

# International IR Rectifier

- Advanced Process Technology
- Dynamic  $dv/dt$  Rating
- 175°C Operating Temperature
- Fast Switching
- Fully Avalanche Rated
- Ease of Paralleling
- Simple Drive Requirements

## Lead-Free Description

Fifth Generation HEXFET® Power MOSFETs from International Rectifier utilize advanced processing techniques to achieve extremely low on-resistance per silicon area. This benefit, combined with the fast switching speed and ruggedized device design that HEXFET Power MOSFETs are well known for, provides the designer with an extremely efficient and reliable device for use in a wide variety of applications.

The TO-220 package is universally preferred for all commercial-industrial applications at power dissipation levels to approximately 50 watts. The low thermal resistance and low package cost of the TO-220 contribute to its wide acceptance throughout the industry.

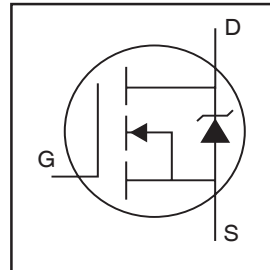
The D²Pak is a surface mount power package capable of accommodating die sizes up to HEX-4. It provides the highest power capability and the lowest possible on-resistance in any existing surface mount package. The D²Pak is suitable for high current applications because of its low internal connection resistance and can dissipate up to 2.0W in a typical surface mount application.

The through-hole version (IRF640NL) is available for low-profile application.

PD - 95046A

IRF640NPbF  
IRF640NSPbF  
IRF640NLPbF

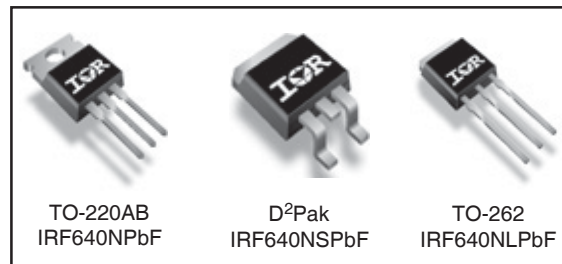
HEXFET® Power MOSFET



$$V_{DS} = 200V$$

$$R_{DS(on)} = 0.15\Omega$$

$$I_D = 18A$$



TO-220AB  
IRF640NPbF

D²Pak  
IRF640NSPbF

TO-262  
IRF640NLPbF

## Absolute Maximum Ratings

|                                   | Parameter                                | Max.                   | Units |
|-----------------------------------|------------------------------------------|------------------------|-------|
| $I_D$ @ $T_C = 25^\circ\text{C}$  | Continuous Drain Current, $V_{GS}$ @ 10V | 18                     | A     |
| $I_D$ @ $T_C = 100^\circ\text{C}$ | Continuous Drain Current, $V_{GS}$ @ 10V | 13                     |       |
| $I_{DM}$                          | Pulsed Drain Current ①                   | 72                     |       |
| $P_D$ @ $T_C = 25^\circ\text{C}$  | Power Dissipation                        | 150                    | W     |
|                                   | Linear Derating Factor                   | 1.0                    | W/°C  |
| $V_{GS}$                          | Gate-to-Source Voltage                   | $\pm 20$               | V     |
| $E_{AS}$                          | Single Pulse Avalanche Energy②           | 247                    | mJ    |
| $I_{AR}$                          | Avalanche Current①                       | 18                     | A     |
| $E_{AR}$                          | Repetitive Avalanche Energy①             | 15                     | mJ    |
| $dv/dt$                           | Peak Diode Recovery $dv/dt$ ⑥            | 8.1                    | V/ns  |
| $T_J$                             | Operating Junction and                   | -55 to +175            | °C    |
| $T_{STG}$                         | Storage Temperature Range                |                        |       |
|                                   | Soldering Temperature, for 10 seconds    | 300 (1.6mm from case ) |       |
|                                   | Mounting torque, 6-32 or M3 screw④       | 10 lbf•in (1.1N•m)     |       |

