

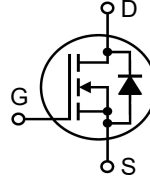
# X2-Class HiPerFET™ Power MOSFET

## IXFH46N60X2A

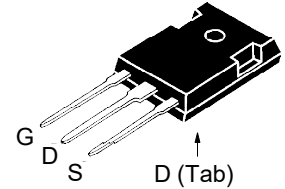
$$\begin{aligned} V_{DSS} &= 600V \\ I_{D25} &= 46A \\ R_{DS(on)} &\leq 69m\Omega \end{aligned}$$

AEC Q101 Qualified

N-Channel Enhancement Mode  
Avalanche Rated



TO-247



G = Gate      D = Drain  
S = Source    Tab = Drain

| Symbol    | Test Conditions                                                                | Maximum Ratings |                  |
|-----------|--------------------------------------------------------------------------------|-----------------|------------------|
| $V_{DSS}$ | $T_J = 25^\circ\text{C to } 150^\circ\text{C}$                                 | 600             | V                |
| $V_{DGR}$ | $T_J = 25^\circ\text{C to } 150^\circ\text{C}, R_{GS} = 1M\Omega$              | 600             | V                |
| $V_{GSS}$ | Continuous                                                                     | $\pm 30$        | V                |
| $V_{GSM}$ | Transient                                                                      | $\pm 40$        | V                |
| $I_{D25}$ | $T_C = 25^\circ\text{C}$                                                       | 46              | A                |
| $I_{DM}$  | $T_C = 25^\circ\text{C}$ , Pulse Width Limited by $T_{JM}$                     | 100             | A                |
| $I_A$     | $T_C = 25^\circ\text{C}$                                                       | 10              | A                |
| $E_{AS}$  | $T_C = 25^\circ\text{C}$                                                       | 2               | J                |
| $dv/dt$   | $I_S \leq I_{DM}, V_{DD} \leq V_{DSS}, T_J \leq 150^\circ\text{C}$             | 50              | V/ns             |
| $P_D$     | $T_C = 25^\circ\text{C}$                                                       | 660             | W                |
| $T_J$     |                                                                                | -55 ... +150    | $^\circ\text{C}$ |
| $T_{JM}$  |                                                                                | 150             | $^\circ\text{C}$ |
| $T_{stg}$ |                                                                                | -55 ... +150    | $^\circ\text{C}$ |
| $T_L$     | 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         |
| Weight    |                                                                                | 6               | g                |

### Features

- International Standard Package
- Low  $R_{DS(ON)}$  and  $Q_G$
- Avalanche Rated
- Low Package Inductance

### Advantages

- High Power Density
- Easy to Mount
- Space Savings

### Applications

- Switch-Mode and Resonant-Mode Power Supplies
- DC-DC Converters
- PFC Circuits
- AC and DC Motor Drives
- Robotics and Servo Controls

| Symbol       | Test Conditions<br>( $T_J = 25^\circ\text{C}$ , Unless Otherwise Specified) | Characteristic Values |      |                          |
|--------------|-----------------------------------------------------------------------------|-----------------------|------|--------------------------|
|              |                                                                             | Min.                  | Typ. | Max.                     |
| $BV_{DSS}$   | $V_{GS} = 0V, I_D = 1mA$                                                    | 600                   |      | V                        |
| $V_{GS(th)}$ | $V_{DS} = V_{GS}, I_D = 4mA$                                                | 3.5                   |      | 5.5 V                    |
| $I_{GSS}$    | $V_{GS} = \pm 30V, V_{DS} = 0V$                                             |                       |      | $\pm 100$ nA             |
| $I_{DSS}$    | $V_{DS} = V_{DSS}, V_{GS} = 0V$<br>$T_J = 125^\circ\text{C}$                |                       |      | 25 $\mu\text{A}$<br>2 mA |
| $R_{DS(on)}$ | $V_{GS} = 10V, I_D = 0.5 \cdot I_{D25}$ , Note 1                            |                       |      | 69 m $\Omega$            |

