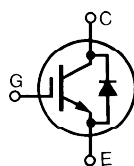


# XPT™ 650V IGBT GenX4™ w/ Sonic Diode

## IXXH40N65B4H1

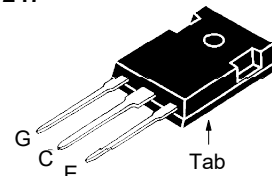


Extreme Light Punch Through  
IGBT for 5-30 kHz Switching

$$\begin{aligned} V_{CES} &= 650V \\ I_{C110} &= 40A \\ V_{CE(sat)} &\leq 2.0V \\ t_{fi(typ)} &= 40ns \end{aligned}$$

| Symbol                        | Test Conditions                                                                                   | Maximum Ratings                         |                  |
|-------------------------------|---------------------------------------------------------------------------------------------------|-----------------------------------------|------------------|
| $V_{CES}$                     | $T_J = 25^\circ\text{C to } 175^\circ\text{C}$                                                    | 650                                     | V                |
| $V_{CGR}$                     | $T_J = 25^\circ\text{C to } 175^\circ\text{C}, R_{GE} = 1M\Omega$                                 | 650                                     | V                |
| $V_{GES}$                     | Continuous                                                                                        | $\pm 20$                                | V                |
| $V_{GEM}$                     | Transient                                                                                         | $\pm 30$                                | V                |
| $I_{C25}$                     | $T_C = 25^\circ\text{C}$ (Chip Capability)                                                        | 123                                     | A                |
| $I_{C110}$                    | $T_C = 110^\circ\text{C}$                                                                         | 40                                      | A                |
| $I_{F110}$                    | $T_C = 110^\circ\text{C}$                                                                         | 40                                      | A                |
| $I_{CM}$                      | $T_C = 25^\circ\text{C}, 1\text{ms}$                                                              | 225                                     | A                |
| <b>SSOA</b><br><b>(RBSOA)</b> | $V_{GE} = 15V, T_{VJ} = 150^\circ\text{C}, R_G = 10\Omega$<br>Clamped Inductive Load              | $I_{CM} = 80$<br>$@V_{CE} \leq V_{CES}$ | A                |
| $t_{sc}$<br><b>(SCSOA)</b>    | $V_{GE} = 15V, V_{CE} = 360V, T_J = 150^\circ\text{C}$<br>$R_G = 82\Omega, \text{Non Repetitive}$ | 10                                      | $\mu\text{s}$    |
| $P_C$                         | $T_C = 25^\circ\text{C}$                                                                          | 455                                     | W                |
| $T_J$                         |                                                                                                   | -55 ... +175                            | $^\circ\text{C}$ |
| $T_{JM}$                      |                                                                                                   | 175                                     | $^\circ\text{C}$ |
| $T_{stg}$                     |                                                                                                   | -55 ... +175                            | $^\circ\text{C}$ |
| $T_L$                         | Maximum Lead Temperature for Soldering<br>1.6 mm (0.062 in.) from Case for 10s                    | 300                                     | $^\circ\text{C}$ |
| $M_d$                         | 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 5-30kHz 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

| Symbol        | Test Conditions<br>( $T_J = 25^\circ\text{C}$ , Unless Otherwise Specified) | Characteristic Values |      |                          |
|---------------|-----------------------------------------------------------------------------|-----------------------|------|--------------------------|
|               |                                                                             | Min.                  | Typ. | Max.                     |
| $BV_{CES}$    | $I_C = 250\mu\text{A}, V_{GE} = 0V$                                         | 650                   |      | V                        |
| $V_{GE(th)}$  | $I_C = 250\mu\text{A}, V_{CE} = V_{GE}$                                     | 4.0                   |      | 6.5 V                    |
| $I_{CES}$     | $V_{CE} = V_{CES}, V_{GE} = 0V$<br>$T_J = 150^\circ\text{C}$                |                       |      | 25 $\mu\text{A}$<br>3 mA |
| $I_{GES}$     | $V_{CE} = 0V, V_{GE} = \pm 20V$                                             |                       |      | $\pm 100$ nA             |
| $V_{CE(sat)}$ | $I_C = 40A, V_{GE} = 15V, \text{Note 1}$<br>$T_J = 150^\circ\text{C}$       | 1.60<br>1.87          |      | 2.00 V<br>V              |

**Symbol Test Conditions**(T<sub>J</sub> = 25°C Unless Otherwise Specified)**Characteristic Values****Min.      Typ.      Max.**

