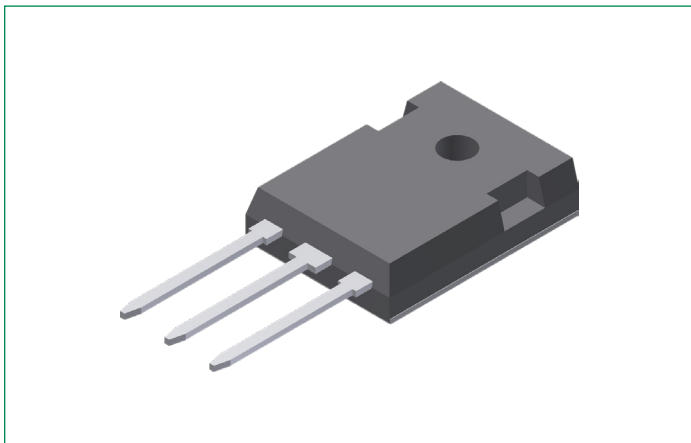


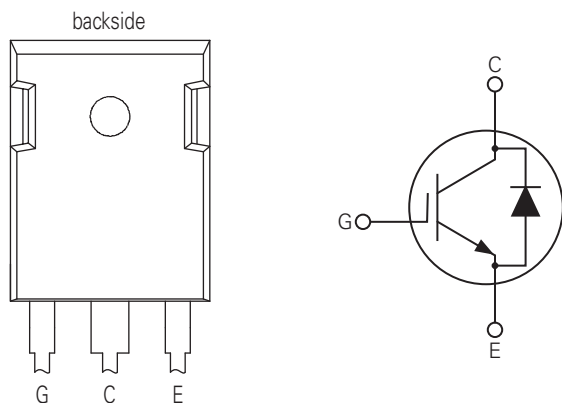
# IXYH40N120B4H1

1200 V, 40 A XPT™ Gen4 IGBT with Sonic Diode

Extreme Light Punch Through IGBT for 5–30 kHz Switching



## Pinout Diagram (TO-247-3L)



**G:** Gate; **C:** Collector; **E:** Emitter; **backside:** 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 energy losses, fast switching, low tail current, and high current densities.

## Features & Benefits:

- Optimized for 5–30 kHz Switching
- Positive Thermal Coefficient of  $V_{CE(sat)}$
- International Standard Package
- High Current Handling Capability
- High Power Density
- Low Gate Drive Requirement
- Anti-Parallel Sonic Diode

## Applications:

- Power Inverters
- UPS
- Motor Drives
- SMPS
- PFC Circuits
- Battery Chargers
- Welding Machines

## Product Summary

| Characteristic | Value | Unit |
|----------------|-------|------|
| $V_{CES}$      | 1200  | V    |
| $I_{C110}$     | 40    | A    |
| $V_{CE(sat)}$  | 2.10  | V    |
| $t_{fi(typ)}$  | 110   | ns   |

## Maximum Ratings

| Symbol          | Characteristic                                                        | Conditions                                                                                                                                         | Value      | Unit               |
|-----------------|-----------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------------------|
| $V_{CES}$       | Collector-Emitter Voltage                                             | $T_J = 25^{\circ}\text{C}$ to $175^{\circ}\text{C}$                                                                                                | 1200       | V                  |
| $V_{GES}$       | Gate-Emitter Voltage                                                  | Continuous                                                                                                                                         | $\pm 20$   | V                  |
| $V_{GEM}$       | Transient Gate-Emitter Voltage                                        | Transient                                                                                                                                          | $\pm 30$   | V                  |
| $I_{C25}$       | Continuous Collector Current                                          | $T_C = 25^{\circ}\text{C}$                                                                                                                         | 112        | A                  |
| $I_{C110}$      | Continuous Collector Current                                          | $T_C = 110^{\circ}\text{C}$                                                                                                                        | 40         | A                  |
| $I_{F110}$      | Diode Forward Current                                                 | $T_C = 110^{\circ}\text{C}$                                                                                                                        | 32         | A                  |
| $I_{CM}$        | Pulsed Collector Current                                              | $T_C = 25^{\circ}\text{C}$ , 1 ms                                                                                                                  | 240        | A                  |
| SSOA<br>(RBSOA) | Switching Safe Operating Area<br>(Reverse Biased Safe Operating Area) | $V_{GE} = 15\text{ V}$ , $T_{VJ} = 150^{\circ}\text{C}$ , $R_G = 5\ \Omega$ ,<br>Clamped Inductive Load, $I_{CM} = V_{CE} \leq 0.8 \times V_{CES}$ | 80         | A                  |
| $P_C$           | Collector Power Dissipation                                           | $T_C = 25^{\circ}\text{C}$                                                                                                                         | 600        | W                  |
| $T_J$           | Junction Temperature                                                  | –                                                                                                                                                  | -55 to 175 | $^{\circ}\text{C}$ |
| $T_{JM}$        | Maximum Junction Temperature                                          | –                                                                                                                                                  | 175        | $^{\circ}\text{C}$ |
| $T_{stg}$       | Storage Temperature                                                   | –                                                                                                                                                  | -55 to 175 | $^{\circ}\text{C}$ |
| $T_L$           | Lead Temperature for Soldering                                        | 1.6 mm (0.062 in.) from Case for 10 s                                                                                                              | 300        | $^{\circ}\text{C}$ |
| $M_d$           | Mounting Torque                                                       | –                                                                                                                                                  | 1.13 / 10  | Nm/lb.in           |
| W               | Weight                                                                | –                                                                                                                                                  | 6          | g                  |