| Symbol                       | Test Conditions<br>(T <sub>J</sub> = 25°C, Unless Otherwise Specified)                                                                                                   | Characteristic Values                                            |      |           |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|------|-----------|
|                              |                                                                                                                                                                          | Min.                                                             | Typ. | Max       |
| g <sub>fs</sub>              | V <sub>DS</sub> = 10V, I <sub>D</sub> = 0.5 • I <sub>D25</sub> , Note 1                                                                                                  | 17                                                               | 28   | S         |
| R <sub>Gi</sub>              | Gate Input Resistance                                                                                                                                                    |                                                                  | 0.9  | Ω         |
| C <sub>iss</sub>             | V <sub>GS</sub> = 0V, V <sub>DS</sub> = 25V, f = 1MHz                                                                                                                    |                                                                  | 4570 | pF        |
| C <sub>oss</sub>             |                                                                                                                                                                          |                                                                  | 2740 | pF        |
| C <sub>rss</sub>             |                                                                                                                                                                          |                                                                  | 2.2  | pF        |
| Effective Output Capacitance |                                                                                                                                                                          |                                                                  |      |           |
| C <sub>o(er)</sub>           | Energy related                                                                                                                                                           | V <sub>GS</sub> = 0V<br>V <sub>DS</sub> = 0.8 • V <sub>DSS</sub> | 165  | pF        |
| C <sub>o(tr)</sub>           | Time related                                                                                                                                                             |                                                                  | 650  | pF        |
| t <sub>d(on)</sub>           | Resistive Switching Times<br>V <sub>GS</sub> = 10V, V <sub>DS</sub> = 0.5 • V <sub>DSS</sub> , I <sub>D</sub> = 0.5 • I <sub>D25</sub><br>R <sub>G</sub> = 3Ω (External) |                                                                  | 25   | ns        |
| t <sub>r</sub>               |                                                                                                                                                                          |                                                                  | 24   | ns        |
| t <sub>d(off)</sub>          |                                                                                                                                                                          |                                                                  | 50   | ns        |
| t <sub>f</sub>               |                                                                                                                                                                          |                                                                  | 12   | ns        |
| Q <sub>g(on)</sub>           | V <sub>GS</sub> = 10V, V <sub>DS</sub> = 0.5 • V <sub>DSS</sub> , I <sub>D</sub> = 0.5 • I <sub>D25</sub>                                                                |                                                                  | 98   | nC        |
| Q <sub>gs</sub>              |                                                                                                                                                                          |                                                                  | 31   | nC        |
| Q <sub>gd</sub>              |                                                                                                                                                                          |                                                                  | 26   | nC        |
| R <sub>thJC</sub>            |                                                                                                                                                                          |                                                                  |      | 0.19 °C/W |
| R <sub>thCS</sub>            |                                                                                                                                                                          |                                                                  | 0.21 | °C/W      |

### Source-Drain Diode

| Symbol   | Test Conditions<br>( $T_J = 25^\circ\text{C}$ , Unless Otherwise Specified)    | Characteristic Values |      |               |
|----------|--------------------------------------------------------------------------------|-----------------------|------|---------------|
|          |                                                                                | Min.                  | Typ. | Max           |
| $I_S$    | $V_{GS} = 0\text{V}$                                                           |                       |      | 46 A          |
| $I_{SM}$ | Repetitive, Pulse Width Limited by $T_{JM}$                                    |                       |      | 184 A         |
| $V_{SD}$ | $I_F = I_S$ , $V_{GS} = 0\text{V}$ , Note 1                                    |                       |      | 1.4 V         |
| $t_{rr}$ | $I_F = 23\text{A}$ , $-di/dt = 100\text{A}/\mu\text{s}$<br>$V_R = 100\text{V}$ |                       | 180  | ns            |
| $Q_{RM}$ |                                                                                |                       | 1.5  | $\mu\text{C}$ |
| $I_{RM}$ |                                                                                |                       | 16.5 | A             |

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

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

LFMOSFETs 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   | 6,404,065B1 | 6,683,344   | 6,727,585   | 7,005,734B2 | 7,157,338B2 |
| 4,860,072 | 5,017,508 | 5,063,307 | 5,381,025 | 6,259,123B1 | 6,534,343   | 6,710,405B2 | 6,759,692   | 7,063,975B2 |             |
| 4,881,106 | 5,034,796 | 5,187,117 | 5,486,715 | 6,306,728B1 | 6,583,505   | 6,710,463   | 6,771,478B2 | 7,071,537   |             |

