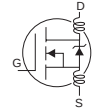


# IRF640N/S/L

International  
**IR** Rectifier

## Electrical Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)

|                                        | Parameter                            | Min. | Typ. | Max. | Units | Conditions                                                                                                      |
|----------------------------------------|--------------------------------------|------|------|------|-------|-----------------------------------------------------------------------------------------------------------------|
| V <sub>(BR)DSS</sub>                   | Drain-to-Source Breakdown Voltage    | 200  | —    | —    | V     | V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA                                                                    |
| ΔV <sub>(BR)DSS</sub> /ΔT <sub>J</sub> | Breakdown Voltage Temp. Coefficient  | —    | 0.25 | —    | V/°C  | Reference to 25°C, I <sub>D</sub> = 1mA                                                                         |
| R <sub>DS(on)</sub>                    | Static Drain-to-Source On-Resistance | —    | —    | 0.15 | Ω     | V <sub>GS</sub> = 10V, I <sub>D</sub> = 11A ③                                                                   |
| V <sub>GS(th)</sub>                    | Gate Threshold Voltage               | 2.0  | —    | 4.0  | V     | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250μA                                                      |
| g <sub>fs</sub>                        | Forward Transconductance             | 6.8  | —    | —    | S     | V <sub>DS</sub> = 50V, I <sub>D</sub> = 11A ③                                                                   |
| I <sub>DSS</sub>                       | Drain-to-Source Leakage Current      | —    | —    | 25   | μA    | V <sub>DS</sub> = 200V, V <sub>GS</sub> = 0V                                                                    |
|                                        |                                      | —    | —    | 250  |       | V <sub>DS</sub> = 160V, V <sub>GS</sub> = 0V, T <sub>J</sub> = 150°C                                            |
| I <sub>GSS</sub>                       | Gate-to-Source Forward Leakage       | —    | —    | 100  | nA    | V <sub>GS</sub> = 20V                                                                                           |
|                                        | Gate-to-Source Reverse Leakage       | —    | —    | -100 |       | V <sub>GS</sub> = -20V                                                                                          |
| Q <sub>g</sub>                         | Total Gate Charge                    | —    | —    | 67   | nC    | I <sub>D</sub> = 11A                                                                                            |
| Q <sub>gs</sub>                        | Gate-to-Source Charge                | —    | —    | 11   |       | V <sub>DS</sub> = 160V                                                                                          |
| Q <sub>gd</sub>                        | Gate-to-Drain ("Miller") Charge      | —    | —    | 33   |       | V <sub>GS</sub> = 10V, See Fig. 6 and 13                                                                        |
| t <sub>d(on)</sub>                     | Turn-On Delay Time                   | —    | 10   | —    | ns    | V <sub>DD</sub> = 100V<br>I <sub>D</sub> = 11A<br>R <sub>G</sub> = 2.5Ω<br>R <sub>D</sub> = 9.0Ω, See Fig. 10 ③ |
| t <sub>r</sub>                         | Rise Time                            | —    | 19   | —    |       |                                                                                                                 |
| t <sub>d(off)</sub>                    | Turn-Off Delay Time                  | —    | 23   | —    |       |                                                                                                                 |
| t <sub>f</sub>                         | Fall Time                            | —    | 5.5  | —    |       |                                                                                                                 |
| L <sub>D</sub>                         | Internal Drain Inductance            | —    | 4.5  | —    | nH    | Between lead,<br>6mm (0.25in.)<br>from package<br>and center of die contact                                     |
| L <sub>S</sub>                         | Internal Source Inductance           | —    | 7.5  | —    |       |                                                                                                                 |
| C <sub>iss</sub>                       | Input Capacitance                    | —    | 1160 | —    | pF    | V <sub>GS</sub> = 0V<br>V <sub>DS</sub> = 25V<br>f = 1.0MHz, See Fig. 5                                         |
| C <sub>oss</sub>                       | Output Capacitance                   | —    | 185  | —    |       |                                                                                                                 |
| C <sub>rss</sub>                       | Reverse Transfer Capacitance         | —    | 53   | —    |       |                                                                                                                 |

