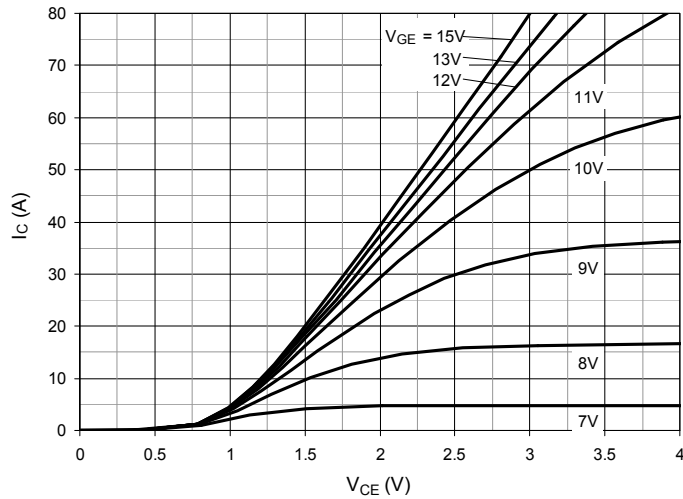
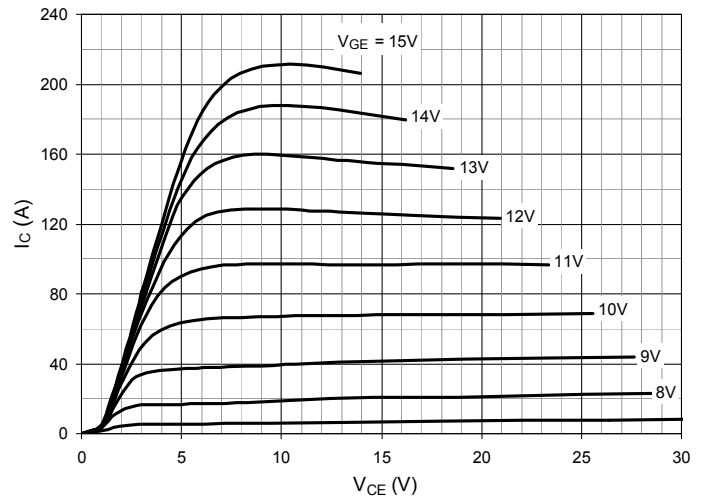
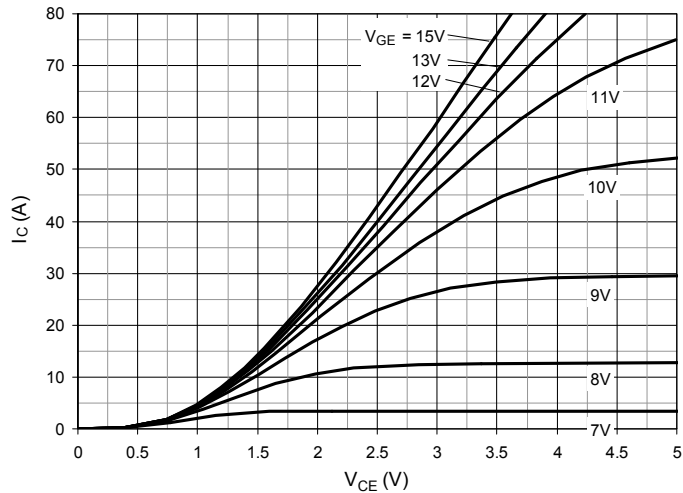
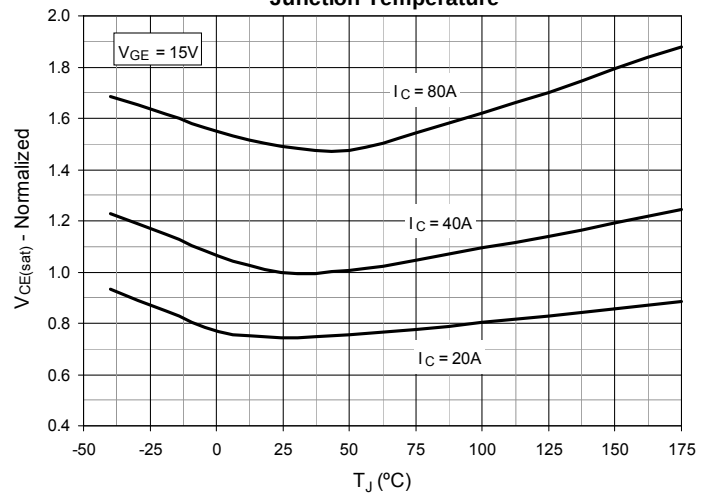
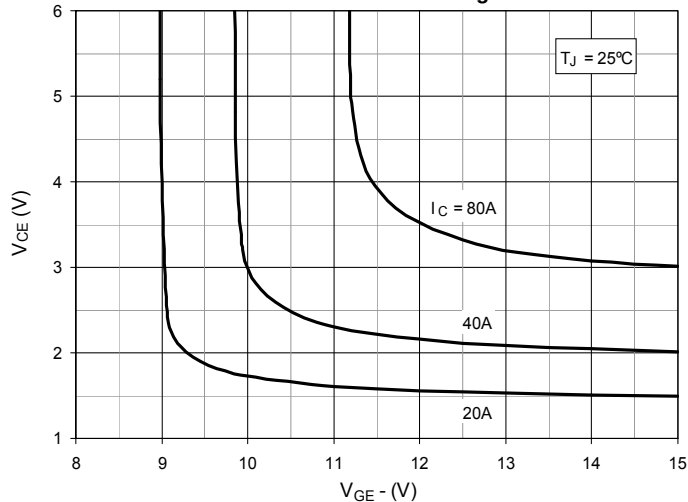
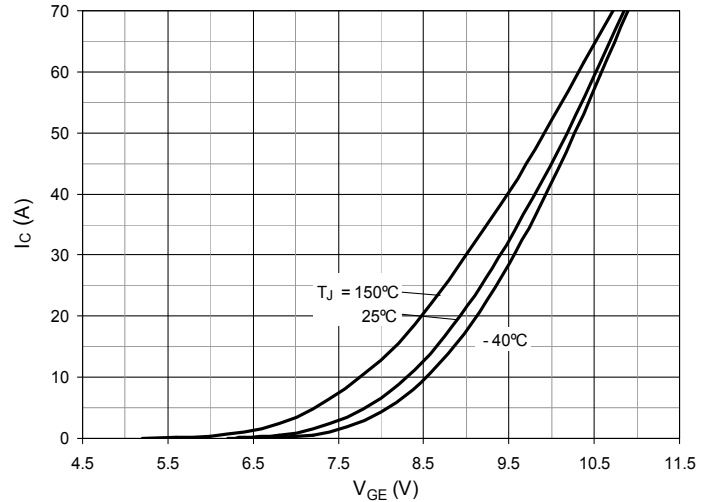
Notes:

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

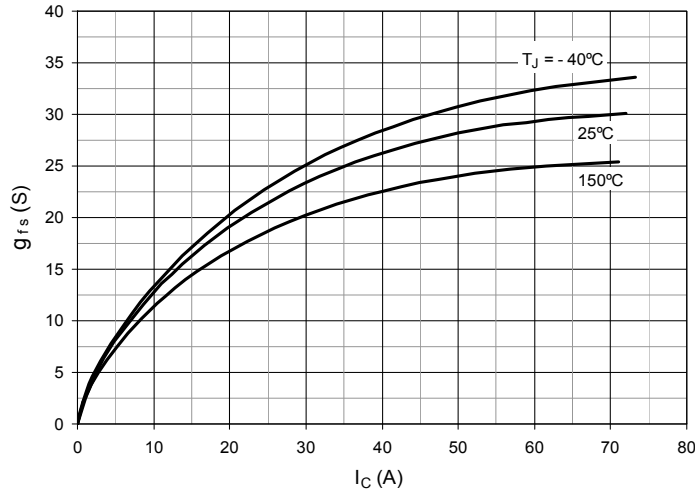
IXYS Reserves the Right to Change Limits, Test Conditions, and Dimensions.

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

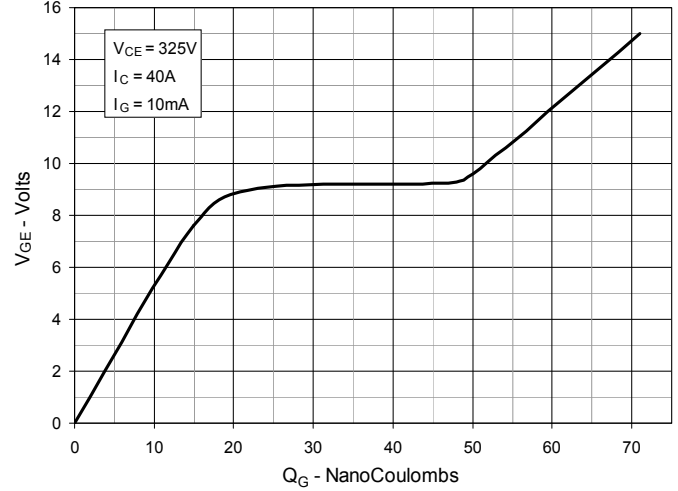
|           |           |           |           |              |              |              |              |              |             |
|-----------|-----------|-----------|-----------|--------------|--------------|--------------|--------------|--------------|-------------|
| 4,835,592 | 4,931,844 | 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 @  $T_J = 25^\circ\text{C}$** 

