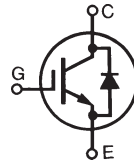


**XPT™ 650V IGBT  
GenX3™ w/ Diode**
**IXYH40N65B3D1  
IXYQ40N65B3D1**

 Extreme Light Punch Through  
IGBT for 5-30kHz Switching


$$V_{CES} = 650V$$

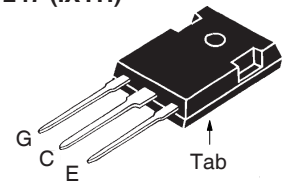
$$I_{C110} = 40A$$

$$V_{CE(sat)} \leq 2.0V$$

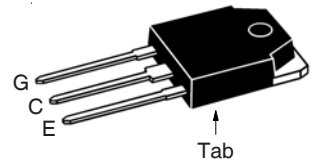
$$t_{fi(typ)} = 73ns$$

| 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          |
| $I_{C25}$                     | $T_C = 25^\circ C$  | 86                                       | A          |
| $I_{C110}$                    | $T_C = 110^\circ C$   | 40                                       | A          |
| $I_{F110}$                    | $T_C = 110^\circ C$   | 50                                       | A          |
| $I_{CM}$                      | $T_C = 25^\circ C$ , 1ms  | 195                                      | 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>                 | TO-247  | 6.0                                      | g          |
|                               | TO-3P   | 5.5                                      | g          |

TO-247 (IXYH)



TO-3P (IXYQ)



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

**Features**

- Optimized for Low 5-30kHz Switching
- Square RBSOA
- Anti-Parallel Fast Diode
- Avalanche Rated
- Short Circuit Capability

**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

| 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>$T_J = 150^\circ C$             |                       |            | 10 $\mu A$<br>1.5 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>$T_J = 150^\circ C$          |                       | 1.7<br>2.0 | 2.0 V<br>V           |

| Symbol Test Conditions<br>( $T_J = 25^\circ\text{C}$ Unless Otherwise Specified) |  | Characteristic Values |      |                    |
|--|--|-----------------------|------|--------------------|
|  |  | Min.                  | Typ. | Max.               |
| $g_{fs}$   | $I_C = 40\text{A}, V_{CE} = 10\text{V}$ , Note 1   | 16                    | 27   | S                  |
| $C_{ies}$  | $V_{CE} = 25\text{V}, V_{GE} = 0\text{V}, f = 1\text{MHz}$   |                       | 1880 | pF                 |
| $C_{oes}$  |  |                       | 210  | pF                 |
| $C_{res}$  |  |                       | 43   | pF                 |
| $Q_{g(on)}$  | $I_C = 40\text{A}, V_{GE} = 15\text{V}, V_{CE} = 0.5 \cdot V_{CES}$  |                       | 68   | nC                 |
| $Q_{ge}$   |  |                       | 10   | nC                 |
| $Q_{gc}$   |  |                       | 33   | 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  |                       | 20   | ns                 |
| $t_{ri}$   |  |                       | 37   | ns                 |
| $E_{on}$   |  |                       | 0.80 | mJ                 |
| $t_{d(off)}$   |  |                       | 140  | ns                 |
| $t_{fi}$   |  |                       | 73   | ns                 |
| $E_{off}$  |  |                       | 0.70 | 1.25 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 |                       | 20   | ns                 |
| $t_{ri}$   |  |                       | 37   | ns                 |
| $E_{on}$   |  |                       | 1.60 | mJ                 |
| $t_{d(off)}$   |  |                       | 176  | ns                 |
| $t_{fi}$   |  |                       | 174  | ns                 |
| $E_{off}$  |  |                       | 1.15 | mJ                 |
| $R_{thJC}$   |  |                       | 0.50 | $^\circ\text{C/W}$ |
| $R_{thCS}$   |  | 0.25                  |      | $^\circ\text{C/W}$ |

**Reverse Diode (FRED)**

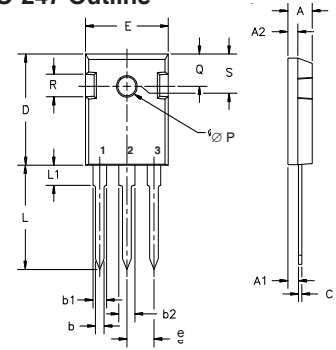
| Symbol Test Conditions<br>( $T_J = 25^\circ\text{C}$ Unless Otherwise Specified) |  | Characteristic Values     |      |                         |
|--|--|---------------------------|------|-------------------------|
|  |  | Min.                      | Typ. | Max.                    |
| $V_F$  | $I_F = 30\text{A}, V_{GE} = 0\text{V}$ , Note 1  |                           |      | 2.5 V                   |
| $I_{rr}$   | $I_F = 30\text{A}, V_{GE} = 0\text{V},$<br>$-di_F/dt = 500\text{A}/\mu\text{s}, V_R = 400\text{V}$ | $T_J = 150^\circ\text{C}$ | 1.2  | V                       |
| $t_{rr}$   |  | $T_J = 150^\circ\text{C}$ | 24   | ns                      |
| $R_{thJC}$   |  |                           |      | 0.60 $^\circ\text{C/W}$ |