## Thermal Characteristics

| Symbol       | Characteristic                        | Value |      |      | Unit                        |
|--------------|---------------------------------------|-------|------|------|-----------------------------|
|              |                                       | Min.  | Typ. | Max. |                             |
| $R_{th, JC}$ | Thermal Resistance, junction-to-case  | –     | –    | 0.25 | $^{\circ}\text{C}/\text{W}$ |
| $R_{th, CS}$ | Thermal Resistance, case-to-heat sink | –     | 0.21 | –    | $^{\circ}\text{C}/\text{W}$ |

## Electrical Characteristics – Static ( $T_J = 25^{\circ}\text{C}$ unless otherwise specified)

| Symbol        | Characteristic                                    | Conditions                                                                 | Value |      |           | Unit          |
|---------------|---------------------------------------------------|----------------------------------------------------------------------------|-------|------|-----------|---------------|
|               |                                                   |                                                                            | Min.  | Typ. | Max.      |               |
| $BV_{CES}$    | Collector-Emitter Breakdown Voltage               | $I_C = 250\ \mu\text{A}$ , $V_{GE} = 0\text{ V}$                           | 1200  | –    | –         | V             |
| $V_{GE(th)}$  | Gate-Emitter Threshold Voltage                    | $I_C = 250\ \mu\text{A}$ , $V_{CE} = V_{GE}$                               | 4.0   | –    | 6.5       | V             |
| $I_{GES}$     | Gate-Emitter Leakage Current                      | $V_{CE} = 0\text{ V}$ , $V_{GE} = \pm 20\text{ V}$                         | –     | –    | $\pm 100$ | nA            |
| $I_{CES}$     | Zero Gate Voltage Collector Current               | $V_{CE} = V_{CES}$ , $V_{GE} = 0\text{ V}$                                 | –     | –    | 50        | $\mu\text{A}$ |
|               |                                                   | $V_{CE} = V_{CES}$ , $V_{GE} = 0\text{ V}$ , $T_J = 125^{\circ}\text{C}$   | –     | –    | 5         | mA            |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage <sup>1</sup> | $I_C = 32\text{ A}$ , $V_{GE} = 15\text{ V}$                               | –     | 1.8  | 2.1       | V             |
|               |                                                   | $I_C = 32\text{ A}$ , $V_{GE} = 15\text{ V}$ , $T_J = 150^{\circ}\text{C}$ | –     | 2.1  | –         | V             |

**Note 1:** Pulse test,  $t \leq 300\ \mu\text{s}$ , duty cycle,  $d \leq 2\%$

**Electrical Characteristics – Dynamic** ( $T_J = 25^\circ\text{C}$  unless otherwise specified)

| Symbol       | Characteristic                   | Conditions                                                                                                                             |                           | Value |      |      | Unit |  |
|--------------|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|---------------------------|-------|------|------|------|--|
|              |                                  |                                                                                                                                        |                           | Min.  | Typ. | Max. |      |  |
| $g_{fs}$     | Transconductance <sup>1</sup>    | $I_C = 32\text{ A}, V_{CE} = 10\text{ V}$                                                                                              |                           | 12    | 22   | –    | S    |  |
| $C_{ies}$    | Input Capacitance                | $V_{GE} = 0\text{ V}, V_{CE} = 25\text{ V}, f = 1\text{ MHz}$                                                                          |                           | –     | 1670 | –    | pF   |  |
| $C_{oes}$    | Output Capacitance               |                                                                                                                                        |                           | –     | 165  | –    |      |  |
| $C_{res}$    | Reverse Transfer Capacitance     |                                                                                                                                        |                           | –     | 60   | –    |      |  |
| $Q_{g(on)}$  | Total Gate Charge                | $V_{GE} = 15\text{ V}, V_{CE} = 0.5 \times V_{CES},$<br>$I_C = 32\text{ A}$                                                            |                           | –     | 94   | –    | nC   |  |
| $Q_{ge}$     | Gate-Emitter Charge              |                                                                                                                                        |                           | –     | 15   | –    |      |  |
| $Q_{gc}$     | Gate-Collector Charge            |                                                                                                                                        |                           | –     | 40   | –    |      |  |
| $t_{d(on)}$  | Turn-on Delay Time <sup>2</sup>  | Inductive Load,<br>$V_{GE} = 15\text{ V},$<br>$V_{CE} = 0.8 \times V_{CES},$<br>$I_C = 32\text{ A},$<br>$R_{G(ext)} = 5\text{ }\Omega$ | $T_J = 25^\circ\text{C}$  | –     | 19   | –    | ns   |  |
|              |                                  |                                                                                                                                        | $T_J = 150^\circ\text{C}$ | –     | 16   | –    |      |  |
| $t_{ri}$     | Turn-on Rise Time <sup>2</sup>   |                                                                                                                                        | $T_J = 25^\circ\text{C}$  | –     | 53   | –    | ns   |  |
|              |                                  |                                                                                                                                        | $T_J = 150^\circ\text{C}$ | –     | 47   | –    |      |  |
| $E_{on}$     | Turn-on Energy <sup>2</sup>      |                                                                                                                                        | $T_J = 25^\circ\text{C}$  | –     | 5.9  | –    | mJ   |  |
|              |                                  |                                                                                                                                        | $T_J = 150^\circ\text{C}$ | –     | 8.9  | –    |      |  |
| $t_{d(off)}$ | Turn-off Delay Time <sup>2</sup> |                                                                                                                                        | $T_J = 25^\circ\text{C}$  | –     | 220  | –    | ns   |  |
|              |                                  |                                                                                                                                        | $T_J = 150^\circ\text{C}$ | –     | 300  | –    |      |  |
| $t_{fi}$     | Turn-off Fall Time <sup>2</sup>  |                                                                                                                                        | $T_J = 25^\circ\text{C}$  | –     | 110  | –    | ns   |  |
|              |                                  |                                                                                                                                        | $T_J = 150^\circ\text{C}$ | –     | 190  | –    |      |  |
| $E_{off}$    | Turn-off Energy <sup>2</sup>     |                                                                                                                                        | $T_J = 25^\circ\text{C}$  | –     | 2.9  | –    | mJ   |  |
|              |                                  |                                                                                                                                        | $T_J = 150^\circ\text{C}$ | –     | 4.4  | –    |      |  |

