IXYS

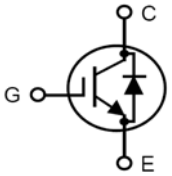
Preliminary Technical Information

# XPT™ 650V IGBT GenX3™ w/Diode

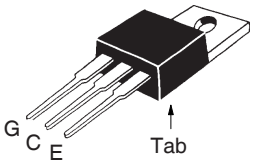
# IXYP10N65C3D1

$V_{CES}$ = 650V
$I_{C110}$ = 10A
$V_{CE(sat)}$ ≤ 2.50V
$t_{fi(typ)}$ = 23ns

Extreme Light Punch Through IGBT for 20-60kHz Switching




TO-220




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

| Symbol | Test Conditions | Maximum Ratings | |
|---|---|---|---|
| $V_{CES}$ | $T_J$ = 25°C to 175°C | 650 | V |
| $V_{CGR}$ | $T_J$ = 25°C to 175°C, $R_{GE}$ = 1MΩ | 650 | V |
| $V_{GES}$ | Continuous | ±20 | V |
| $V_{GEM}$ | Transient | ±30 | V |
| $I_{C25}$ | $T_C$ = 25°C | 30 | A |
| $I_{C110}$ | $T_C$ = 110°C | 10 | A |
| $I_{F110}$ | $T_C$ = 110°C | 9 | A |
| $I_{CM}$ | $T_C$ = 25°C, 1ms | 54 | A |
| $I_A$ | $T_C$ = 25°C | 5 | A |
| $E_{AS}$ | $T_C$ = 25°C | 50 | mJ |
| SSOA (RBSOA) | $V_{GE}$ = 15V, $T_{VJ}$ = 150°C, $R_G$ = 50Ω Clamped Inductive Load | $I_{CM}$ = 20 $V_{CE} \leq V_{CES}$ | A |
| $t_{sc}$ (SCSOA) | $V_{GE}$ = 15V, $V_{CE}$ = 360V, $T_J$ = 150°C $R_G$ = 150Ω, Non Repetitive | 8 | μs |
| $P_C$ | $T_C$ = 25°C | 160 | W |
| $T_J$ | | -55 ... +175 | °C |
| $T_{JM}$ | | 175 | °C |
| $T_{stg}$ | | -55 ... +175 | °C |
| $T_L$ | Maximum Lead Temperature for Soldering | 300 | °C |
| $T_{SOLD}$ | 1.6 mm (0.062in.) from Case for 10s | 260 | °C |
| $M_d$ | Mounting Torque | 1.13/10 | Nm/lb.in. |
| Weight | | 2.5 | g |

| Symbol | Test Conditions ($T_J$ = 25°C, Unless Otherwise Specified) | Characteristic Values Min. | Typ. | Max. | |
|---|---|---|---|---|---|
| $BV_{CES}$ | $I_C$ = 250μA, $V_{GE}$ = 0V | 650 | | | V |
| $V_{GE(th)}$ | $I_C$ = 250μA, $V_{CE}$ = $V_{GE}$ | 3.5 | | 6.0 | V |
| $I_{CES}$ | $V_{CE}$ = $V_{CES}$, $V_{GE}$ = 0V | | | 10 | μA |
| | $T_J$ = 150°C | | | 200 | μA |
| $I_{GES}$ | $V_{CE}$ = 0V, $V_{GE}$ = ±20V | | | ±100 | nA |
| $V_{CE(sat)}$ | $I_C$ = 10A, $V_{GE}$ = 15V, Note 1 | | 2.27 | 2.50 | V |
| | $T_J$ = 150°C | | 2.54 | | V |

**Features**

- Optimized for 20-60kHz Switching
- Square RBSOA
- Avalanche Rated
- Anti-Parallel Fast Diode
- 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

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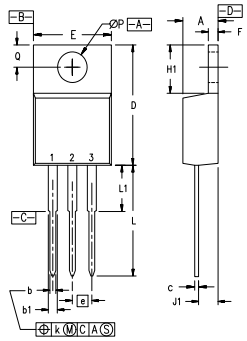
| Symbol | Test Conditions ($T_J$ = 25°C Unless Otherwise Specified) | Characteristic Values Min. | Typ. | Max. | |
|---|---|---|---|---|---|
| $g_{fs}$ | $I_C$ = 10A, $V_{CE}$ = 10V, Note 1 | 3.8 | 6.2 | | S |
| $C_{ies}$ | $V_{CE}$ = 25V, $V_{GE}$ = 0V, f = 1MHz | | 423 | | pF |
| $C_{oes}$ | | | 42 | | pF |
| $C_{res}$ | | | 10 | | pF |
| $Q_{g(on)}$ | $I_C$ = 10A, $V_{GE}$ = 15V, $V_{CE}$ = 0.5 • $V_{CES}$ | | 18 | | nC |
| $Q_{ge}$ | | | 4 | | nC |
| $Q_{gc}$ | | | 8 | | nC |
| $t_{d(on)}$ | **Inductive load, $T_J$ = 25°C** | | 20 | | ns |
| $t_{ri}$ | $I_C$ = 10A, $V_{GE}$ = 15V | | 26 | | ns |
| $E_{on}$ | $V_{CE}$ = 400V, $R_G$ = 50Ω | | 0.24 | | mJ |
| $t_{d(off)}$ | Note 2 | | 77 | | ns |
| $t_{fi}$ | | | 23 | | ns |
| $E_{off}$ | | | 0.11 | 0.17 | mJ |
| $t_{d(on)}$ | **Inductive load, $T_J$ = 150°C** | | 17 | | ns |
| $t_{ri}$ | $I_C$ = 10A, $V_{GE}$ = 15V | | 27 | | ns |
| $E_{on}$ | $V_{CE}$ = 400V, $R_G$ = 50Ω | | 0.44 | | mJ |
| $t_{d(off)}$ | Note 2 | | 90 | | ns |
| $t_{fi}$ | | | 38 | | ns |
| $E_{off}$ | | | 0.15 | | mJ |
| $R_{thJC}$ | | | | 0.94 | °C/W |
| $R_{thCS}$ | | | 0.50 | | °C/W |