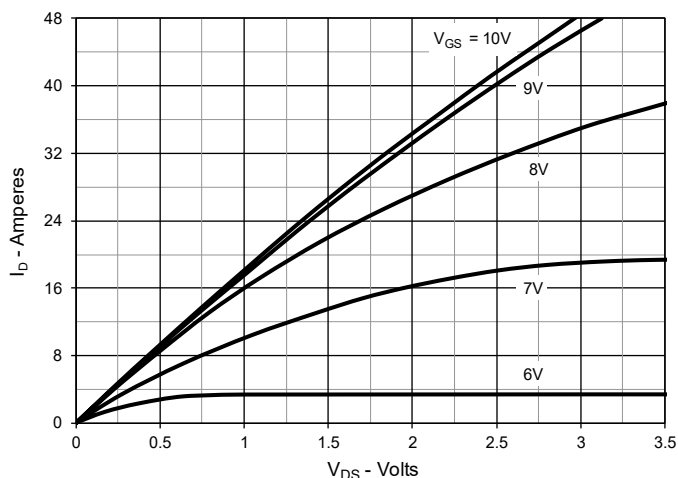
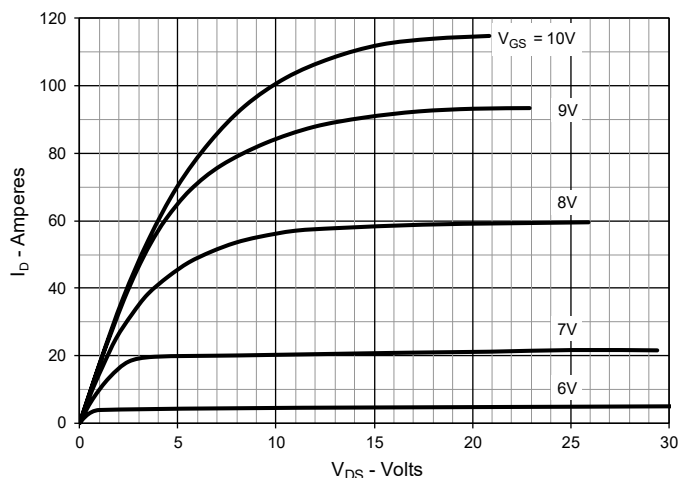
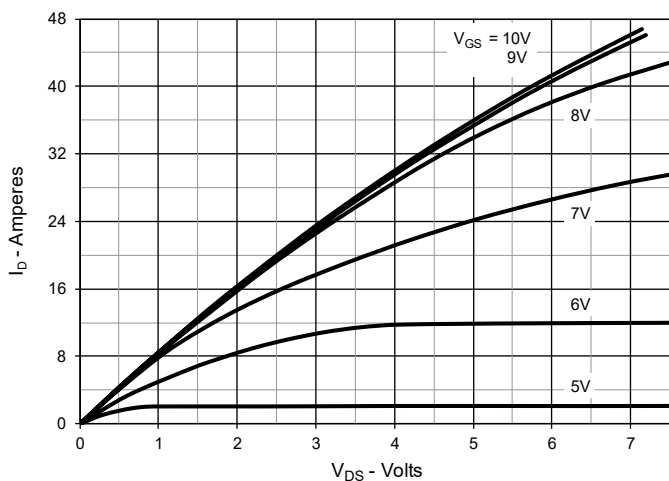
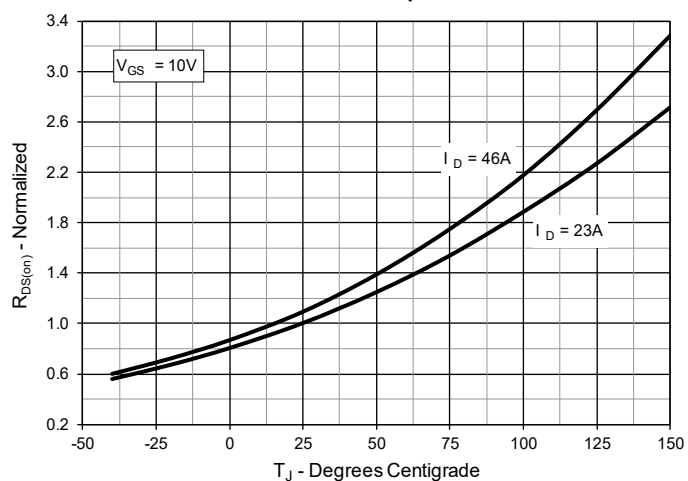
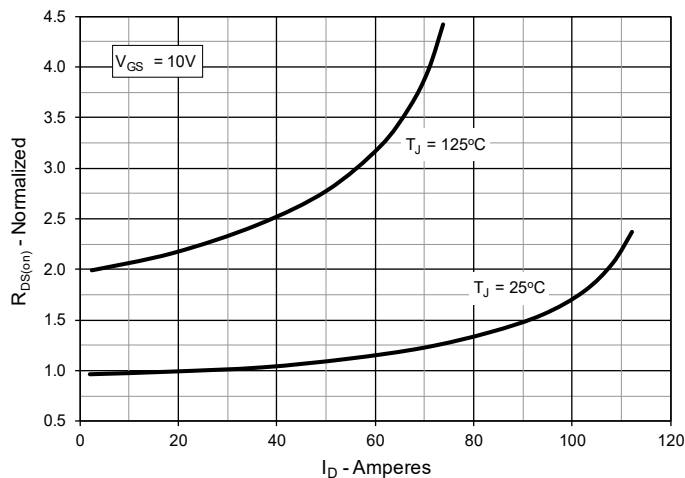
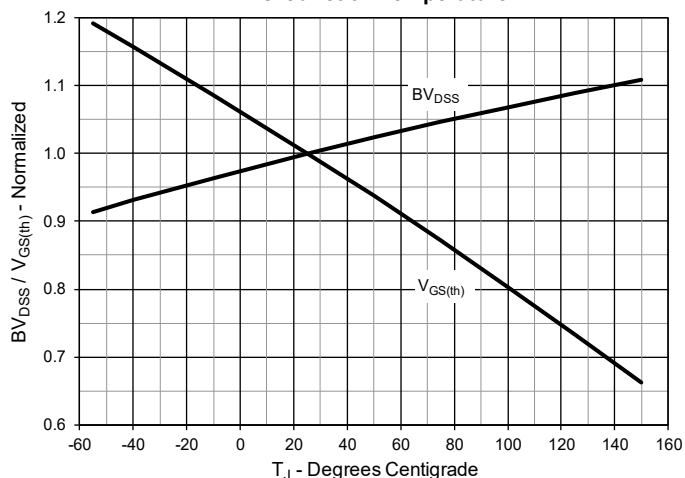
Fig. 1. Output Characteristics @  $T_J = 25^\circ\text{C}$ Fig. 2. Extended Output Characteristics @  $T_J = 25^\circ\text{C}$ Fig. 3. Output Characteristics @  $T_J = 125^\circ\text{C}$ Fig. 4.  $R_{DS(on)}$  Normalized to  $I_D = 23\text{A}$  Value vs. Junction TemperatureFig. 5.  $R_{DS(on)}$  Normalized to  $I_D = 23\text{A}$  Value vs. Drain Current