**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**


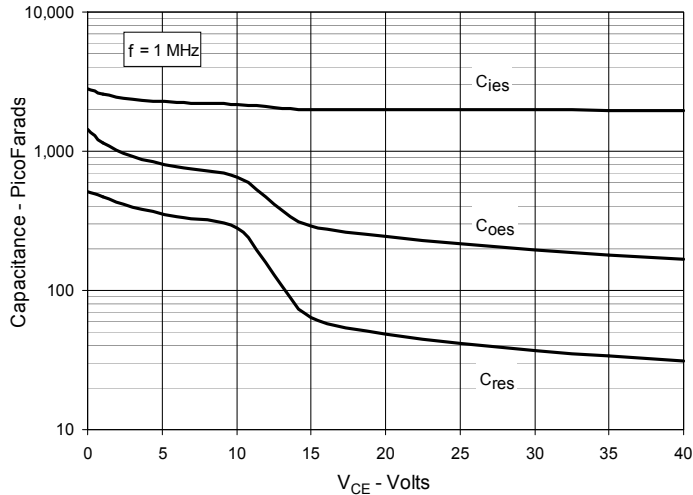
**Fig. 7. Transconductance**



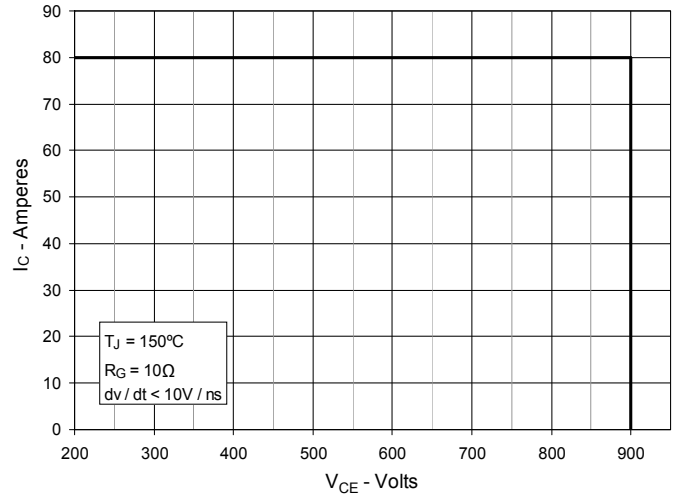
**Fig. 8. Gate Charge**



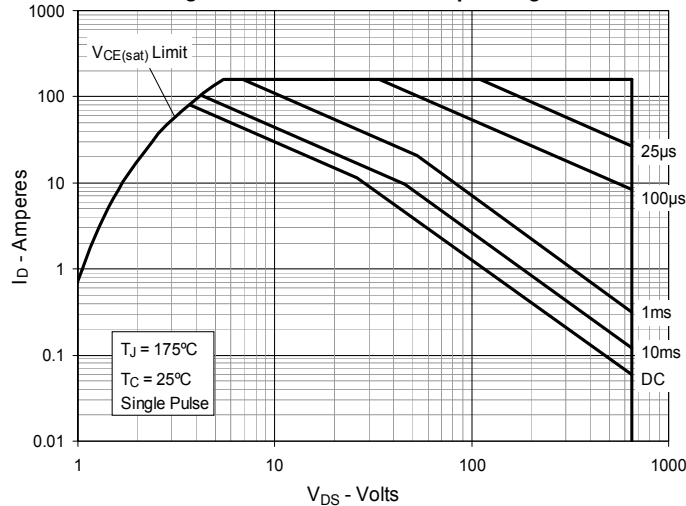
**Fig. 9. Capacitance**



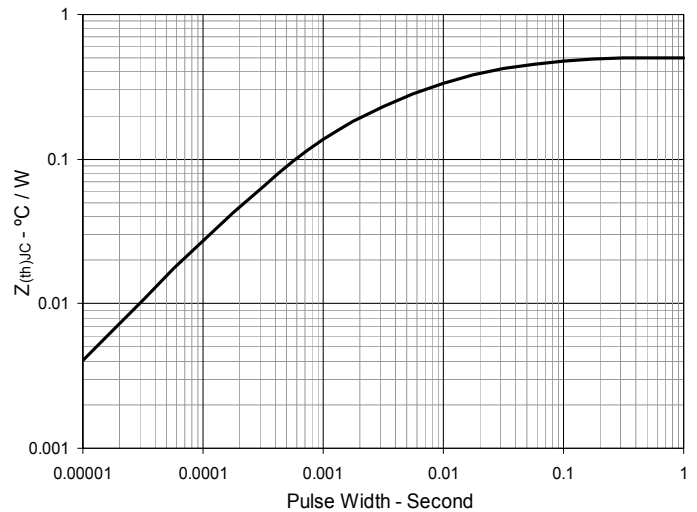