**Note 1:** Pulse test,  $t \leq 300\ \mu\text{s}$ , duty cycle,  $d \leq 2\%$ **Note 2:** Switching times and energy losses may increase for higher  $V_{CE(clamp)}$ ,  $T_J$ , or  $R_G$ .**Reverse Sonic Diode (FRD)** ( $T_J = 25^\circ\text{C}$  unless otherwise specified)

| Symbol       | Characteristic                       | Conditions                                                                                                                     | Value |      |      | Unit                      |
|--------------|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|-------|------|------|---------------------------|
|              |                                      |                                                                                                                                | Min.  | Typ. | Max. |                           |
| $V_F$        | Diode Forward Voltage <sup>1</sup>   | $I_F = 32\text{ A}, V_{GE} = 0\text{ V}$                                                                                       | –     | 2.2  | 2.8  | V                         |
|              |                                      | $I_F = 32\text{ A}, V_{GE} = 0\text{ V}, T_J = 125^\circ\text{C}$                                                              | –     | 2.7  | –    |                           |
| $I_{RM}$     | Reverse Recovery Current             | $I_F = 32\text{ A}, V_{GE} = 0\text{ V}, T_J = 125^\circ\text{C}$<br>$-di_F/dt = 400\text{ A}/\mu\text{s}, V_R = 600\text{ V}$ | –     | 23   | –    | A                         |
| $t_{rr}$     | Reverse Recovery Time                |                                                                                                                                | –     | 430  | –    | ns                        |
| $R_{th, JC}$ | Thermal Resistance, junction-to-case | –                                                                                                                              | –     | –    | 0.35 | $^\circ\text{C}/\text{W}$ |

**Note 1:** Pulse test,  $t \leq 300\ \mu\text{s}$ , duty cycle,  $d \leq 2\%$

## Characteristic Curves

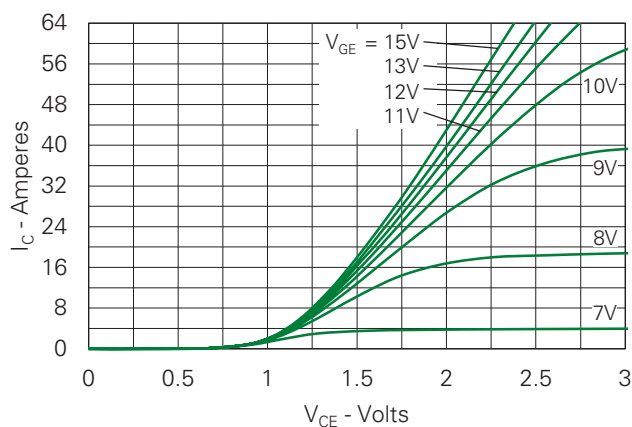
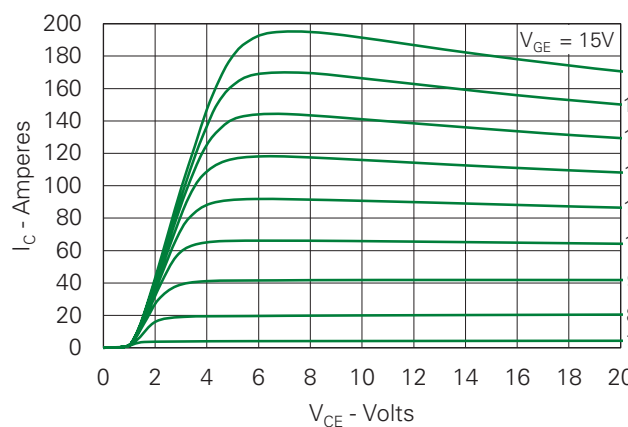
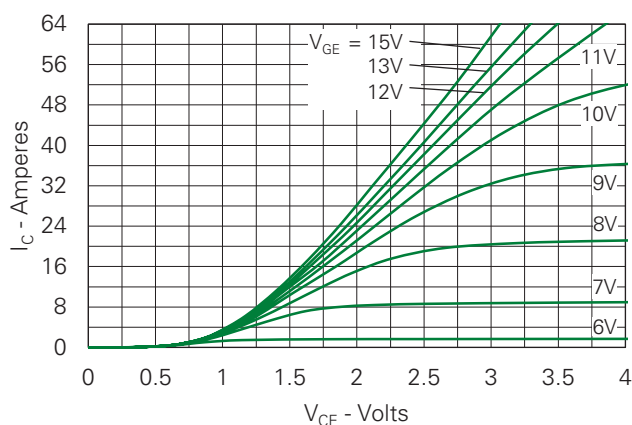
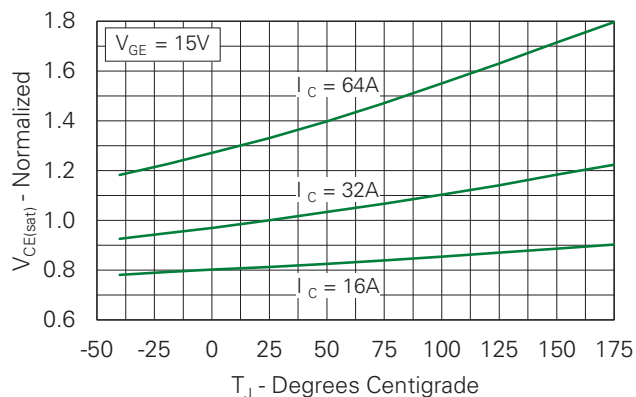
Fig. 1. Output Characteristics @  $T_J = 25^\circ\text{C}$ Fig. 2. Extended Output Characteristics @  $T_J = 25^\circ\text{C}$ Fig. 3. Output Characteristics @  $T_J = 150^\circ\text{C}$ Fig. 4. Dependence of  $V_{CE(sat)}$  on Junction Temperature