**Notes:**

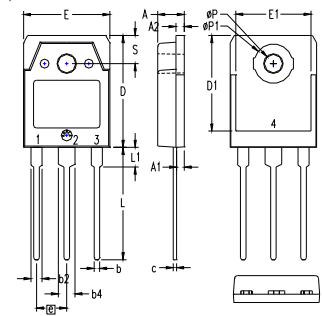
1. Pulse test,  $t \leq 300\mu\text{s}$ , duty cycle,  $d \leq 2\%$ .
2. Switching times & energy losses may increase for higher  $V_{CE}(\text{clamp})$ ,  $T_J$  or  $R_G$ .

**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.

**TO-247 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   |

**TO-3P Outline**

 1 = Gate 2,4 = Collector  
 3 = Emitter

| SYM | INCHES |         | MILLIMETERS |          |
|-----|--------|---------|-------------|----------|
|     | MIN    | MAX     | MIN         | MAX      |
| A   | .185   | .193    | 4.70        | 4.90     |
| A1  | .051   | .059    | 1.30        | 1.50     |
| A2  | .057   | .065    | 1.45        | 1.65     |
| b   | .035   | .045    | 0.90        | 1.15     |
| b2  | .075   | .087    | 1.90        | 2.20     |
| b4  | .114   | .126    | 2.90        | 3.20     |
| c   | .022   | .031    | 0.55        | 0.80     |
| D   | .780   | .799    | 19.80       | 20.30    |
| D1  | .665   | .677    | 16.90       | 17.20    |
| E   | .610   | .622    | 15.50       | 15.80    |
| E1  | .531   | .539    | 13.50       | 13.70    |
| e   |        | 215 BSC |             | 5.45 BSC |
| L   | .779   | .795    | 19.80       | 20.20    |
| L1  | .134   | .142    | 3.40        | 3.60     |
| ∅P  | .126   | .134    | 3.20        | 3.40     |
| ∅P1 | .272   | .280    | 6.90        | 7.10     |
| S   | .193   | .201    | 4.90        | 5.10     |

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 @  $T_J = 25^\circ\text{C}$