Fig. 6. Normalized Breakdown &amp; Threshold Voltages vs. Junction Temperature



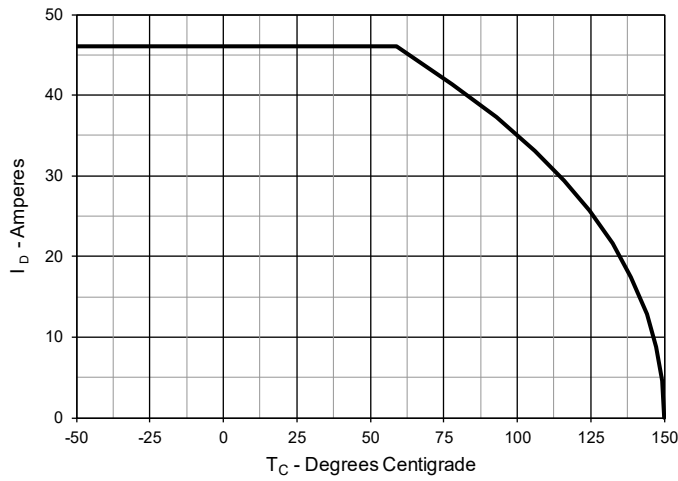
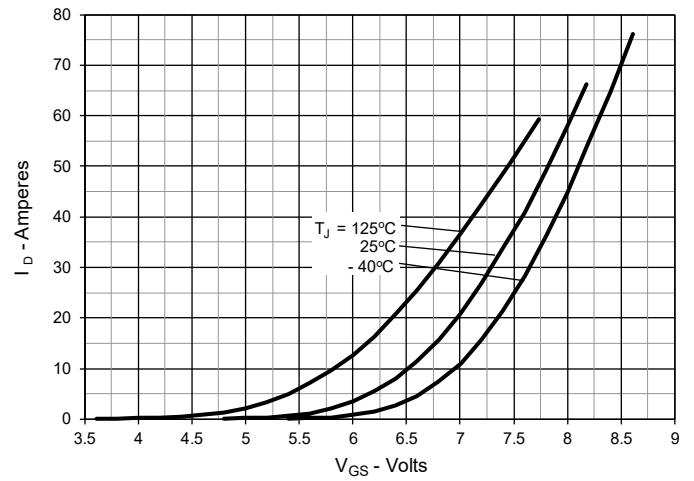
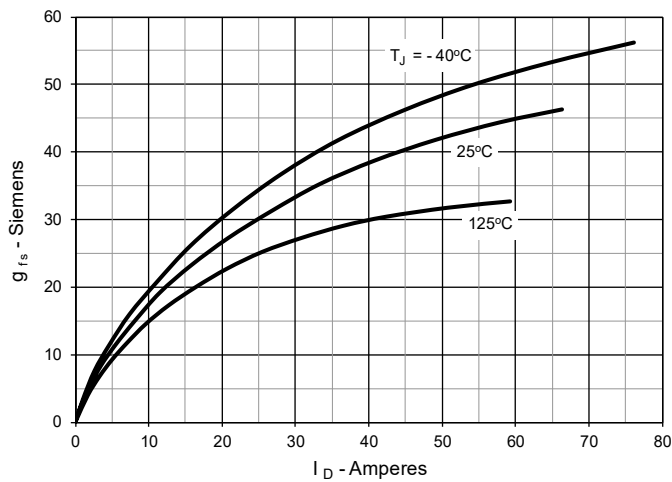
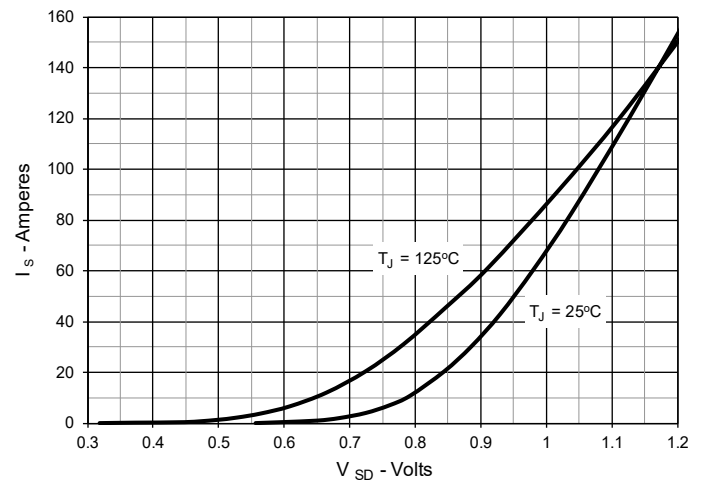
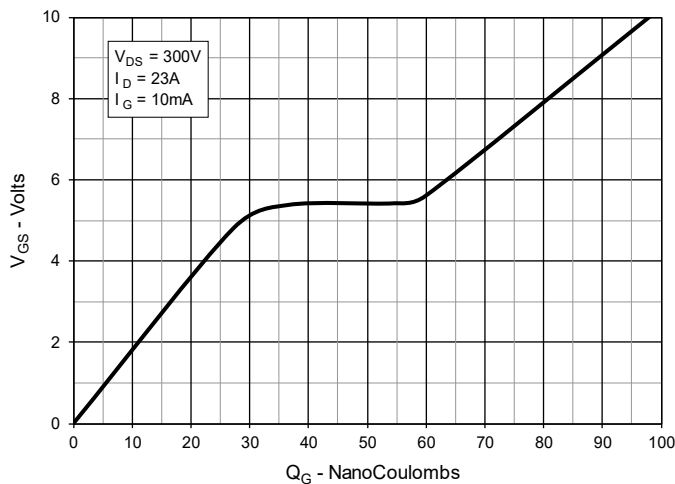
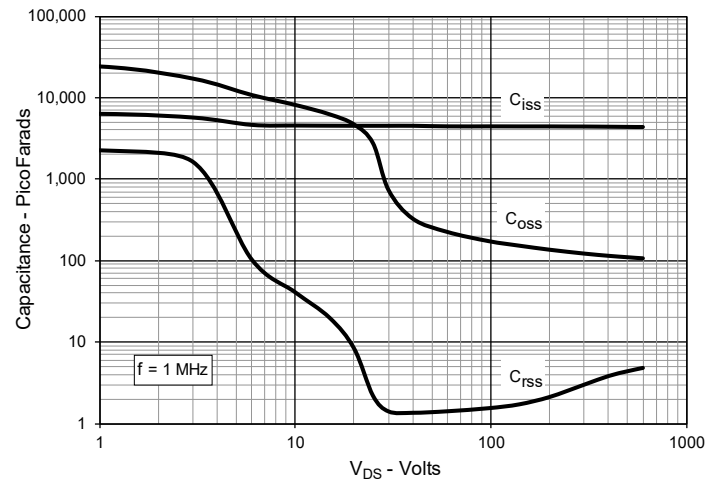
**Fig. 7. Maxing Drain Current vs. Case Temperature**