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

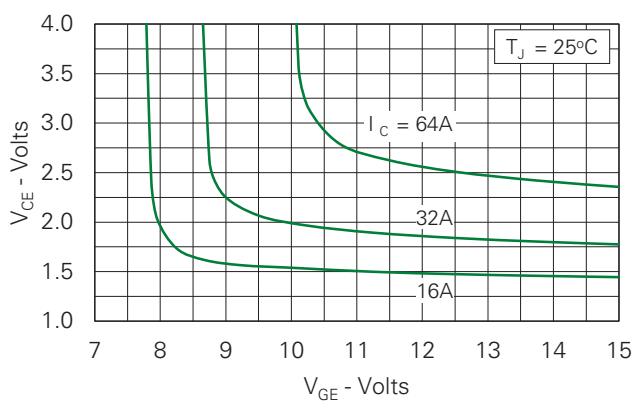


Fig. 6. Input Admittance

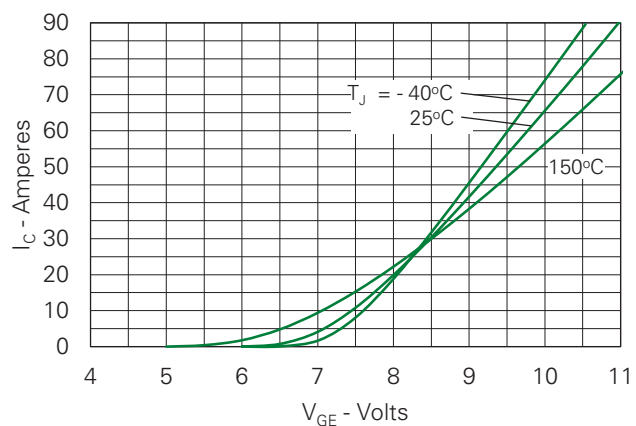


Fig. 7. Transconductance

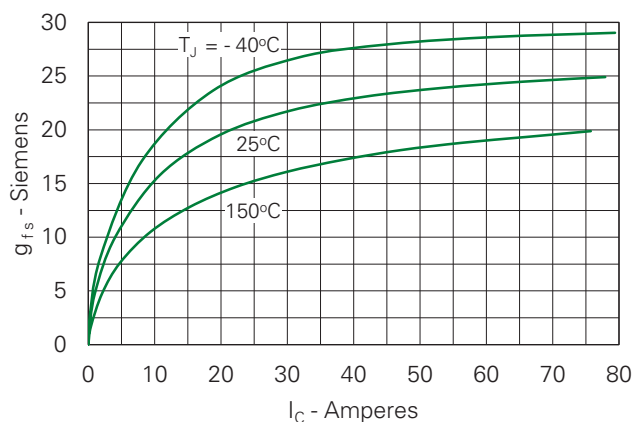


Fig. 8. Gate Charge