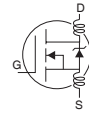
www.irf.com

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07/23/10

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

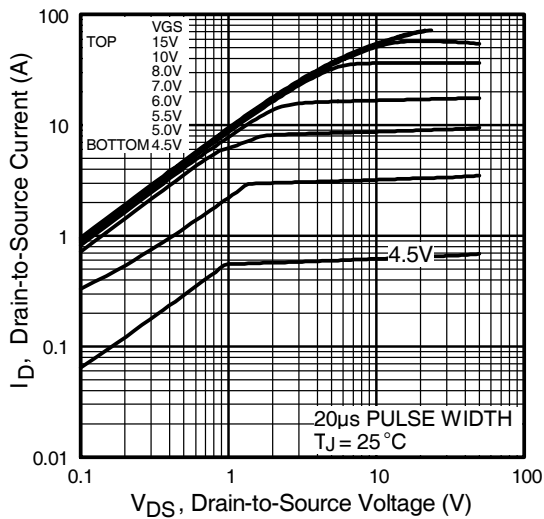
|                                 | Parameter                            | Min. | Typ. | Max. | Units               | Conditions                                                                  |
|---------------------------------|--------------------------------------|------|------|------|---------------------|-----------------------------------------------------------------------------|
| $V_{(BR)DSS}$                   | Drain-to-Source Breakdown Voltage    | 200  | —    | —    | V                   | $V_{GS} = 0V, I_D = 250\mu A$                                               |
| $\Delta V_{(BR)DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient  | —    | 0.25 | —    | V/ $^\circ\text{C}$ | Reference to $25^\circ\text{C}, I_D = 1\text{mA}$                           |
| $R_{DS(on)}$                    | Static Drain-to-Source On-Resistance | —    | —    | 0.15 | $\Omega$            | $V_{GS} = 10V, I_D = 11A$ ③                                                 |
| $V_{GS(th)}$                    | Gate Threshold Voltage               | 2.0  | —    | 4.0  | V                   | $V_{DS} = V_{GS}, I_D = 250\mu A$                                           |
| $g_{fs}$                        | Forward Transconductance             | 6.8  | —    | —    | S                   | $V_{DS} = 50V, I_D = 11A$ ③                                                 |
| $I_{DSS}$                       | Drain-to-Source Leakage Current      | —    | —    | 25   | $\mu A$             | $V_{DS} = 200V, V_{GS} = 0V$                                                |
|                                 |                                      | —    | —    | 250  |                     | $V_{DS} = 160V, V_{GS} = 0V, T_J = 150^\circ\text{C}$                       |
| $I_{GSS}$                       | Gate-to-Source Forward Leakage       | —    | —    | 100  | nA                  | $V_{GS} = 20V$                                                              |
|                                 | Gate-to-Source Reverse Leakage       | —    | —    | -100 |                     | $V_{GS} = -20V$                                                             |
| $Q_g$                           | Total Gate Charge                    | —    | —    | 67   | nC                  | $I_D = 11A$                                                                 |
| $Q_{gs}$                        | Gate-to-Source Charge                | —    | —    | 11   |                     | $V_{DS} = 160V$                                                             |
| $Q_{gd}$                        | Gate-to-Drain ("Miller") Charge      | —    | —    | 33   |                     | $V_{GS} = 10V$ , See Fig. 6 and 13                                          |
| $t_{d(on)}$                     | Turn-On Delay Time                   | —    | 10   | —    | ns                  | $V_{DD} = 100V$                                                             |
| $t_r$                           | Rise Time                            | —    | 19   | —    |                     | $I_D = 11A$                                                                 |
| $t_{d(off)}$                    | Turn-Off Delay Time                  | —    | 23   | —    |                     | $R_G = 2.5\Omega$                                                           |
| $t_f$                           | Fall Time                            | —    | 5.5  | —    |                     | $R_D = 9.0\Omega$ , See Fig. 10 ③                                           |
| $L_D$                           | Internal Drain Inductance            | —    | 4.5  | —    | nH                  | Between lead,<br>6mm (0.25in.)<br>from package<br>and center of die contact |
| $L_S$                           | Internal Source Inductance           | —    | 7.5  | —    |                     |                                                                             |
| $C_{iss}$                       | Input Capacitance                    | —    | 1160 | —    | pF                  | $V_{GS} = 0V$                                                               |
| $C_{oss}$                       | Output Capacitance                   | —    | 185  | —    |                     | $V_{DS} = 25V$                                                              |
| $C_{rss}$                       | Reverse Transfer Capacitance         | —    | 53   | —    |                     | $f = 1.0\text{MHz}$ , See Fig. 5                                            |

**Source-Drain Ratings and Characteristics**

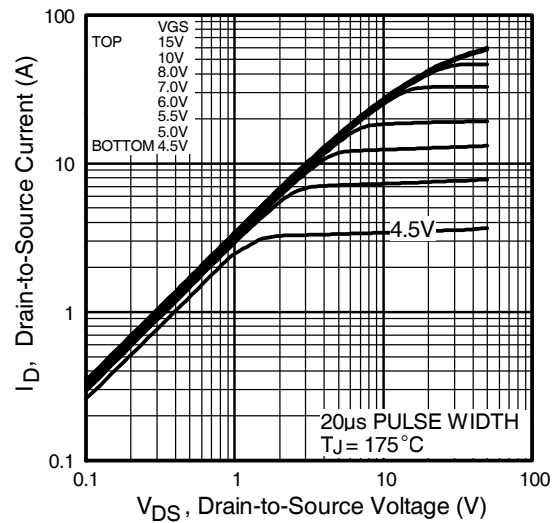
|          | Parameter                              | Min.                                                                        | Typ. | Max. | Units | Conditions                                                     |
|----------|----------------------------------------|-----------------------------------------------------------------------------|------|------|-------|----------------------------------------------------------------|
| $I_S$    | Continuous Source Current (Body Diode) | —                                                                           | —    | 18   | A     | MOSFET symbol showing the integral reverse p-n junction diode. |
| $I_{SM}$ | Pulsed Source Current (Body Diode)①    | —                                                                           | —    | 72   |       |                                                                |
| $V_{SD}$ | Diode Forward Voltage                  | —                                                                           | —    | 1.3  | V     | $T_J = 25^\circ\text{C}, I_S = 11A, V_{GS} = 0V$ ③             |
| $t_{rr}$ | Reverse Recovery Time                  | —                                                                           | 167  | 251  | ns    | $T_J = 25^\circ\text{C}, I_F = 11A$                            |
| $Q_{rr}$ | Reverse Recovery Charge                | —                                                                           | 929  | 1394 | nC    | $di/dt = 100A/\mu s$ ③                                         |
| $t_{on}$ | Forward Turn-On Time                   | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S + L_D$ ) |      |      |       |                                                                |