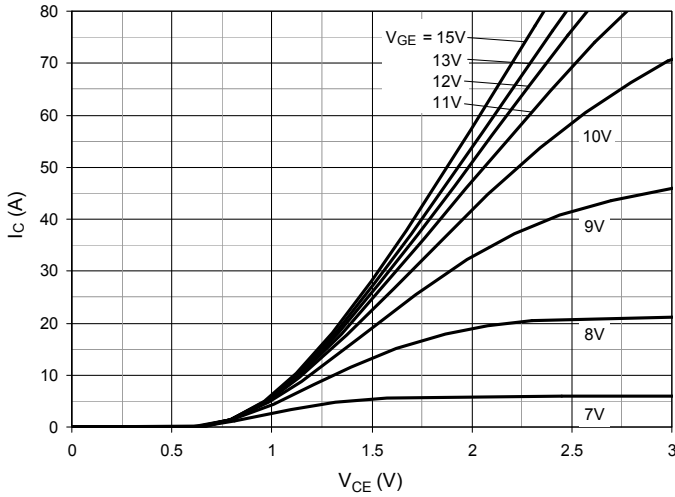


Fig. 2. Extended Output Characteristics @  $T_J = 25^\circ\text{C}$

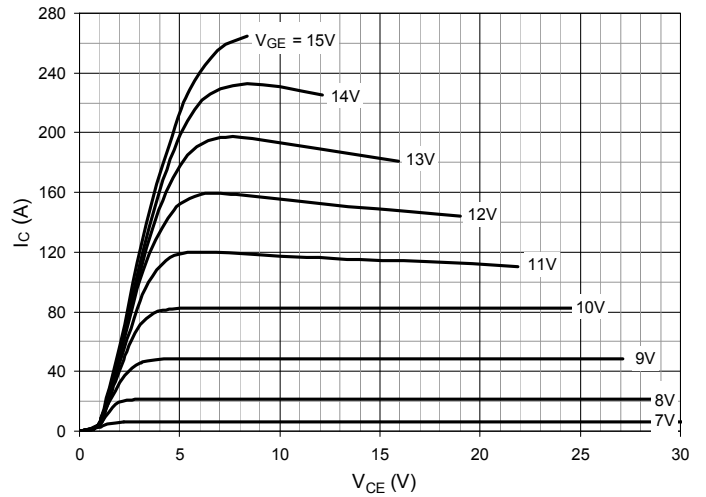


Fig. 3. Output Characteristics @  $T_J = 150^\circ\text{C}$

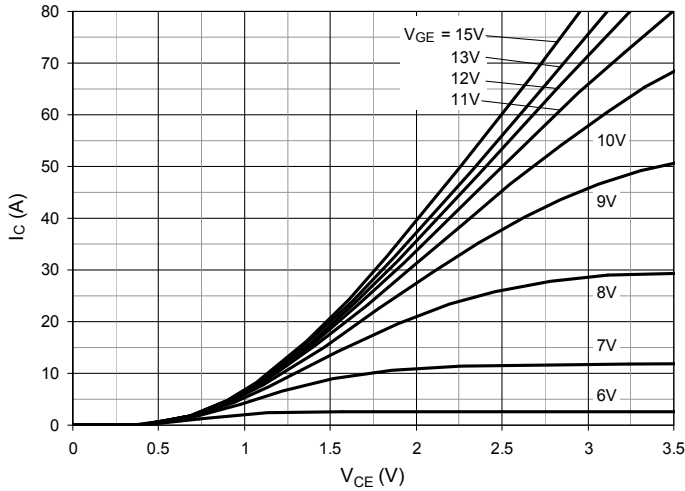


Fig. 4. Dependence of  $V_{CE(sat)}$  on Junction Temperature

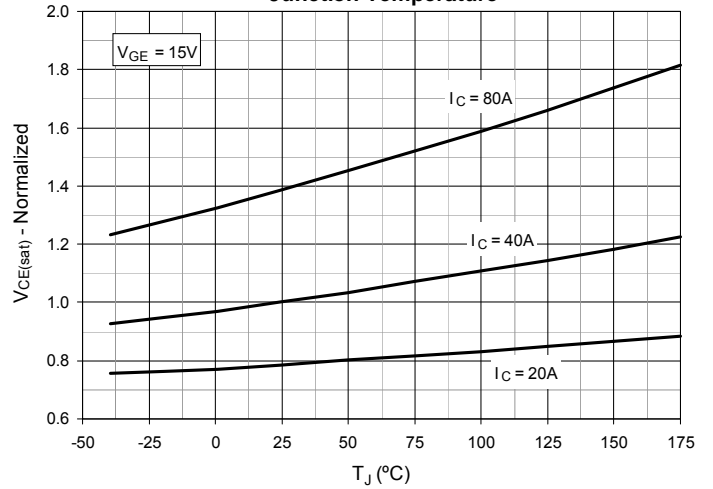