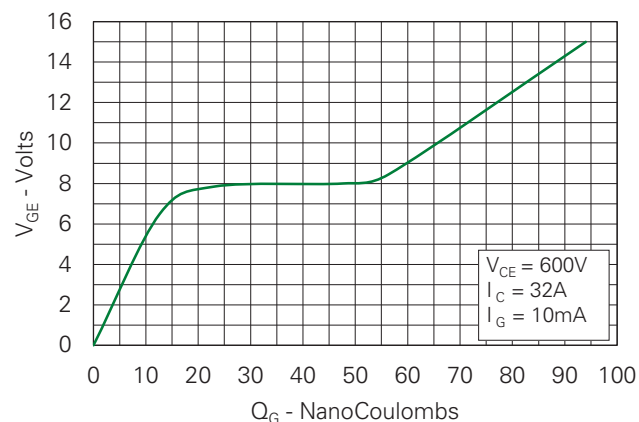


Fig. 9. Capacitance

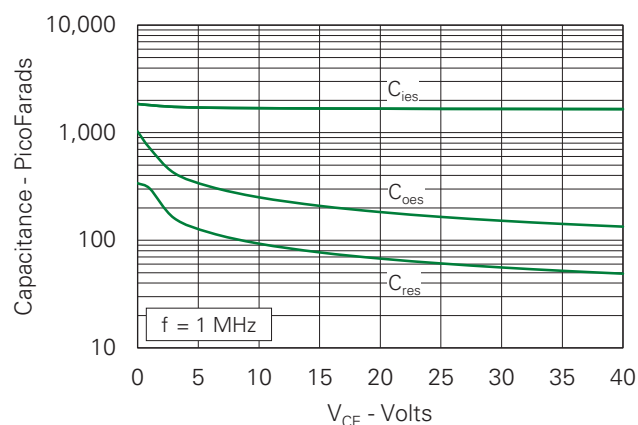


Fig. 10. Reverse-Bias Safe Operating Area

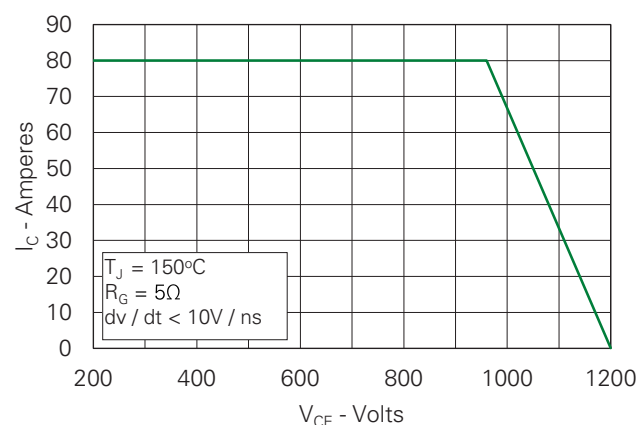


Fig. 11. Maximum Transient Thermal Impedance

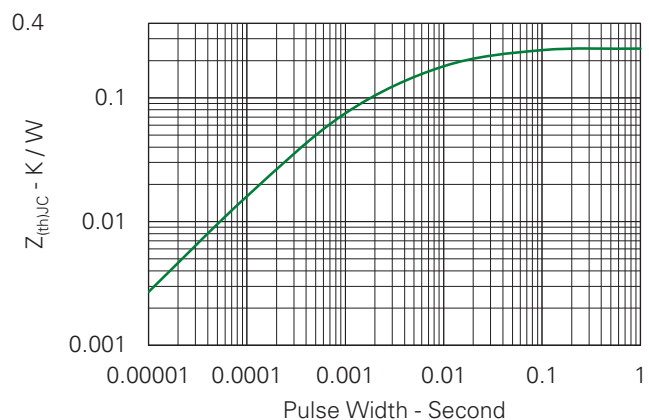
