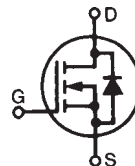


# PolarHV™ HiPerFET Power MOSFET

IXFK 48N60P  
IXFX 48N60P

$V_{DSS} = 600 \text{ V}$   
 $I_{D2} = 48 \text{ A}$   
 $R_{DS(on)} \leq 135 \text{ m}\Omega$   
 $t_{rr} \leq 200 \text{ ns}$

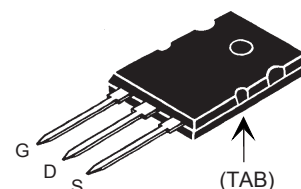
N-Channel Enhancement Mode  
Avalanche Rated  
Fast Intrinsic Diode



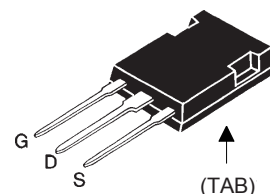
| Symbol     | Test Conditions                                                                                                                          | Maximum Ratings   |                   |
|------------|------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------------|
| $V_{DSS}$  | $T_J = 25^\circ \text{C to } 150^\circ \text{C}$                                                                                         | 600               | V                 |
| $V_{DGR}$  | $T_J = 25^\circ \text{C to } 150^\circ \text{C}; R_{GS} = 1 \text{ M}\Omega$                                                             | 600               | V                 |
| $V_{GSS}$  | Continuous                                                                                                                               | $\pm 30$          | V                 |
| $V_{GSM}$  | Transient                                                                                                                                | $\pm 40$          | V                 |
| $I_{D25}$  | $T_C = 25^\circ \text{C}$                                                                                                                | 48                | A                 |
| $I_{DM}$   | $T_C = 25^\circ \text{C}$ , pulse width limited by $T_{JM}$                                                                              | 110               | A                 |
| $I_{AR}$   | $T_C = 25^\circ \text{C}$                                                                                                                | 48                | A                 |
| $E_{AR}$   | $T_C = 25^\circ \text{C}$                                                                                                                | 70                | mJ                |
| $E_{AS}$   | $T_C = 25^\circ \text{C}$                                                                                                                | 2.0               | J                 |
| $dv/dt$    | $I_S \leq I_{DM}$ , $di/dt \leq 100 \text{ A}/\mu\text{s}$ , $V_{DD} \leq V_{DSS}$ ,<br>$T_J \leq 150^\circ \text{C}$ , $R_G = 4 \Omega$ | 20                | V/ns              |
| $P_D$      | $T_C = 25^\circ \text{C}$                                                                                                                | 830               | W                 |
| $T_J$      |                                                                                                                                          | -55 ... +150      | $^\circ \text{C}$ |
| $T_{JM}$   |                                                                                                                                          | 150               | $^\circ \text{C}$ |
| $T_{stg}$  |                                                                                                                                          | -55 ... +150      | $^\circ \text{C}$ |
| $M_d$      | Mounting torque (TO-264)                                                                                                                 | 1.13/10 Nm/lb.in. |                   |
| Weight     | TO-264                                                                                                                                   | 10                | g                 |
|            | PLUS247                                                                                                                                  | 6                 | g                 |
| $T_L$      | 1.6 mm (0.062 in.) from case for 10 s                                                                                                    | 300               | $^\circ \text{C}$ |
| $T_{SOLD}$ | Plastic body for 10 s                                                                                                                    | 260               | $^\circ \text{C}$ |

| Symbol       | Test Conditions<br>( $T_J = 25^\circ \text{C}$ , unless otherwise specified)                                     | Characteristic Values |      |                                        |
|--------------|------------------------------------------------------------------------------------------------------------------|-----------------------|------|----------------------------------------|
|              |                                                                                                                  | Min.                  | Typ. | Max.                                   |
| $BV_{DSS}$   | $V_{GS} = 0 \text{ V}$ , $I_D = 250 \mu\text{A}$                                                                 | 600                   |      | V                                      |
| $V_{GS(th)}$ | $V_{DS} = V_{GS}$ , $I_D = 8 \text{ mA}$                                                                         | 3.0                   |      | 5.0 V                                  |
| $I_{GSS}$    | $V_{GS} = \pm 30 \text{ V}_{DC}$ , $V_{DS} = 0$                                                                  |                       |      | $\pm 200 \text{ nA}$                   |
| $I_{DSS}$    | $V_{DS} = V_{DSS}$<br>$V_{GS} = 0 \text{ V}$<br>$T_J = 125^\circ \text{C}$                                       |                       |      | 25 $\mu\text{A}$<br>1000 $\mu\text{A}$ |
| $R_{DS(on)}$ | $V_{GS} = 10 \text{ V}$ , $I_D = 0.5 I_{D25}$<br>Pulse test, $t \leq 300 \mu\text{s}$ , duty cycle $d \leq 2 \%$ |                       |      | 135 $\text{m}\Omega$                   |

TO-264 (IXFK)



PLUS247 (IXFX)



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

## Features

- International standard packages
- Fast recovery diode
- Unclamped Inductive Switching (UIS) rated
- Low package inductance
- easy to drive and to protect

