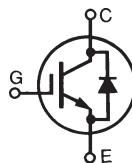


# XPT™ 650V IGBT GenX4™ w/Diode

## IXXH40N65C4D1

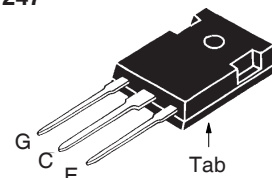
Extreme Light Punch Through  
IGBT for 5-20 kHz Switching



$$\begin{aligned} V_{CES} &= 650V \\ I_{C110} &= 40A \\ V_{CE(sat)} &\leq 2.3V \\ t_{fi(typ)} &= 27ns \end{aligned}$$

| 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                |
| $I_{C25}$                     | $T_C = 25^\circ\text{C}$                                                                          | 110                                      | A                |
| $I_{C110}$                    | $T_C = 110^\circ\text{C}$                                                                         | 40                                       | A                |
| $I_{F110}$                    | $T_C = 110^\circ\text{C}$                                                                         | 55                                       | A                |
| $I_{CM}$                      | $T_C = 25^\circ\text{C}$ , 1ms                                                                    | 215                                      | A                |
| <b>SSOA</b><br><b>(RBSOA)</b> | $V_{GE} = 15V$ , $T_{VJ} = 150^\circ\text{C}$ , $R_G = 5\Omega$<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>$R_G = 82\Omega$ , 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                                                            | 300                                      | $^\circ\text{C}$ |
| $T_{SOLD}$                    | 1.6 mm (0.062in.) from Case for 10s                                                               | 260                                      | $^\circ\text{C}$ |
| $M_d$                         | 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 5-20kHz Switching
- Square RBSOA
- Anti-Parallel 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>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>$T_J = 150^\circ\text{C}$          | 1.90<br>2.24          |      | V<br>V                     |

### Symbol Test Conditions

( $T_1 = 25^\circ\text{C}$  Unless Otherwise Specified)

### Characteristic Values

Min.

**Typ.**

**Max.**

|                           |                                                                                                                                                                       |                                                            |             |                                 |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|-------------|---------------------------------|
| <b>g<sub>fs</sub></b>     | <b>I<sub>C</sub> = 40A, V<sub>CE</sub> = 10V, Note 1</b>                                                                                                              | <b>14</b>                                                  | <b>24</b>   | <b>S</b>                        |
| <b>C<sub>ies</sub></b>    | <b>C<sub>oes</sub></b><br><b>C<sub>res</sub></b>                                                                                                                      | <b>V<sub>CE</sub> = 25V, V<sub>GE</sub> = 0V, f = 1MHz</b> | <b>2100</b> | <b>pF</b>                       |
| <b>C<sub>oes</sub></b>    |                                                                                                                                                                       |                                                            | <b>200</b>  | <b>pF</b>                       |
| <b>C<sub>res</sub></b>    |                                                                                                                                                                       |                                                            | <b>32</b>   | <b>pF</b>                       |
| <b>Q<sub>g(on)</sub></b>  | <b>I<sub>C</sub> = 40A, V<sub>GE</sub> = 15V, V<sub>CE</sub> = 0.5 • V<sub>CES</sub></b>                                                                              |                                                            | <b>68</b>   | <b>nC</b>                       |
| <b>Q<sub>ge</sub></b>     |                                                                                                                                                                       |                                                            | <b>14</b>   | <b>nC</b>                       |
| <b>Q<sub>gc</sub></b>     |                                                                                                                                                                       |                                                            | <b>26</b>   | <b>nC</b>                       |
| <b>t<sub>d(on)</sub></b>  | <b>Inductive load, T<sub>J</sub> = 25°C</b><br><b>I<sub>C</sub> = 40A, V<sub>GE</sub> = 15V</b><br><b>V<sub>CE</sub> = 400V, R<sub>G</sub> = 5Ω</b><br><b>Note 2</b>  |                                                            | <b>20</b>   | <b>ns</b>                       |
| <b>t<sub>ri</sub></b>     |                                                                                                                                                                       |                                                            | <b>62</b>   | <b>ns</b>                       |
| <b>E<sub>on</sub></b>     |                                                                                                                                                                       |                                                            | <b>1.60</b> | <b>mJ</b>                       |
| <b>t<sub>d(off)</sub></b> |                                                                                                                                                                       |                                                            | <b>100</b>  | <b>ns</b>                       |
| <b>t<sub>fi</sub></b>     |                                                                                                                                                                       |                                                            | <b>27</b>   | <b>ns</b>                       |
| <b>E<sub>off</sub></b>    |                                                                                                                                                                       |                                                            | <b>0.42</b> | <b>mJ</b>                       |
| <b>t<sub>d(on)</sub></b>  | <b>Inductive load, T<sub>J</sub> = 150°C</b><br><b>I<sub>C</sub> = 40A, V<sub>GE</sub> = 15V</b><br><b>V<sub>CE</sub> = 400V, R<sub>G</sub> = 5Ω</b><br><b>Note 2</b> |                                                            | <b>19</b>   | <b>ns</b>                       |
| <b>t<sub>ri</sub></b>     |                                                                                                                                                                       |                                                            | <b>52</b>   | <b>ns</b>                       |
| <b>E<sub>on</sub></b>     |                                                                                                                                                                       |                                                            | <b>2.75</b> | <b>mJ</b>                       |
| <b>t<sub>d(off)</sub></b> |                                                                                                                                                                       |                                                            | <b>106</b>  | <b>ns</b>                       |
| <b>t<sub>fi</sub></b>     |                                                                                                                                                                       |                                                            | <b>36</b>   | <b>ns</b>                       |
| <b>E<sub>off</sub></b>    |                                                                                                                                                                       |                                                            | <b>0.64</b> | <b>mJ</b>                       |
| <b>R<sub>thJC</sub></b>   |                                                                                                                                                                       |                                                            | <b>0.21</b> | <b>0.33 °C/W</b><br><b>°C/W</b> |
| <b>R<sub>thCS</sub></b>   |                                                                                                                                                                       |                                                            |             |                                 |