**Fig. 10. Reverse-Bias Safe Operating Area**



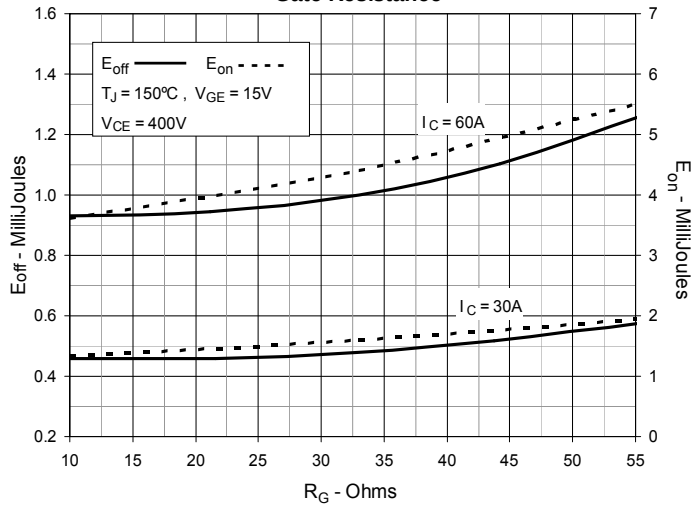
**Fig. 11. Forward-Bias Safe Operating Area**



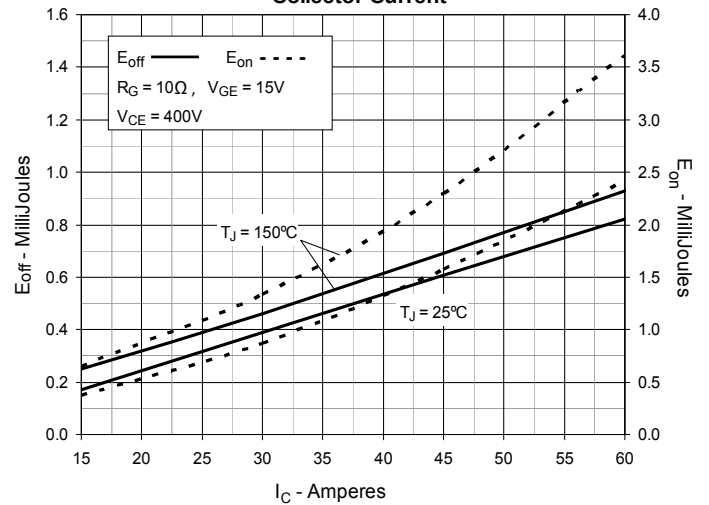
**Fig. 12. Maximum Transient Thermal Impedance (IGBT)**



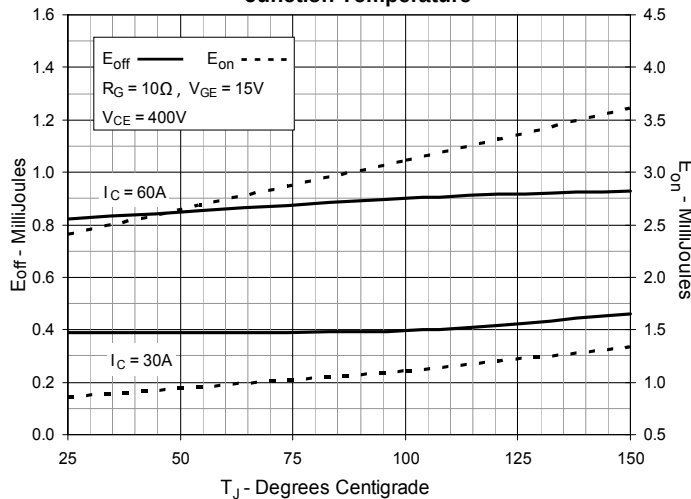
**Fig. 13. Inductive Switching Energy Loss vs. Gate Resistance**