**TO-220 Outline**




Pins: 1 - Gate 2 - Collector
3 - Emitter

| SYM | INCHES MIN | INCHES MAX | MILLIMETERS MIN | MILLIMETERS MAX |
|---|---|---|---|---|
| A | .170 | .190 | 4.32 | 4.83 |
| b | .025 | .040 | 0.64 | 1.02 |
| b1 | .045 | .065 | 1.15 | 1.65 |
| c | .014 | .022 | 0.35 | 0.56 |
| D | .580 | .630 | 14.73 | 16.00 |
| E | .390 | .420 | 9.91 | 10.66 |
| e | .100 BSC | | 2.54 BSC | |
| F | .045 | .055 | 1.14 | 1.40 |
| H1 | .230 | .270 | 5.85 | 6.85 |
| J1 | .090 | .110 | 2.29 | 2.79 |
| k | 0 | .015 | 0 | 0.38 |
| L | .500 | .550 | 12.70 | 13.97 |
| L1 | .110 | .230 | 2.79 | 5.84 |
| ØP | .139 | .161 | 3.53 | 4.08 |
| Q | .100 | .125 | 2.54 | 3.18 |

**Reverse Diode (FRED)**

| Symbol | Test Conditions ($T_J$ = 25°C, Unless Otherwise Specified) | Characteristic Values Min. | Typ. | Max. | |
|---|---|---|---|---|---|
| $V_F$ | $I_F$ = 10A, $V_{GE}$ = 0V, Note 1 | | | 2.5 | V |
| | $T_J$ = 150°C | | 1.5 | | V |
| $I_{RM}$ | $I_F$ = 10A, $V_{GE}$ = 0V, $-di_F/dt$ = 200A/μs, $V_R$ = 400V, $T_J$ = 150°C | | 6.3 | | A |
| $t_{rr}$ | | | 170 | | ns |
| $R_{thJC}$ | | | | 2.30 | °C/W |

Notes:

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

**PRELIMANARY 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 4,860,072 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 @ $T_J$ = 25ºC**