**Thermal Resistance**

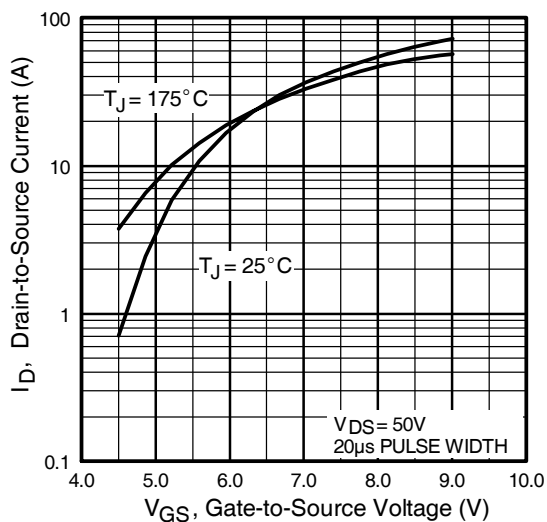
|                 | Parameter                             | Typ. | Max. | Units              |
|-----------------|---------------------------------------|------|------|--------------------|
| $R_{\theta JC}$ | Junction-to-Case                      | —    | 1.0  | $^\circ\text{C}/W$ |
| $R_{\theta CS}$ | Case-to-Sink, Flat, Greased Surface ④ | 0.50 | —    |                    |
| $R_{\theta JA}$ | Junction-to-Ambient④                  | —    | 62   |                    |
| $R_{\theta JA}$ | Junction-to-Ambient (PCB mount)⑤      | —    | 40   |                    |



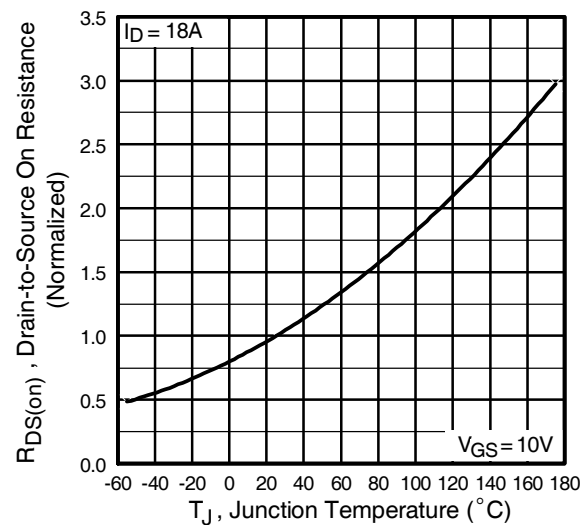
**Fig 1.** Typical Output Characteristics



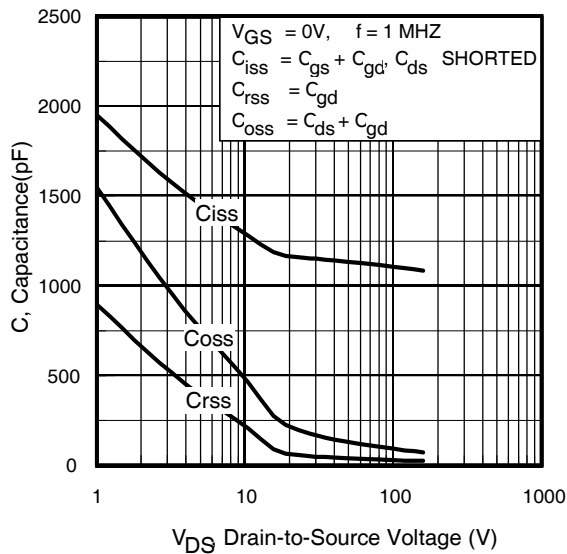
**Fig 2.** Typical Output Characteristics



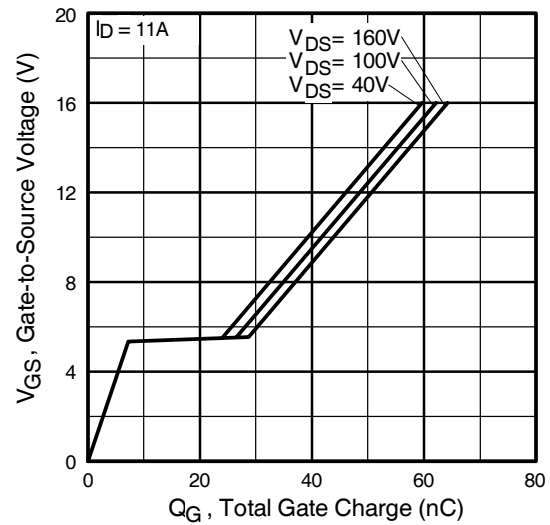
**Fig 3.** Typical Transfer Characteristics



