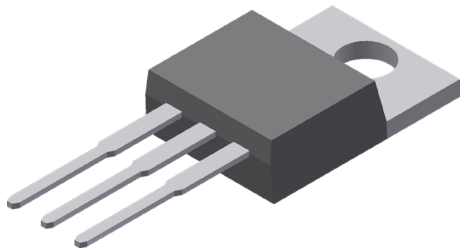
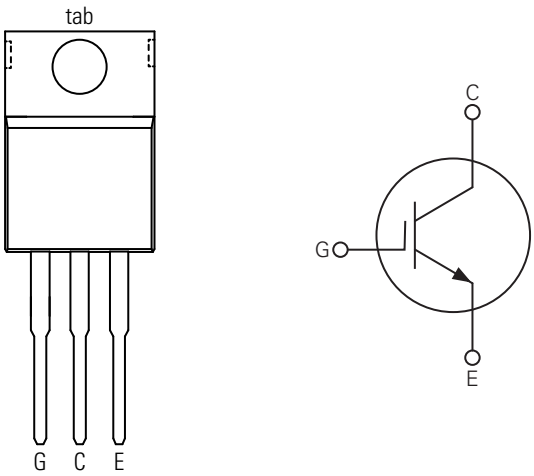
# IXYP48N65A5

## 650 V, 48 A Gen5 XPT™ IGBT

Extreme Light Punch Through IGBT for up to 5 kHz Switching



## Pinout Diagram (TO-220-3L)




**G:** Gate; **C:** Collector; **E:** Emitter, **tab:** Collector

## Description

Developed using our proprietary XPT™ thin-wafer technology and state-of-the-art Trench IGBT process, these devices feature reduced thermal resistance, low conduction losses, and low gate driver requirements.

## Features & Benefits

- Optimized for low conduction losses
- High Surge Current Capability
- Square RBSOA
- International Standard Package
- Low Gate Charge $Q_G$
- Low Gate Drive Requirement

## Applications

- Power Inverters
- UPS
- PFC Circuits
- Battery Chargers
- Welding Machines
- Lamp Ballasts
- Inrush Current Protection Circuits

## Product Summary

| Characteristic | Value | Unit |
|---|---|---|
| $V_{CES}$ | 650 | V |
| $I_{C110}$ | 48 | A |
| $V_{CE(sat)}$ | 1.40 | V |
| $t_{fi(typ)}$ | 137 | ns |

## Maximum Ratings

| Symbol | Characteristic | Conditions | Value | Unit |
|---|---|---|---|---|
| $V_{CES}$ | Collector-Emitter Voltage | $T_J$ = 25 °C to 175 °C | 650 | V |
| $V_{GES}$ | Gate-Emitter Voltage | Continuous | ±20 | V |
| $V_{GEM}$ | Transient Gate-Emitter Voltage | Transient, <1ms | ±30 | V |
| $I_{C25}$ | Continuous Collector Current | $T_C$ = 25 °C | 130 | A |
| $I_{C110}$ | Continuous Collector Current | $T_C$ = 110 °C | 48 | A |
| $I_{CM}$ | Pulsed Collector Current | $T_C$ = 25 °C, 1 ms | 236 | A |
| SSOA (RBSOA) | Switching Safe Operating Area (Reverse Biased Safe Operating Area) | $V_{GE}$ = 15 V, $T_{VJ}$ = 150 °C, $R_G$ = 10 Ω, Clamped Inductive Load, $I_{CM}$ @ $V_{CE} \le V_{CES}$ | 80 | A |
| $P_C$ | Collector Power Dissipation | $T_C$ = 25 °C | 326 | W |
| $T_J$ | Junction Temperature | - | -55 to 175 | °C |
| $T_{JM}$ | Maximum Junction Temperature | - | 175 | °C |
| $T_{stg}$ | Storage Temperature | - | -55 to 175 | °C |
| $T_L$ | Lead Temperature for Soldering | 1.6 mm (0.062 in.) from Case for 10 s | 300 | °C |
| $M_d$ | Mounting Torque | - | 1.13 / 10 | Nm / lb.in |
| W | Weight | - | 3 | g |

## Thermal Characteristics

| Symbol | Characteristic | Value | | | Unit |
|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | |
| $R_{th,JC}$ | Thermal Resistance, junction-to-case | - | - | 0.46 | °C/W |
| $R_{th,CS}$ | Thermal Resistance, case-to-sink | - | 0.50 | - | °C/W |