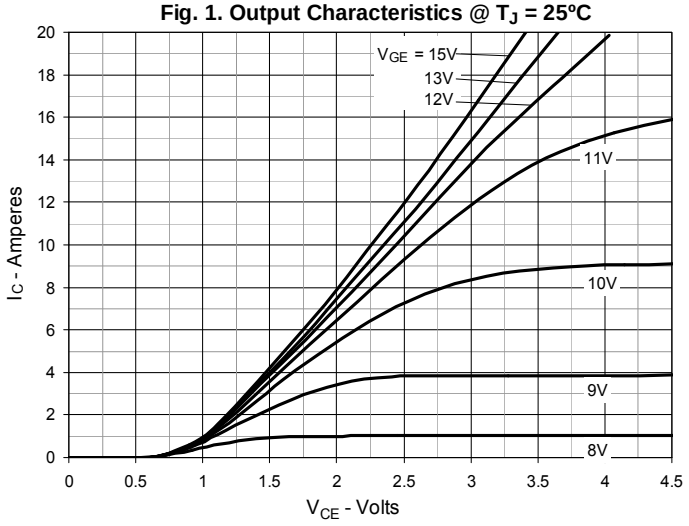



**Fig. 2. Extended Output Characteristics @ $T_J$ = 25ºC**

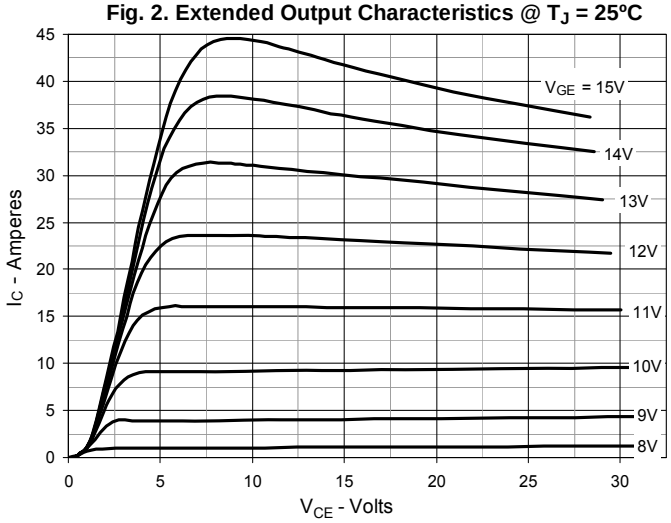



**Fig. 3. Output Characteristics @ $T_J$ = 150ºC**

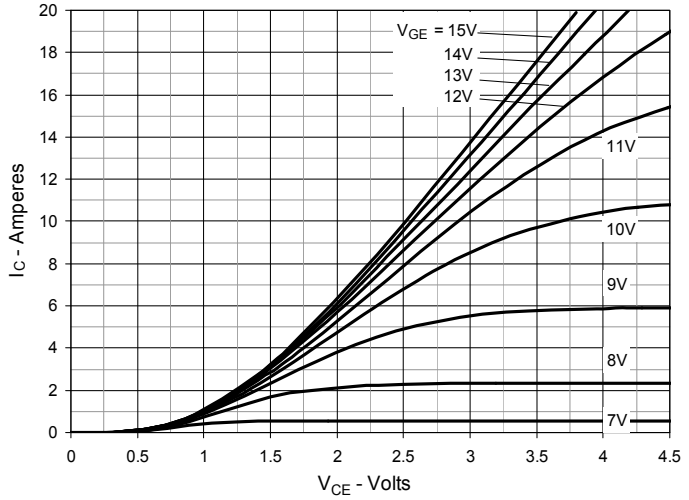



**Fig. 4. Dependence of $V_{CE(sat)}$ on Junction Temperature**

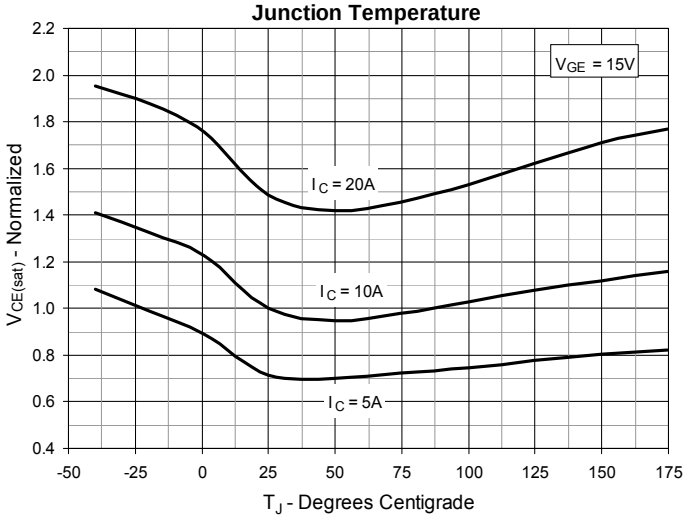