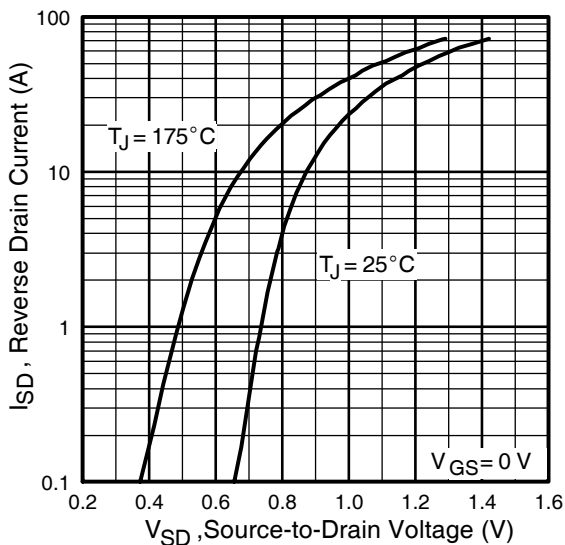
**Fig 4.** Normalized On-Resistance  
Vs. Temperature



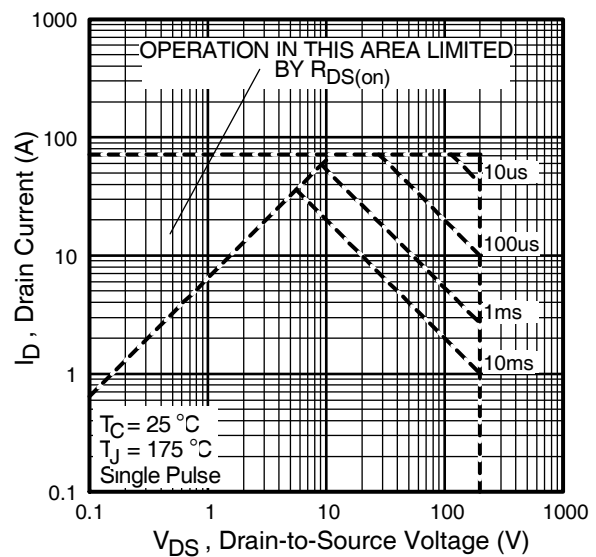
**Fig 5.** Typical Capacitance Vs.  
Drain-to-Source Voltage



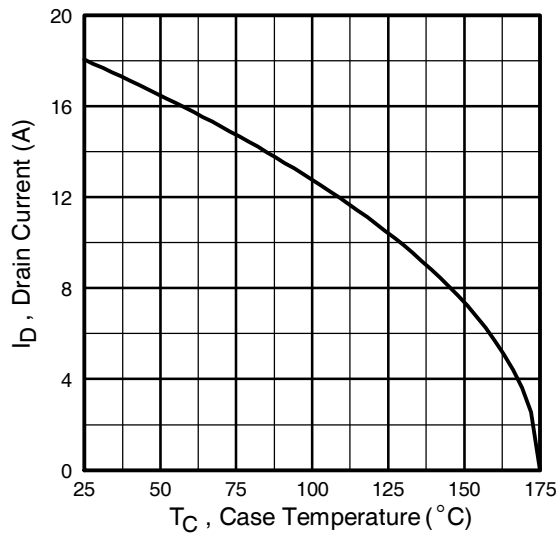
**Fig 6.** Typical Gate Charge Vs.  
Gate-to-Source Voltage



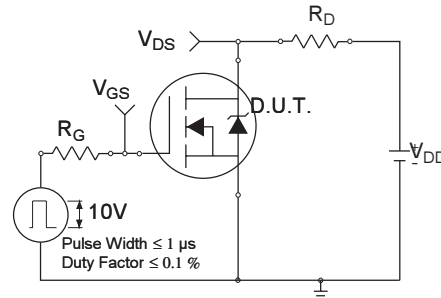
**Fig 7.** Typical Source-Drain Diode  
Forward Voltage



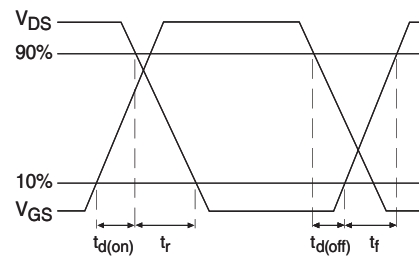
**Fig 8.** Maximum Safe Operating Area



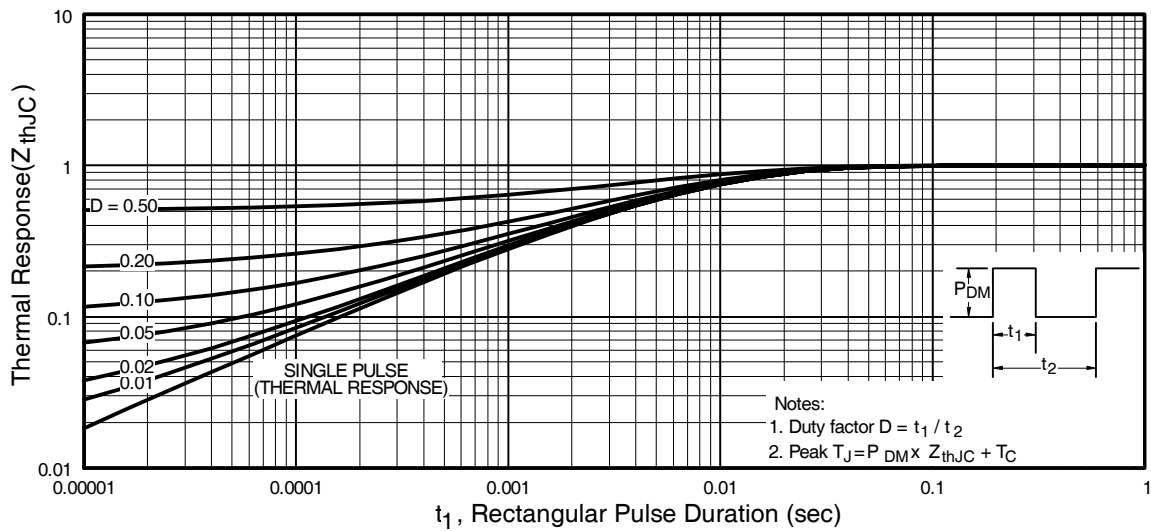
**Fig 9. Maximum Drain Current Vs. Case Temperature**