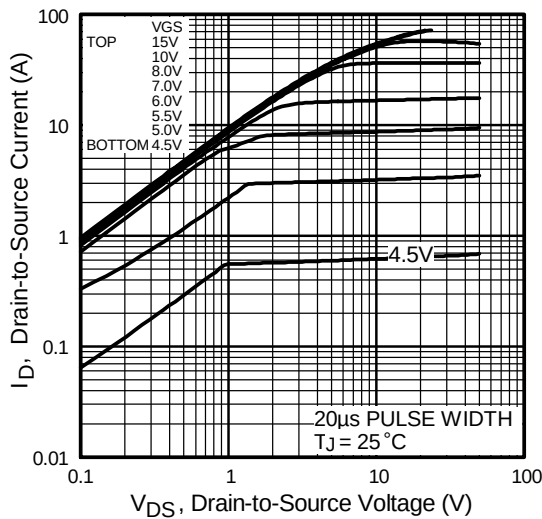


## Source-Drain Ratings and Characteristics

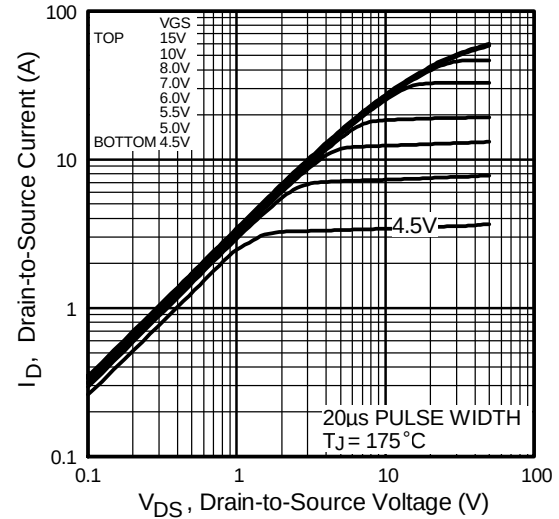
|                 | Parameter                              | Min.                                                                                           | Typ. | Max. | Units | Conditions                                                          |
|-----------------|----------------------------------------|------------------------------------------------------------------------------------------------|------|------|-------|---------------------------------------------------------------------|
| I <sub>S</sub>  | Continuous Source Current (Body Diode) | —                                                                                              | —    | 18   | A     | MOSFET symbol showing the integral reverse p-n junction diode.      |
| I <sub>SM</sub> | Pulsed Source Current (Body Diode)①    | —                                                                                              | —    | 72   |       |                                                                     |
| V <sub>SD</sub> | Diode Forward Voltage                  | —                                                                                              | —    | 1.3  | V     | T <sub>J</sub> = 25°C, I <sub>S</sub> = 11A, V <sub>GS</sub> = 0V ③ |
| t <sub>rr</sub> | Reverse Recovery Time                  | —                                                                                              | 167  | 251  | ns    | T <sub>J</sub> = 25°C, I <sub>F</sub> = 11A                         |
| Q <sub>rr</sub> | Reverse Recovery Charge                | —                                                                                              | 929  | 1394 | nC    | di/dt = 100A/μs ③                                                   |
| t <sub>on</sub> | Forward Turn-On Time                   | Intrinsic turn-on time is negligible (turn-on is dominated by L <sub>S</sub> +L <sub>D</sub> ) |      |      |       |                                                                     |

## Thermal Resistance

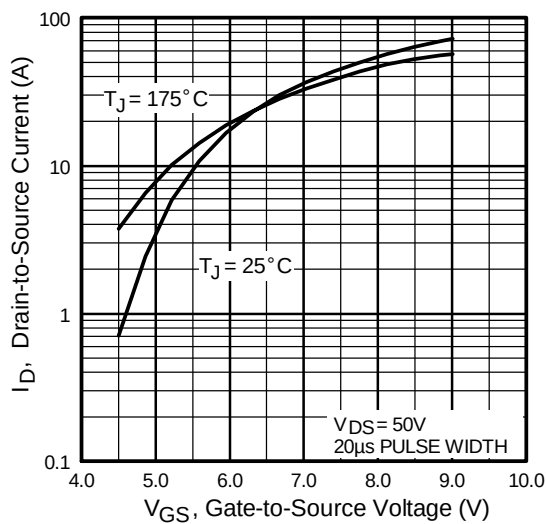
|                  | Parameter                             | Typ. | Max. | Units |
|------------------|---------------------------------------|------|------|-------|
| R <sub>θJC</sub> | Junction-to-Case                      | —    | 1.0  | °C/W  |
| R <sub>θCS</sub> | Case-to-Sink, Flat, Greased Surface ④ | 0.50 | —    |       |
| R <sub>θJA</sub> | Junction-to-Ambient④                  | —    | 62   |       |
| R <sub>θJA</sub> | Junction-to-Ambient (PCB mount)⑤      | —    | 40   |       |