**Fig. 5. Collector-to-Emitter Voltage vs. Gate-to-Emitter Voltage**

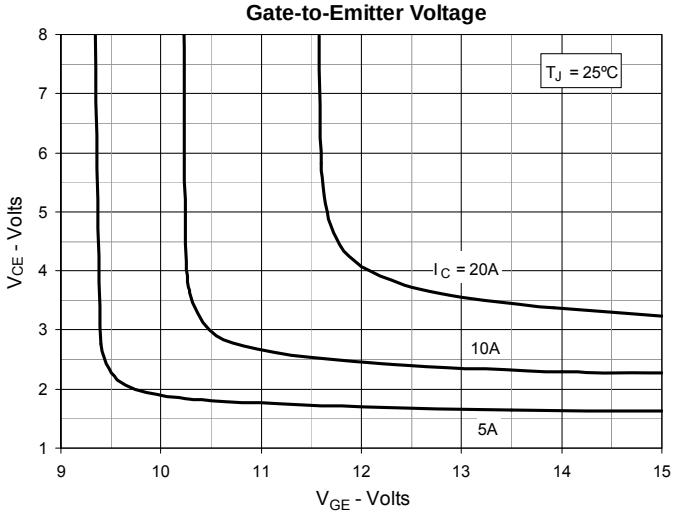



**Fig. 6. Input Admittance**

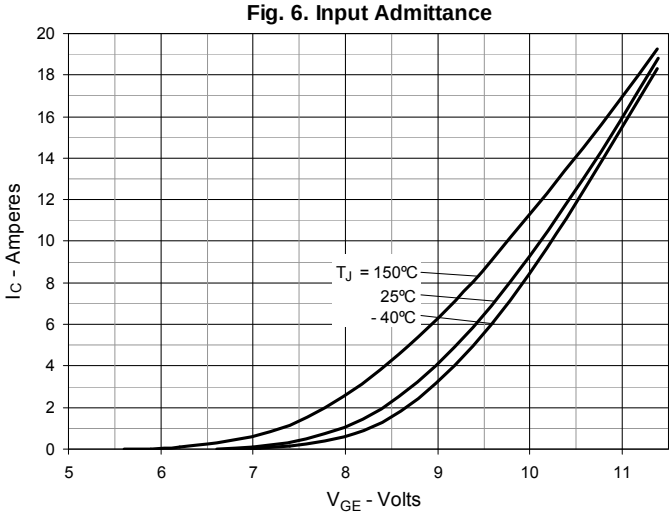



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**Fig. 7. Transconductance**