### Reverse Diode (FRED)

### Symbol Test Conditions

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

### Characteristic Values

Min.

**Typ.**

Max.

|                                                |                                                                                    |                        |     |           |
|------------------------------------------------|------------------------------------------------------------------------------------|------------------------|-----|-----------|
| <b>V<sub>F</sub></b>                           | I <sub>F</sub> = 30A, V <sub>GE</sub> = 0V, Note 1                                 | T <sub>J</sub> = 150°C | 1.3 | 2.6       |
| <b>I<sub>RM</sub></b><br><b>t<sub>rr</sub></b> | $I_F = 30A, V_{GE} = 0V, T_J = 150^\circ C$<br>$-di_F/dt = 500A/\mu s, V_R = 400V$ |                        | 20  | A         |
|                                                |                                                                                    |                        | 155 | ns        |
| <b>R<sub>thJC</sub></b>                        |                                                                                    |                        |     | 0.60 °C/W |

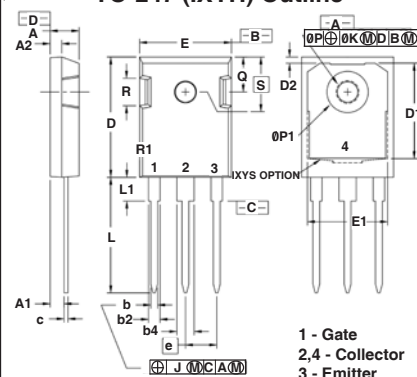
Notes:

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

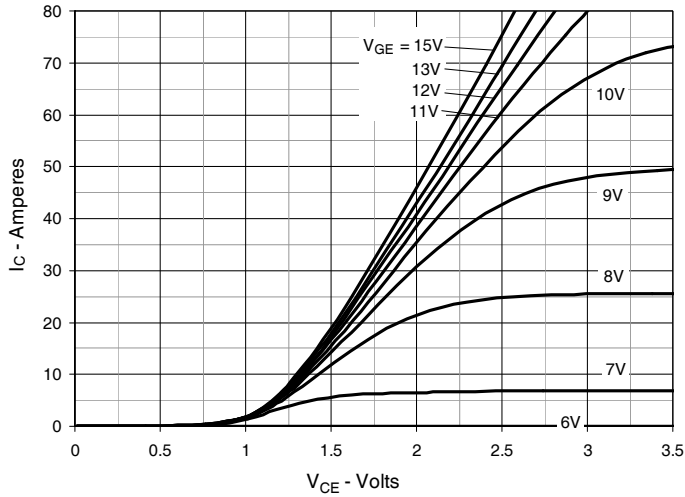
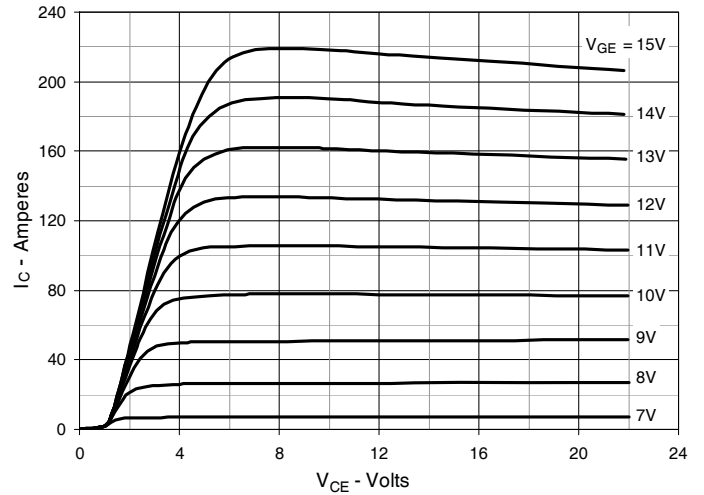
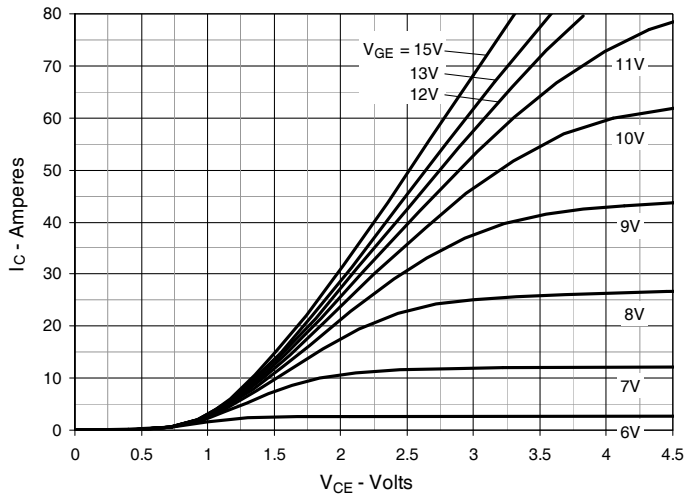
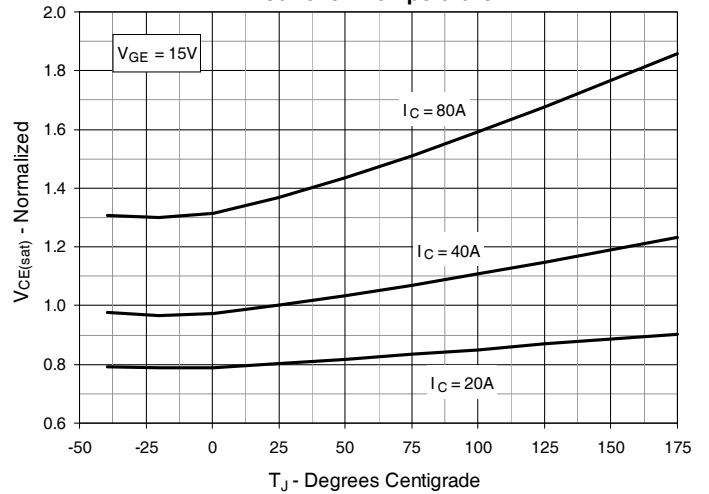
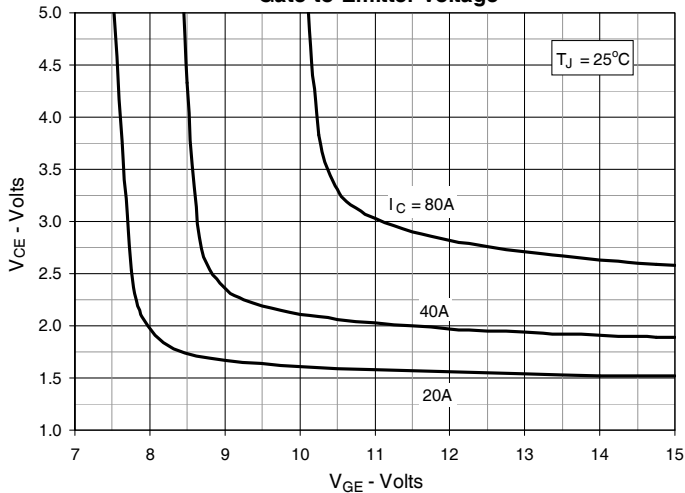
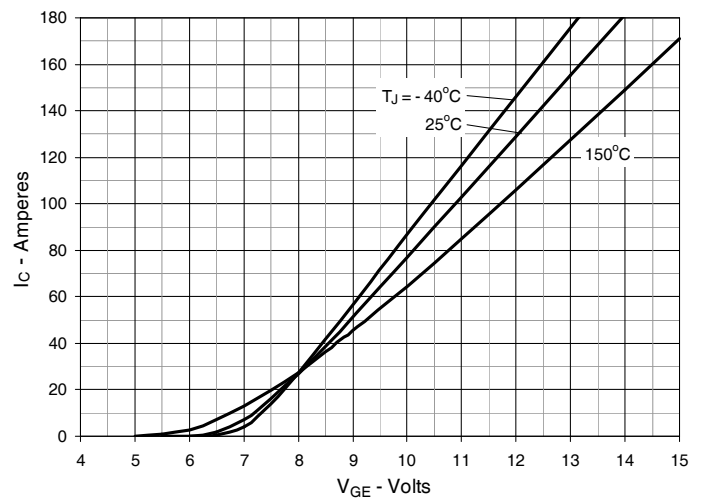
## ADVANCE TECHNICAL INFORMATION