|                           |                                                                                                                                                      |    |      |           |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|----|------|-----------|
| <b>g<sub>fs</sub></b>     | I <sub>C</sub> = 40A, V <sub>CE</sub> = 10V, Note 1                                                                                                  | 14 | 23   | S         |
| <b>C<sub>ies</sub></b>    | <b>        </b><br>V <sub>CE</sub> = 25V, V <sub>GE</sub> = 0V, f = 1MHz                                                                             |    | 2110 | pF        |
| <b>C<sub>oes</sub></b>    |                                                                                                                                                      |    | 200  | pF        |
| <b>C<sub>res</sub></b>    |                                                                                                                                                      |    | 33   | pF        |
|                           |                                                                                                                                                      |    |      |           |
| <b>Q<sub>g(on)</sub></b>  | <b>        </b><br>I <sub>C</sub> = 40A, V <sub>GE</sub> = 15V, V <sub>CE</sub> = 0.5 • V <sub>CES</sub>                                             |    | 66   | nC        |
| <b>Q<sub>ge</sub></b>     |                                                                                                                                                      |    | 16   | nC        |
| <b>Q<sub>gc</sub></b>     |                                                                                                                                                      |    | 27   | nC        |
| <b>t<sub>d(on)</sub></b>  | <b>Inductive load, T<sub>J</sub> = 25°C</b><br>I <sub>C</sub> = 40A, V <sub>GE</sub> = 15V<br>V <sub>CE</sub> = 400V, R <sub>G</sub> = 5Ω<br>Note 2  |    | 19   | ns        |
| <b>t<sub>ri</sub></b>     |                                                                                                                                                      |    | 48   | ns        |
| <b>E<sub>on</sub></b>     |                                                                                                                                                      |    | 1.40 | mJ        |
| <b>t<sub>d(off)</sub></b> |                                                                                                                                                      |    | 112  | ns        |
| <b>t<sub>fi</sub></b>     |                                                                                                                                                      |    | 40   | ns        |
| <b>E<sub>off</sub></b>    |                                                                                                                                                      |    | 0.75 | mJ        |
| <b>t<sub>d(on)</sub></b>  | <b>Inductive load, T<sub>J</sub> = 150°C</b><br>I <sub>C</sub> = 40A, V <sub>GE</sub> = 15V<br>V <sub>CE</sub> = 400V, R <sub>G</sub> = 5Ω<br>Note 2 |    | 17   | ns        |
| <b>t<sub>ri</sub></b>     |                                                                                                                                                      |    | 44   | ns        |
| <b>E<sub>on</sub></b>     |                                                                                                                                                      |    | 2.20 | mJ        |
| <b>t<sub>d(off)</sub></b> |                                                                                                                                                      |    | 134  | ns        |
| <b>t<sub>fi</sub></b>     |                                                                                                                                                      |    | 73   | ns        |
| <b>E<sub>off</sub></b>    |                                                                                                                                                      |    | 1.40 | mJ        |
| <b>R<sub>thJC</sub></b>   |                                                                                                                                                      |    | 0.21 | 0.33 °C/W |
| <b>R<sub>thCS</sub></b>   |                                                                                                                                                      |    |      | °C/W      |

**Reverse Sonic Diode (FRD)****Symbol Test Conditions**(T<sub>J</sub> = 25°C Unless Otherwise Specified)**Characteristic Values****Min.      Typ.      Max.**

|                         |                                                                                                                                     |                              |      |           |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------|------------------------------|------|-----------|
| <b>V<sub>F</sub></b>    | <b>I<sub>F</sub> = 30A, V<sub>GE</sub> = 0V, Note 1</b>                                                                             | <b>T<sub>J</sub> = 150°C</b> | 2.15 | 2.5 V     |
| <b>I<sub>RM</sub></b>   | <b>I<sub>F</sub> = 30A, V<sub>GE</sub> = 0V, T<sub>J</sub> = 150°C</b><br><b>-di<sub>F</sub>/dt = 500A/μs, V<sub>R</sub> = 300V</b> |                              | 25   | A         |
| <b>t<sub>rr</sub></b>   |                                                                                                                                     |                              | 120  | ns        |
| <b>R<sub>thJC</sub></b> |                                                                                                                                     |                              |      | 0.60 °C/W |