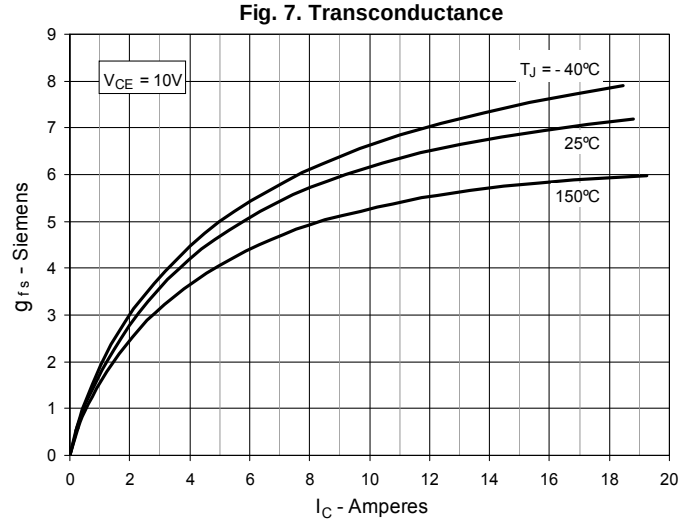



**Fig. 8. Gate Charge**

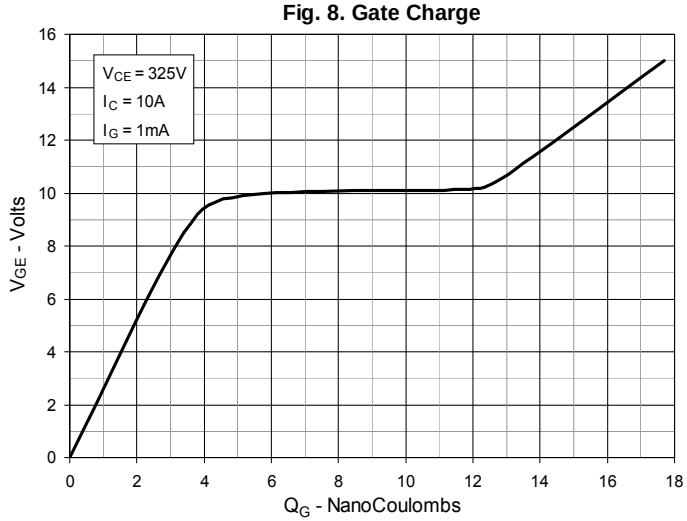



**Fig. 9. Capacitance**

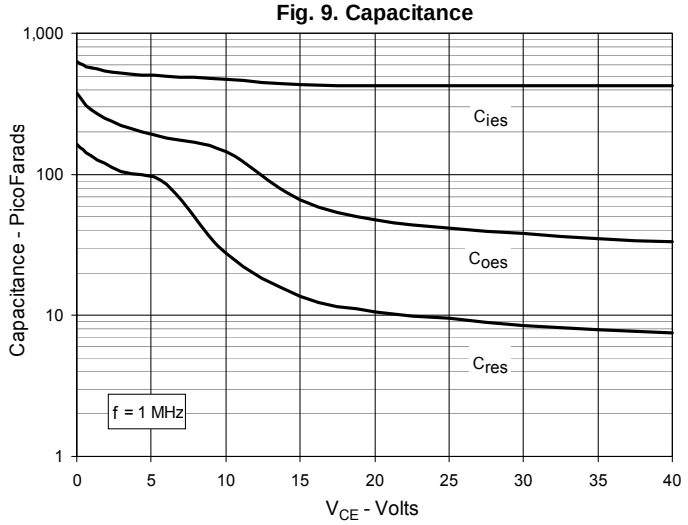



**Fig. 10. Reverse-Bias Safe Operating Area**

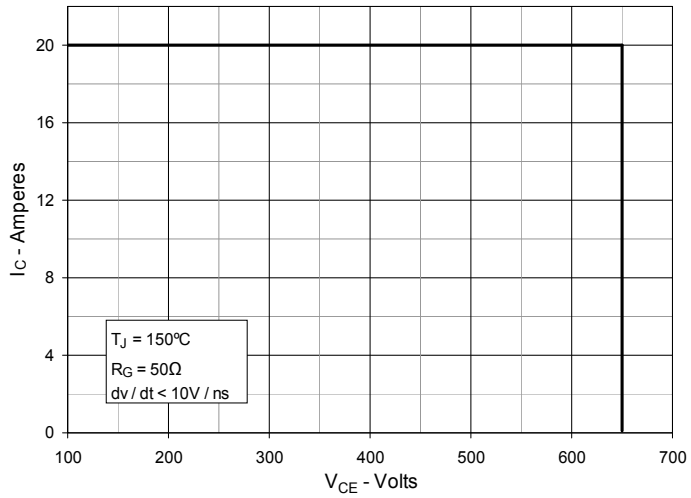



**Fig. 11. Forward-Bias Safe Operating Area**

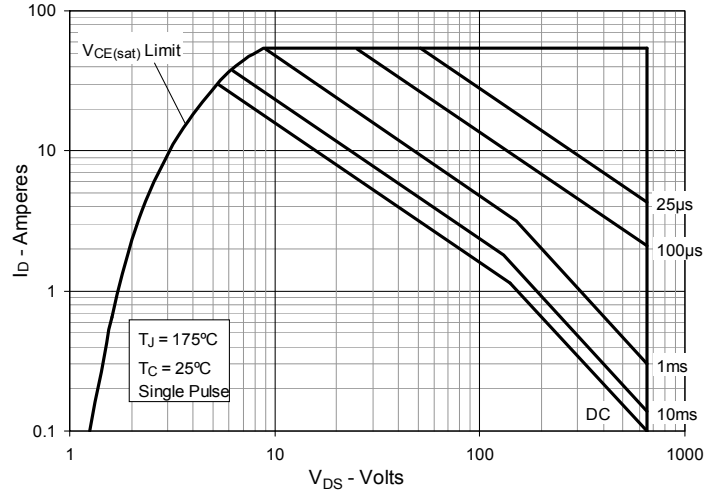
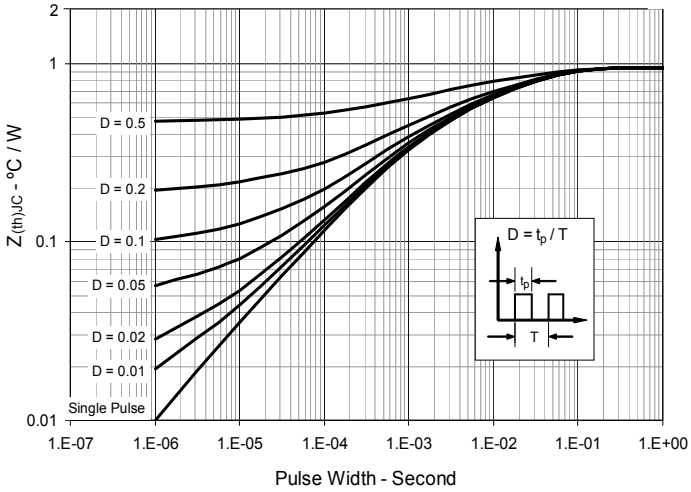