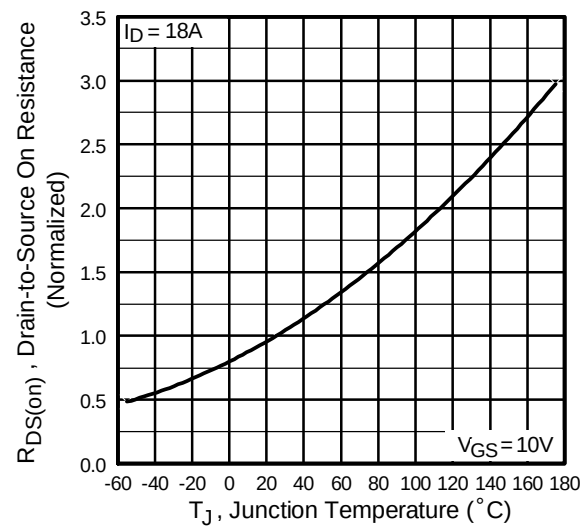
**Fig 1.** Typical Output Characteristics



**Fig 2.** Typical Output Characteristics



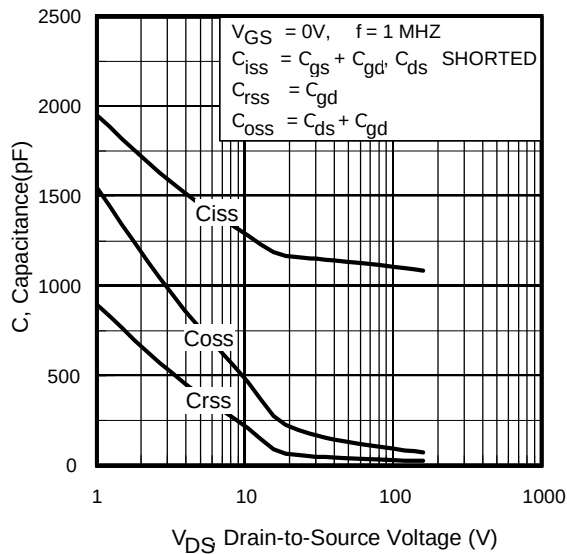
**Fig 3.** Typical Transfer Characteristics



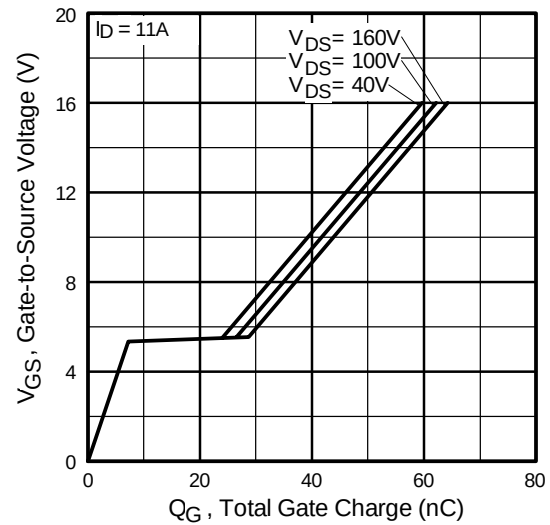
**Fig 4.** Normalized On-Resistance Vs. Temperature

# IRF640N/S/L

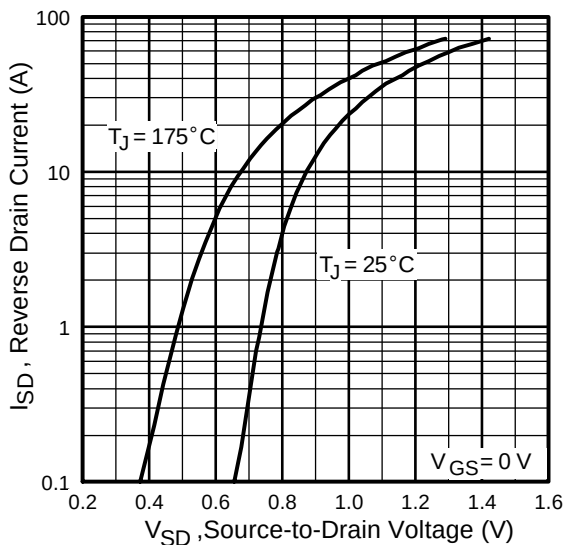
International  
**IR** Rectifier



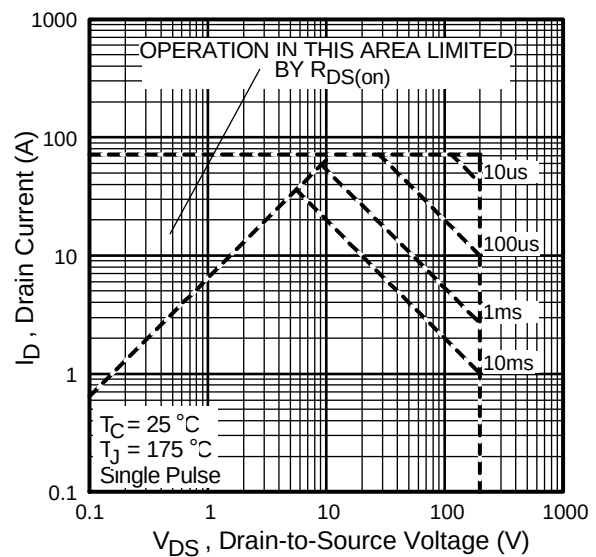
**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage