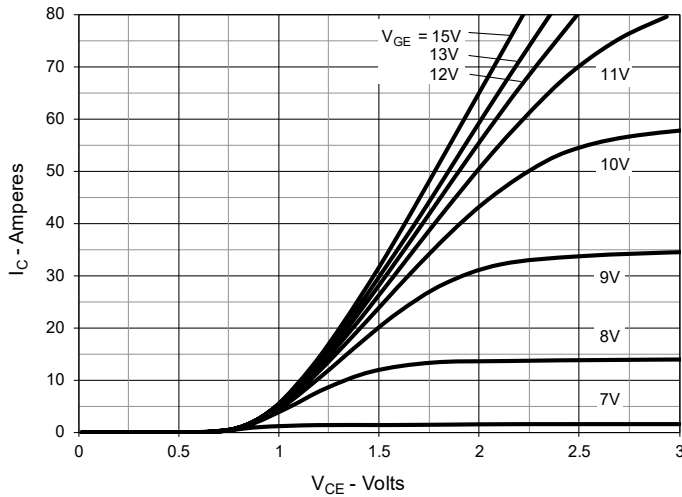
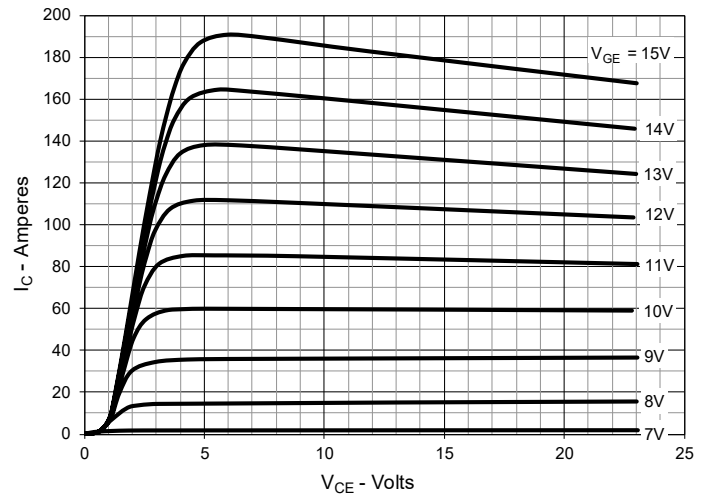
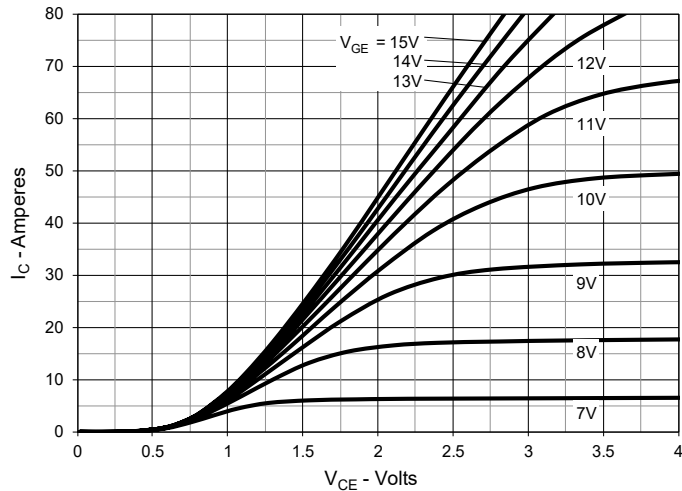
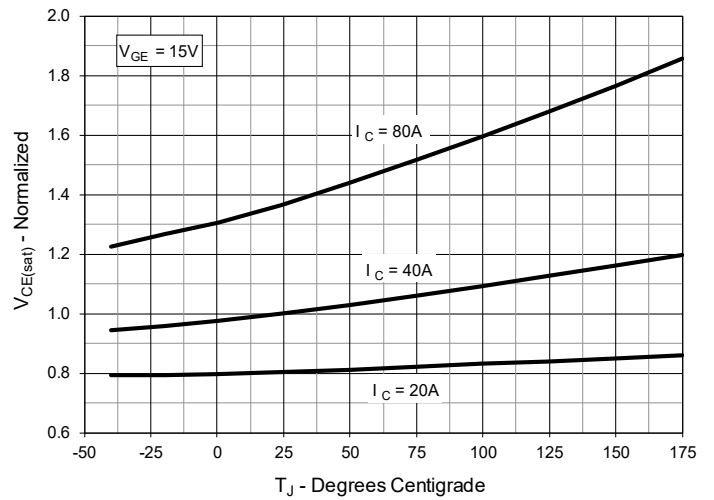
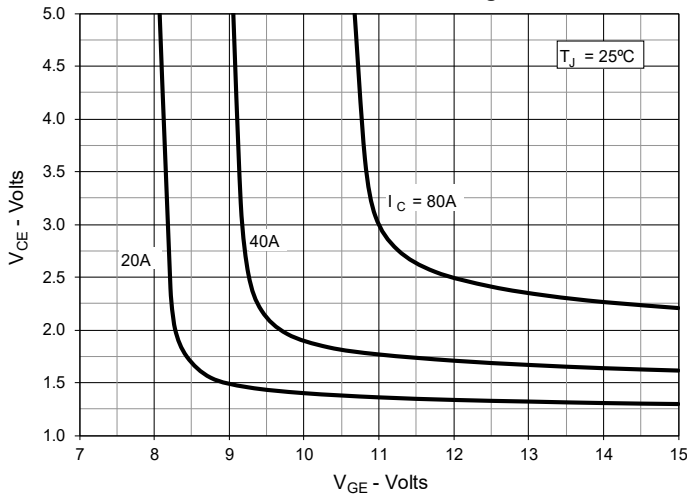
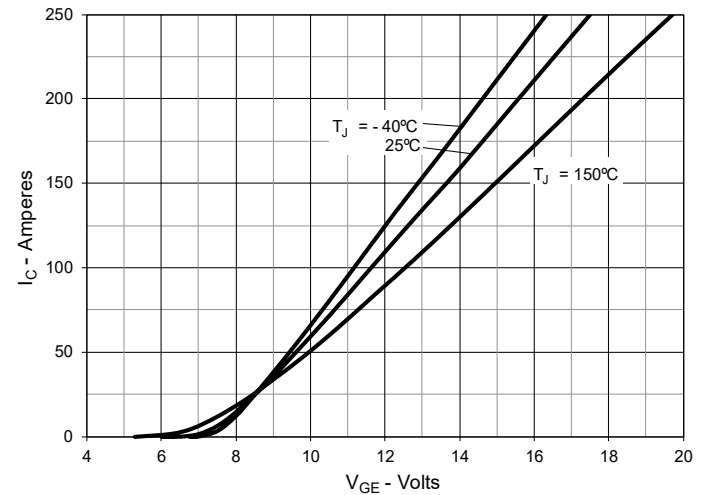
**Notes:**

1. Pulse test, t ≤ 300μs, duty cycle, d ≤ 2%.
2. Switching times & energy losses may increase for higher V<sub>CE</sub>(clamp), T<sub>J</sub> or R<sub>G</sub>.

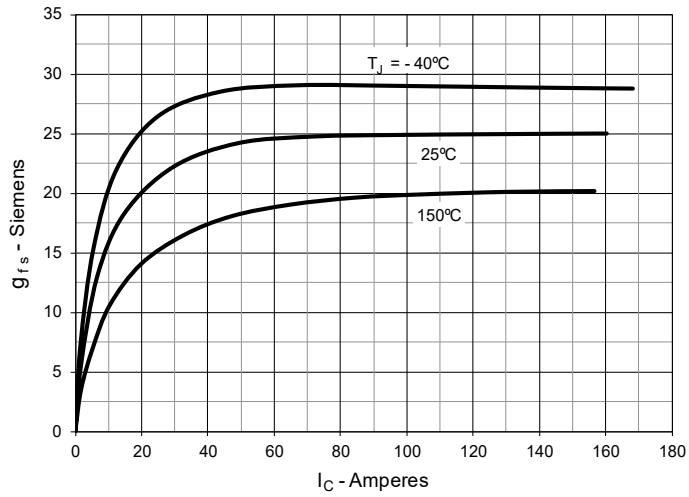
Littelfuse reserves the right to change limits, test conditions, and dimensions.