**Fig. 12. Maximum Transient Thermal Impedance (IGBT)**




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

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

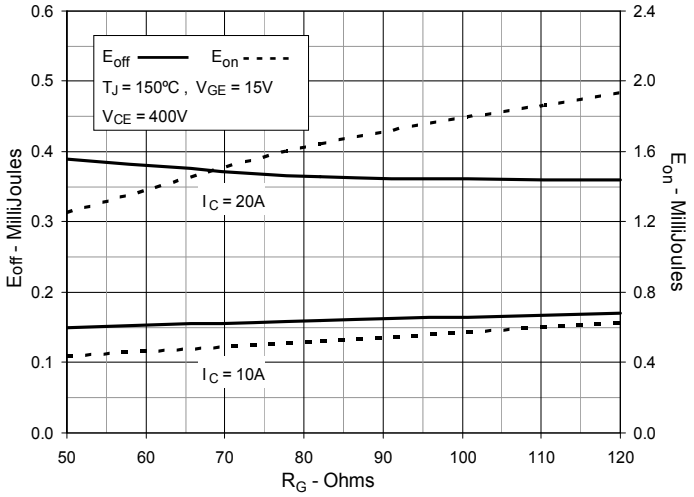



**Fig. 14. Inductive Switching Energy Loss vs. Collector Current**

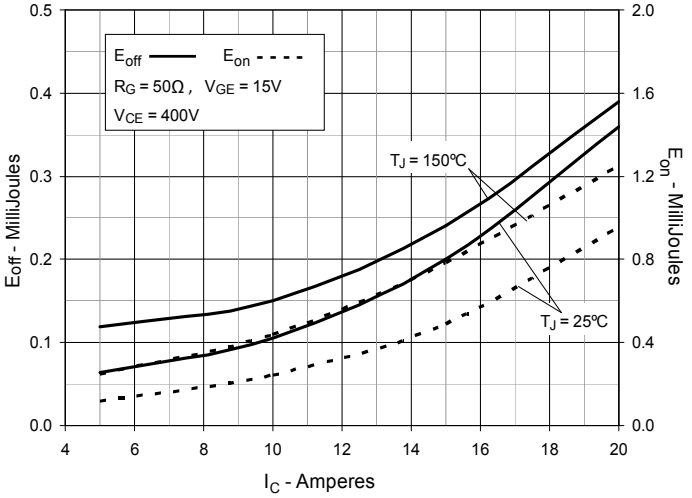



**Fig. 15. Inductive Switching Energy Loss vs. Junction Temperature**

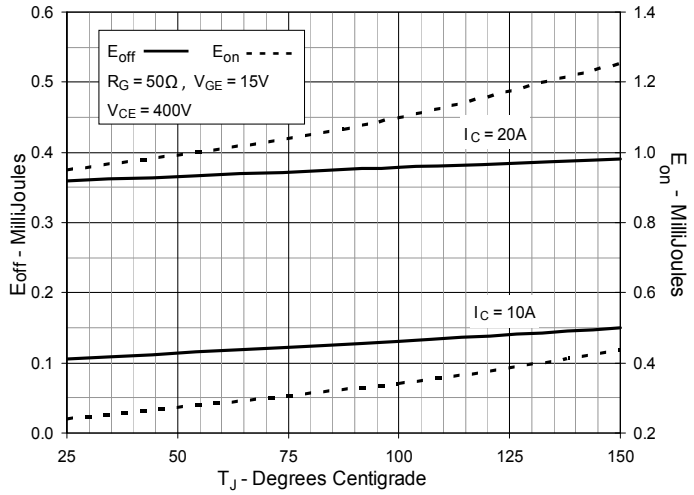



**Fig. 16. Inductive Turn-off Switching Times vs. Gate Resistance**

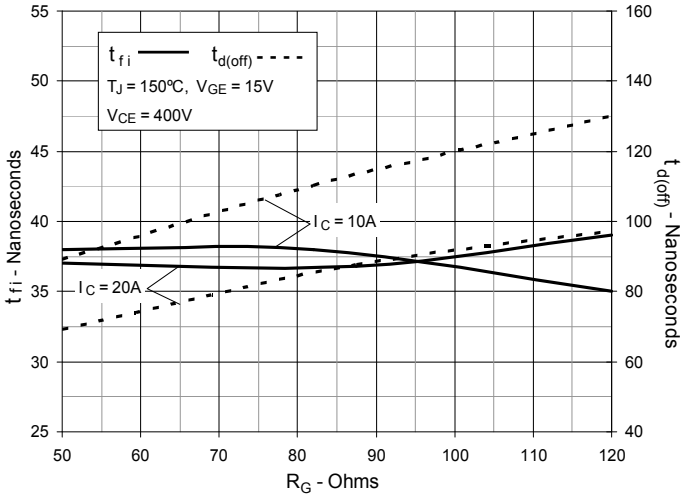



**Fig. 17. Inductive Turn-off Switching Times vs. Collector Current**

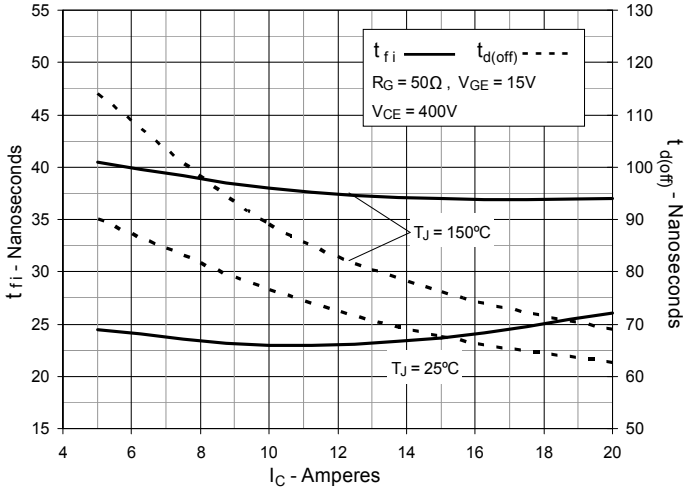



**Fig. 18. Inductive Turn-off Switching Times vs. Junction Temperature**

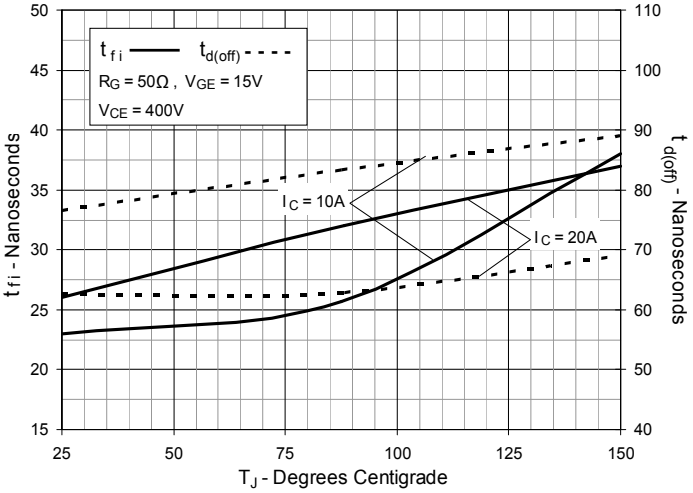



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**Fig. 19. Inductive Turn-on Switching Times vs. Gate Resistance**