## Electrical Characteristics - Static ($T_J$ = 25 °C unless otherwise specified)

| Symbol | Characteristic | Conditions | Value | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| $BV_{CES}$ | Collector-Emitter Breakdown Voltage | $I_C$ = 250 µA, $V_{GE}$ = 0 V | 650 | - | - | V |
| $V_{GE(th)}$ | Gate-Emitter Threshold Voltage | $I_C$ = 250 µA, $V_{GE}$ = $V_{CE}$ | 3.7 | - | 5.8 | V |
| $I_{GES}$ | Gate-Emitter Leakage Current | $V_{CE}$ = 0 V, $V_{GE}$ = ±20 V | - | - | ±100 | nA |
| $I_{CES}$ | Zero Gate Voltage Collector Current | $V_{CE}$ = $V_{CES}$, $V_{GE}$ = 0 V | - | - | 5 | µA |
| | | $V_{CE}$ = $V_{CES}$, $V_{GE}$ = 0 V, $T_J$ = 150 °C | - | - | 250 | µA |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage [1] | $I_C$ = 30 A, $V_{GE}$ = 15 V | - | 1.27 | 1.40 | V |
| | | $I_C$ = 30 A, $V_{GE}$ = 15 V, $T_J$ = 150 °C | - | 1.35 | - | V |

**Note 1:** Pulse test, t ≤ 300 µs; duty cycle, d ≤ 2%

## Electrical Characteristics - Dynamic ($T_J$ = 25 °C unless otherwise specified)

| Symbol | Characteristic | Conditions | | Value | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| $g_{fs}$ | Transconductance [1] | $I_C$ = 30 A, $V_{CE}$ = 10 V | | 17 | 28 | - | S |
| $C_{ies}$ | Input Capacitance | $V_{GE}$ = 0 V, $V_{CE}$ = 25 V, f = 1 MHz | | - | 1500 | - | pF |
| $C_{oes}$ | Output Capacitance | | | - | 82 | - | |
| $C_{res}$ | Reverse Transfer Capacitance | | | - | 60 | - | |
| $Q_{g(on)}$ | Total Gate Charge | $V_{GE}$ = 15 V, $V_{CE}$ = 0.5 × $V_{CES}$, $I_C$ = 30 A | | - | 100 | - | nC |
| $Q_{ge}$ | Gate-Emitter Charge | | | - | 9 | - | |
| $Q_{gc}$ | Gate-Collector (Miller) Charge | | | - | 50 | - | |
| $t_{d(on)}$ | Turn-on Delay Time [2] | Inductive Load, $V_{GE}$ = 15 V, $V_{CE}$ = 400 V, $I_C$ = 30 A, $R_{G(ext)}$ = 5 Ω | $T_J$ = 25 °C | - | 20 | - | ns |
| | | | $T_J$ = 150 °C | - | 15 | - | |
| $t_{ri}$ | Turn-on Rise Time [2] | | $T_J$ = 25 °C | - | 20 | - | ns |
| | | | $T_J$ = 150 °C | - | 24 | - | |
| $E_{on}$ | Turn-on Energy [2] | | $T_J$ = 25 °C | - | 0.40 | - | mJ |
| | | | $T_J$ = 150 °C | - | 0.87 | - | |
| $t_{d(off)}$ | Turn-off Delay Time [2] | | $T_J$ = 25 °C | - | 205 | - | ns |
| | | | $T_J$ = 150 °C | - | 235 | - | |
| $t_{fi}$ | Turn-off Fall Time [2] | | $T_J$ = 25 °C | - | 137 | - | ns |
| | | | $T_J$ = 150 °C | - | 247 | - | |
| $E_{off}$ | Turn-off Energy [2] | | $T_J$ = 25 °C | - | 1.25 | - | mJ |
| | | | $T_J$ = 150 °C | - | 1.80 | - | |