Fig. 5. Collector-to-Emitter Voltage vs. Gate-to-Emitter Voltage

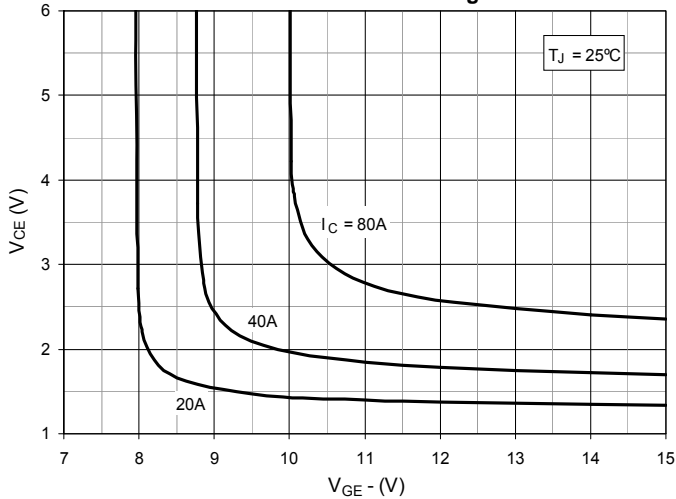


Fig. 6. Input Admittance

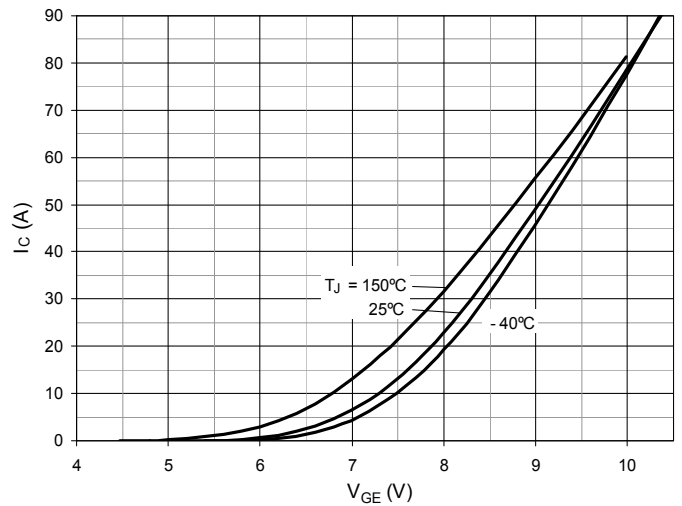


Fig. 7. Transconductance

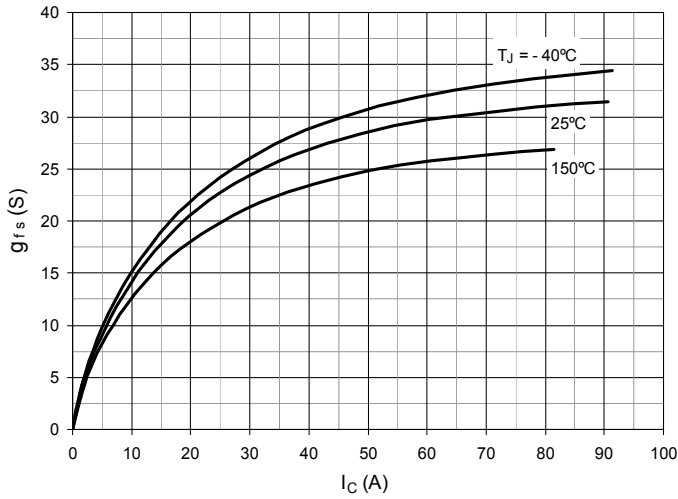


Fig. 8. Gate Charge

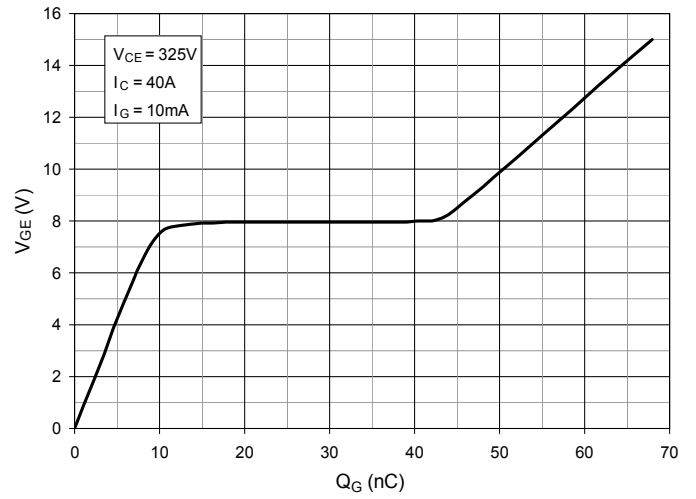


Fig. 9. Capacitance

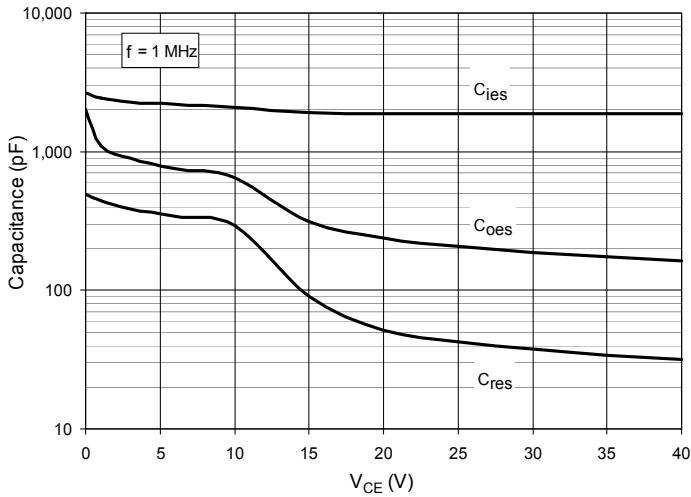