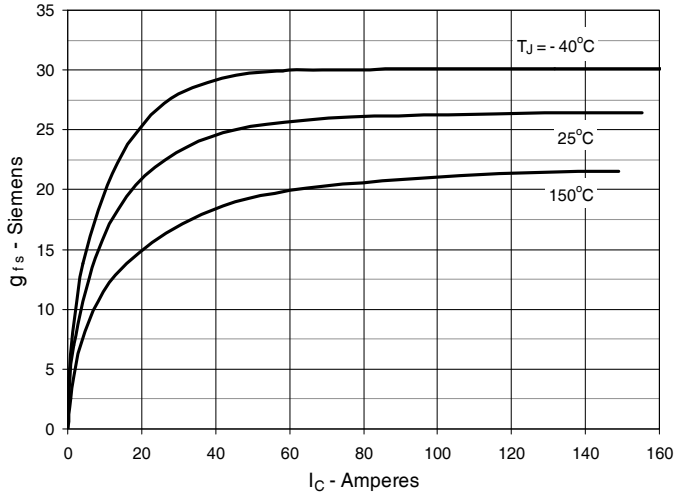
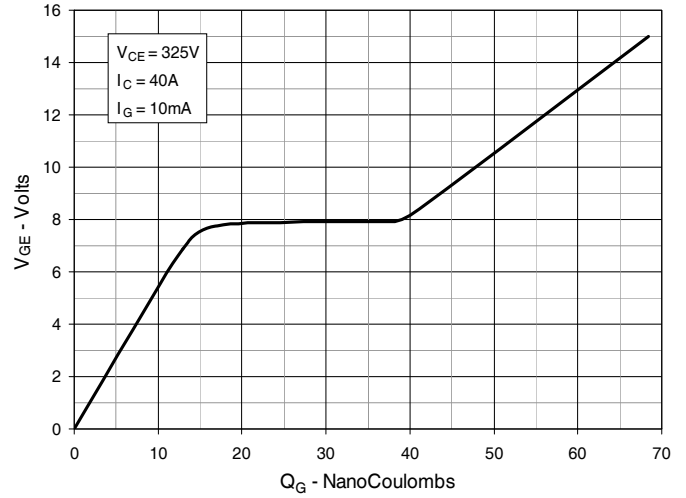
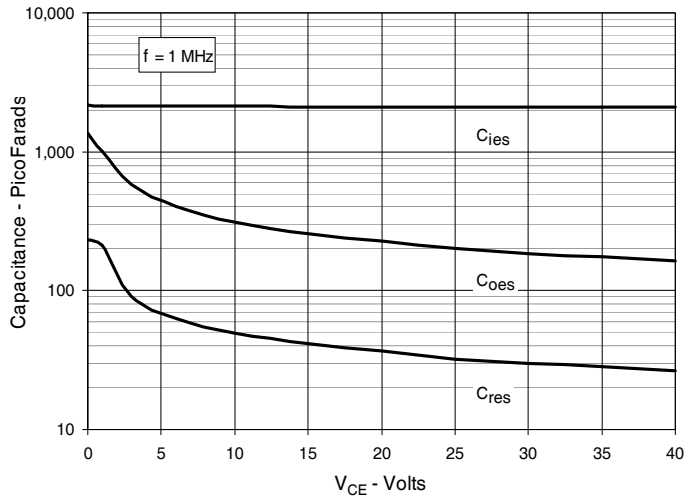
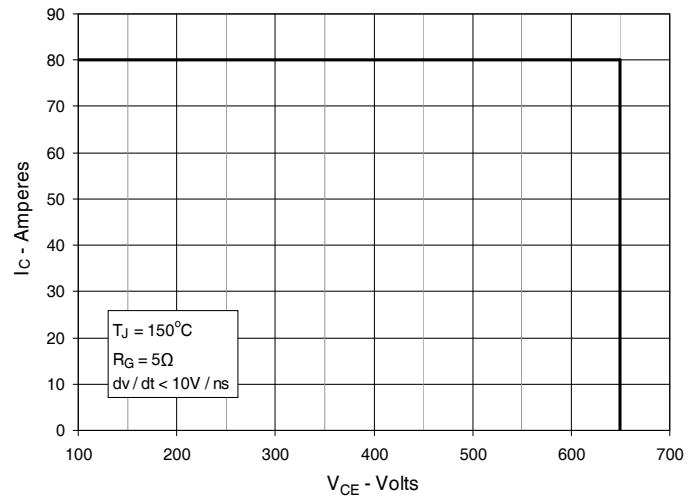
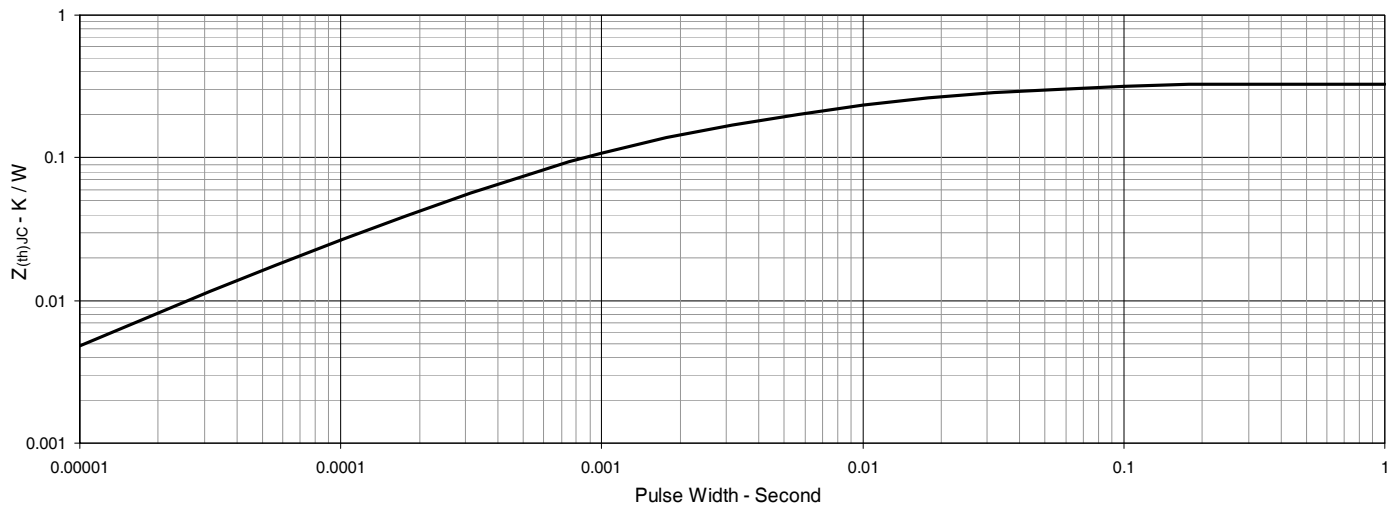
The product presented herein is under development. The Technical Specifications offered are derived from a subjective evaluation of the design, based upon prior knowledge and experience, and constitute a "considered reflection" of the anticipated result. IXYS reserves the right to change limits, test conditions, and dimensions without notice.