## Advantages

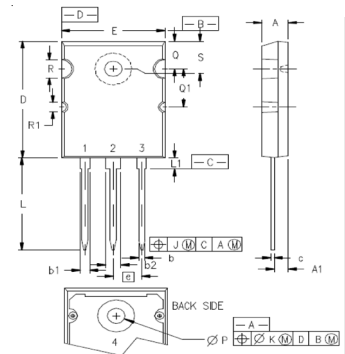
- Easy to mount
- Space savings
- High power density

| Symbol       | Test Conditions                                                              | Characteristic Values<br>( $T_J = 25^\circ\text{C}$ , unless otherwise specified) |      |                    |
|--------------|------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------|--------------------|
|              |                                                                              | Min.                                                                              | Typ. | Max.               |
| $g_{fs}$     | $V_{DS} = 20\text{ V}; I_D = 0.5 I_{D25}$ , pulse test                       | 35                                                                                | 53   | S                  |
| $C_{iss}$    | $V_{GS} = 0\text{ V}, V_{DS} = 25\text{ V}, f = 1\text{ MHz}$                |                                                                                   | 8860 | pF                 |
| $C_{oss}$    |                                                                              |                                                                                   | 850  | pF                 |
| $C_{rss}$    |                                                                              |                                                                                   | 60   | pF                 |
| $t_{d(on)}$  | $V_{GS} = 10\text{ V}, V_{DS} = 0.5 I_{D25}$<br>$R_G = 2\ \Omega$ (External) |                                                                                   | 30   | ns                 |
| $t_r$        |                                                                              |                                                                                   | 25   | ns                 |
| $t_{d(off)}$ |                                                                              |                                                                                   | 85   | ns                 |
| $t_f$        |                                                                              |                                                                                   | 22   | ns                 |
| $Q_{g(on)}$  | $V_{GS} = 10\text{ V}, V_{DS} = 0.5 V_{DSS}, I_D = 0.5 I_{D25}$              |                                                                                   | 150  | nC                 |
| $Q_{gs}$     |                                                                              |                                                                                   | 50   | nC                 |
| $Q_{gd}$     |                                                                              |                                                                                   | 50   | nC                 |
| $R_{thJC}$   | TO-264 and PLUS247                                                           |                                                                                   | 0.15 | $^\circ\text{C/W}$ |
| $R_{thCs}$   |                                                                              |                                                                                   |      | $^\circ\text{C/W}$ |

**Source-Drain Diode**

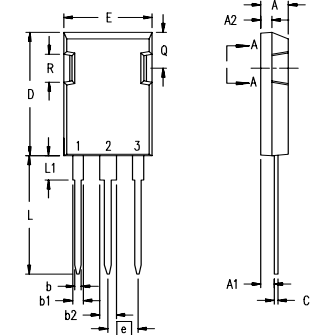
Characteristic Values  
( $T_J = 25^\circ\text{C}$ , unless otherwise specified)

| Symbol   | Test Conditions                                                                                       | Min. | Typ. | Max.          |
|----------|-------------------------------------------------------------------------------------------------------|------|------|---------------|
| $I_S$    | $V_{GS} = 0\text{ V}$                                                                                 |      |      | 48 A          |
| $I_{SM}$ | Repetitive                                                                                            |      |      | 110 A         |
| $V_{SD}$ | $I_F = I_S, V_{GS} = 0\text{ V}$ ,<br>Pulse test, $t \leq 300\ \mu\text{s}$ , duty cycle $d \leq 2\%$ |      |      | 1.5 V         |
| $t_{rr}$ | $I_F = 25\text{ A}, -di/dt = 100\text{ A}/\mu\text{s}$<br>$V_R = 100\text{ V}$                        |      | 0.8  | 200 ns        |
| $Q_{RM}$ |                                                                                                       |      |      | $\mu\text{C}$ |
| $I_{RM}$ |                                                                                                       |      |      | A             |

**TO-264 (IXFK) Outline**


1 - GATE  
2, 4 - DRAIN (COLLECTOR)  
3 - SOURCE (EMITTER)

| SYM | INCHES   |       | MILLIMETERS |       |
|-----|----------|-------|-------------|-------|
|     | MIN.     | MAX.  | MIN.        | MAX.  |
| A   | .185     | .209  | 4.70        | 5.31  |
| A1  | .102     | .118  | 2.59        | 3.00  |
| b   | .037     | .055  | 0.94        | 1.40  |
| b1  | .087     | .102  | 2.21        | 2.59  |
| b2  | .110     | .126  | 2.79        | 3.20  |
| c   | .017     | .029  | 0.43        | 0.74  |
| D   | 1.007    | 1.047 | 25.58       | 26.59 |
| E   | .760     | .799  | 19.30       | 20.29 |
| e   | .215 BSC |       | 5.46 BSC    |       |
| J   | .000     | .010  | 0.00        | 0.25  |
| K   | .000     | .010  | 0.00        | 0.25  |
| L   | .779     | .842  | 19.79       | 21.39 |
| L1  | .087     | .102  | 2.21        | 2.59  |
| ØP  | .122     | .138  | 3.10        | 3.51  |
| Q   | .240     | .256  | 6.10        | 6.50  |
| Q1  | .330     | .346  | 8.38        | 8.79  |
| ØR  | .155     | .187  | 3.94        | 4.75  |
| ØR1 | .085     | .093  | 2.16        | 2.36  |
| S   | .243     | .253  | 6.17        | 6.43  |