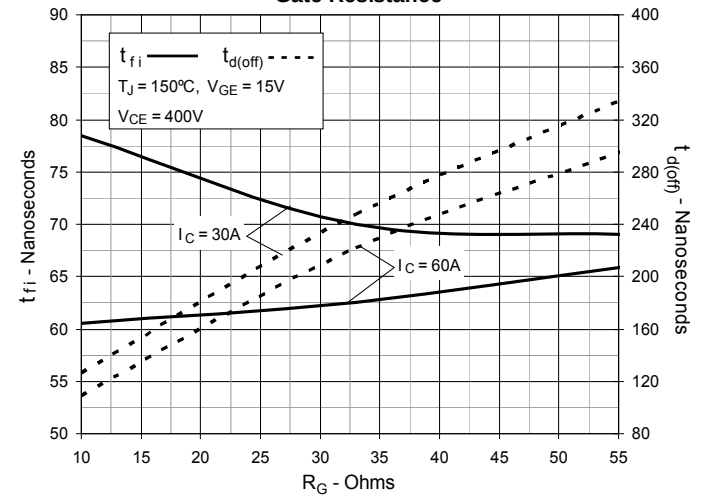
**Fig. 14. Inductive Switching Energy Loss vs. Collector Current**



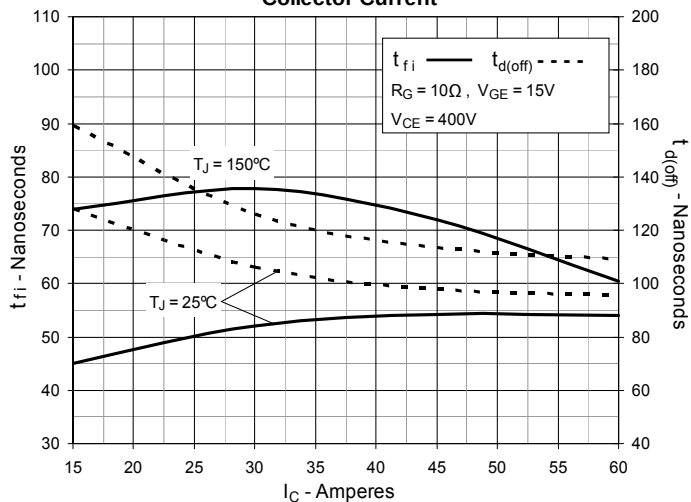
**Fig. 15. Inductive Switching Energy Loss vs. Junction Temperature**



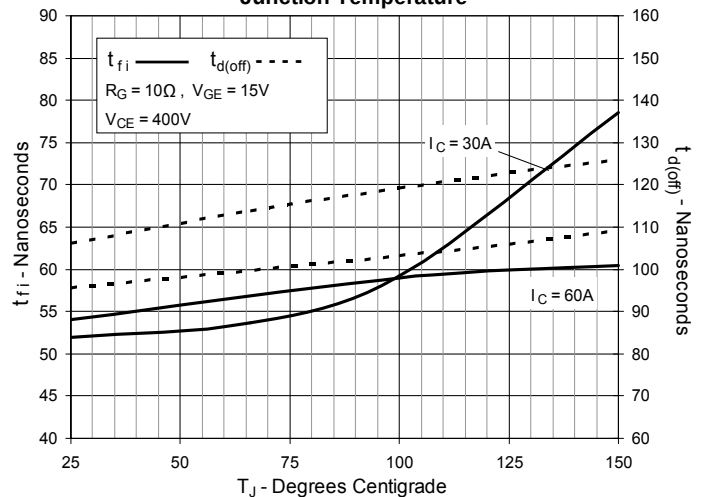
**Fig. 16. Inductive Turn-off Switching Times vs. Gate Resistance**