## TO-247 (IXYH) Outline

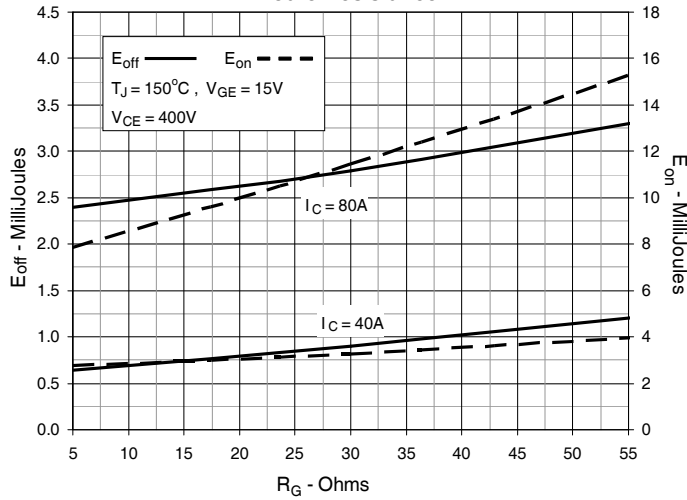


| Dim. | Millimeter |       | Inches    |       |
|------|------------|-------|-----------|-------|
|      | min        | max   | min       | max   |
| A    | 4.70       | 5.30  | 0.185     | 0.209 |
| A1   | 2.21       | 2.59  | 0.087     | 0.102 |
| A2   | 1.50       | 2.49  | 0.059     | 0.098 |
| b    | 0.99       | 1.40  | 0.039     | 0.055 |
| b2   | 1.65       | 2.39  | 0.065     | 0.094 |
| b4   | 2.59       | 3.43  | 0.102     | 0.135 |
| c    | 0.38       | 0.89  | 0.015     | 0.035 |
| D    | 20.79      | 21.45 | 0.819     | 0.845 |
| D1   | 13.07      | -     | 0.515     | -     |
| D2   | 0.51       | 1.35  | 0.020     | 0.053 |
| E    | 15.48      | 16.24 | 0.610     | 0.640 |
| E1   | 13.45      | -     | 0.53      | -     |
| E2   | 4.31       | 5.48  | 0.170     | 0.216 |
| e    | 5.45 BSC   |       | 0.215 BSC |       |
| L    | 19.80      | 20.30 | 0.078     | 0.800 |
| L1   | -          | 4.49  | -         | 0.177 |
| Ø P  | 3.55       | 3.65  | 0.140     | 0.144 |
| Ø P1 | -          | 7.39  | -         | 0.290 |
| Q    | 5.38       | 6.19  | 0.212     | 0.244 |
| S    | 6.14 BSC   |       | 0.242 BSC |       |

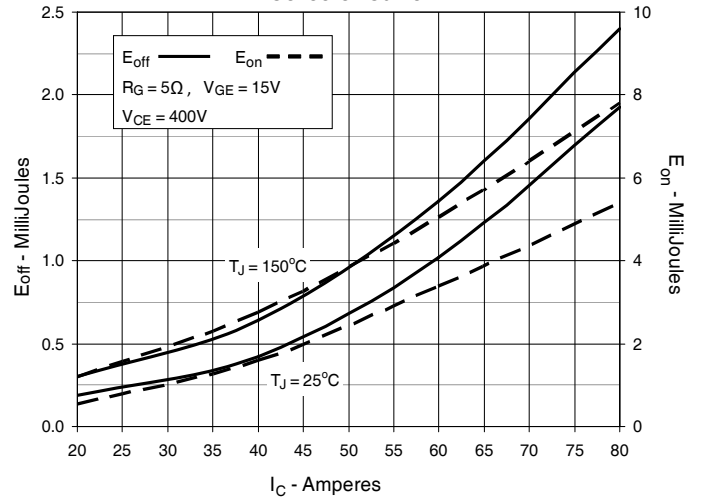
**Fig. 1. Output Characteristics @  $T_J = 25^\circ\text{C}$** 