**PLUS 247™ (IXFX) Outline**


Terminals: 1 - Gate  
2 - Drain (Collector)  
3 - Source (Emitter)  
4 - Drain (Collector)

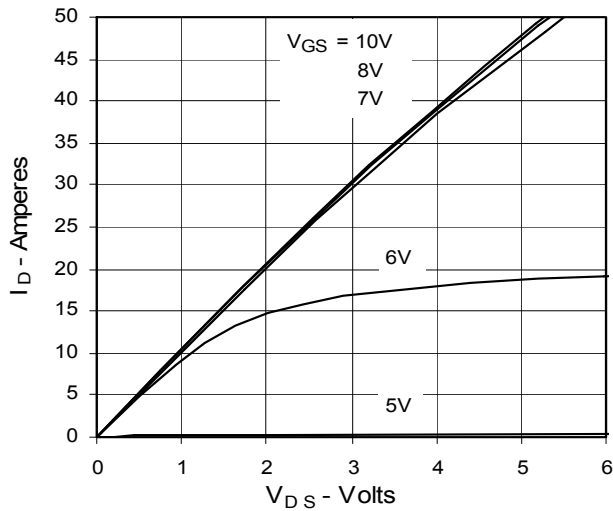
| Dim. | Millimeter |       | Inches   |       |
|------|------------|-------|----------|-------|
|      | Min.       | Max.  | Min.     | Max.  |
| A    | 4.83       | 5.21  | .190     | .205  |
| A1   | 2.29       | 2.54  | .090     | .100  |
| A2   | 1.91       | 2.16  | .075     | .085  |
| b    | 1.14       | 1.40  | .045     | .055  |
| b1   | 1.91       | 2.13  | .075     | .084  |
| b2   | 2.92       | 3.12  | .115     | .123  |
| C    | 0.61       | 0.80  | .024     | .031  |
| D    | 20.80      | 21.34 | .819     | .840  |
| E    | 15.75      | 16.13 | .620     | .635  |
| e    | 5.45 BSC   |       | .215 BSC |       |
| L    | 19.81      | 20.32 | .780     | .800  |
| L1   | 3.81       | 4.32  | .150     | .170  |
| Q    | 5.59       | 6.20  | .220     | 0.244 |
| R    | 4.32       | 4.83  | .170     | .190  |

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

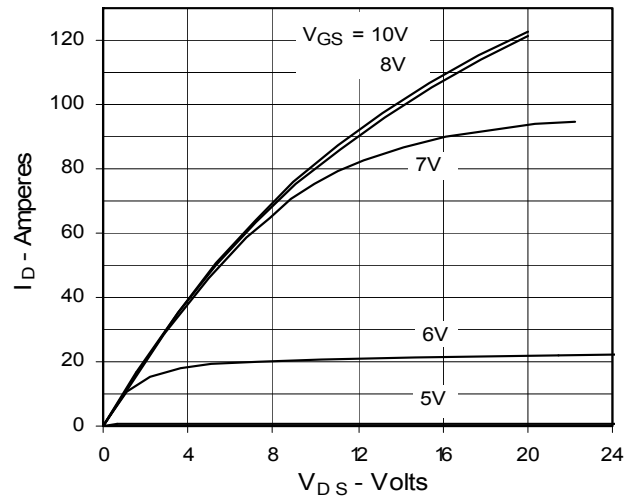
IXYS MOSFETs and IGBTs are covered by one or more of the following U.S. patents:

|           |           |           |           |              |              |              |              |
|-----------|-----------|-----------|-----------|--------------|--------------|--------------|--------------|
| 4,835,592 | 4,931,844 | 5,049,961 | 5,237,481 | 6,162,665    | 6,404,065 B1 | 6,683,344    | 6,727,585    |
| 4,850,072 | 5,017,508 | 5,063,307 | 5,381,025 | 6,259,123 B1 | 6,534,343    | 6,710,405 B2 | 6,759,692    |
| 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 |

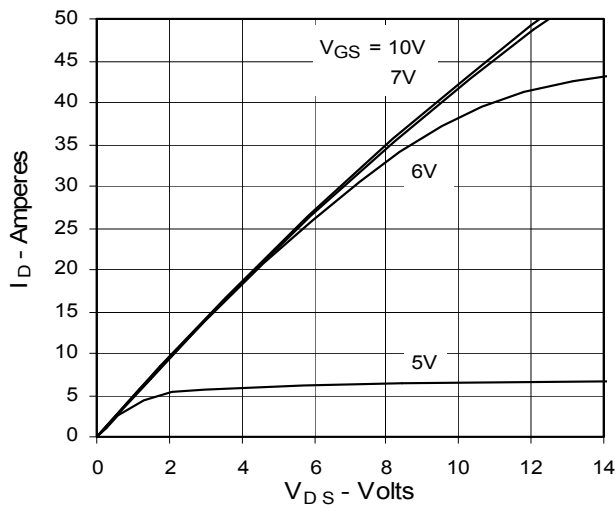
**Fig. 1. Output Characteristics**  
**@ 25°C**