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

## Characteristic Curves

**Fig. 1. Output Characteristics ($T_J$ = 25 °C)**

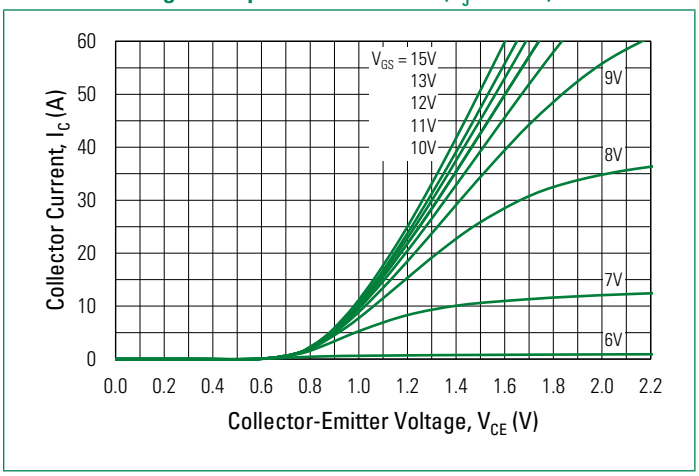



**Fig. 2. Extended Output Characteristics ($T_J$ = 25 °C)**

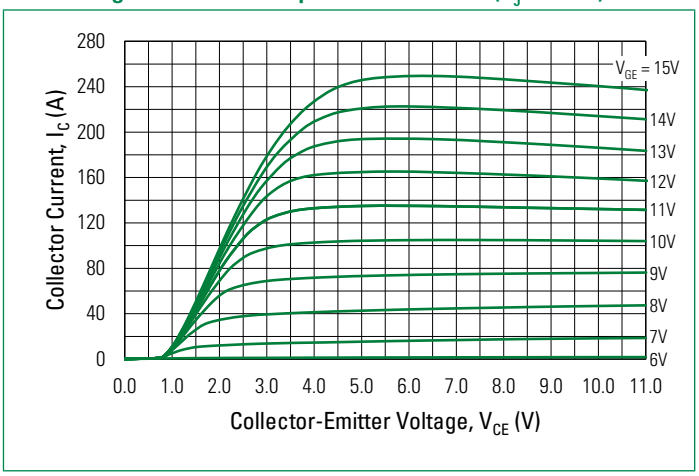


**Fig. 3. Output Characteristics ($T_J$ = 150 °C)**

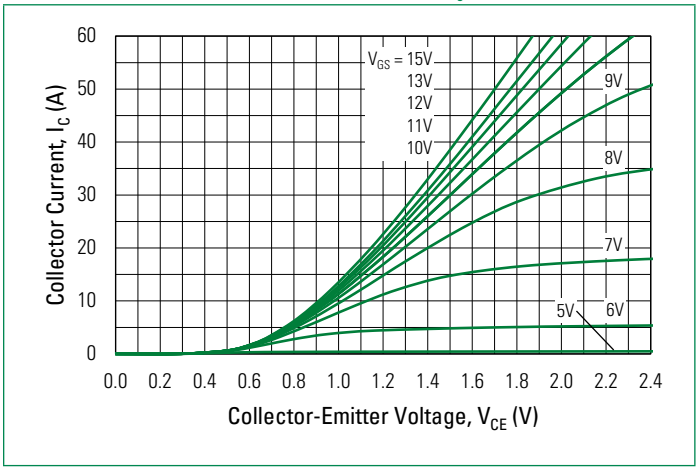



**Fig. 4. Dependence of $V_{CE(sat)}$ on Junction Temperature**

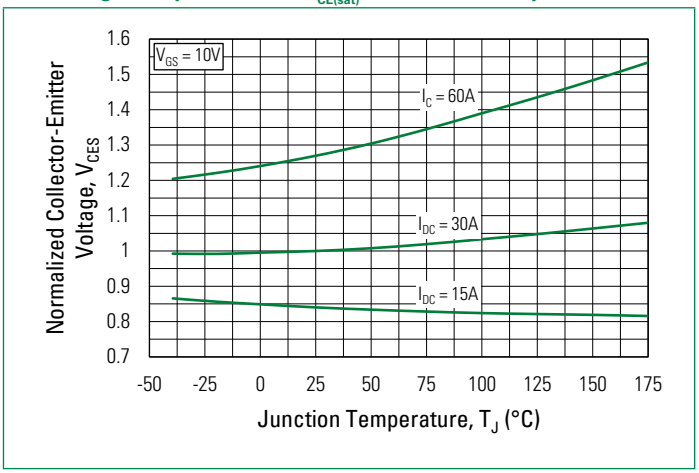