Fig. 10. Reverse-Bias Safe Operating Area

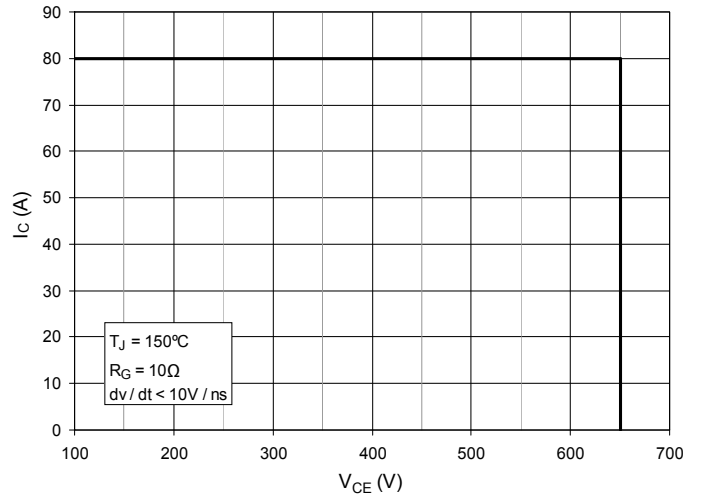


Fig. 11. Forward-Bias Safe Operating Area

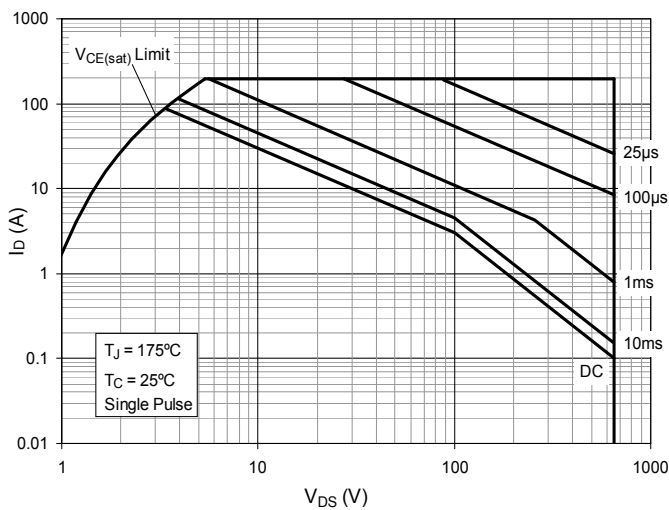
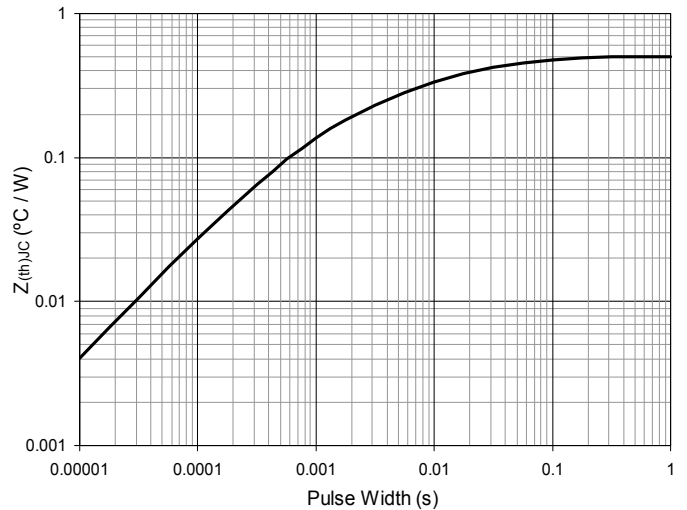
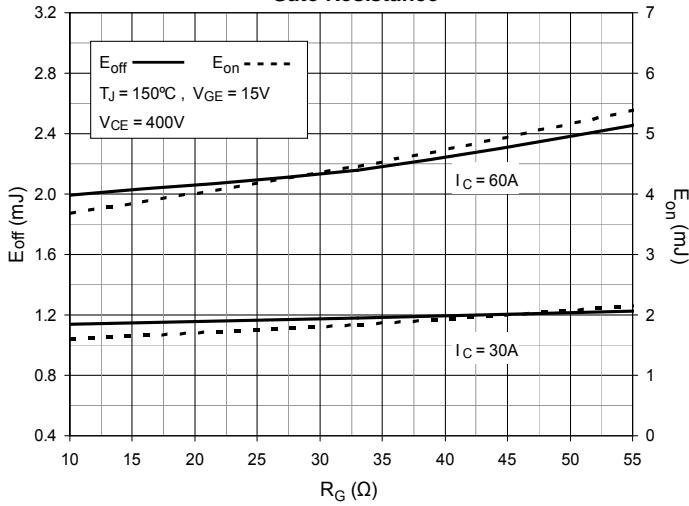


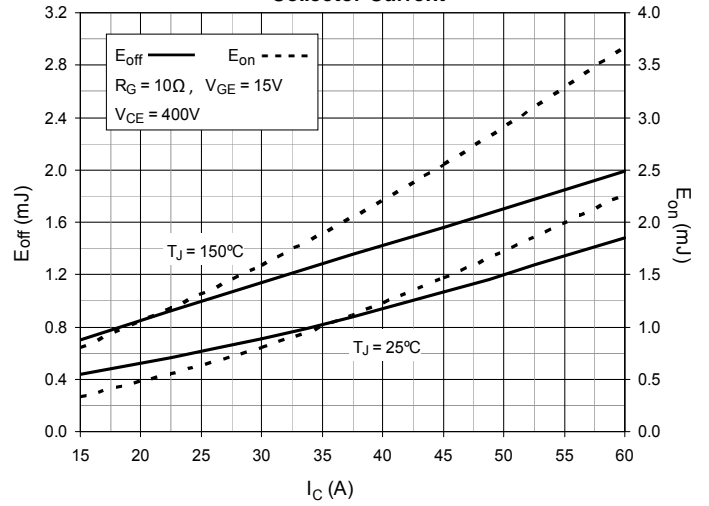
Fig. 12. Maximum Transient Thermal Impedance (IGBT)