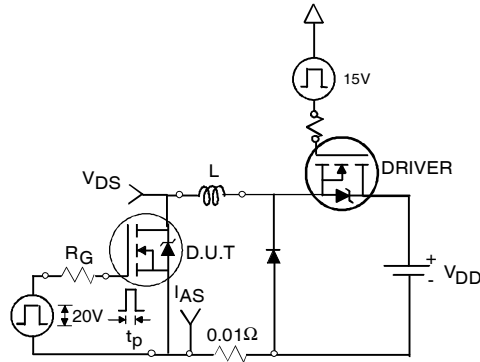
**Fig 10a. Switching Time Test Circuit**



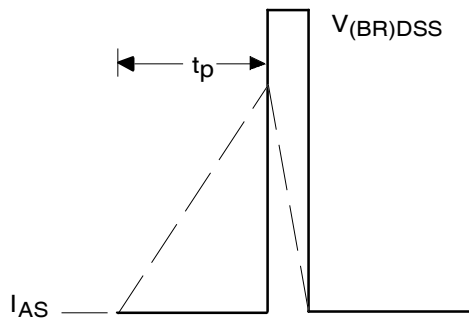
**Fig 10b. Switching Time Waveforms**



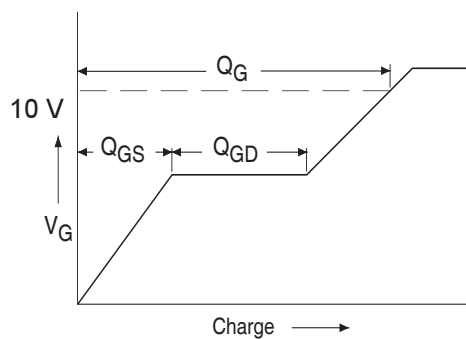
**Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case**



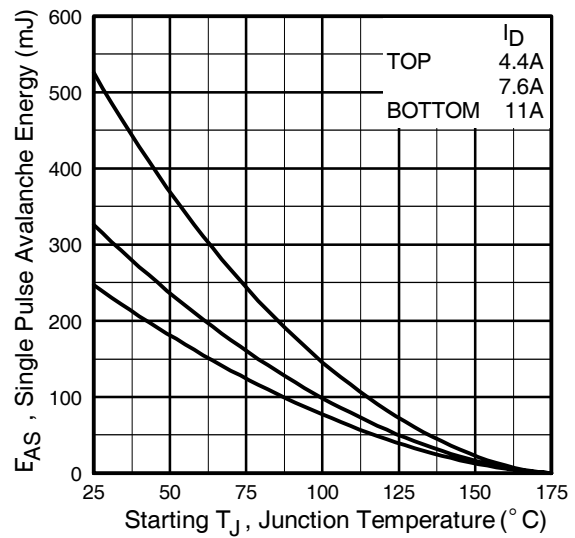
**Fig 12a.** Unclamped Inductive Test Circuit



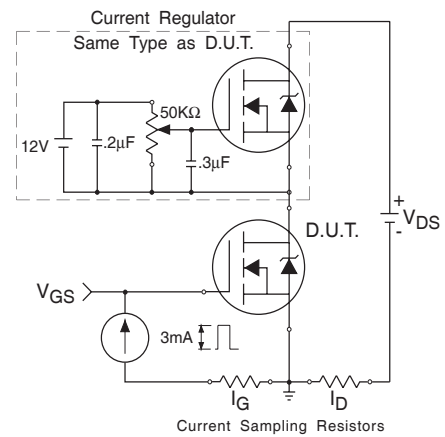
**Fig 12b.** Unclamped Inductive Waveforms