**Fig. 5. Collector-to-Emitter Voltage vs. Gate-to-Emitter Voltage**

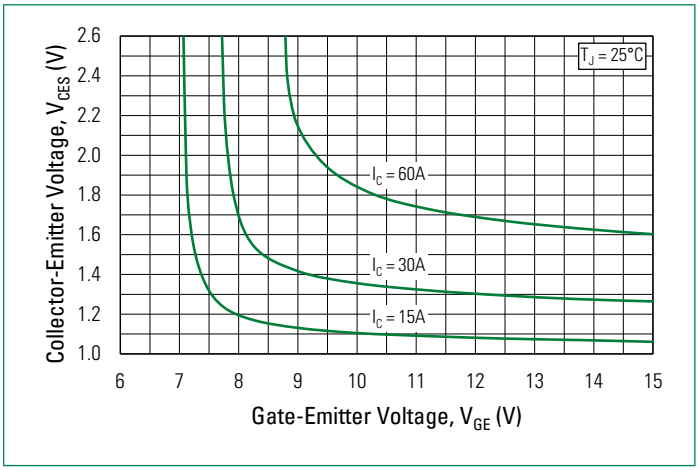



**Fig. 6. Input Admittance**

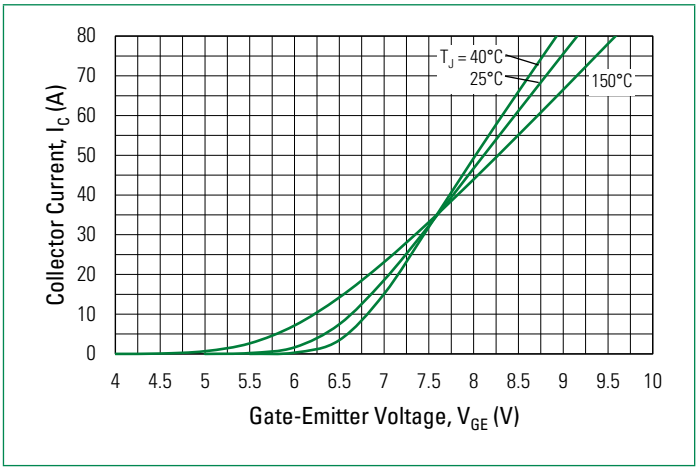



**Fig. 7. Transconductance**

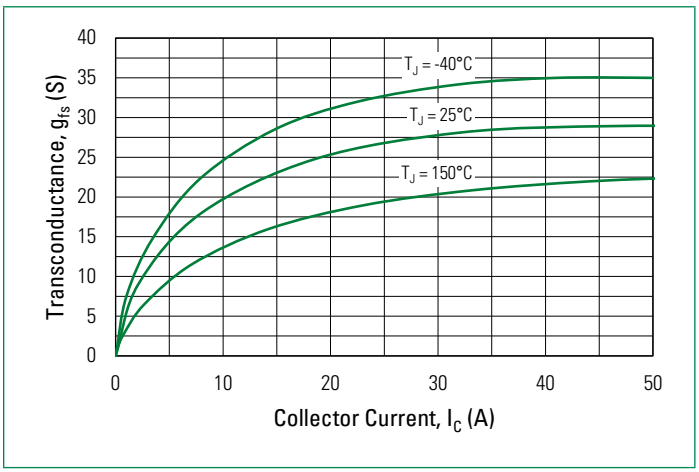



**Fig. 8. Gate Charge**

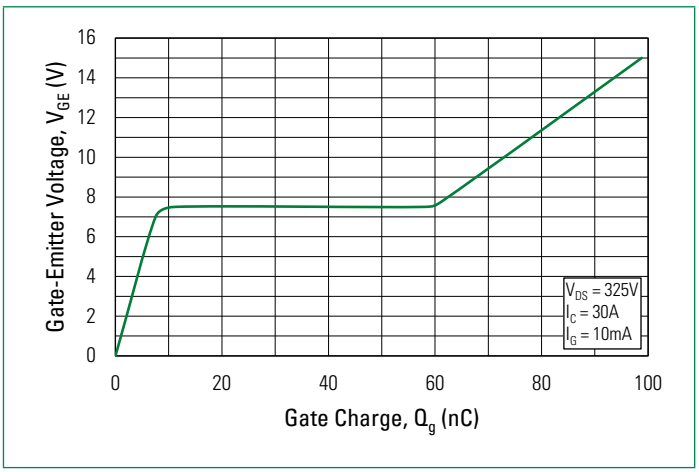


**Fig. 9. Capacitance**

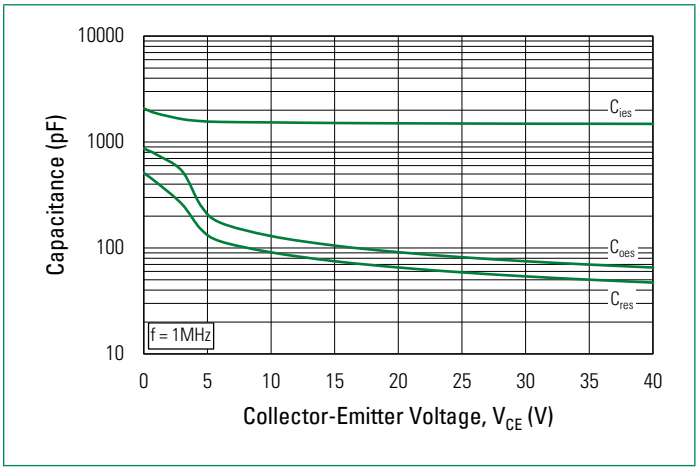



**Fig. 10. Reverse-Bias Safe Operating Area**

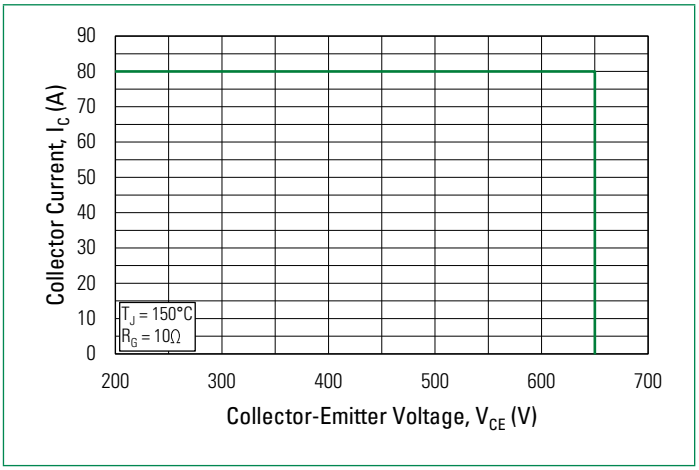