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

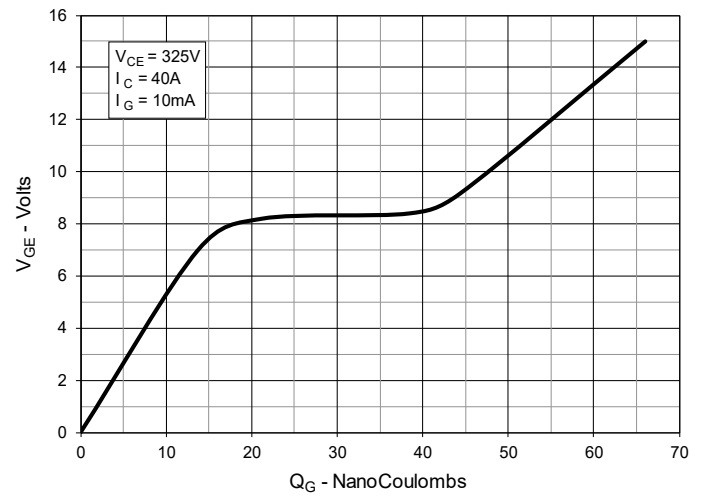
|           |           |           |           |              |              |              |              |              |             |
|-----------|-----------|-----------|-----------|--------------|--------------|--------------|--------------|--------------|-------------|
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| 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-Emmitter Voltage vs. Gate-to-Emmitter Voltage**