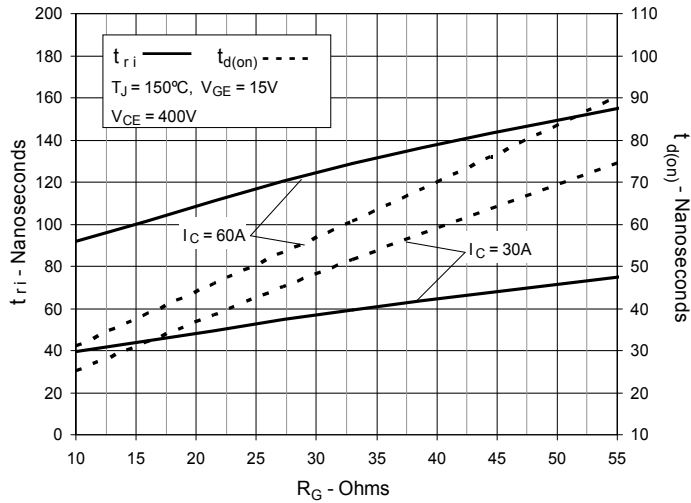
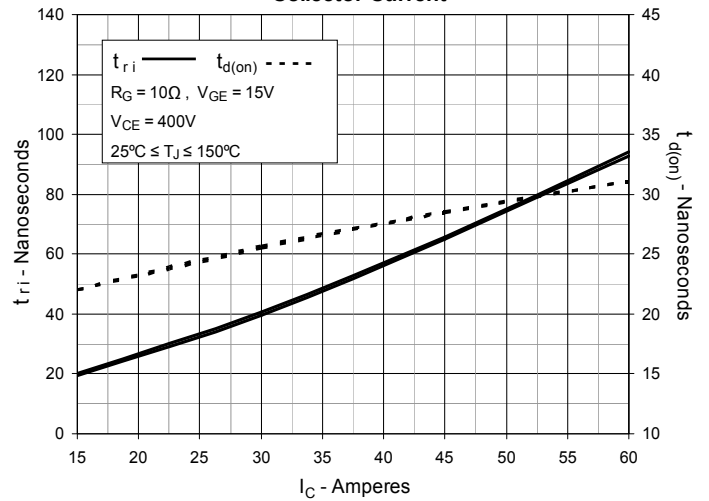
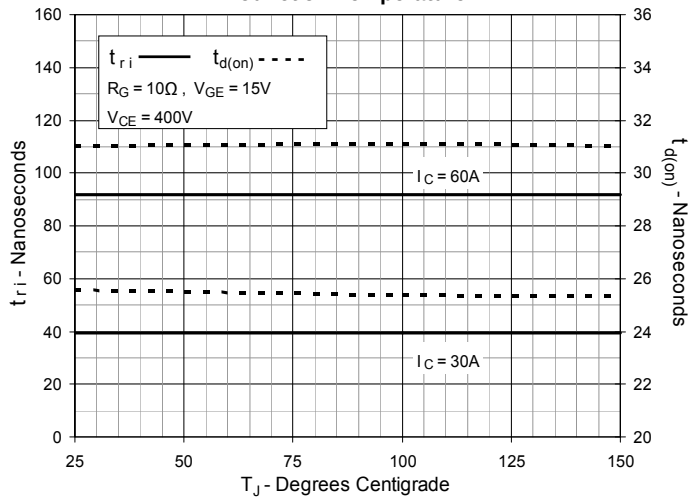
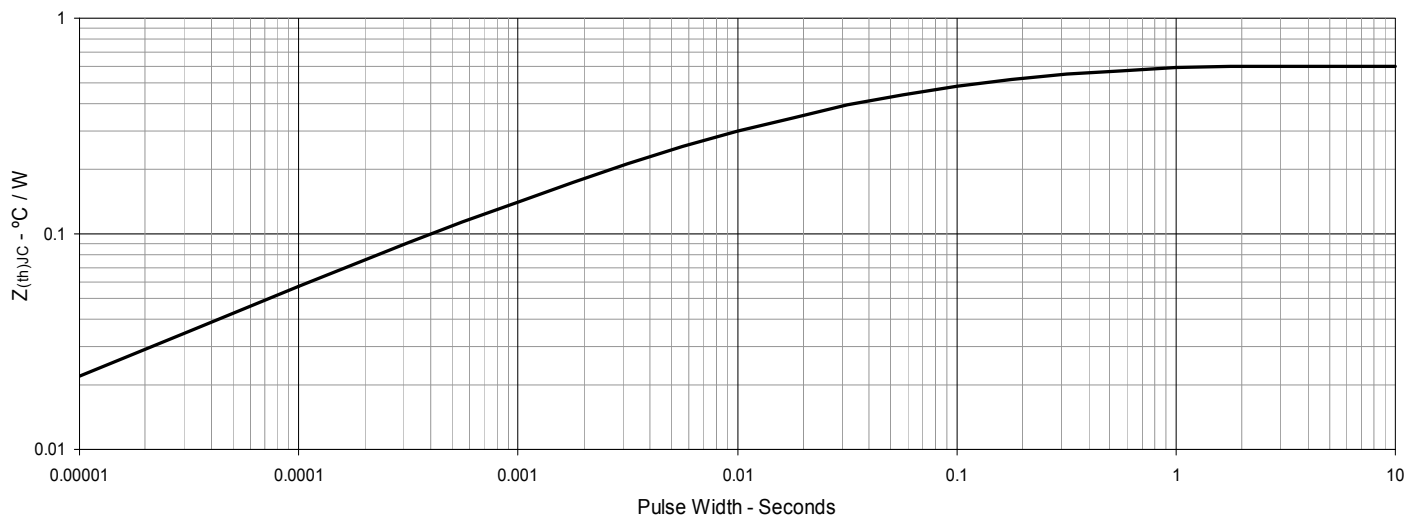