**Fig. 11. Maximum Transient Thermal Impedance**

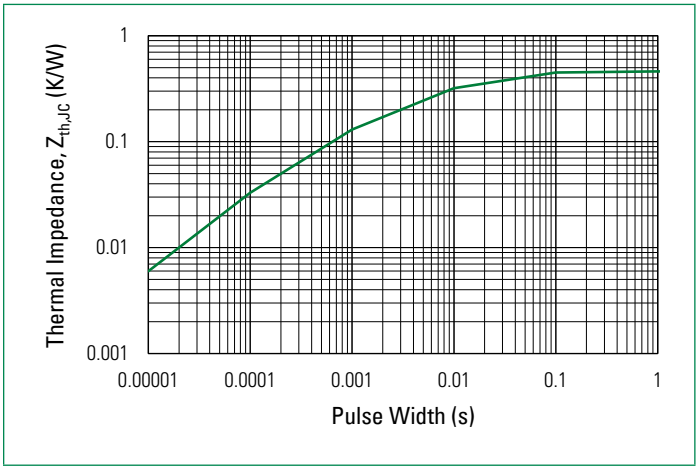



**Fig. 12. Inductive Switching Energy Loss vs. Collector Current**

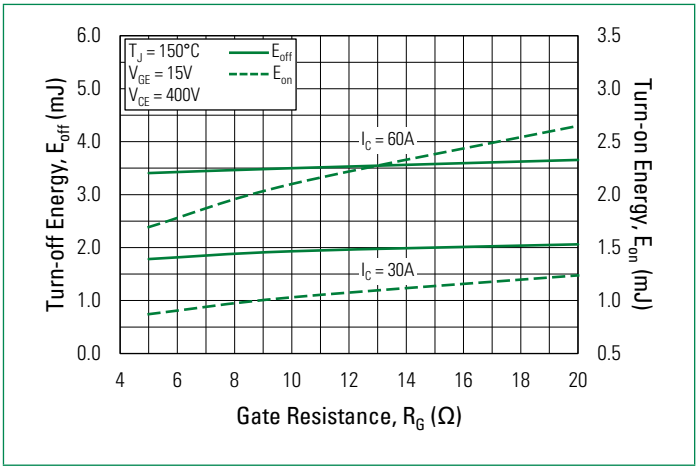



**Fig. 13. Inductive Switching Energy Loss vs. Gate Resistance**

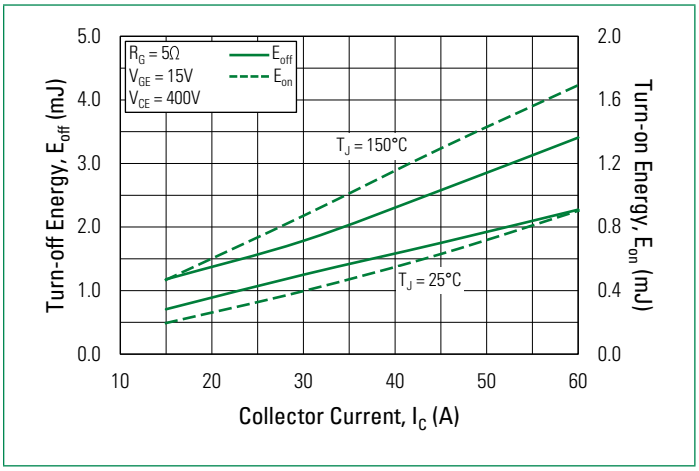



**Fig. 14. Inductive Switching Energy vs. Junction Temperature**

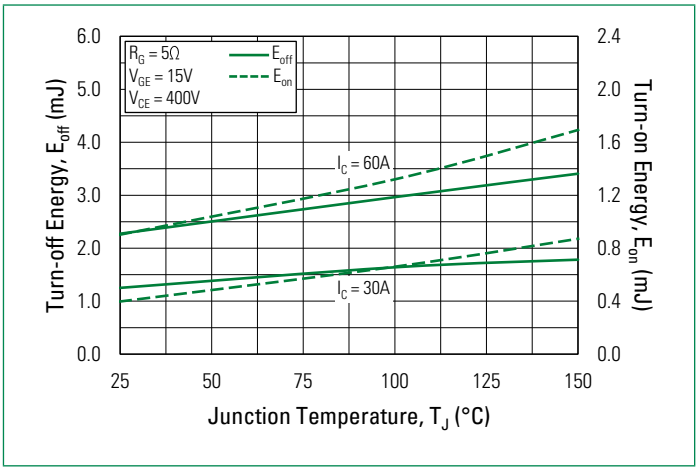