**Fig. 8. Input Admittance**

**Fig. 9. Transconductance**

**Fig. 10. Forward Voltage Drop of Intrinsic Diode**

**Fig. 11. Gate Charge**

**Fig. 12. Capacitance**


Fig. 13. Output Capacitance Stored Energy

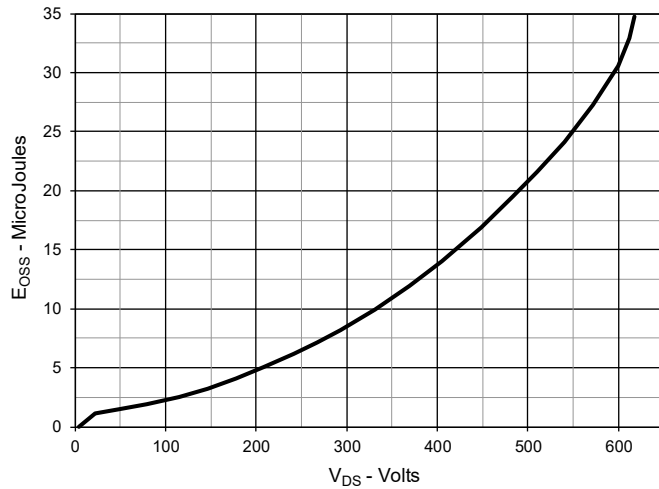


Fig. 14. Forward-Bias Safe Operating Area

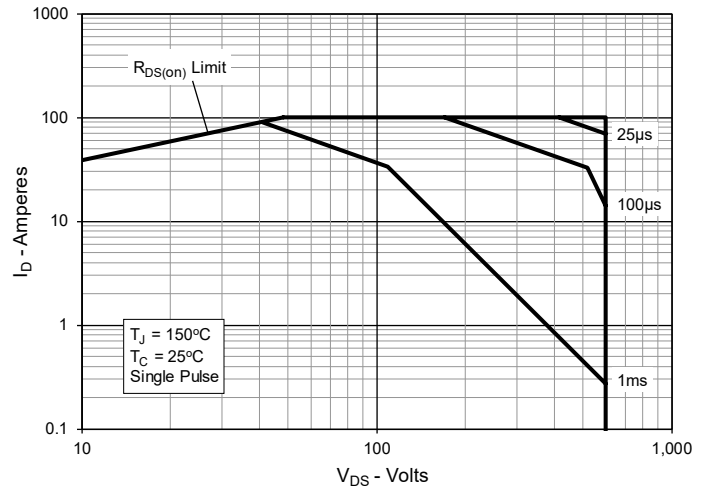
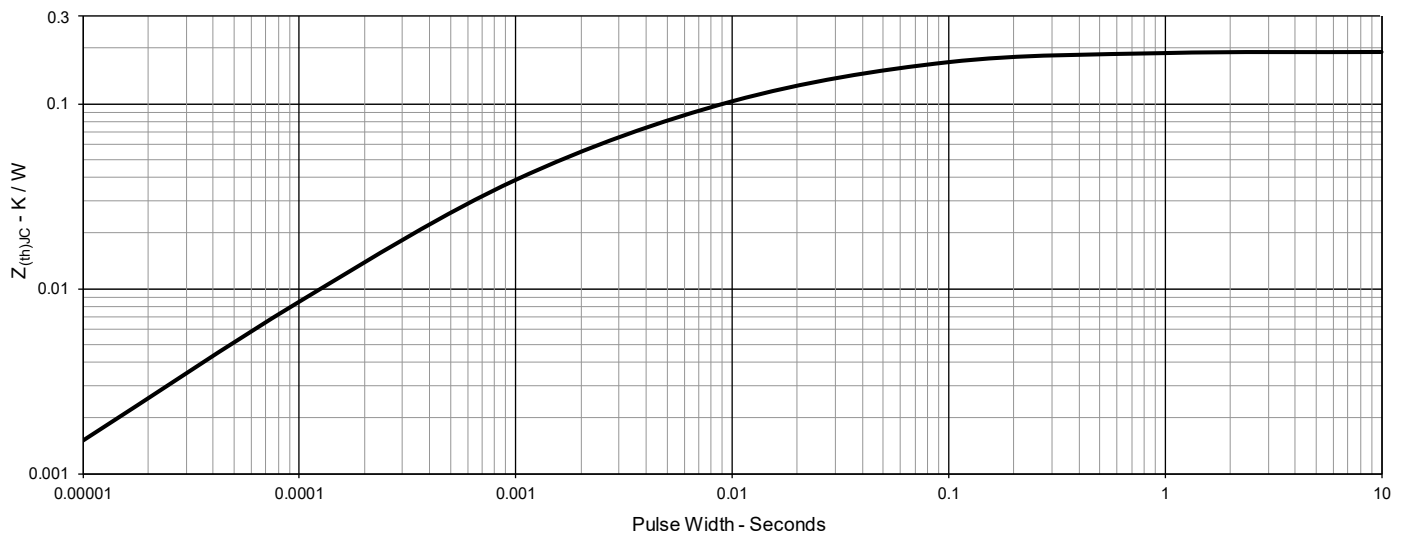
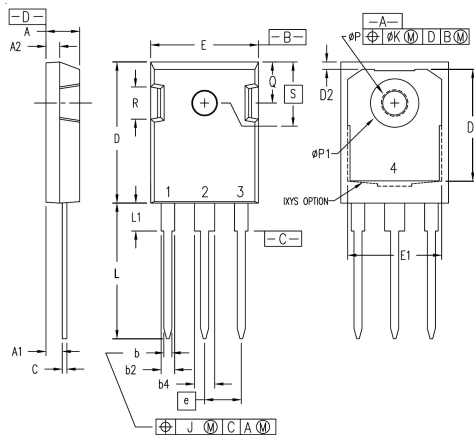


Fig. 15. Maximum Transient Thermal Impedance



**TO-247 Outline**


1 - Gate  
 2,4 - Drain  
 3 - Source

| SYM | INCHES    |       | INCHES   |       |
|-----|-----------|-------|----------|-------|
|     | MIN       | MAX   | MIN      | MAX   |
| A   | 0.190     | 0.205 | 4.83     | 5.21  |
| A1  | 0.090     | 0.100 | 2.29     | 2.54  |
| A2  | 0.075     | 0.085 | 1.91     | 2.16  |
| b   | 0.045     | 0.055 | 1.14     | 1.40  |