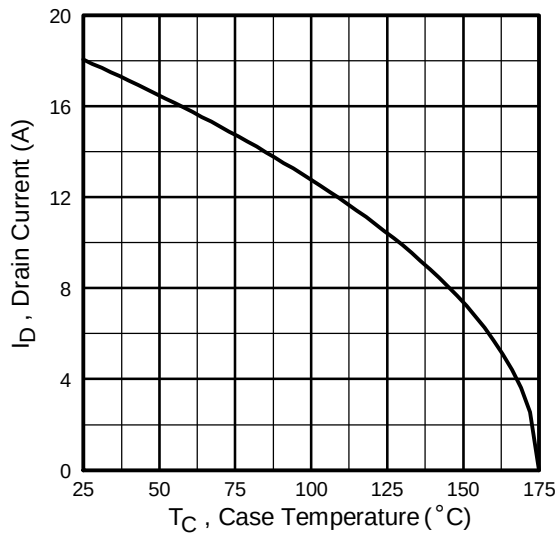
**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage



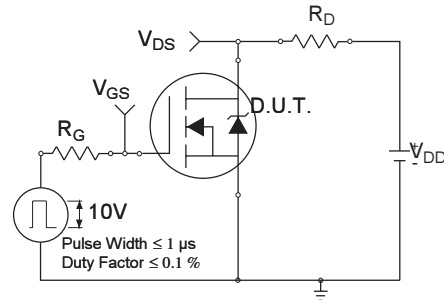
**Fig 7.** Typical Source-Drain Diode Forward Voltage



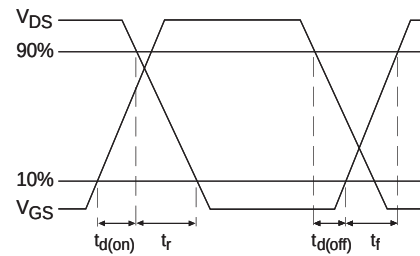
**Fig 8.** Maximum Safe Operating Area



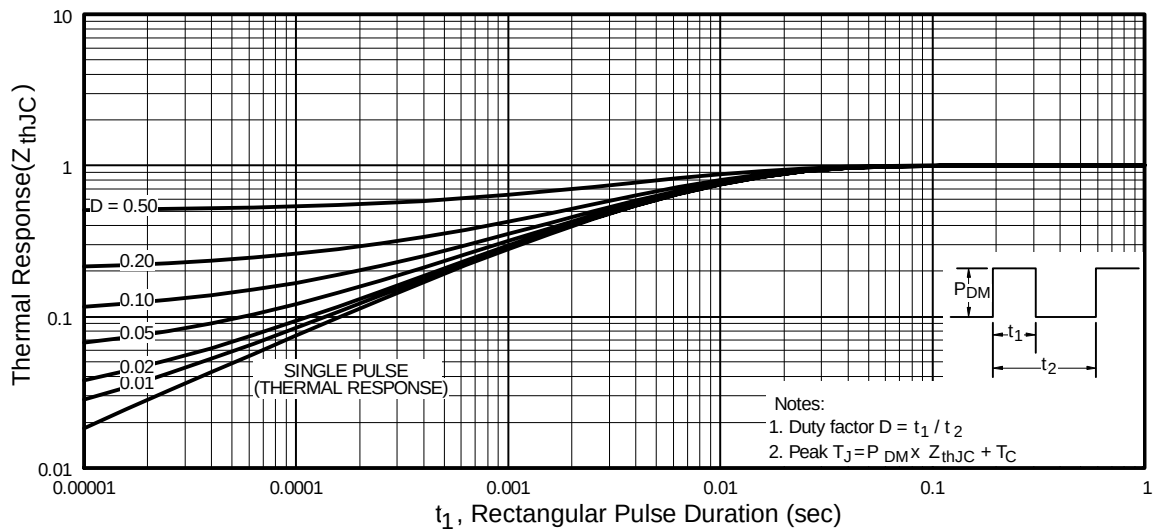
**Fig 9.** Maximum Drain Current Vs. Case Temperature