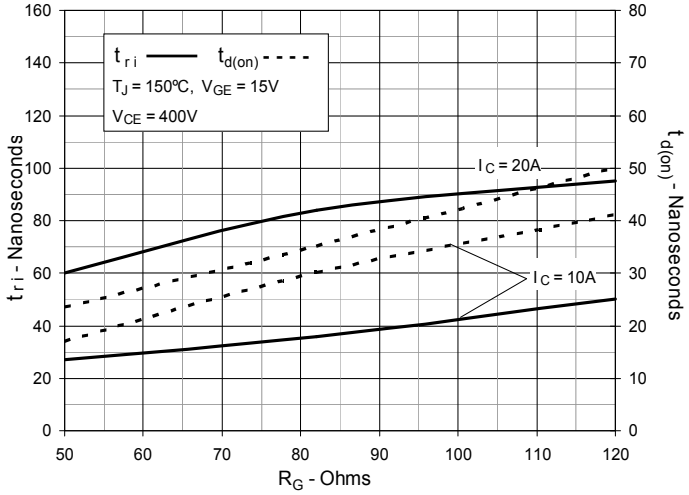


**Fig. 20. Inductive Turn-on Switching Times vs. Collector Current**

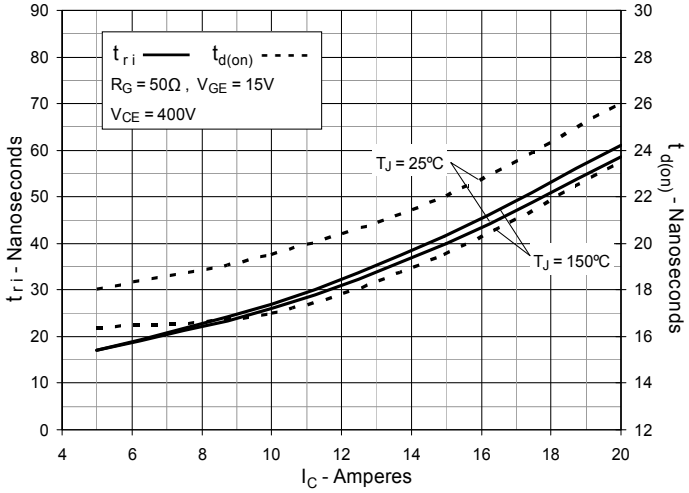


**Fig. 21. Inductive Turn-on Switching Times vs. Junction Temperature**

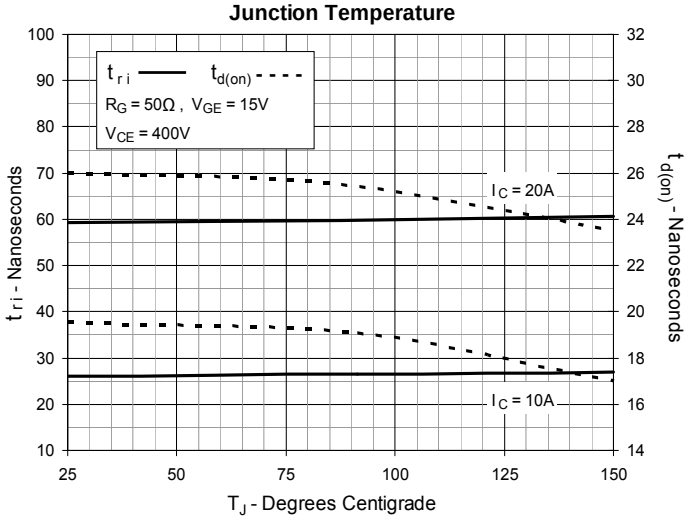


**Fig. 22. Diode Forward Characteristics**

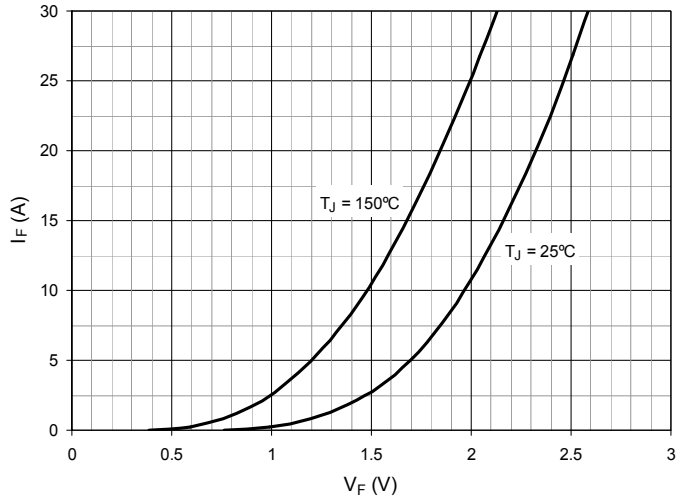


**Fig. 23. Reverse Recovery Charge vs. -di$_F$/dt**

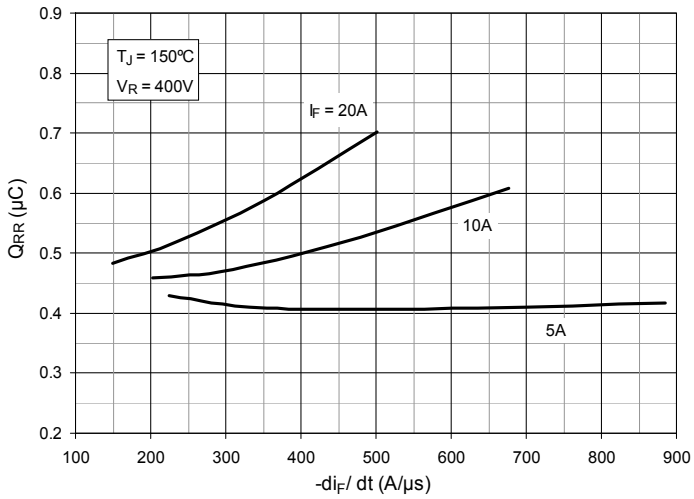


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**Fig. 24. Reverse Recovery Current vs. -di$_F$/dt**