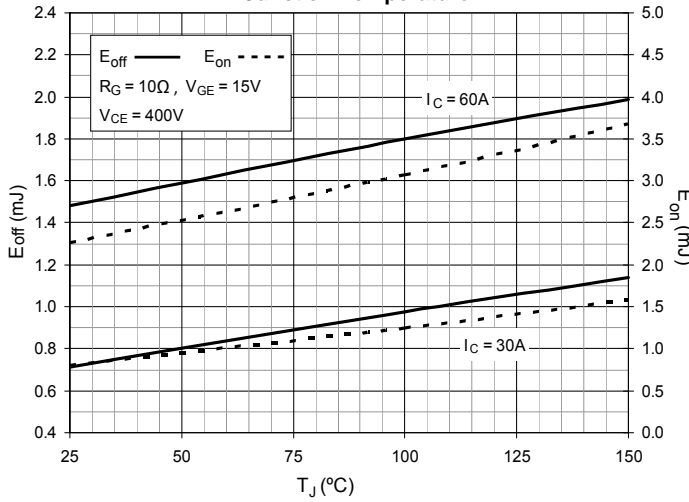
**Fig. 13. Inductive Switching Energy Loss vs. Gate Resistance**



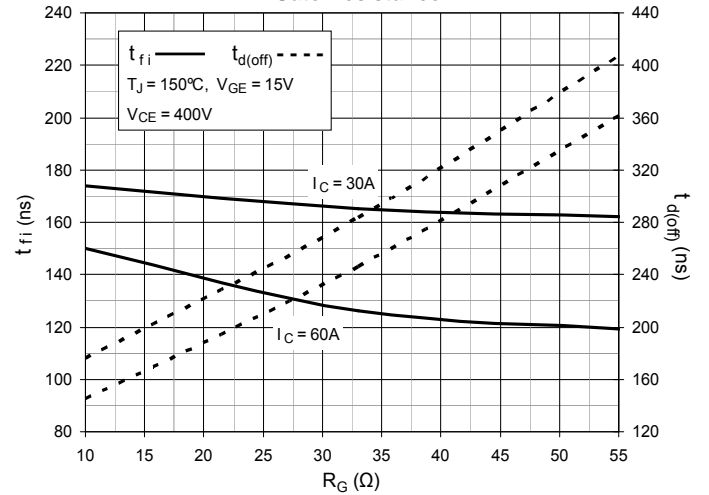
**Fig. 14. Inductive Switching Energy Loss vs. Collector Current**



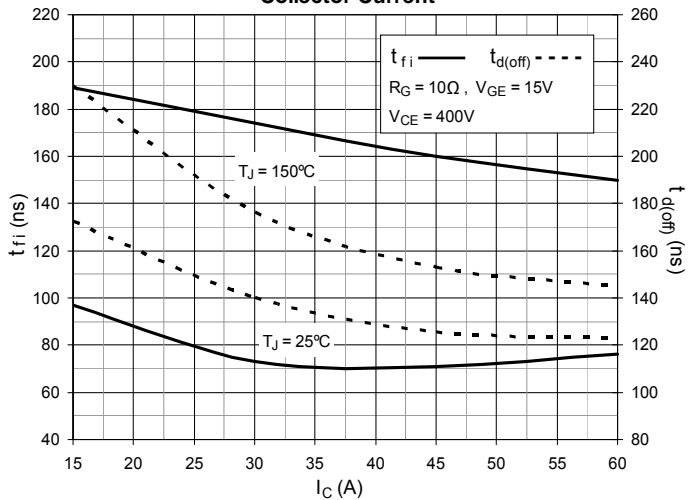
**Fig. 15. Inductive Switching Energy Loss vs. Junction Temperature**



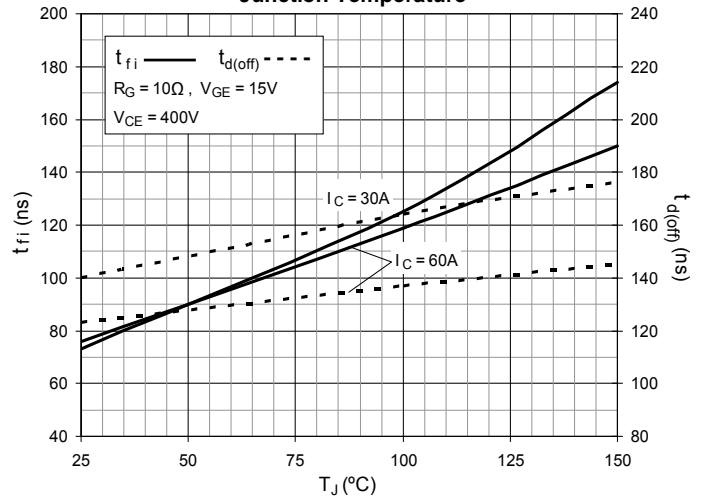
**Fig. 16. Inductive Turn-off Switching Times vs. Gate Resistance**