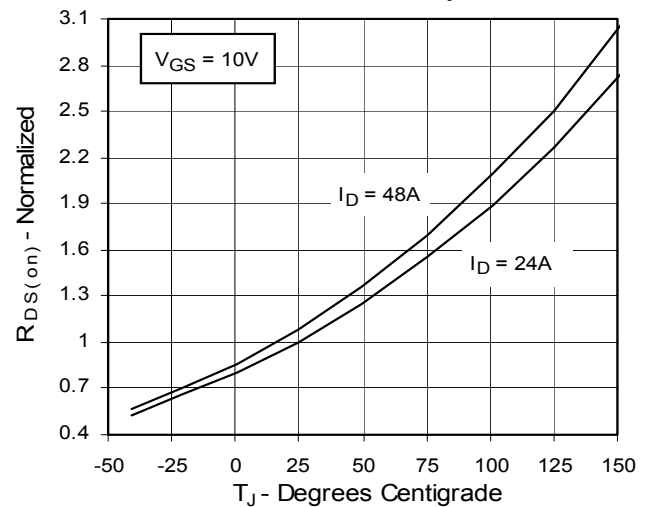
**Fig. 2. Extended Output Characteristics**  
**@ 25°C**



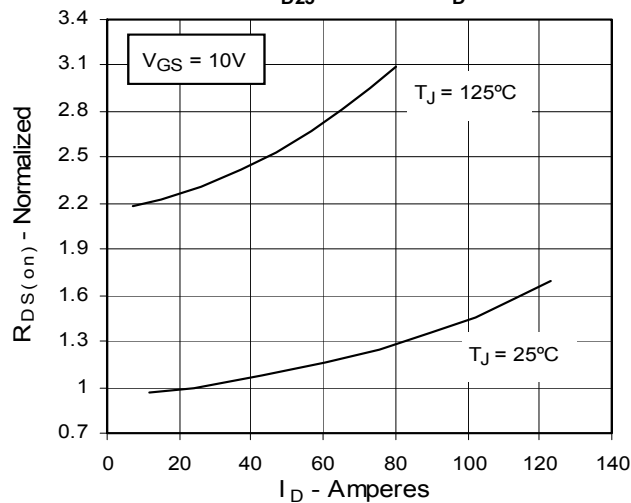
**Fig. 3. Output Characteristics**  
**@ 125°C**