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



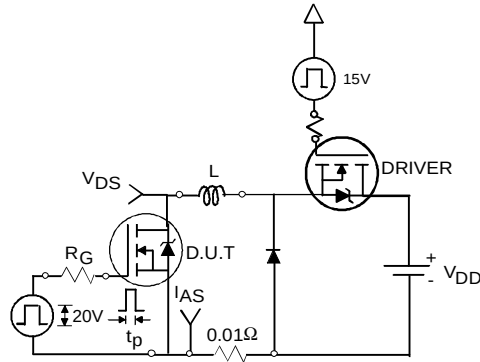
**Fig 10b.** Switching Time Waveforms



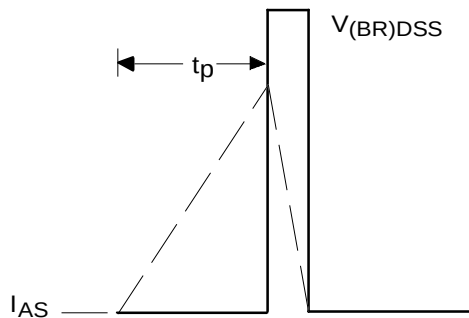
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

# IRF640N/S/L

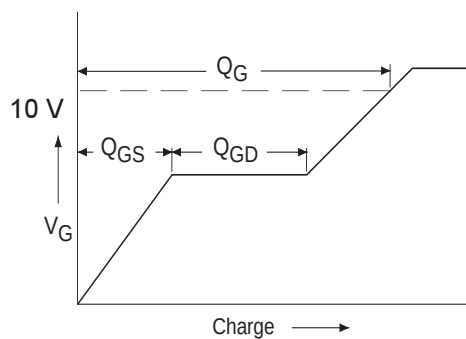
International  
**IR** Rectifier



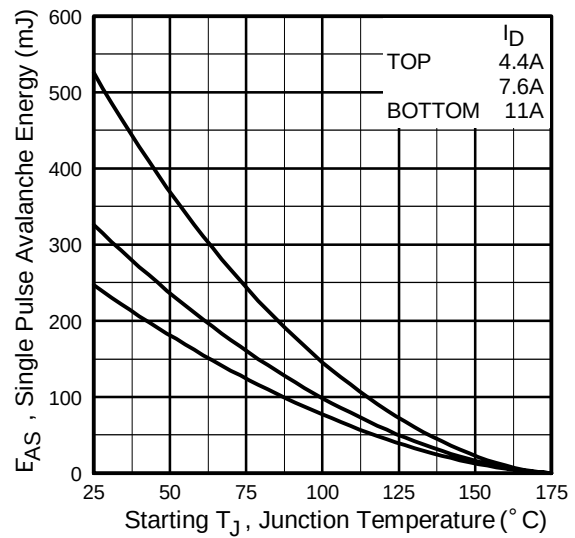
**Fig 12a.** Unclamped Inductive Test Circuit



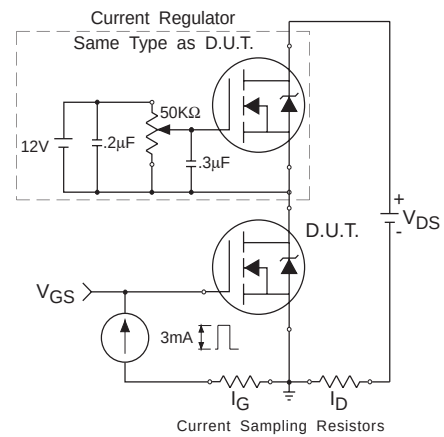
**Fig 12b.** Unclamped Inductive Waveforms