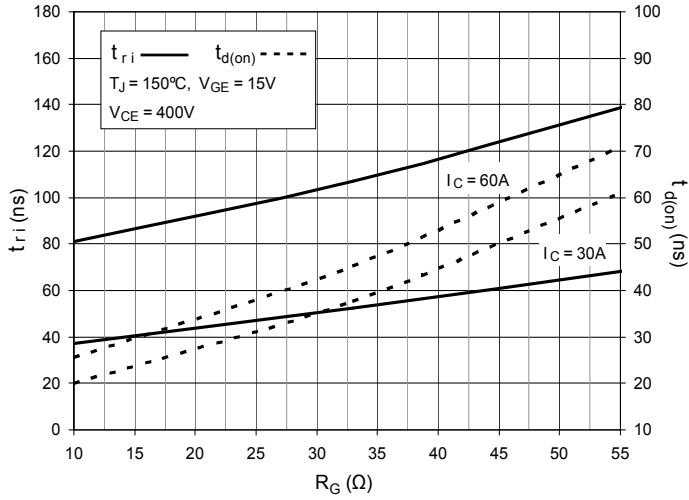
**Fig. 17. Inductive Turn-off Switching Times vs. Collector Current**



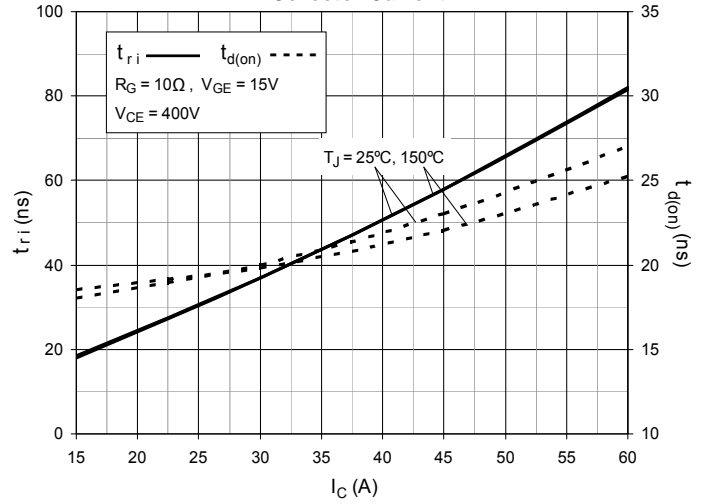
**Fig. 18. Inductive Turn-off Switching Times vs. Junction Temperature**