**Fig. 15. Inductive Turn-off Switching Times vs. Gate Resistance**

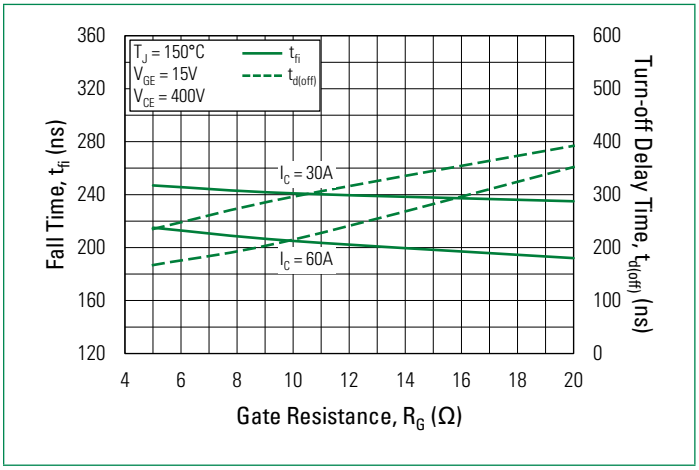



**Fig. 16. Inductive Turn-off Switching Times vs. Collector Current**

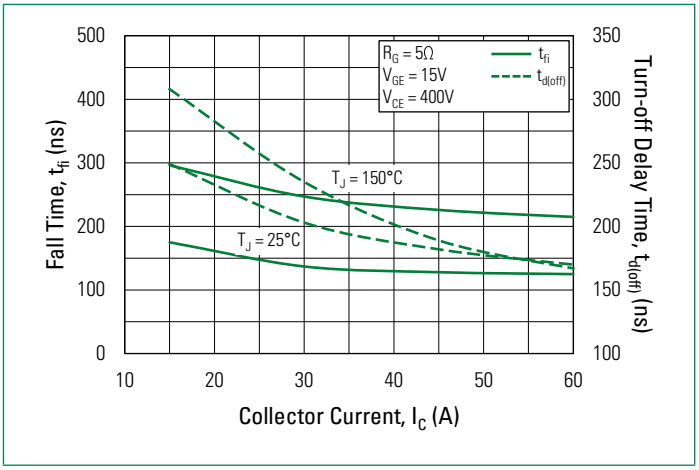



**Fig. 17. Inductive Turn-off Switching Times vs. Junction Temperature**

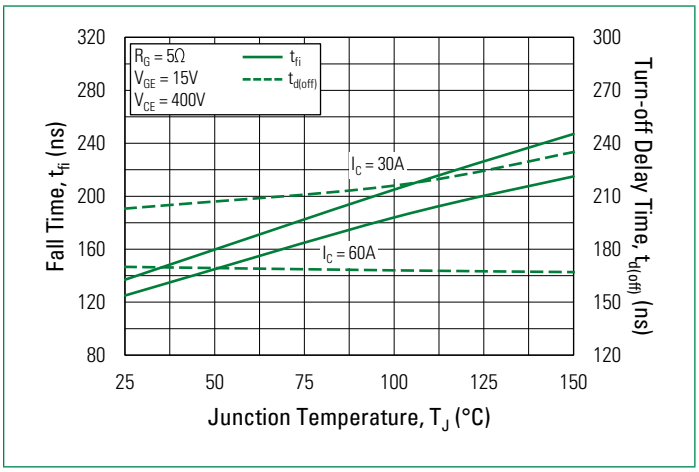



**Fig. 18. Inductive Turn-on Switching Times vs. Gate Resistance**

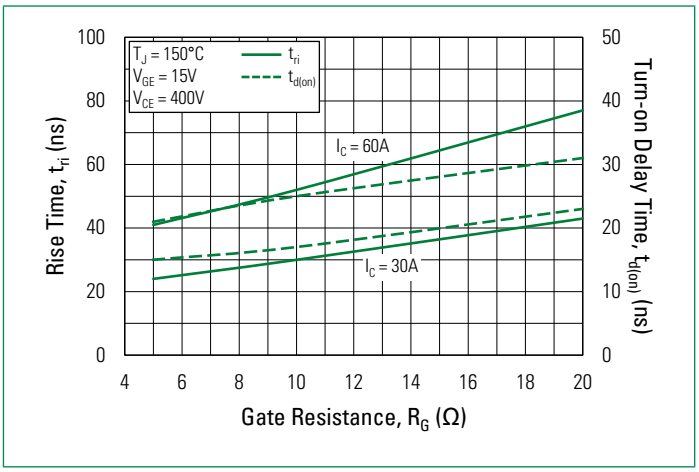