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

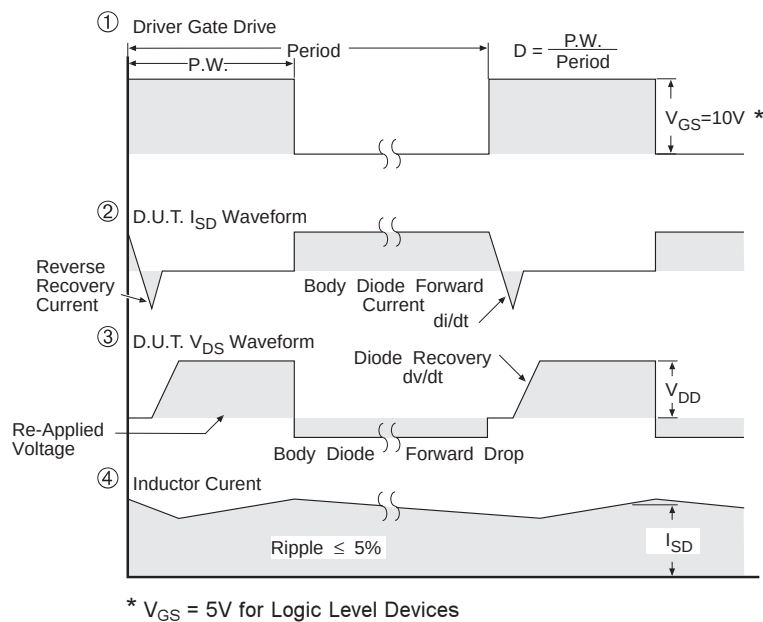
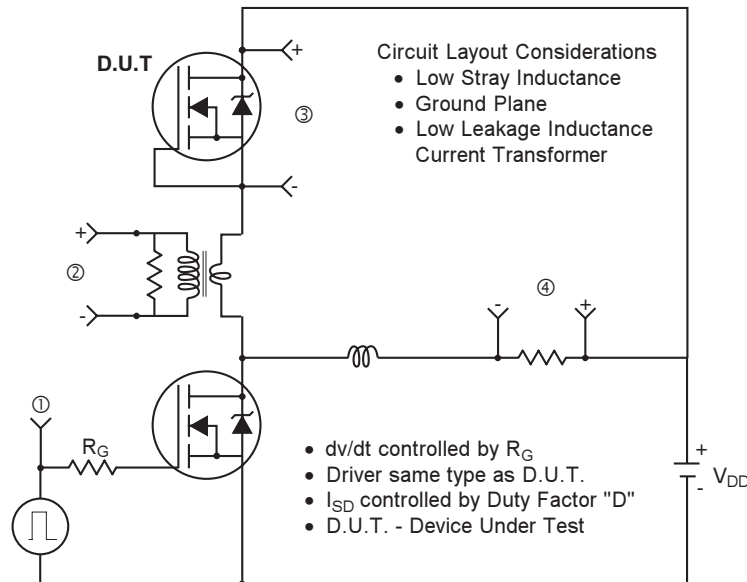


**Fig 12c.** Maximum Avalanche Energy Vs. Drain Current



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

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



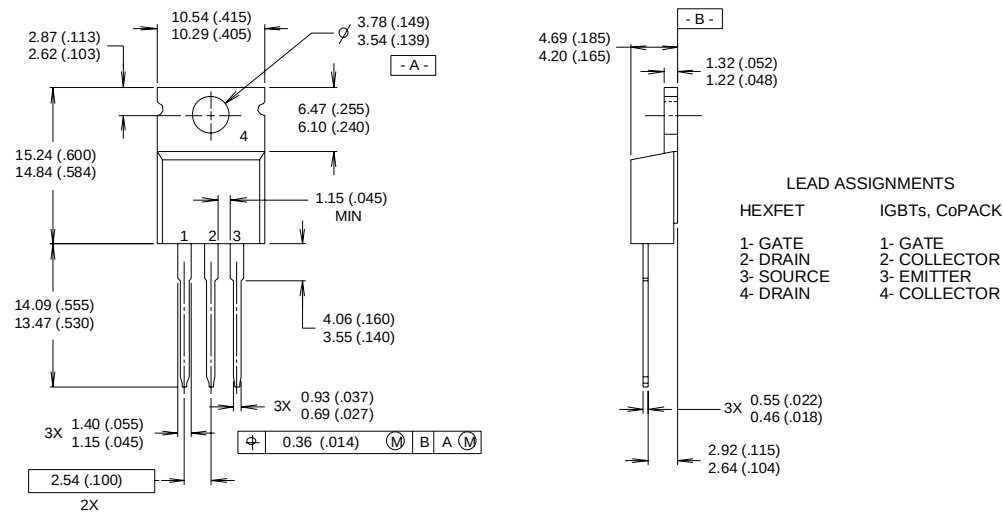
**Fig 14.** For N-Channel HEXFET® Power MOSFETs

# IRF640N/S/L

International  
**IR** Rectifier

## TO-220AB Package Outline

Dimensions are shown in millimeters (inches)



### NOTES:

- 1 DIMENSIONING & TOLERANCING PER ANSI Y14.5M, 1982.
- 2 CONTROLLING DIMENSION : INCH

- 3 OUTLINE CONFORMS TO JEDEC OUTLINE TO-220AB.
- 4 HEATSINK & LEAD MEASUREMENTS DO NOT INCLUDE BURRS.