**Fig. 17. Inductive Turn-off Switching Times vs. Collector Current**

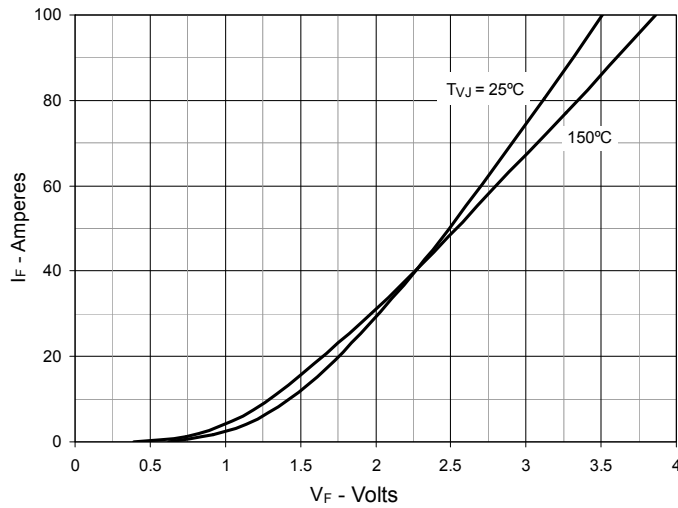


**Fig. 18. Inductive Turn-off Switching Times vs. Junction Temperature**

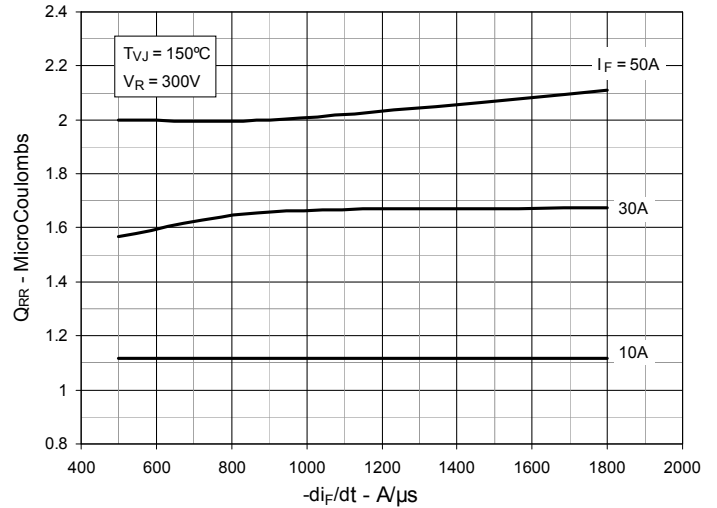


**Fig. 19. Inductive Turn-on Switching Times vs. Gate Resistance**

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

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

**Fig. 22. Maximum Transient Thermal Impedance (Diode)**


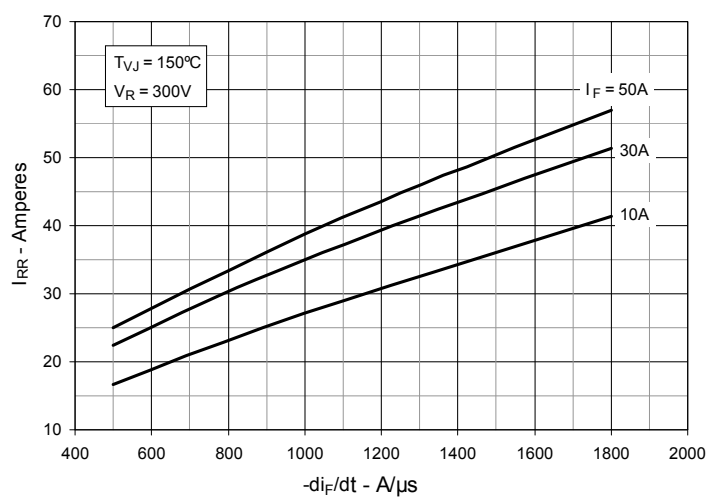
**Fig. 23. Forward Current vs. Forward Voltage**