**Fig. 19. Inductive Turn-on Switching Times vs. Collector Current**

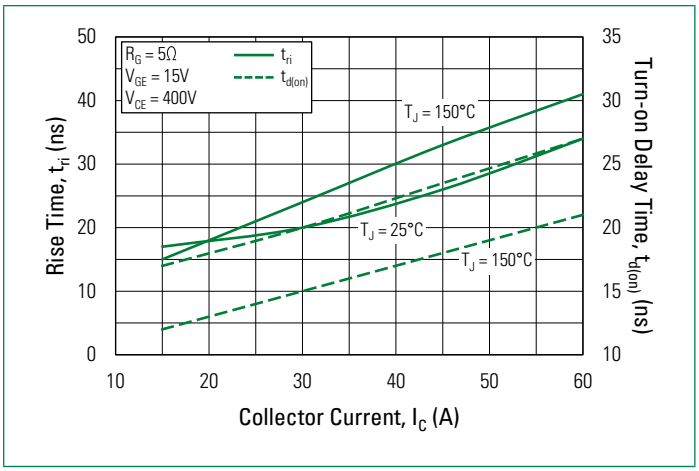



**Fig. 20. Inductive Turn-on Switching Times vs. Junction Temperature**

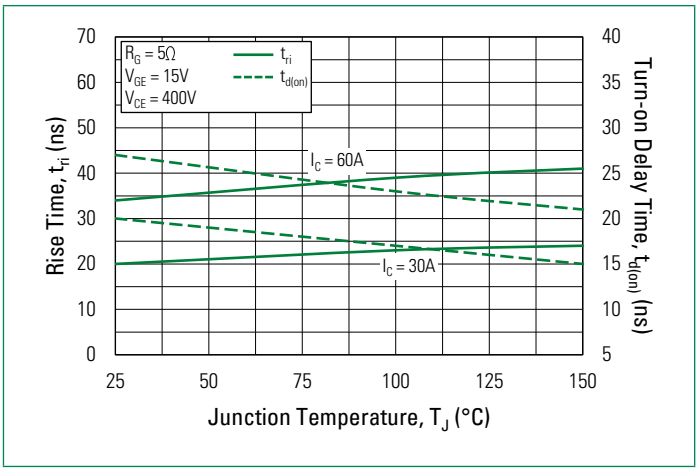
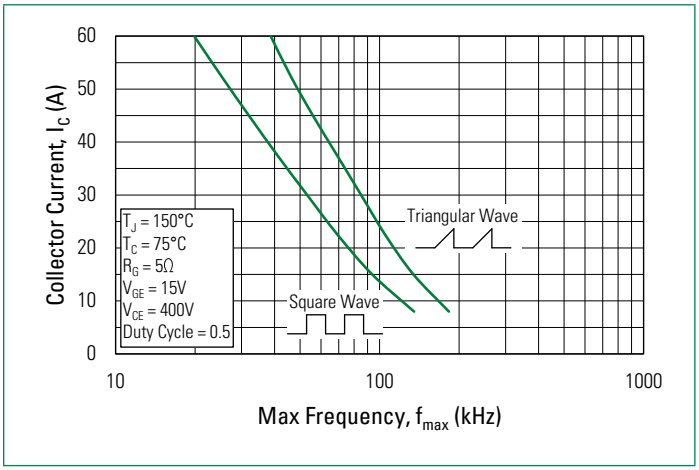
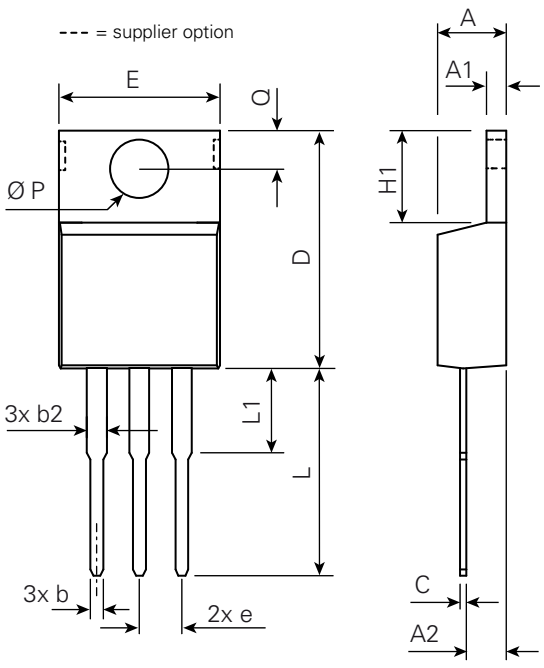


**Fig. 21. Maximum Peak Load Current vs. Frequency**




## Part Outline Drawing (TO-220-3L)




| Symbol | Inches | | Millimeters | |
|---|---|---|---|---|
| | Min. | Max. | Min. | Max. |
| A | 0.170 | 0.190 | 4.32 | 4.82 |
| A1 | 0.045 | 0.055 | 1.14 | 1.39 |
| A2 | 0.090 | 0.110 | 2.29 | 2.79 |
| b | 0.025 | 0.040 | 0.64 | 1.01 |
| b2 | 0.045 | 0.065 | 1.15 | 1.65 |
| C | 0.014 | 0.022 | 0.35 | 0.56 |
| D | 0.580 | 0.630 | 14.73 | 16.00 |
| E | 0.390 | 0.420 | 9.91 | 10.66 |
| e | 0.100 BSC | | 2.54 BSC | |
| H1 | 0.230 | 0.270 | 5.85 | 6.85 |
| L | 0.500 | 0.550 | 12.70 | 13.97 |
| L1 | 0.110 | 0.230 | 2.79 | 5.84 |
| Ø P | 0.139 | 0.161 | 3.54 | 4.08 |
| Q | 0.100 | 0.125 | 2.54 | 3.18 |