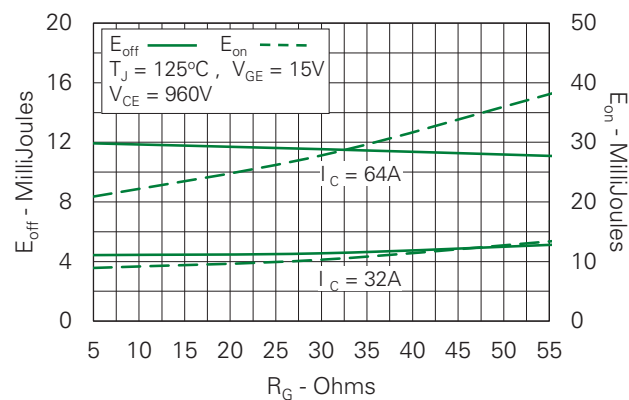
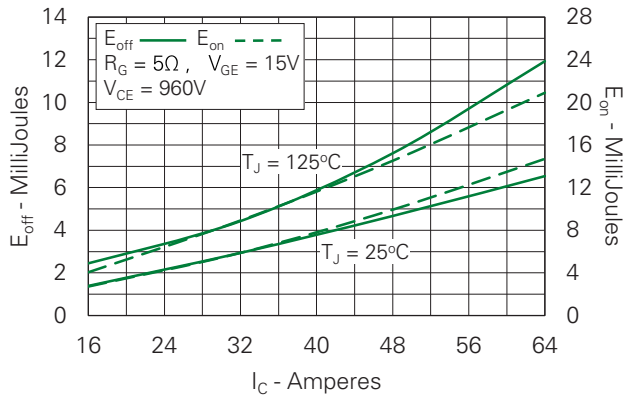
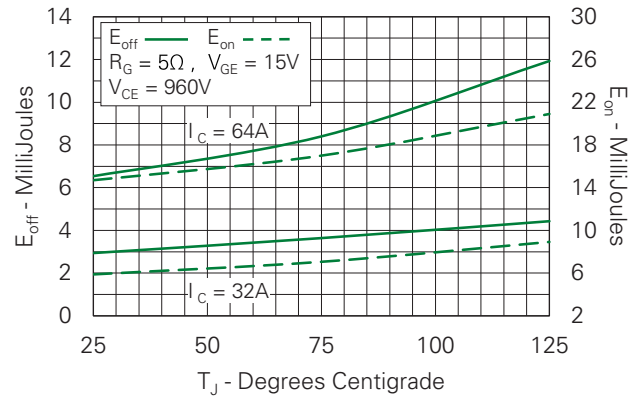
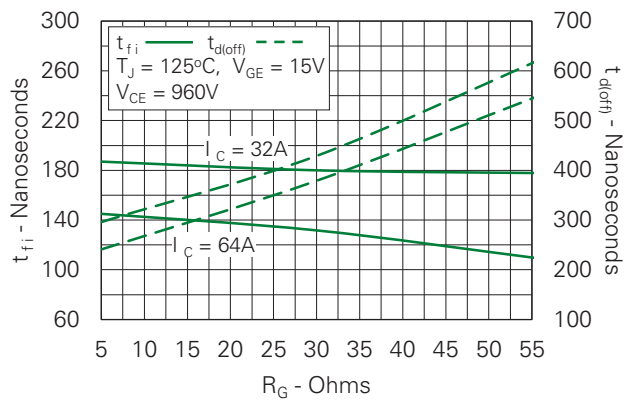
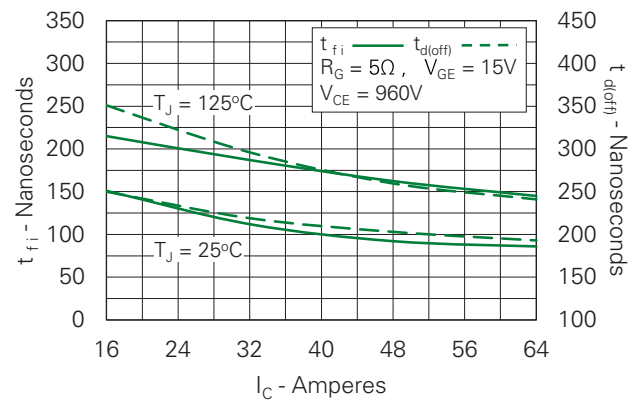
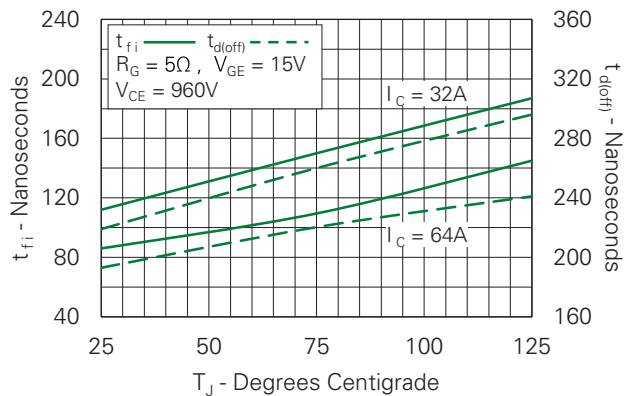
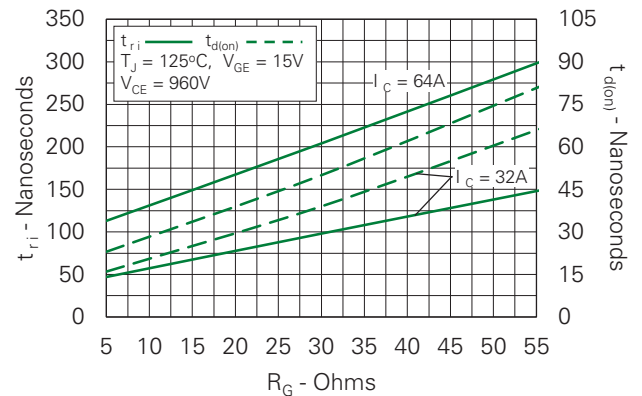