**Fig. 4.  $R_{DS(on)}$  Normalized to 0.5  $I_{D25}$  Value vs. Junction Temperature**



**Fig. 5.  $R_{DS(on)}$  Normalized to 0.5  $I_{D25}$  Value vs.  $I_D$**



**Fig. 6. Drain Current vs. Case Temperature**

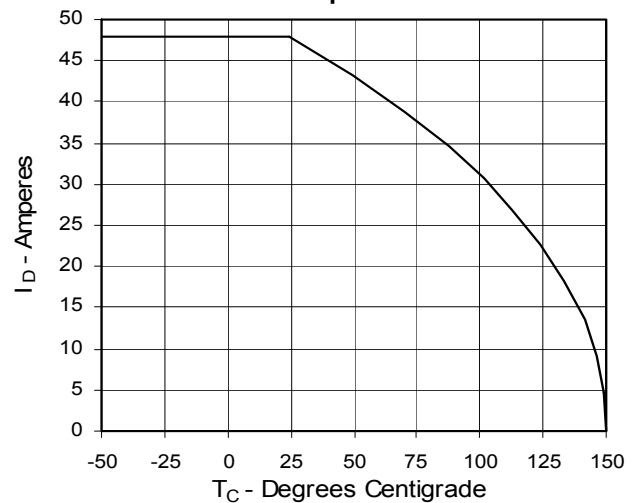


Fig. 7. Input Admittance

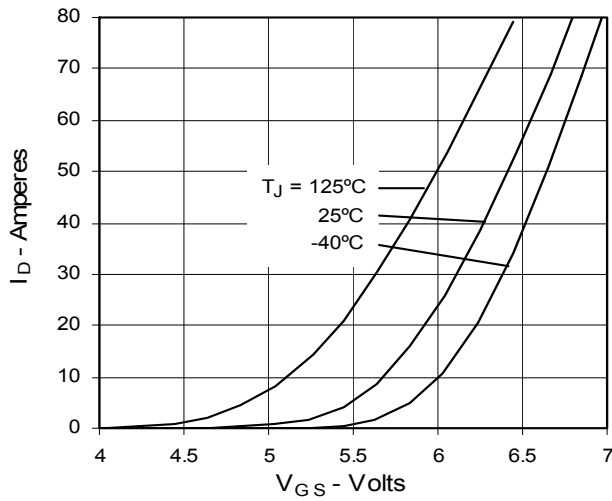


Fig. 8. Transconductance

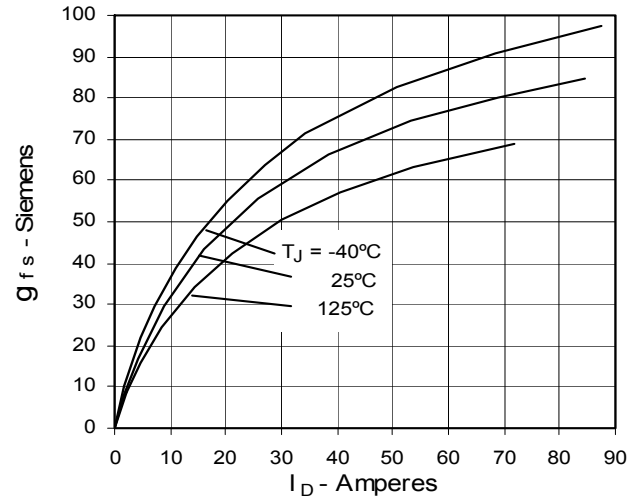


Fig. 9. Source Current vs. Source-To-Drain Voltage

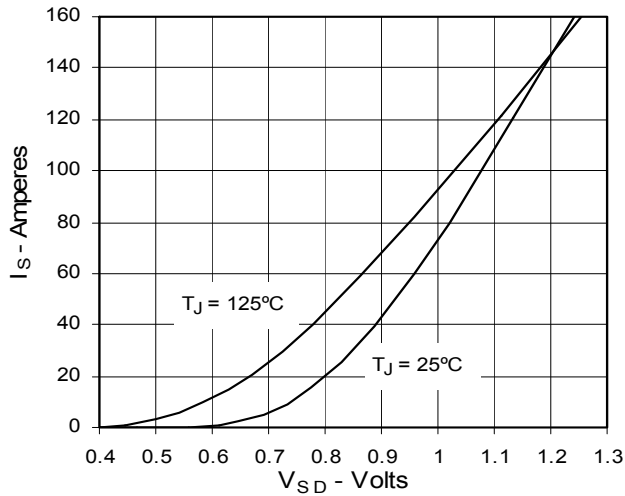


Fig. 10. Gate Charge

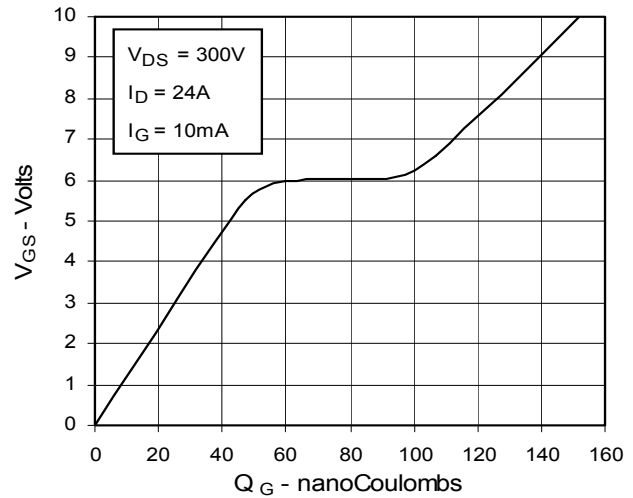


Fig. 11. Capacitance

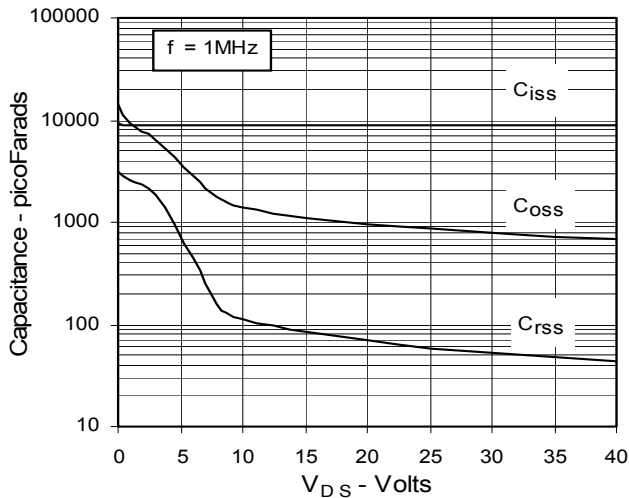
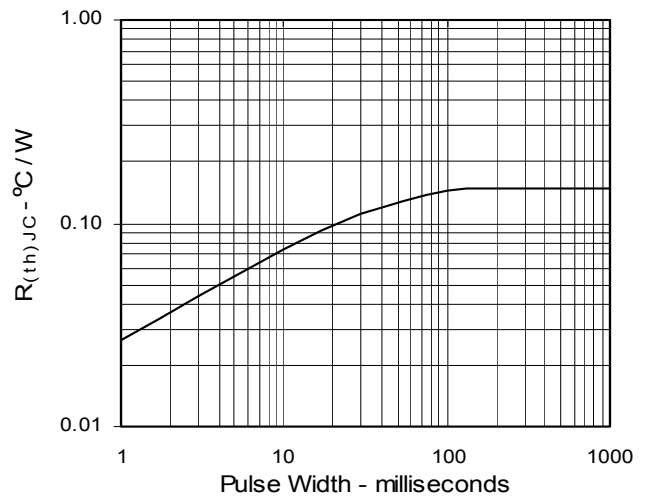