**Fig. 6. Input Admittance**


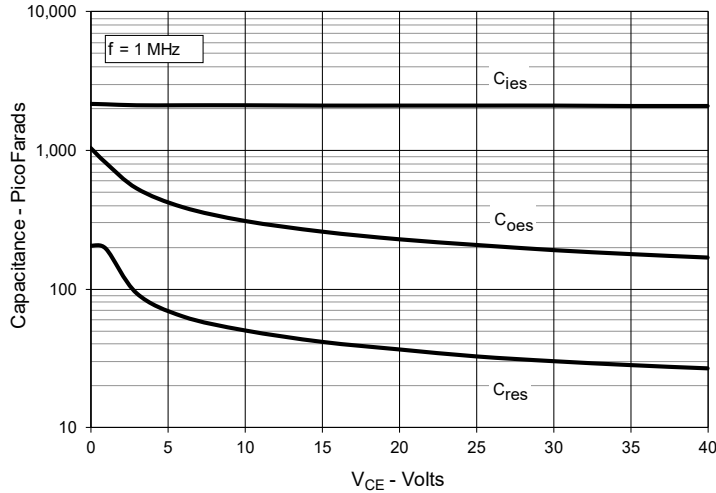
**Fig. 7. Transconductance**



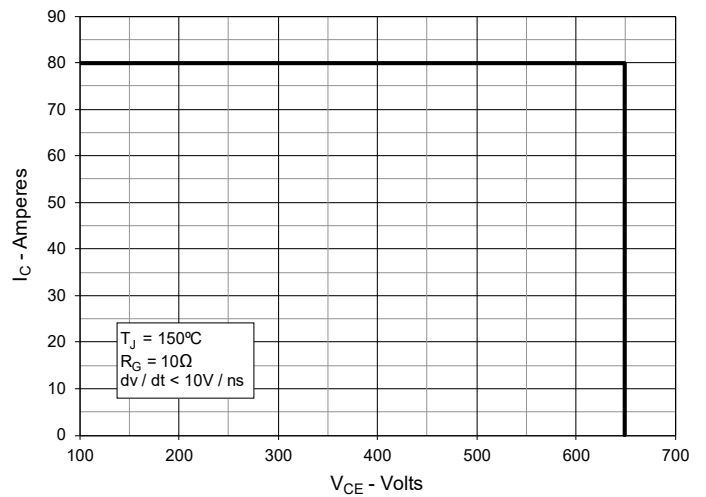
**Fig. 8. Gate Charge**



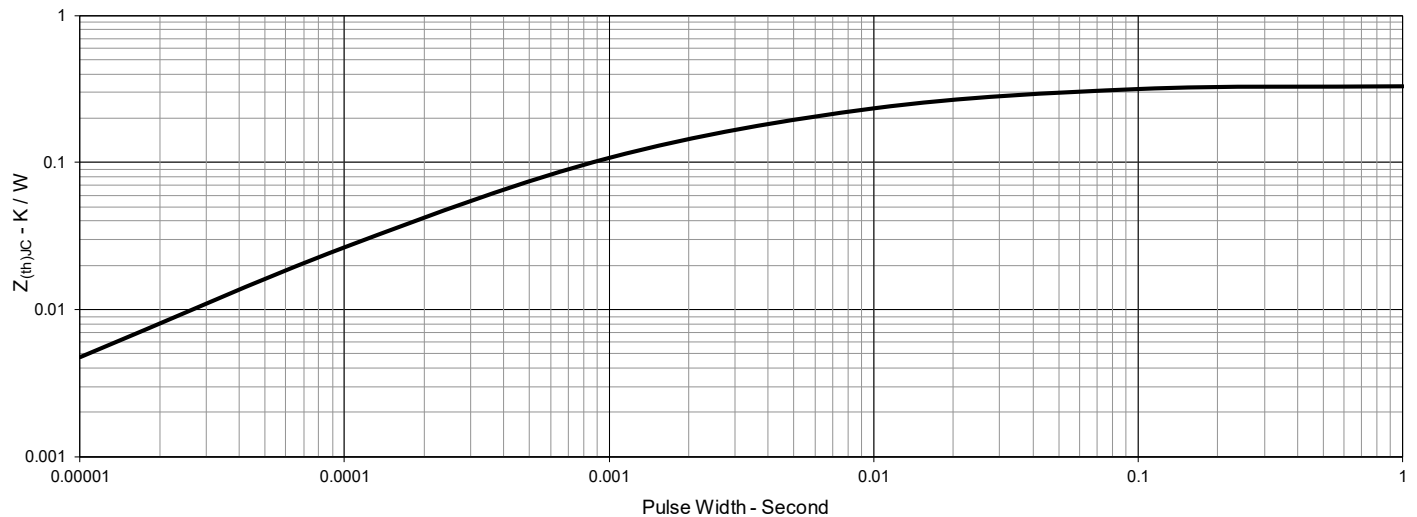
**Fig. 9. Capacitance**



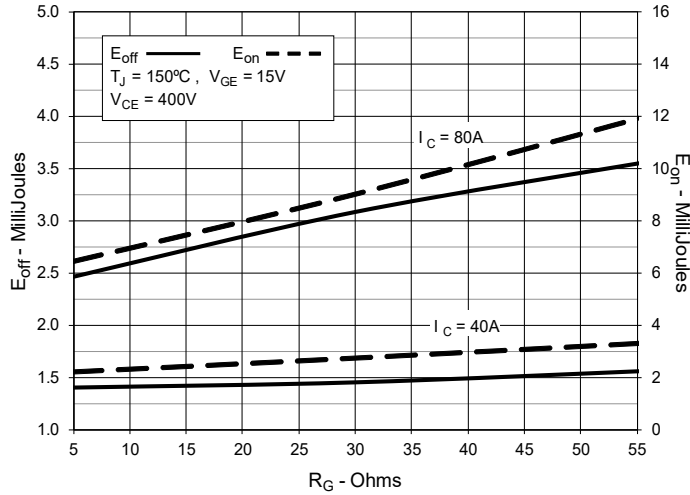
**Fig. 10. Reverse-Bias Safe Operating Area**



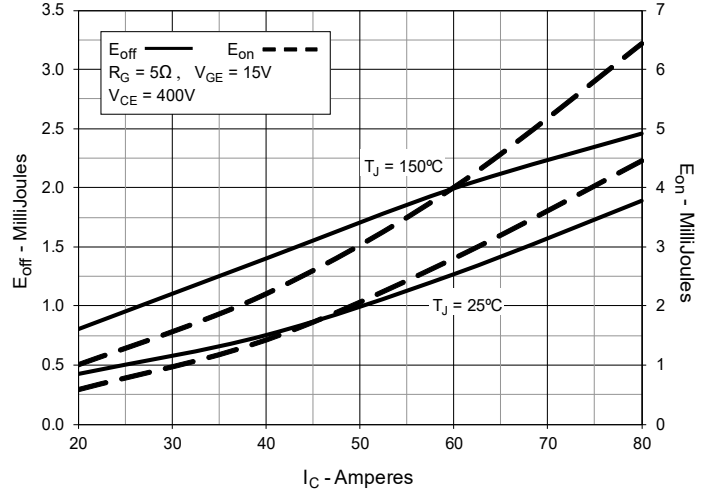
**Fig. 11. Maximum Transient Thermal Impedance (IGBT)**



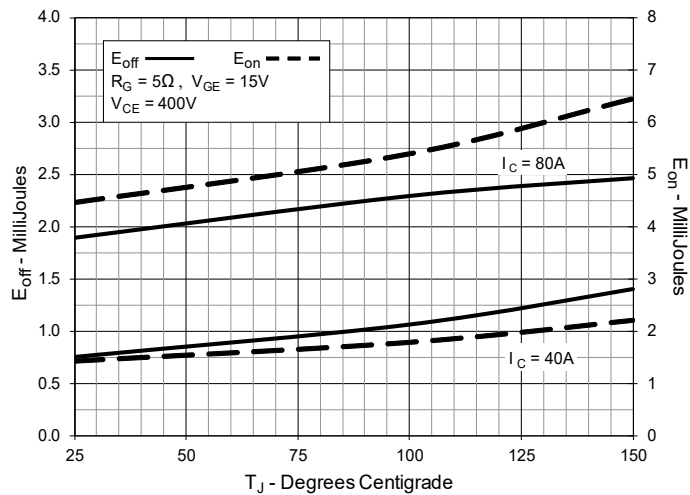
**Fig. 12. Inductive Switching Energy Loss vs. Gate Resistance**



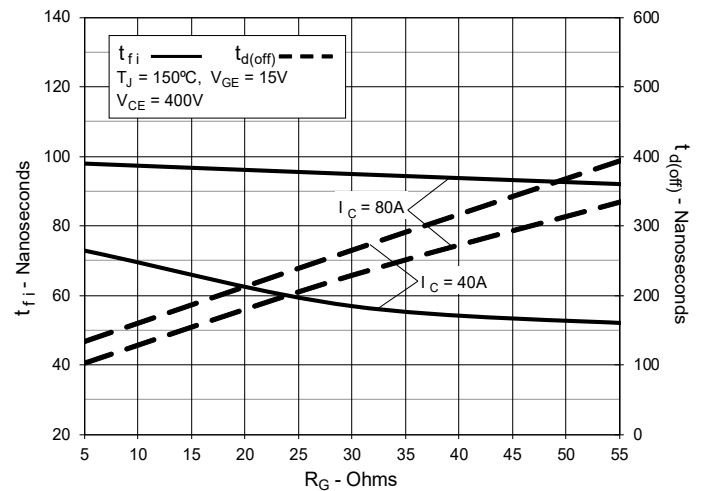
**Fig. 13. Inductive Switching Energy Loss vs. Collector Current**



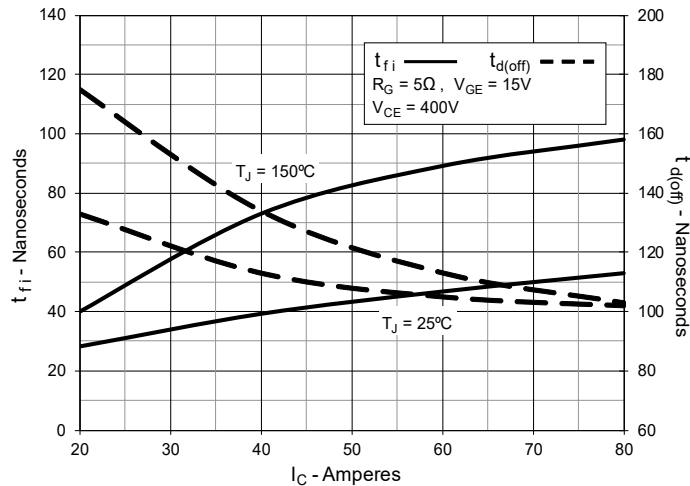
**Fig. 14. Inductive Switching Energy Loss vs. Junction Temperature**