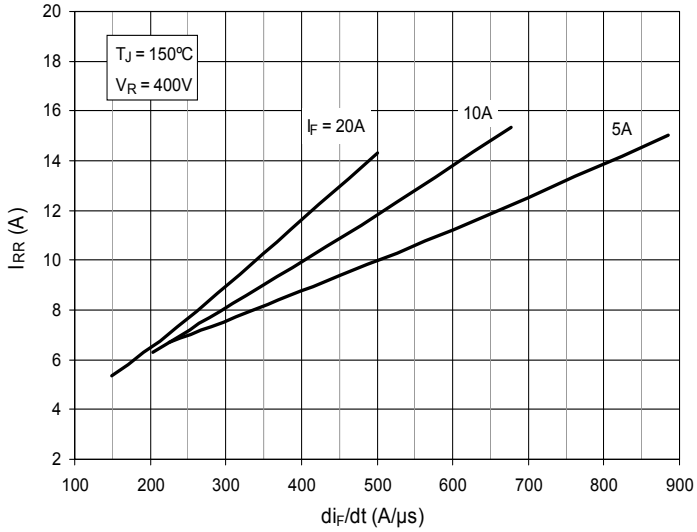



**Fig. 25. Reverse Recovery Time vs. -di$_F$/dt**

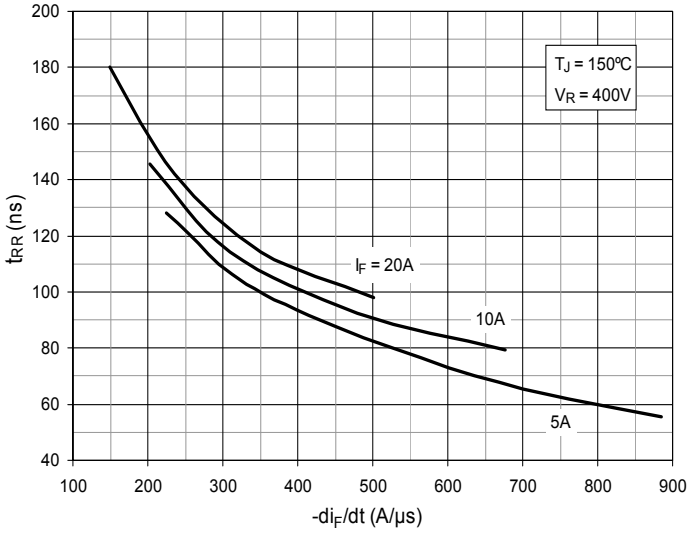



**Fig. 26. Dynamic Parameters $Q_{RR}$, $I_{RR}$ vs. Junction Temperature**

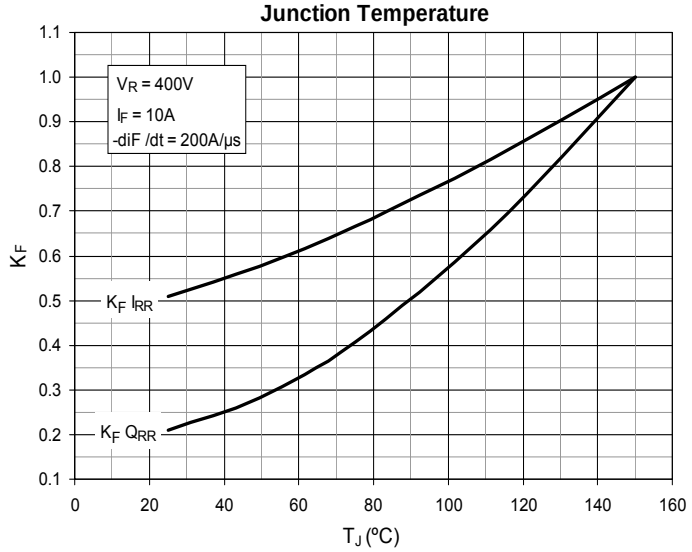



**Fig. 27. Maximum Transient Thermal Impedance (Diode)**

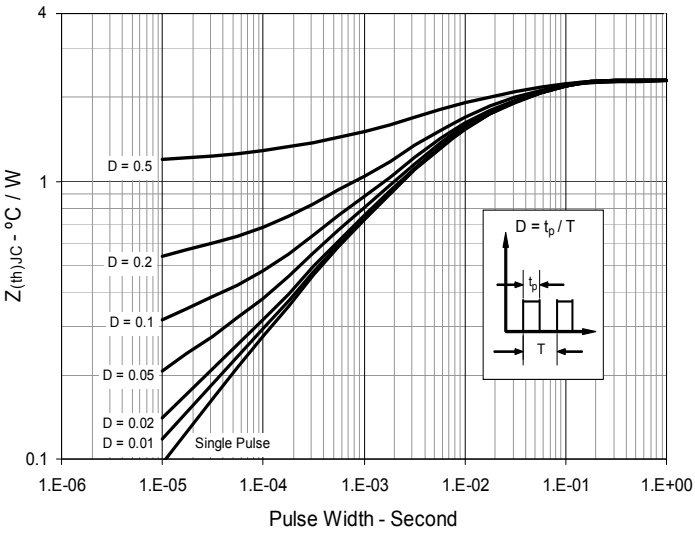
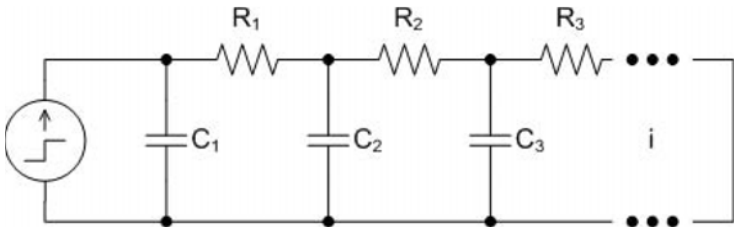



**Fig. 28. Cauer Thermal Network**




**IGBT**

| i | Ri (°C/W) | Ci (J/°C) |
|---|---|---|
| 1 | 0.314390 | 0.00097276 |
| 2 | 0.289260 | 0.00981820 |
| 3 | 0.090928 | 0.07681600 |

**DIODE**

| i | Ri (°C/W) | Ci (J/°C) |
|---|---|---|
| 1 | 0.862020 | 0.00082372 |
| 2 | 0.650090 | 0.00427340 |
| 3 | 0.192070 | 0.05408700 |

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