## TO-220AB Part Marking Information

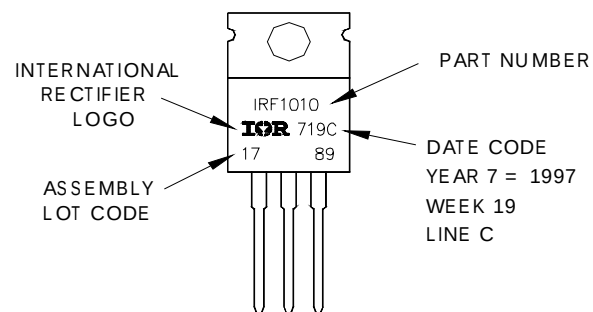
EXAMPLE: THIS IS AN IRF1010

LOT CODE 1789

ASSEMBLED ON WW 19, 1997

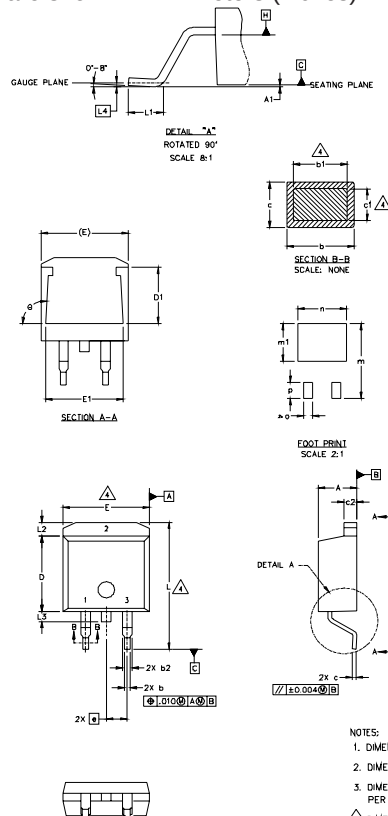
IN THE ASSEMBLY LINE "C"

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



## D<sup>2</sup>Pak Package Outline

Dimensions are shown in millimeters (inches)



| SYMBOL | DIMENSIONS  |       |        |      | NOTES |
|--------|-------------|-------|--------|------|-------|
|        | MILLIMETERS |       | INCHES |      |       |
|        | MIN.        | MAX.  | MIN.   | MAX. |       |
| A      | 4.06        | 4.83  | .160   | .190 |       |
| A1     |             | 0.127 |        | .005 |       |
| b      | 0.51        | 0.99  | .020   | .039 |       |
| b1     | 0.51        | 0.89  | .020   | .035 | 4     |
| b2     | 1.14        | 1.40  | .045   | .055 |       |
| c      | 0.43        | 0.63  | .017   | .025 |       |
| c1     | 0.38        | 0.74  | .015   | .029 | 4     |
| c2     | 1.14        | 1.40  | .045   | .055 |       |
| D      | 8.51        | 9.65  | .335   | .380 | 3     |
| D1     | 5.33        |       | .210   |      |       |
| E      | 9.65        | 10.67 | .380   | .420 | 3     |
| E1     | 6.25        |       | .245   |      |       |
| e      | 2.54        | BSC   | .100   | BSC  |       |
| L      | 14.61       | 15.88 | .575   | .625 |       |
| L1     | 1.78        | 2.79  | .070   | .110 |       |
| L2     |             | 1.65  |        | .065 |       |
| L3     | 1.27        | 1.78  | .050   | .070 |       |
| L4     | 0.25        | BSC   | .010   | BSC  |       |
| m      | 17.78       |       | .700   |      |       |
| m1     | 8.89        |       | .350   |      |       |
| n      | 11.43       |       | .450   |      |       |
| o      | 2.08        |       | .082   |      |       |
| p      | 3.81        |       | .150   |      |       |
| ø      | 90°         | 93°   | 90°    | 93°  |       |

### LEAD ASSIGNMENTS

| HEXFET     | IGBTs, CoPACK | DIODES      |
|------------|---------------|-------------|
| 1.- GATE   | 1.- GATE      | 1.- ANODE * |
| 2.- DRAIN  | 2.- COLLECTOR | 2.- CATHODE |
| 3.- SOURCE | 3.- EMITTER   | 3.- ANODE   |

\* PART DEPENDENT.

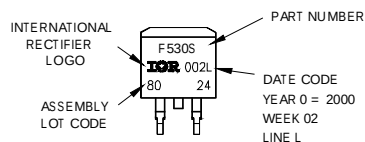
NOTES:

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.
4. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
5. CONTROLLING DIMENSION: INCH.