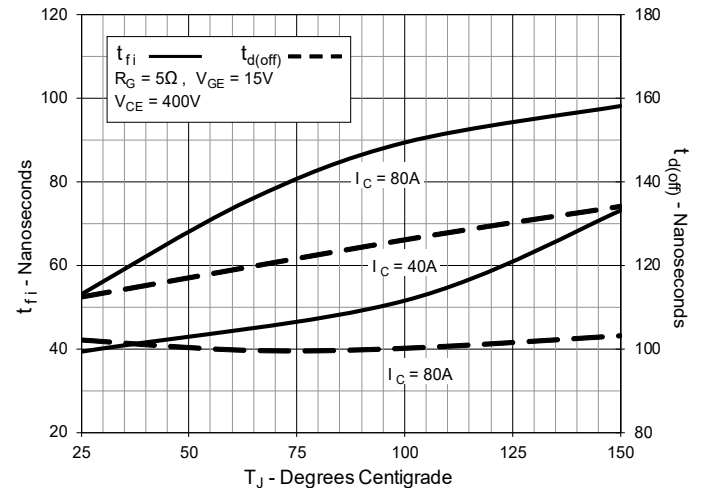
**Fig. 15. Inductive Turn-off Switching Times vs. Gate Resistance**

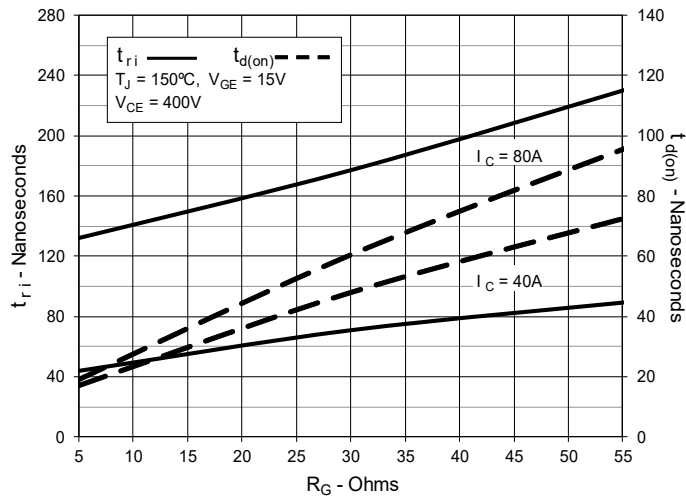
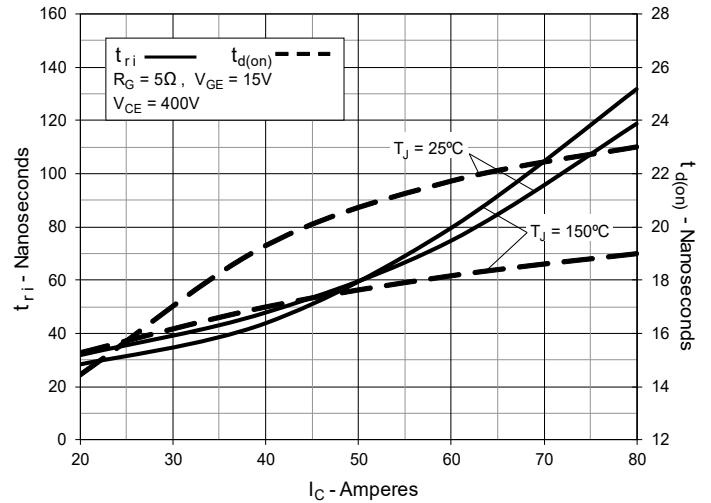
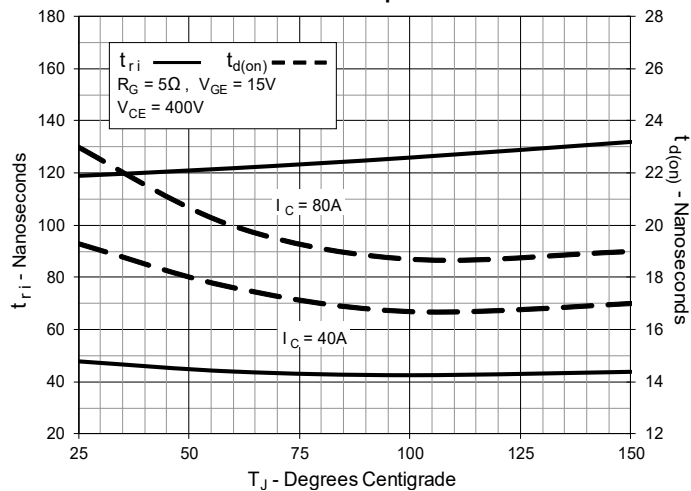
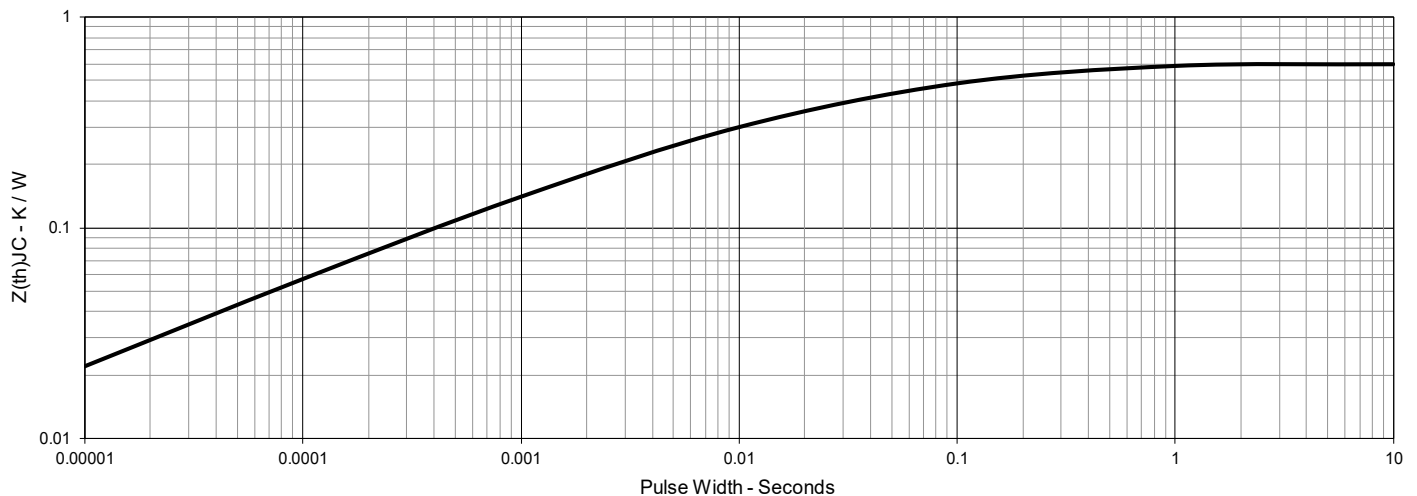