**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**

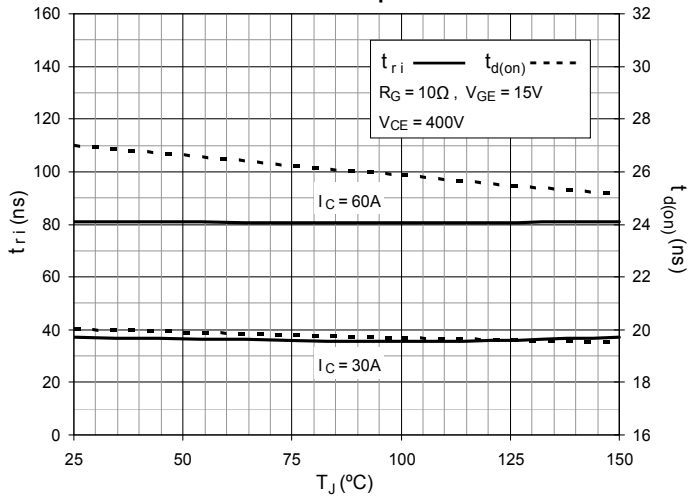


Fig. 22. Diode Forward Characteristics

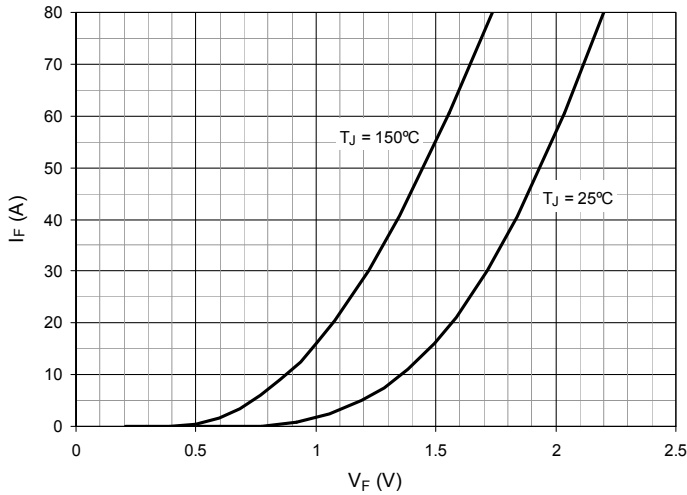


Fig. 23. Reverse Recovery Charge vs.  $-di_F/dt$

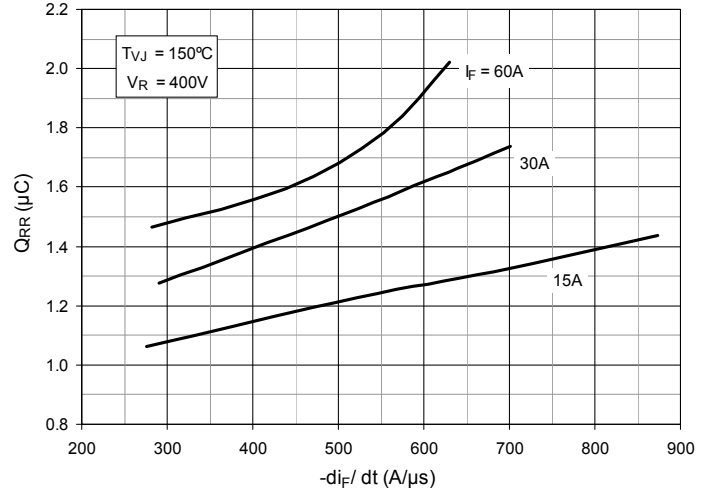


Fig. 24. Reverse Recovery Current vs.  $-di_F/dt$

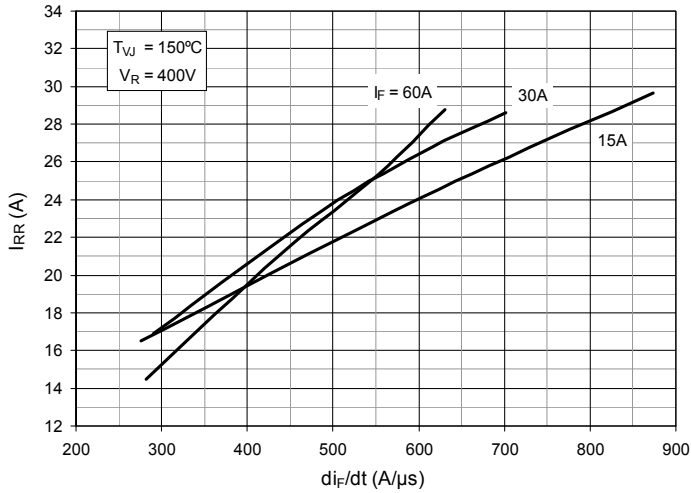


Fig. 25. Reverse Recovery Time vs.  $-di_F/dt$

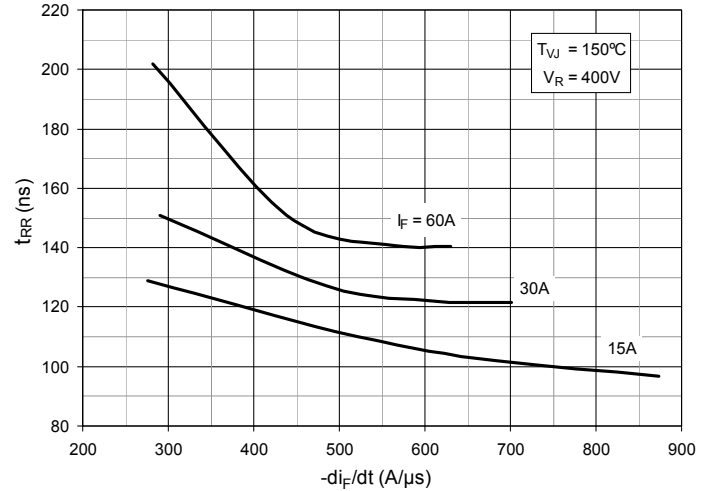


Fig. 26. Dynamic Parameters  $Q_{RR}$ ,  $I_{RR}$  vs. Junction Temperature

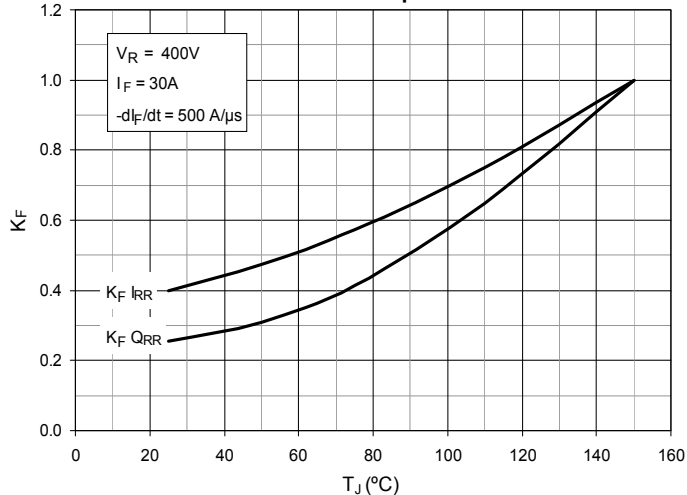


Fig. 27. Maximum Transient Thermal Impedance (Diode)