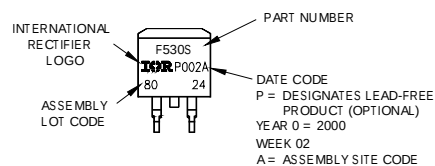
## D<sup>2</sup>Pak Part Marking Information

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

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



OR





Dimensions are shown in millimeters (inches)

| S<br>Y<br>M<br>B<br>O<br>L | DIMENSIONS  |       |          |      | N<br>O<br>T<br>E<br>S |
|----------------------------|-------------|-------|----------|------|-----------------------|
|                            | 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 |                       |
| D                          | 8.51        | 9.65  | .335     | .380 | 3                     |
| D1                         | 5.33        |       | .210     |      |                       |
| E                          | 9.65        | 10.67 | .380     | .420 | 3                     |
| E1                         | 6.22        |       | .245     |      |                       |
| e                          | 2.54 BSC    |       | .100 BSC |      |                       |
| L                          | 13.46       | 14.09 | .530     | .555 |                       |
| L1                         | 3.56        | 3.71  | .140     | .146 |                       |
| L2                         |             | 1.65  |          | .065 |                       |

IGBT

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

1 - GATE  
2 - COLLECTOR  
3 - EMITTER

NOTES:

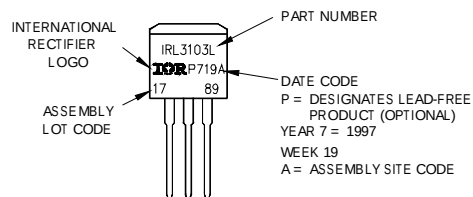
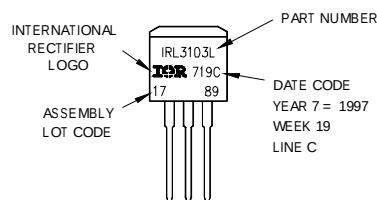
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [0.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.

 DIMENSION B1 AND C1 APPLY TO BASE METAL ONLY.

5. CONTROLLING DIMENSION: INCH.

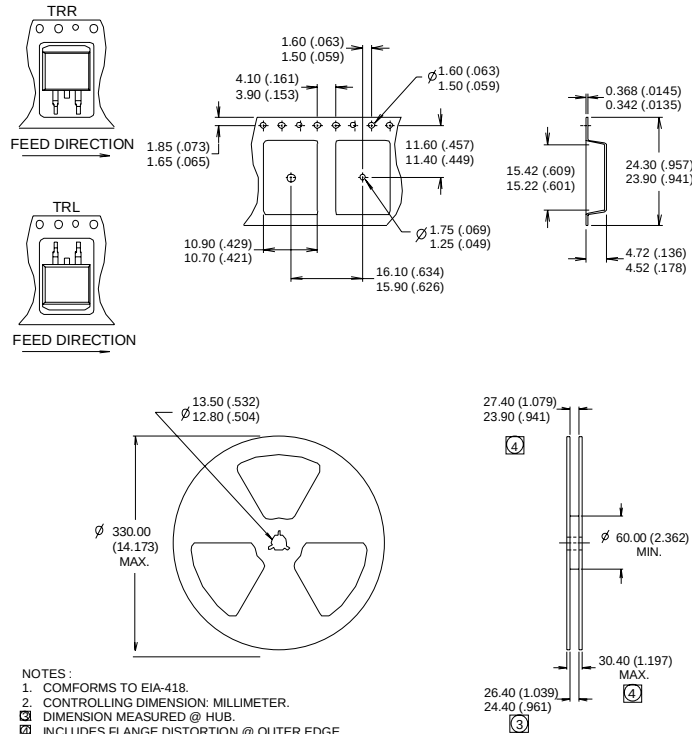
EXAMPLE: THIS IS AN IRL3103L  
LOT CODE 1789  
ASSEMBLED ON WW 19, 1997  
IN THE ASSEMBLY LINE "C"

OR



## 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  $I_{SD} \leq 11\text{A}$ ,  $di/dt \leq 344\text{A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  
 $T_J \leq 175^\circ\text{C}$

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

Data and specifications subject to change without notice.  
 This product has been designed and qualified for the automotive [Q101] (IRF640N)  
 & industrial market (IRF640NS/L).  
 Qualification Standards can be found on IR's Web site.

International  
**IR** Rectifier

**IR WORLD HEADQUARTERS:** 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105  
 TAC Fax: (310) 252-7903

Visit us at [www.irf.com](http://www.irf.com) for sales contact information. 10/04

Note: For the most current drawings please refer to the IR website at:  
<http://www.irf.com/package/>