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


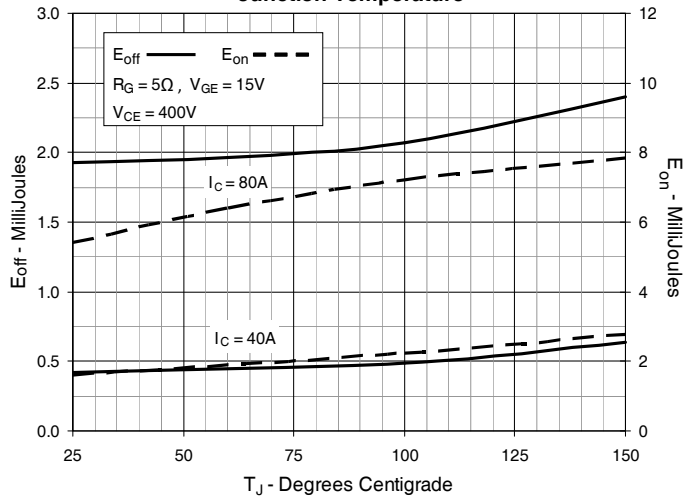
**Fig. 12. Inductive Switching Energy Loss vs. Gate Resistance**



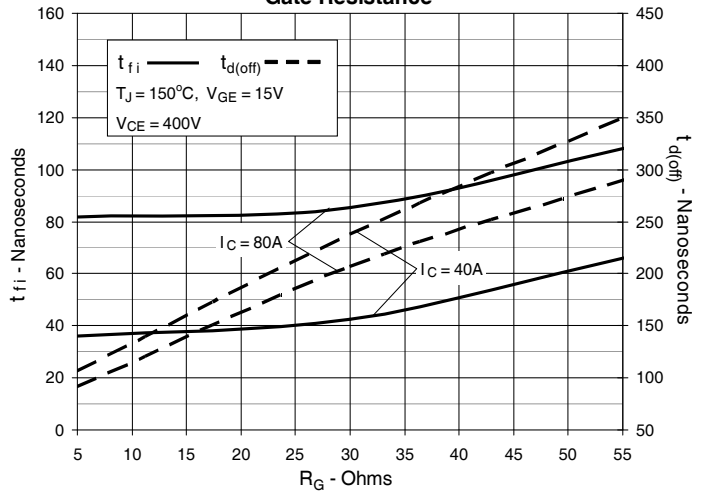
**Fig. 13. Inductive Switching Energy Loss vs. Collector Current**



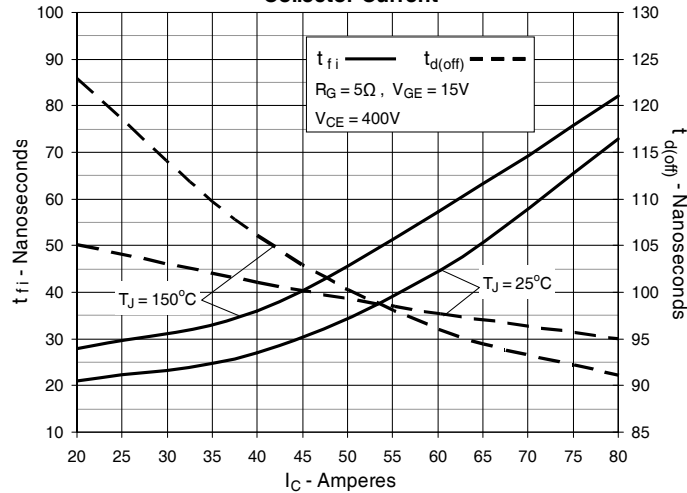
**Fig. 14. Inductive Switching Energy Loss vs. Junction Temperature**



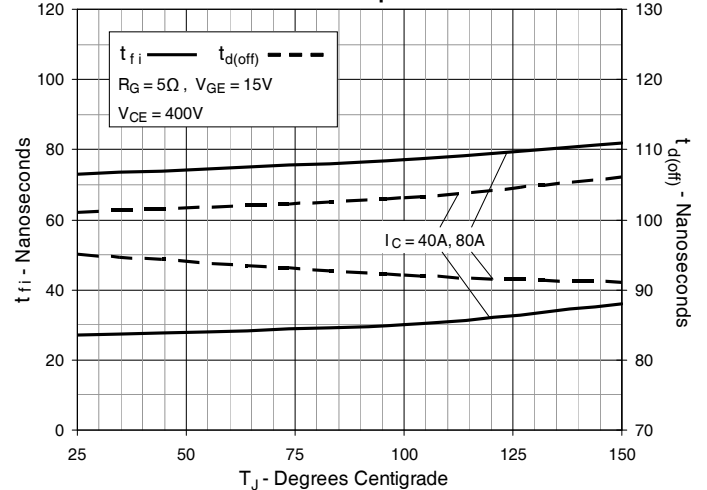
**Fig. 15. Inductive Turn-off Switching Times vs. Gate Resistance**