**Fig 13a.** Basic Gate Charge Waveform

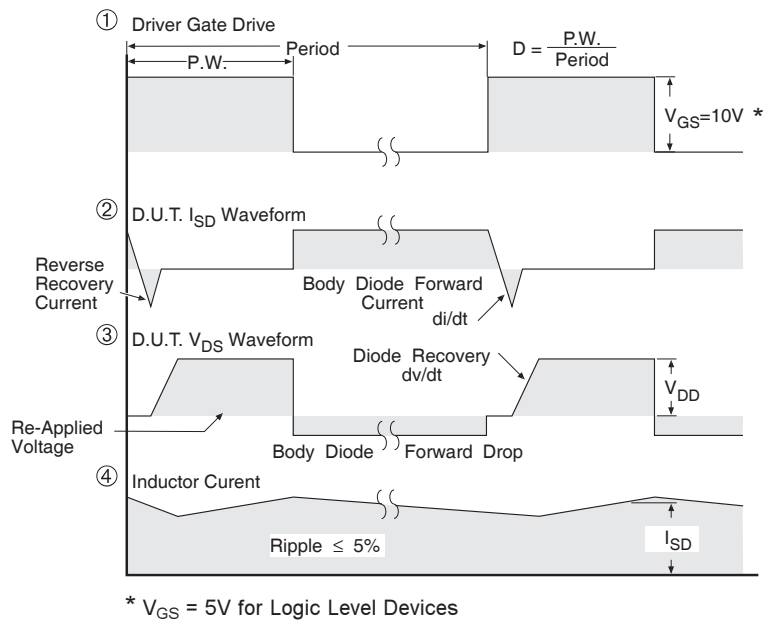
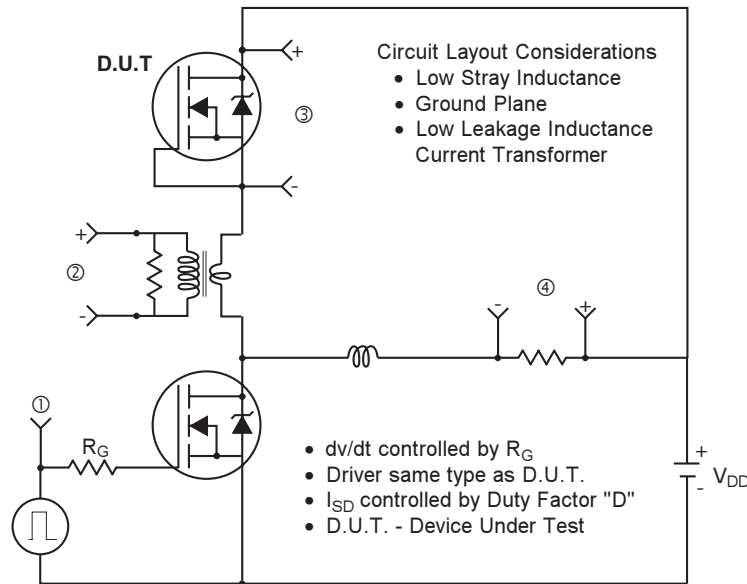


**Fig 12c.** Maximum Avalanche Energy Vs. Drain Current



**Fig 13b.** Gate Charge Test Circuit

### Peak Diode Recovery $dv/dt$ Test Circuit



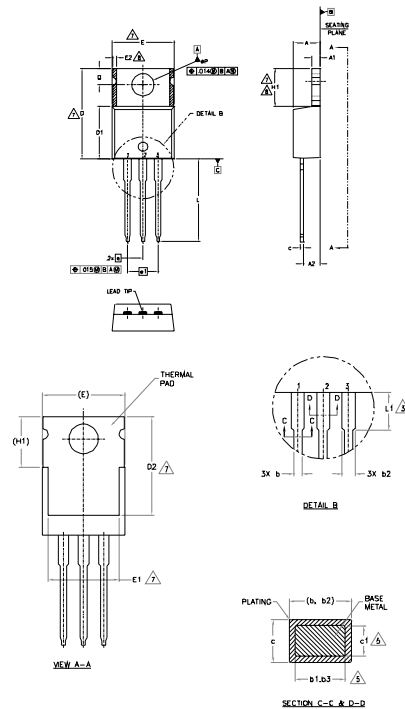
**Fig 14.** For N-Channel HEXFET® Power MOSFETs

# IRF640N/S/LPbF

International  
**IR** Rectifier

## TO-220AB Package Outline

Dimensions are shown in millimeters (inches)



- NOTES:
- 1.- DIMENSIONING AND TOLERANCING AS PER ASME Y14.5 M-1994.
  - 2.- DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
  - 3.- LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
  - 4.- DIMENSION D, D1 & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
  - 5.- DIMENSION b1, b3 & c1 APPLY TO BASE METAL ONLY.
  - 6.- CONTROLLING DIMENSION: INCHES.
  - 7.- THERMAL PAD CONTOUR OPTIONAL. WITHIN DIMENSIONS E, H1, D2 & E1.
  - 8.- DIMENSION E2 X H1 DEFINE A ZONE WHERE STAMPING AND SINGULATION IRREGULARITIES ARE ALLOWED.
  - 9.- OUTLINE CONFORMS TO JEDEC TO-220, EXCEPT A2 (max.) AND D2 (min.) WHERE DIMENSIONS ARE DERIVED FROM THE ACTUAL PACKAGE OUTLINE.