Fig. 13. Maximum Transient Thermal Resistance



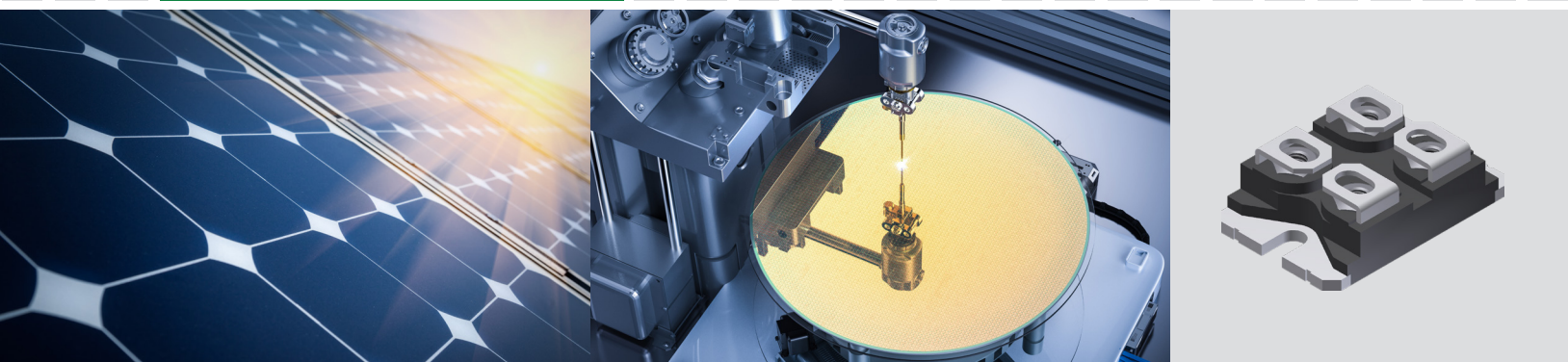


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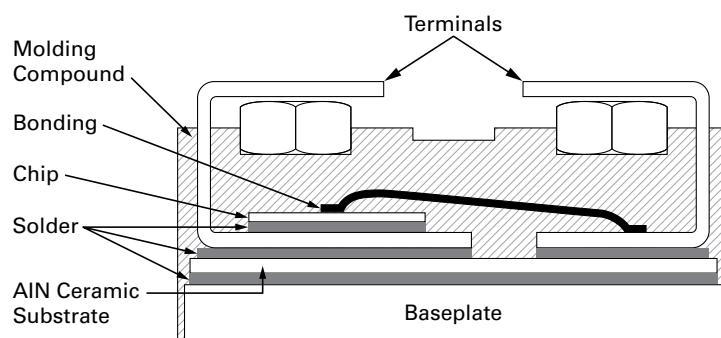
Expertise Applied | Answers Delivered



## Isolated **miniature power BLOCK** (miniBLOC™) solution for Plasma Power Supplies

Littelfuse's isolated miniBLOC™ (SOT-227B) is a discrete miniature power BLOCK, conveniently bridging the power gap between inexpensive discrete packages and full-sized power modules. Littelfuse offers a wide range of Si and SiC miniBLOC™ MOSFET solutions catering to the design demands of plasma power supplies.

The miniBLOC™ solution offering fully isolated base plate, higher power densities, faster switching speeds, wide device choice, ease of application, and long-term reliability will serve as a key enabler, providing the right solution to development needs at different power levels.



**Cross-section of SOT-227B (miniBLOC)**

## The **miniature power BLOCK** Advantage

### Features

- Aluminum Nitride ceramic-based compact discrete package with electrically isolated baseplate
- Reduced overall junction-sink thermal impedance in comparison to non-isolated discretes
- Isolation up to 2.5 kV  $V_{RMS}/60$  s or 3 kV  $V_{RMS}/1$  s
- Extended creepage and clearance distances:
  - Terminal-terminal: clearance of up to 7 mm and creepage of up to 10.5 mm
  - Terminal-baseplate: clearance of up to 8.5 mm and creepage of up to 10.5 mm
- Discrete power block with high current-handling capability
- Low internal lead inductance < 5 nH
- Option for Kelvin-Source terminal
- Screw-mounted discrete package with four screwed terminal leads

### Advantages

- Aluminum Nitride internal isolation increases power density, simplifies thermal design, improves reliability, and enables superior power cycling capability with cooler chip temperatures compared to non-isolated and conventionally isolated discretes
- Optimal for high-voltage design given the inherent isolation and extended creepage and clearance
- Reduced paralleling effort and decreased part count resulting in PCB space savings
- Higher safety overvoltage margin with reduced overvoltage stress at chip level due to lower package stray inductance
- Kelvin-Source terminal improves controllability, enabling faster switching speeds
- Rugged and stable mounting, ease of manufacturing and handling in assembly

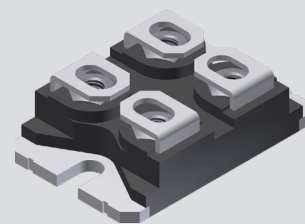
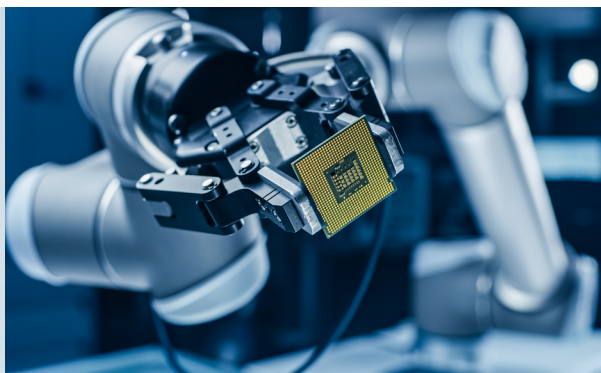
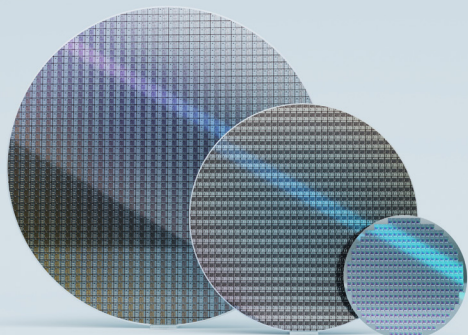
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Expertise Applied | Answers Delivered