Fig. 12. Inductive Switching Energy Loss vs. Gate Resistance



**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**

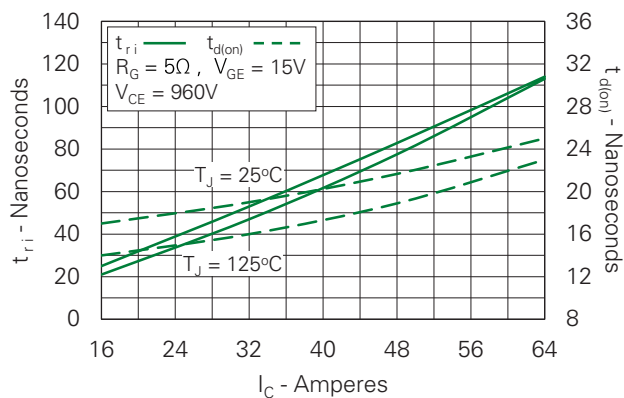
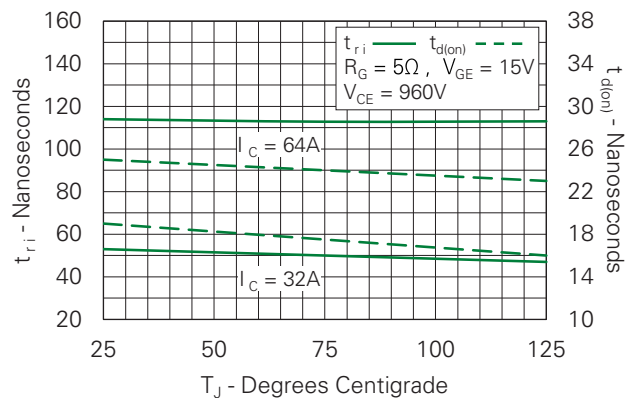
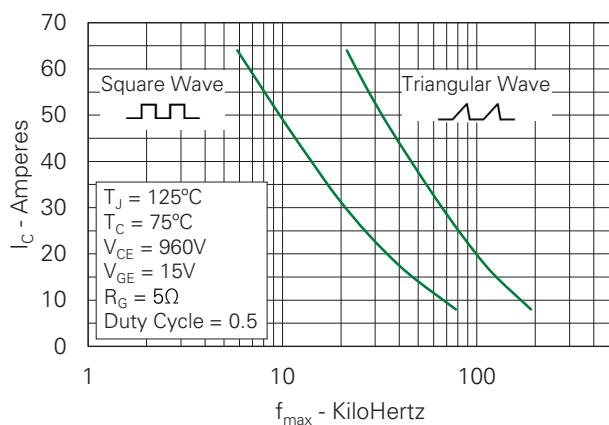
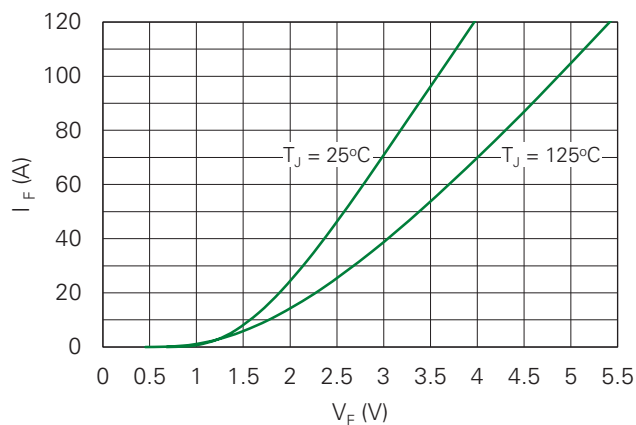
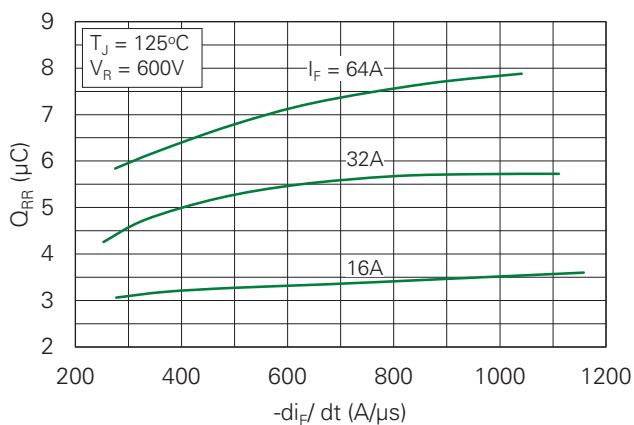
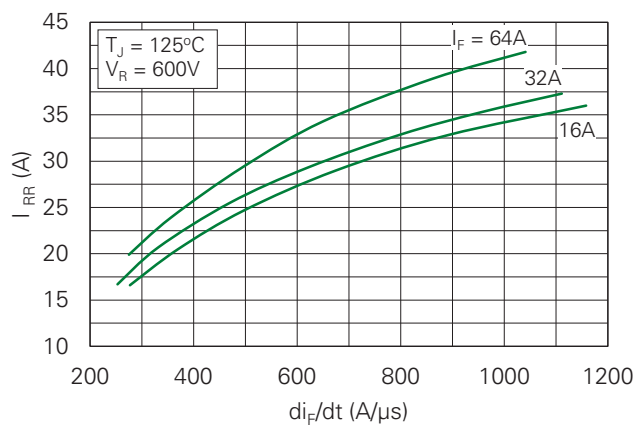
**Fig. 19. Inductive Turn-on Switching Times vs. Collector Current****Fig. 20. Inductive Turn-on Switching Times vs. Junction Temperature****Fig. 21. Maximum Peak Load Current vs. Frequency****Fig. 22. Diode Forward Characteristics****Fig. 23. Reverse Recovery Charge vs.  $-di_F/dt$** **Fig. 24 Reverse Recovery Current vs.  $-di_F/dt$** 