**Fig. 16. Inductive Turn-off Switching Times vs. Collector Current**



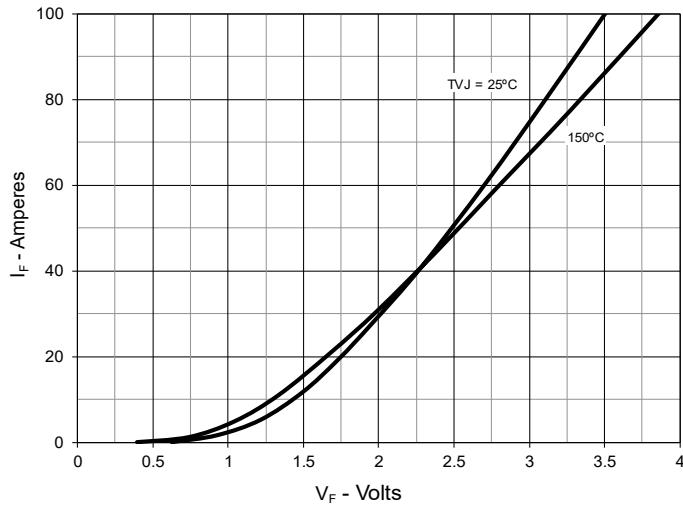
**Fig. 17. Inductive Turn-off Switching Times vs. Junction Temperature**



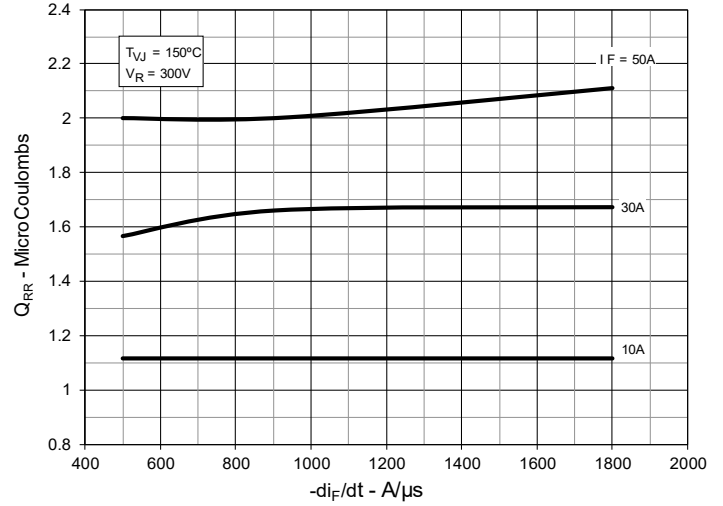
**Fig. 18. Inductive Turn-on Switching Times vs. Gate Resistance**

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

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

**Fig. 21. Maximum Transient Thermal Impedance (Diode)**


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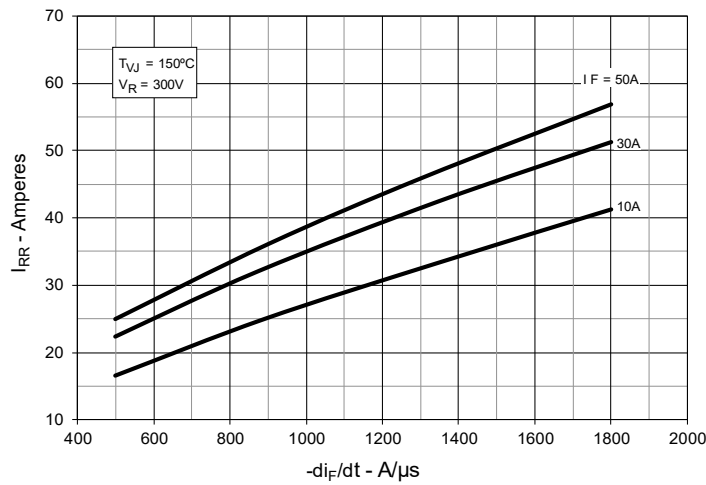
**Fig. 22. Forward Current vs. Forward Voltage**