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## High Current (> 50 A), 650 V Ultra Junction X2-Class MOSFETs in miniBLOC™

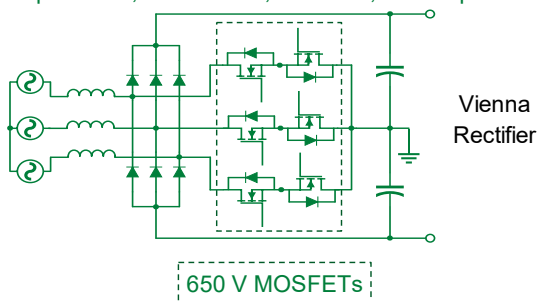
| $R_{DS(on),max}$<br>[mΩ] | $I_{D25}$<br>[A] | miniBLOC™<br> |
|--------------------------|------------------|------------------------------------------------------------------------------------------------|
| 13                       | 170              | IXFN170N65X2 ●                                                                                 |
| 17                       | 145              | IXFN150N65X2 ●                                                                                 |
| 24                       | 108              | IXFN120N65X2 ●                                                                                 |
| 30                       | 78               | IXFN100N65X2 ●                                                                                 |
| 30                       | 76               | IXTN102N65X2 ●                                                                                 |

- HiPerFET™ (fast-body diode)
- Standard body diode

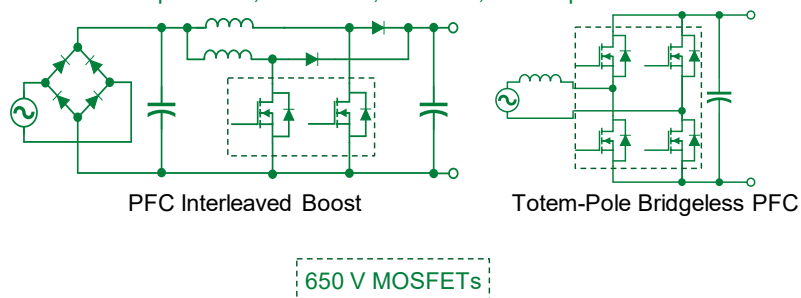
The 650 V X2-Class Ultra Junction MOSFETs in miniBLOC™ package from Littelfuse exhibit some of the highest current ratings, lowest on-state resistances  $R_{DS(on)}$ , low gate charge  $Q_g$ , and superior dv/dt performance. Their superior avalanche capability further enhances device ruggedness in critical applications. Additionally, the HiPerFET™ devices with fast soft-recovery body diode have reduced switching losses and a better electromagnetic interference (EMI) behavior.

These benefits of the 650 V Ultra Junction X2-Class MOSFETs in combination with the advantages offered by the miniBLOC™ package make them a preferred choice for plasma power supplies.

AC Input: 3-Ph, 170 - 480 V, 50/60 Hz; DC Output: 600 - 800 V



AC Input: 1-Ph, 85 - 265 V, 50/60 Hz; DC Output: < 400 V



Scan this QR code to access the Littelfuse webpage on Ultra Junction X2-Class MOSFETs

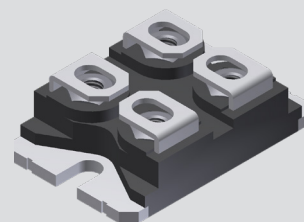
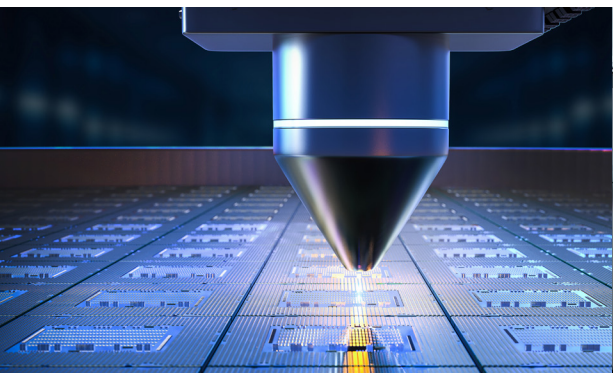


# Littelfuse®

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Expertise Applied | Answers Delivered