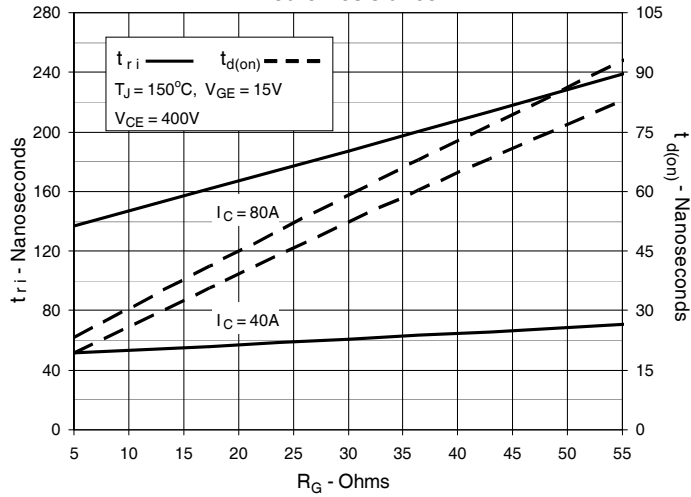
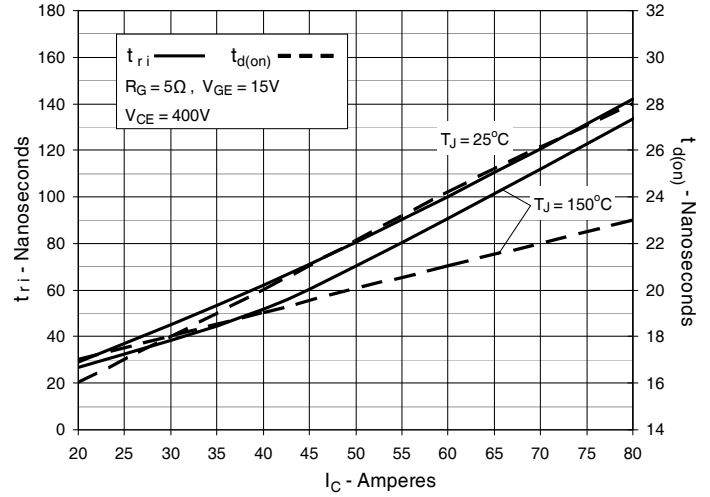
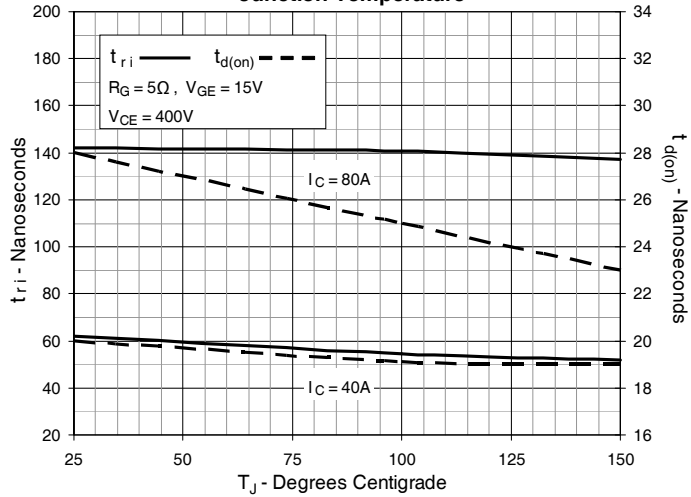