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

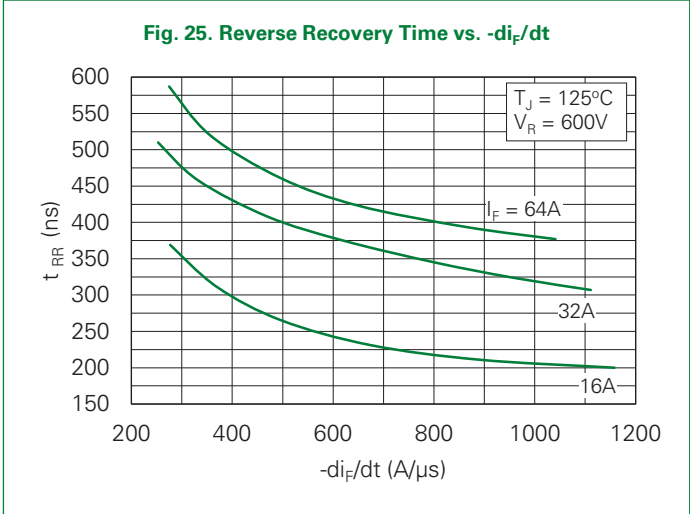


Fig. 26. Dynamic Parameters  $Q_{RR}$ ,  $I_{RR}$  vs. Junction Temperature

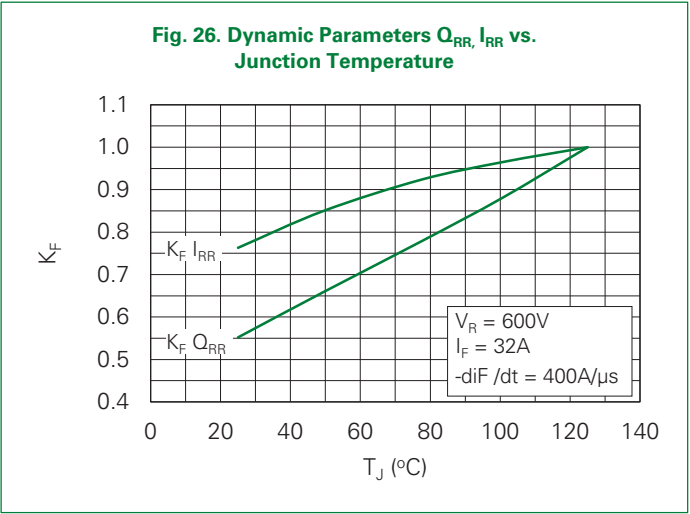
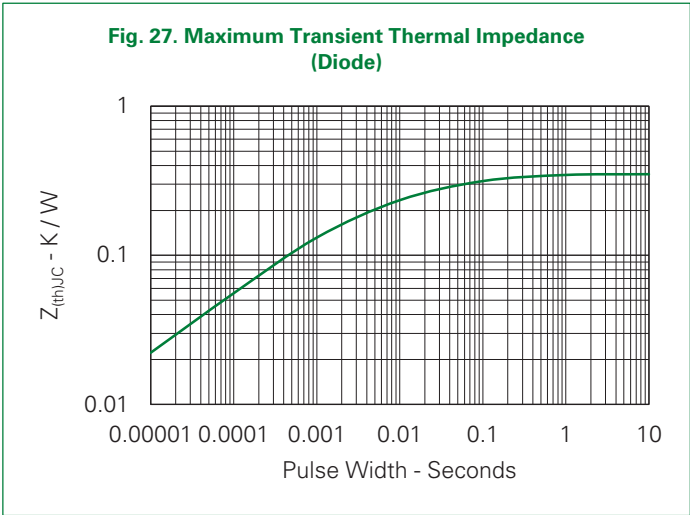
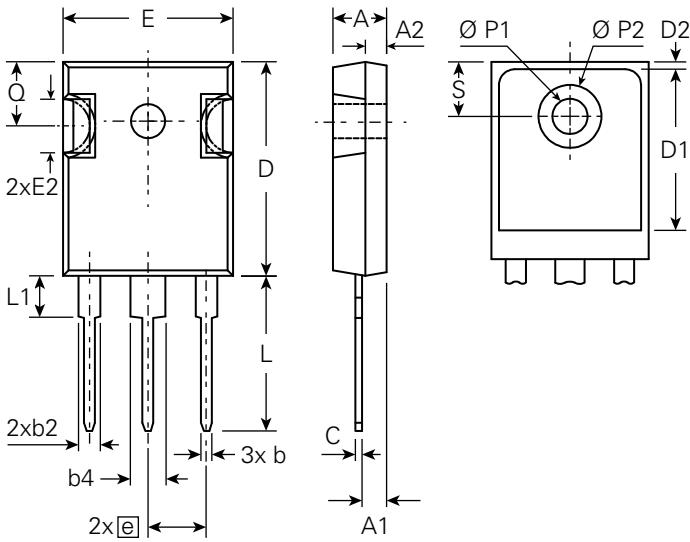


Fig. 27. Maximum Transient Thermal Impedance (Diode)





Part Outline Drawing (TO-247-3L)



| Symbol | Inches    |         |       | Millimeters |         |       |
|--------|-----------|---------|-------|-------------|---------|-------|
|        | Min.      | Typical | Max.  | Min.        | Typical | Max   |
| A      | 0.185     | –       | 0.209 | 4.70        | –       | 5.30  |
| A1     | 0.087     | –       | 0.102 | 2.21        | –       | 2.59  |
| A2     | 0.059     | –       | 0.098 | 1.50        | –       | 2.49  |
| b      | 0.039     | –       | 0.055 | 0.99        | –       | 1.40  |
| b2     | 0.065     | –       | 0.094 | 1.65        | –       | 2.39  |
| b4     | 0.102     | –       | 0.135 | 2.59        | –       | 3.43  |
| c      | 0.015     | –       | 0.035 | 0.38        | –       | 0.89  |
| D      | 0.819     | –       | 0.844 | 20.79       | –       | 21.45 |
| D1     | 0.515     | –       | –     | 13.07       | –       | –     |
| D2     | 0.020     | –       | 0.053 | 0.51        | –       | 1.35  |
| E      | 0.609     | –       | 0.639 | 15.48       | –       | 16.24 |
| E1     | 0.530     | –       | –     | 13.45       | –       | –     |
| E2     | 0.170     | –       | 0.216 | 4.31        | –       | 5.48  |
| e      | 0.215 BSC |         |       | 5.45 BSC    |         |       |
| L      | 0.780     | –       | 0.799 | 19.80       | –       | 20.30 |
| L1     | –         | –       | 0.177 | –           | –       | 4.49  |
| Ø P1   | 0.140     | –       | 0.144 | 3.55        | –       | 3.65  |
| Ø P2   | –         | –       | 0.291 | –           | –       | 7.39  |
| Q      | 0.212     | –       | 0.244 | 5.38        | –       | 6.19  |
| S      | 0.242 BSC |         |       | 6.14 BSC    |         |       |

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