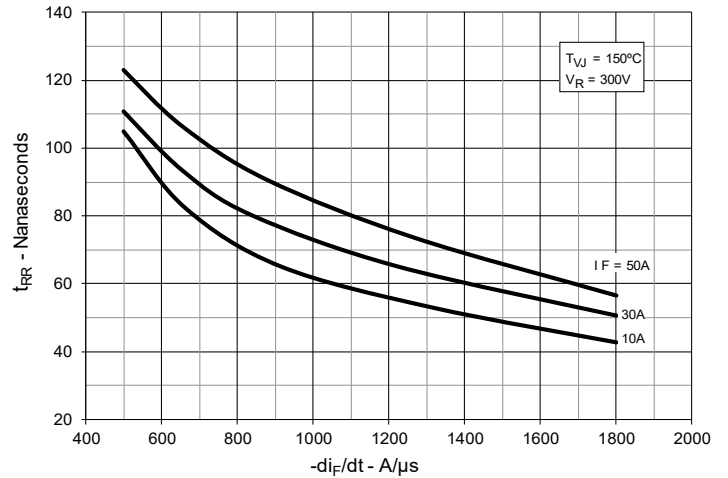
**Fig. 23. Reverse Recovery Charge  $Q_{RR}$  vs.  $-di_F/dt$**



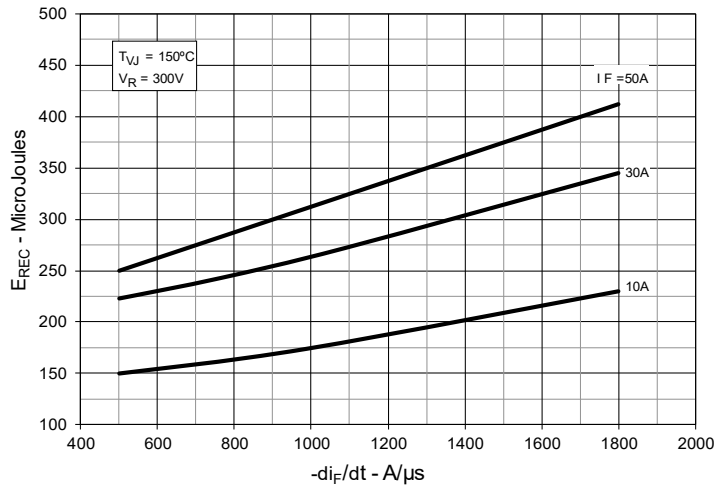
**Fig. 24. Peak Reverse Current  $I_{RM}$  vs.  $-di_F/dt$**



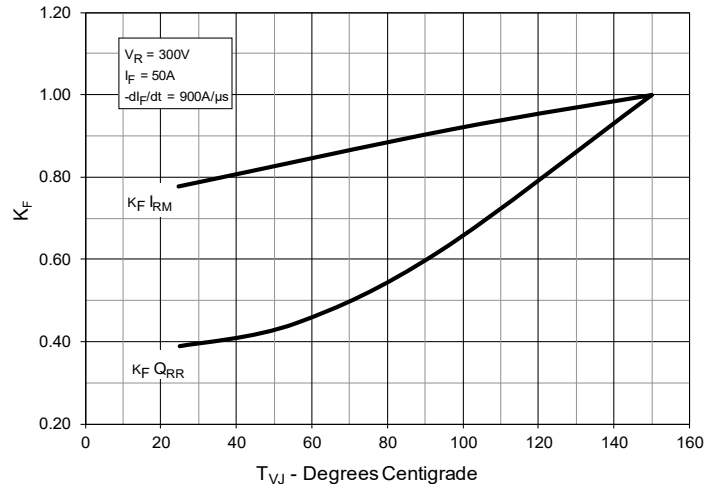
**Fig. 25. Recover Time  $t_{RR}$  vs.  $-di_F/dt$**

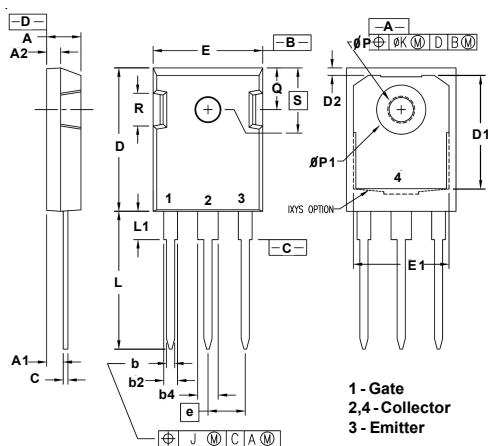


**Fig. 26. Recovery Energy  $E_{REC}$  vs.  $-di_F/dt$**



**Fig. 27. Dynamic Parameters  $Q_{RR}$ ,  $I_{RM}$  vs. Virtual Junction Temperature  $T_{VJ}$**



**TO-247 Outline**


| SYM | INCHES   |      | MILLIMETERS |       |
|-----|----------|------|-------------|-------|
|     | MIN      | MAX  | MIN         | MAX   |
| A   | .190     | .205 | 4.83        | 5.21  |
| A1  | .090     | .100 | 2.29        | 2.54  |
| A2  | .075     | .085 | 1.91        | 2.16  |
| b   | .045     | .055 | 1.14        | 1.40  |
| b2  | .075     | .087 | 1.91        | 2.20  |
| b4  | .115     | .126 | 2.92        | 3.20  |
| C   | .024     | .031 | 0.61        | 0.80  |
| D   | .819     | .840 | 20.80       | 21.34 |
| D1  | .650     | .690 | 16.51       | 17.53 |
| D2  | .035     | .050 | 0.89        | 1.27  |
| E   | .620     | .635 | 15.75       | 16.13 |
| E1  | .545     | .565 | 13.84       | 14.35 |
| e   | .215 BSC |      | 5.45 BSC    |       |
| J   | --       | .010 | --          | 0.25  |
| K   | --       | .025 | --          | 0.64  |
| L   | .780     | .810 | 19.81       | 20.57 |
| L1  | .150     | .170 | 3.81        | 4.32  |
| øP  | .140     | .144 | 3.55        | 3.65  |
| øP1 | .275     | .290 | 6.99        | 7.37  |
| Q   | .220     | .244 | 5.59        | 6.20  |
| R   | .170     | .190 | 4.32        | 4.83  |
| S   | .242 BSC |      | 6.15 BSC    |       |





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