**Fig. 16. Inductive Turn-off Switching Times vs. Collector Current**

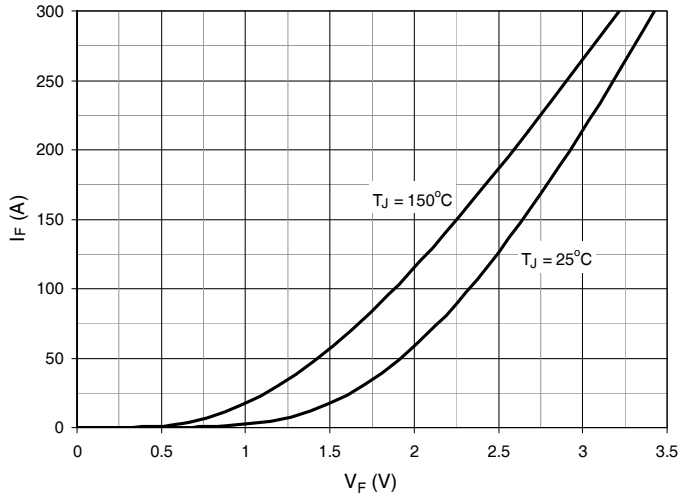


**Fig. 17. Inductive Turn-off Switching Times vs. Junction Temperature**

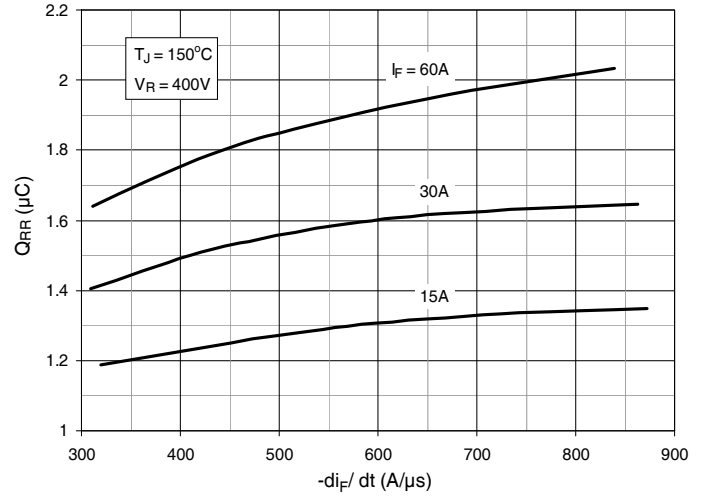


**Fig. 18. Inductive Turn-on Switching Times vs. Gate Resistance**

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

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


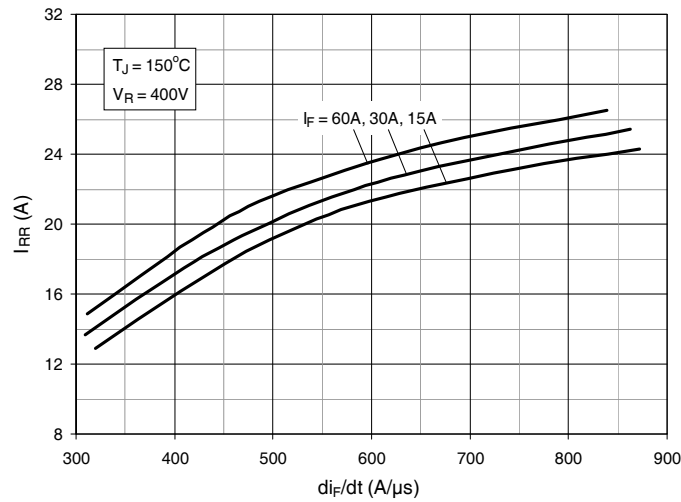
**Fig. 21. Diode Forward Characteristics**



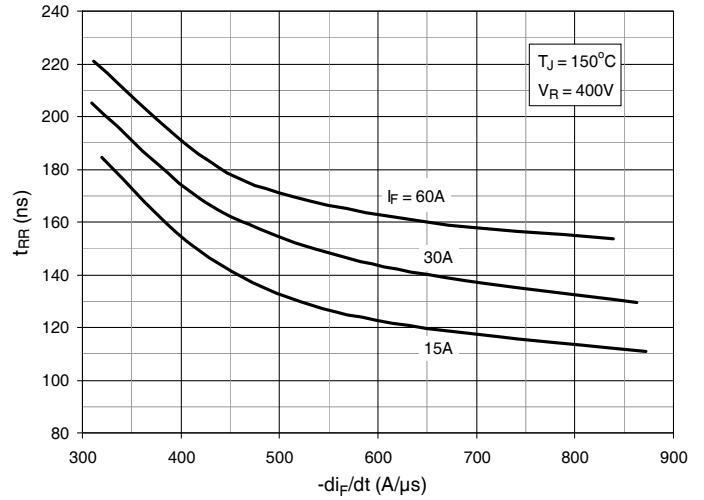
**Fig. 22. Reverse Recovery Charge vs.  $-di_F/dt$**



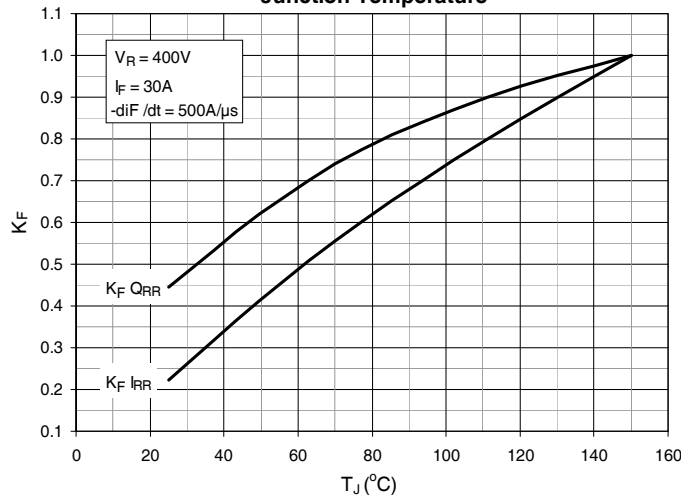
**Fig. 23. Reverse Recovery Current vs.  $-di_F/dt$**



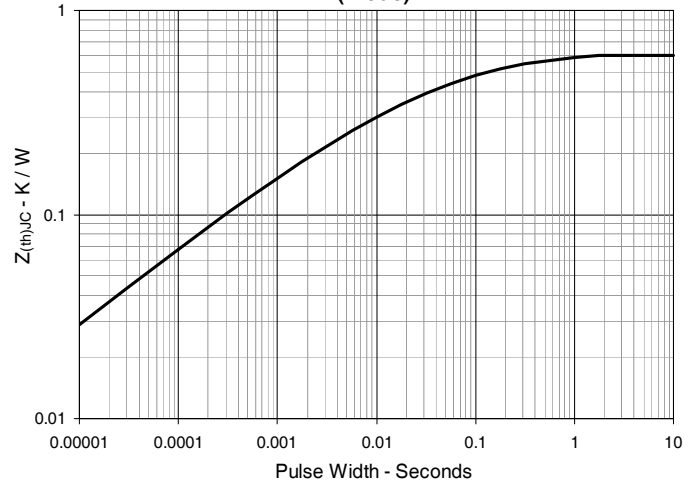
**Fig. 24. Reverse Recovery Time vs.  $-di_F/dt$**



**Fig. 25. Dynamic Parameters  $Q_{RR}$ ,  $I_{RR}$  vs. Junction Temperature**



**Fig. 26. Maximum Transient Thermal Impedance (Diode)**



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