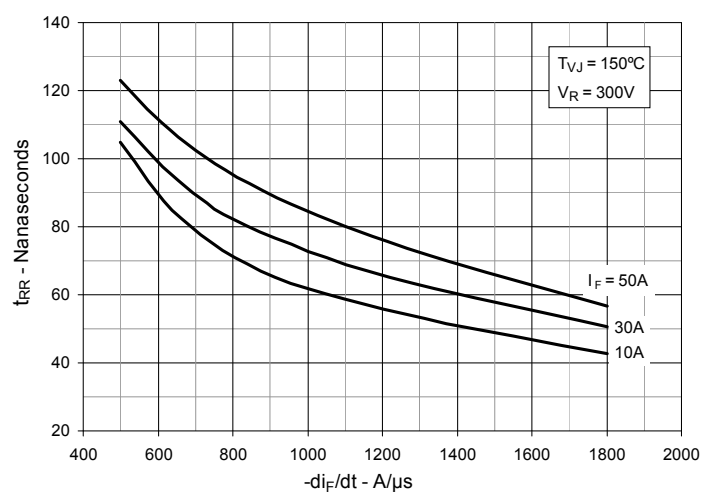
**Fig. 24. Reverse Recovery Charge  $Q_{RR}$  vs.  $-di_F/dt$**



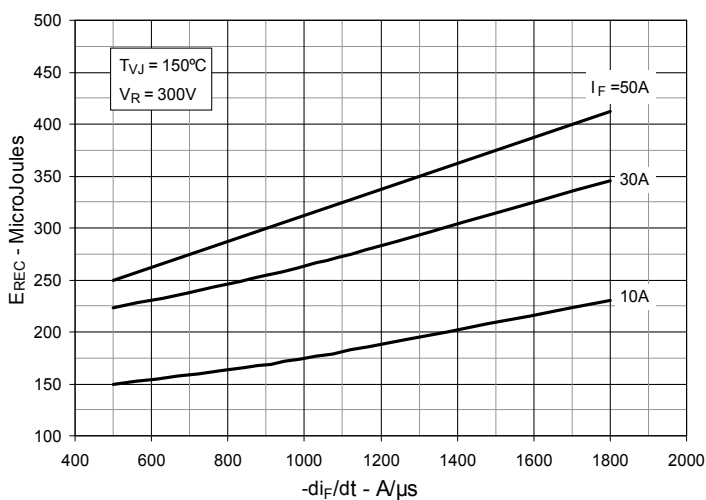
**Fig. 25. Peak Reverse Current  $I_{RR}$  vs.  $-di_F/dt$**



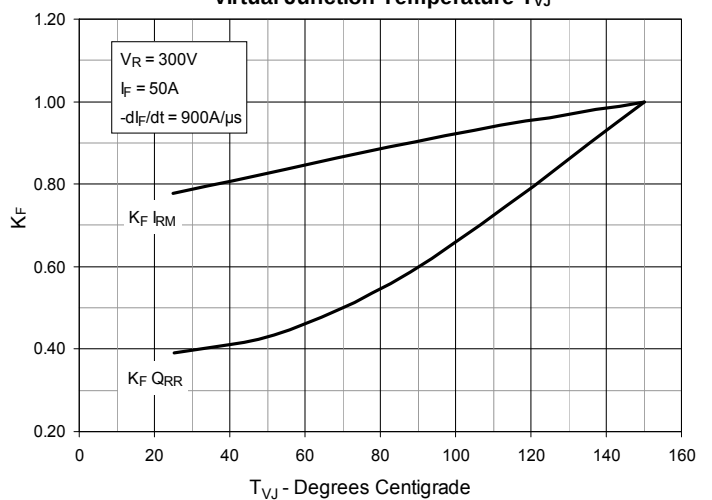
**Fig. 26. Recover Time  $t_{RR}$  vs.  $-di_F/dt$**



**Fig. 27. Recovery Energy  $E_{REC}$  vs.  $-di_F/dt$**



**Fig. 28. Dynamic Parameters  $Q_{RR}$ ,  $I_{RM}$  vs. Virtual Junction Temperature  $T_{VJ}$**





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