| b2  | 0.075     | 0.087 | 1.91     | 2.20  |
| b4  | 0.115     | 0.126 | 2.92     | 3.20  |
| C   | 0.024     | 0.031 | 0.61     | 0.80  |
| D   | 0.819     | 0.840 | 20.80    | 21.34 |
| D1  | 0.650     | 0.690 | 16.51    | 17.53 |
| D2  | 0.035     | 0.050 | 0.89     | 1.27  |
| E   | 0.620     | 0.635 | 15.57    | 16.13 |
| E1  | 0.545     | 0.565 | 13.84    | 14.35 |
| e   | 0.215 BSC |       | 5.45 BSC |       |
| J   | --        | 0.010 | --       | 0.250 |
| K   | --        | 0.025 | --       | 0.640 |
| L   | 0.780     | 0.810 | 19.81    | 20.57 |
| L1  | 0.150     | 0.170 | 3.81     | 4.32  |
| ØP  | 0.140     | 0.144 | 3.55     | 3.65  |
| ØP1 | 0.275     | 0.290 | 6.99     | 7.37  |
| Q   | 0.220     | 0.244 | 5.59     | 6.20  |
| R   | 0.170     | 0.190 | 4.32     | 4.83  |
| S   | 0.242 BSC |       | 6.15 BSC |       |