| SYMBOL | DIMENSIONS  |       |          |      | NOTES |
|--------|-------------|-------|----------|------|-------|
|        | MILLIMETERS |       | INCHES   |      |       |
|        | MIN.        | MAX.  | MIN.     | MAX. |       |
| A      | 3.56        | 4.83  | .140     | .190 |       |
| A1     | 0.51        | 1.40  | .020     | .055 |       |
| A2     | 2.03        | 2.92  | .080     | .115 |       |
| b      | 0.38        | 1.01  | .015     | .040 |       |
| b1     | 0.38        | 0.97  | .015     | .038 |       |
| b2     | 1.14        | 1.78  | .045     | .070 |       |
| b3     | 1.14        | 1.73  | .045     | .068 | 5     |
| c      | 0.36        | 0.61  | .014     | .024 |       |
| c1     | 0.36        | 0.56  | .014     | .022 | 5     |
| D      | 14.22       | 16.51 | .560     | .650 | 4     |
| D1     | 8.38        | 9.02  | .330     | .355 |       |
| D2     | 11.68       | 12.88 | .460     | .507 | 7     |
| E      | 9.65        | 10.67 | .380     | .420 | 4, 7  |
| E1     | 6.86        | 8.89  | .270     | .350 | 7     |
| E2     | -           | 0.76  | -        | .030 | 8     |
| e      | 2.54 BSC    |       | .100 BSC |      |       |
| e1     | 5.08 BSC    |       | .200 BSC |      |       |
| H1     | 5.84        | 6.86  | .230     | .270 | 7, 8  |
| L      | 12.70       | 14.73 | .500     | .580 |       |
| L1     | 3.56        | 4.06  | .140     | .160 | 3     |
| W      | 3.54        | 4.08  | .139     | .161 |       |
| Q      | 2.54        | 3.42  | .100     | .135 |       |

### LEAD ASSIGNMENTS

- 1- GATE  
2- DRAIN  
3- SOURCE

### GATE, DRAIN

- 1- GATE  
2- DRAIN  
3- SOURCE

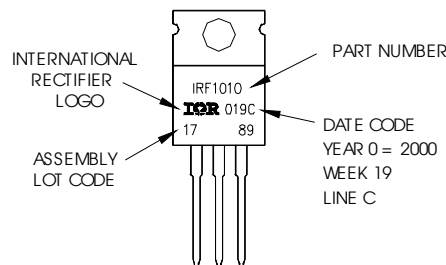
### DIODES

- 1- ANODE  
2- CATHODE  
3- ANODE

## TO-220AB Part Marking Information

EXAMPLE: THIS IS AN IRF1010  
LOT CODE 1789  
ASSEMBLED ON WW 19, 2000  
IN THE ASSEMBLY LINE "C"

Note: "P" in assembly line position  
indicates "Lead-Free"



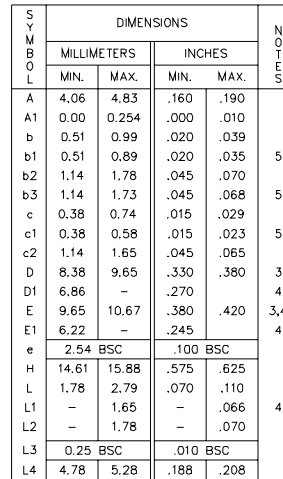
TO-220AB package is not recommended for Surface Mount Application

### Notes:

1. For an Automotive Qualified version of this part please see <http://www.irf.com/product-info/auto/>
2. For the most current drawing please refer to IR website at <http://www.irf.com/package/>

[www.irf.com](http://www.irf.com)

Dimensions are shown in millimeters (inches)



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES]
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [0.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY AT DATUM H.
4. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.
5. DIMENSION B1 AND C1 APPLY TO BARE METAL ONLY.
6. DATUM A & B TO BE DETERMINED AT DATUM PLANE H.
7. CONTROLLING DIMENSION: INCH.
8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-263AB.

EXAMPLE: THIS IS AN IRF530S WITH  
LOT CODE 8024  
ASSEMBLED ON WW 02, 2000  
IN THE ASSEMBLY LINE "L"

Diagram of a TO-18 package with callouts for markings:

- INTERNATIONAL RECTIFIER LOGO
- PART NUMBER (F530S)
- DATE CODE (002L)
- YEAR 0 = 2000
- WEEK 02
- LINE L
- ASSEMBLY LOT CODE (80, 24)

Diagram of a 2-pin rectifier component with the following labels and markings:

- INTERNATIONAL RECTIFIER LOGO**: Points to the IR logo on the component.
- PART NUMBER**: Points to the text **F530S** on the component.
- DATE CODE**: Points to the text **P002A** on the component.
- ASSEMBLY LOT CODE**: Points to the text **80 24** on the component.
- P = DESIGNATES LEAD-FREE PRODUCT (OPTIONAL)**: Points to the letter **P** in the part number.
- YEAR 0 = 2000**: Points to the **0** in the date code.
- WEEK 02**: Points to the **02** in the date code.
- A = ASSEMBLY SITE CODE**: Points to the **A** in the date code.