## 900–1200 V Polar™ HiPerFET™ in miniBLOC™

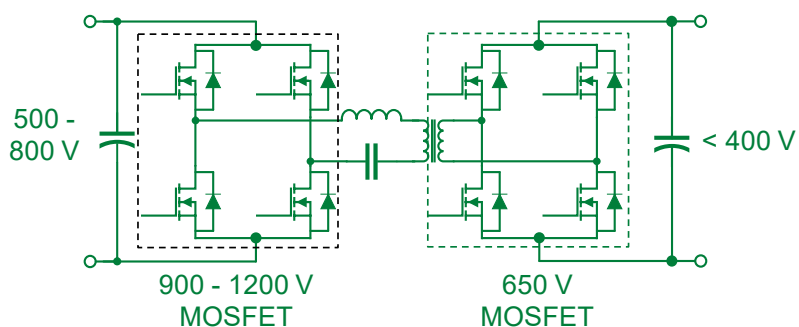
| $R_{DS(on),max}$<br>[Ω] | $I_{D25}$<br>[A] | $V_{DSS}$<br>[V] | miniBLOC™<br> |
|-------------------------|------------------|------------------|------------------------------------------------------------------------------------------------|
| 0.145                   | 56               | 900              | IXFN56N90P                                                                                     |
| 0.160                   | 43               | 900              | IXFN52N90P                                                                                     |
| 0.230                   | 33               | 900              | IXFN40N90P                                                                                     |
| 0.21                    | 38               | 1000             | IXFN38N100P                                                                                    |
| 0.22                    | 37               | 1000             | IXFN44N100P                                                                                    |
| 0.32                    | 27               | 1000             | IXFN32N100P                                                                                    |
| 0.39                    | 23               | 1000             | IXFN26N100P                                                                                    |
| 0.26                    | 34               | 1100             | IXFN40N110P                                                                                    |
| 0.31                    | 32               | 1200             | IXFN32N120P                                                                                    |
| 0.35                    | 30               | 1200             | IXFN30N120P                                                                                    |
| 0.46                    | 23               | 1200             | IXFN26N120P                                                                                    |
| 0.57                    | 20               | 1200             | IXFN20N120P                                                                                    |

Littelfuse 900–1200 V Polar™ HiPerFET™ devices are tailored to provide designers with a rugged device solution that offers the best advantage in performance and cost in high frequency applications.

These devices incorporate the Polar technology platform to achieve low on-state resistances  $R_{DS(on)}$  which improves conduction behavior. The low gate charge  $Q_g$  and fast body diode results in more efficient switching at all frequencies. The dv/dt and avalanche capabilities of these devices provide additional safeguards against overvoltage transients.

The benefits of the Polar™ HiPerFET™ devices, in addition to the advantages offered by the miniBLOC™ package, make them the best solution for plasma power supplies.

### DC/DC LLC Converter



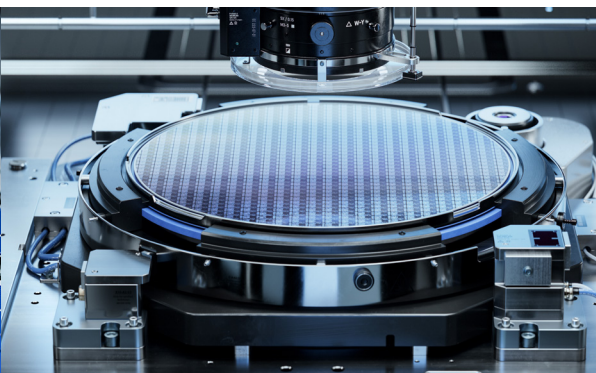
Scan this QR code to access the Littelfuse webpage on Polar HiPerFET™ devices

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Expertise Applied | Answers Delivered



## 1200 V SiC MOSFETs in miniBLOC™ with Kelvin-Source

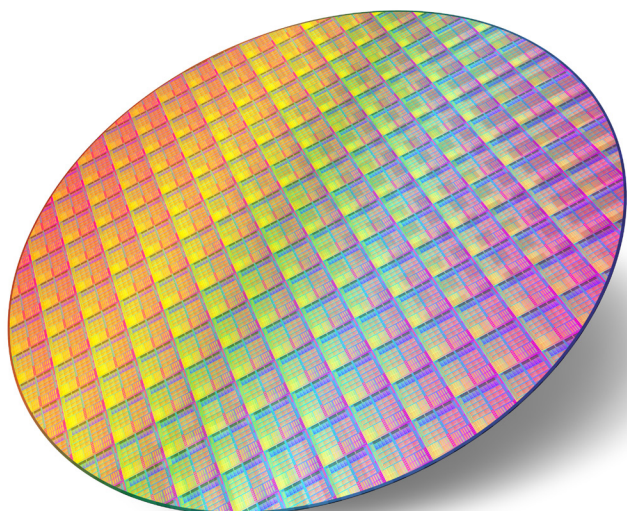
| $R_{DS(on),max}$<br>[mΩ] | $I_{D25}$<br>[A] | $V_{DSS}$<br>[V] | miniBLOC™ w/<br>Kelvin-Source<br> |
|--------------------------|------------------|------------------|--------------------------------------------------------------------------------------------------------------------|
| 10                       | 130              | 900              | IXFN130N90SK                                                                                                       |
| 21                       | 75               | 1200             | IXFN75N120SK                                                                                                       |
| 32                       | 55               | 1200             | IXFN55N120SK                                                                                                       |
| 75                       | 30               | 1200             | IXFN30N120SK                                                                                                       |

Note: Preliminary datasheet and engineering samples available for the SiC MOSFETs in the table above

Littelfuse 1200 V SiC MOSFETs featuring low  $R_{DS(on)}$  and low device capacitances, offer the highest efficiency for reduced cooling effort. The excellent conduction and switching behavior combined with higher frequency operation improves power density in the application.

The SiC MOSFETs in miniBLOC™ featuring a Kelvin-Source connection offer superior immunity to parasitic turn-on/turn-off events, thereby maximizing the high-speed switching performance of the MOSFET.

These advantages of SiC MOSFETs combined with the benefits offered by the miniBLOC™ package make them a preferred choice in Plasma Power Supplies.



Scan this QR code to access  
the Littelfuse webpage on  
SiC MOSFETs

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