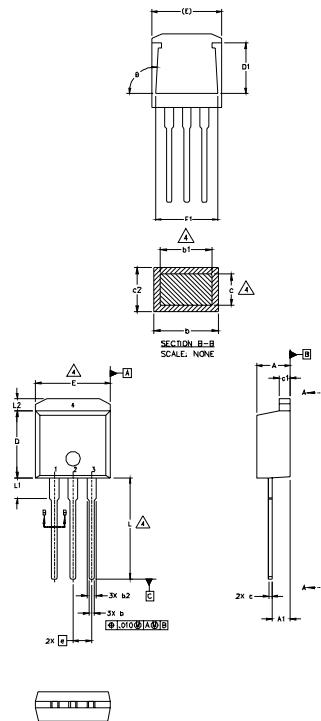
1. For an Automotive Qualified version of this part please see <http://www.irf.com/product-info/auto/>
2. For the most current drawing please refer to IR website at <http://www.irf.com/package/>

# IRF640N/S/LPbF

International  
**IR** Rectifier

## TO-262 Package Outline

Dimensions are shown in millimeters (inches)



| SYMBOL | DIMENSIONS  |       |          |      | NOTES |
|--------|-------------|-------|----------|------|-------|
|        | MILLIMETERS |       | INCHES   |      |       |
|        | MIN.        | MAX.  | MIN.     | MAX. |       |
| A      | 4.06        | 4.83  | .160     | .190 | 4     |
| A1     | 2.03        | 2.92  | .080     | .115 |       |
| b      | 0.51        | 0.99  | .020     | .039 |       |
| b1     | 0.51        | 0.89  | .020     | .035 |       |
| b2     | 1.14        | 1.40  | .045     | .055 | 4     |
| c      | 0.38        | 0.63  | .015     | .025 |       |
| c1     | 1.14        | 1.40  | .045     | .055 |       |
| c2     | 0.43        | .063  | .017     | .029 | 3     |
| D      | 8.51        | 9.65  | .335     | .380 |       |
| D1     | 5.33        |       | .210     |      |       |
| E      | 9.65        | 10.67 | .380     | .420 |       |
| E1     | 6.22        |       | .245     |      | 3     |
| e      | 2.54 BSC    |       | .100 BSC |      |       |
| L      | 13.46       | 14.09 | .530     | .555 |       |
| L1     | 3.56        | 3.71  | .140     | .146 |       |
| L2     |             | 1.65  |          | .065 |       |

### LEAD ASSIGNMENTS

#### HEXFET

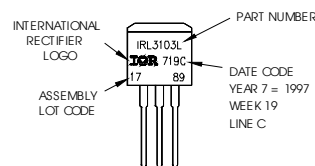
- 1.- GATE
- 2.- DRAIN
- 3.- SOURCE
- 4.- DRAIN

#### IGBT

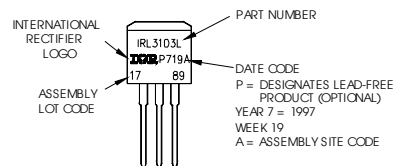
- 1 - GATE
- 2 - COLLECTOR
- 3 - EMITTER

## TO-262 Part Marking Information

EXAMPLE: THIS IS AN IRL3103L  
LOT CODE 1789  
ASSEMBLED ON WW 19, 1997  
IN THE ASSEMBLY LINE "C"  
Note: "P" in assembly line position indicates "Lead-Free"



OR



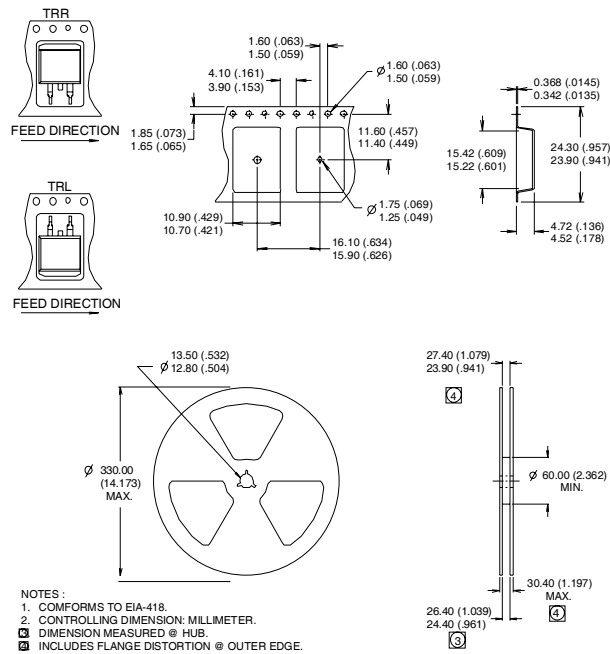
### Notes:

1. For an Automotive Qualified version of this part please see <http://www.irf.com/product-info/auto/>
2. For the most current drawing please refer to IR website at <http://www.irf.com/package/>

[www.irf.com](http://www.irf.com)

## D<sup>2</sup>Pak Tape & Reel Information

Dimensions are shown in millimeters (inches)



### Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Starting  $T_J = 25^\circ\text{C}$ ,  $L = 4.2\text{mH}$   
 $R_G = 25\Omega$ ,  $I_{AS} = 11\text{A}$ .
- ③ Pulse width  $\leq 400\mu\text{s}$ ; duty cycle  $\leq 2\%$ .
- ④ This is only applied to TO-220AB package
- ⑤ This is applied to D<sup>2</sup>Pak, when mounted on 1" square PCB ( FR-4 or G-10 Material ).  
For recommended footprint and soldering techniques refer to application note #AN-994.
- ⑥  $I_{SD} \leq 11\text{A}$ ,  $di/dt \leq 344\text{A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  
 $T_J \leq 175^\circ\text{C}$

Data and specifications subject to change without notice.

International  
**IOR** Rectifier

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