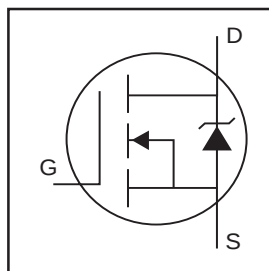


### Features

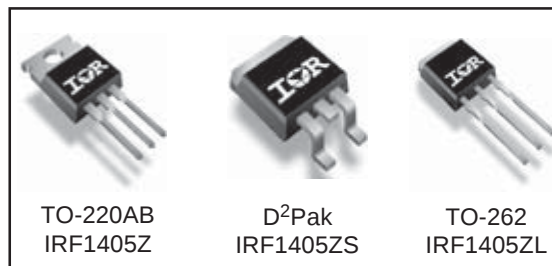
- Advanced Process Technology
- Ultra Low On-Resistance
- 175°C Operating Temperature
- Fast Switching
- Repetitive Avalanche Allowed up to  $T_{jmax}$

### Description

Specifically designed for Automotive applications, this HEXFET® Power MOSFET utilizes the latest processing techniques to achieve extremely low on-resistance per silicon area. Additional features of this design are a 175°C junction operating temperature, fast switching speed and improved repetitive avalanche rating. These features combine to make this design an extremely efficient and reliable device for use in Automotive applications and a wide variety of other applications.



|                           |
|---------------------------|
| $V_{DS} = 55V$            |
| $R_{DS(on)} = 4.9m\Omega$ |
| $I_D = 75A$               |



### Absolute Maximum Ratings

|                              | Parameter                                                  | Max.                     | Units |
|------------------------------|------------------------------------------------------------|--------------------------|-------|
| $I_D @ T_C = 25^\circ C$     | Continuous Drain Current, $V_{GS} @ 10V$ (Silicon Limited) | 150                      | A     |
| $I_D @ T_C = 100^\circ C$    | Continuous Drain Current, $V_{GS} @ 10V$                   | 110                      |       |
| $I_D @ T_C = 25^\circ C$     | Continuous Drain Current, $V_{GS} @ 10V$ (Package Limited) | 75                       |       |
| $I_{DM}$                     | Pulsed Drain Current ①                                     | 600                      |       |
| $P_D @ T_C = 25^\circ C$     | Power Dissipation                                          | 230                      | W     |
|                              | Linear Derating Factor                                     | 1.5                      | W/°C  |
| $V_{GS}$                     | Gate-to-Source Voltage                                     | $\pm 20$                 | V     |
| $E_{AS}$ (Thermally limited) | Single Pulse Avalanche Energy ②                            | 270                      | mJ    |
| $E_{AS}$ (Tested)            | Single Pulse Avalanche Energy Tested Value ③               | 420                      |       |
| $I_{AR}$                     | Avalanche Current ④                                        | See Fig.12a, 12b, 15, 16 | A     |
| $E_{AR}$                     | Repetitive Avalanche Energy ⑤                              |                          | mJ    |
| $T_J$                        | Operating Junction and                                     | -55 to + 175             | °C    |
| $T_{STG}$                    | Storage Temperature Range                                  |                          |       |
|                              | Soldering Temperature, for 10 seconds                      |                          |       |
|                              | Mounting Torque, 6-32 or M3 screw                          | 10 lbf•in (1.1N•m)       |       |

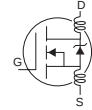
### Thermal Resistance

|                 | Parameter                                       | Typ. | Max. | Units |
|-----------------|-------------------------------------------------|------|------|-------|
| $R_{\theta JC}$ | Junction-to-Case                                | —    | 0.65 | °C/W  |
| $R_{\theta CS}$ | Case-to-Sink, Flat, Greased Surface             | 0.50 | —    |       |
| $R_{\theta JA}$ | Junction-to-Ambient                             | —    | 62   |       |
| $R_{\theta JA}$ | Junction-to-Ambient (PCB Mount, steady state) ⑦ | —    | 40   |       |

HEXFET® is a registered trademark of International Rectifier.

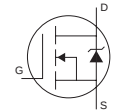
## Electrical Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

|                                 | Parameter                            | Min. | Typ.  | Max. | Units      | Conditions                                                                  |
|---------------------------------|--------------------------------------|------|-------|------|------------|-----------------------------------------------------------------------------|
| $V_{(BR)DSS}$                   | Drain-to-Source Breakdown Voltage    | 55   | —     | —    | V          | $V_{GS} = 0V, I_D = 250\mu A$                                               |
| $\Delta V_{(BR)DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient  | —    | 0.049 | —    | V/°C       | Reference to $25^\circ\text{C}$ , $I_D = 1mA$                               |
| $R_{DS(on)}$                    | Static Drain-to-Source On-Resistance | —    | 3.7   | 4.9  | m $\Omega$ | $V_{GS} = 10V, I_D = 75A$ ③                                                 |
| $V_{GS(th)}$                    | Gate Threshold Voltage               | 2.0  | —     | 4.0  | V          | $V_{DS} = V_{GS}, I_D = 250\mu A$                                           |
| gfs                             | Forward Transconductance             | 88   | —     | —    | S          | $V_{DS} = 25V, I_D = 75A$                                                   |
| $I_{DSS}$                       | Drain-to-Source Leakage Current      | —    | —     | 20   | $\mu A$    | $V_{DS} = 55V, V_{GS} = 0V$                                                 |
|                                 |                                      | —    | —     | 250  |            | $V_{DS} = 55V, V_{GS} = 0V, T_J = 125^\circ\text{C}$                        |
| $I_{GSS}$                       | Gate-to-Source Forward Leakage       | —    | —     | 200  | nA         | $V_{GS} = 20V$                                                              |
|                                 | Gate-to-Source Reverse Leakage       | —    | —     | -200 |            | $V_{GS} = -20V$                                                             |
| $Q_g$                           | Total Gate Charge                    | —    | 120   | 180  |            | $I_D = 75A$                                                                 |
| $Q_{gs}$                        | Gate-to-Source Charge                | —    | 31    | —    | nC         | $V_{DS} = 44V$                                                              |
| $Q_{gd}$                        | Gate-to-Drain ("Miller") Charge      | —    | 46    | —    |            | $V_{GS} = 10V$ ③                                                            |
| $t_{d(on)}$                     | Turn-On Delay Time                   | —    | 18    | —    |            | $V_{DD} = 25V$                                                              |
| $t_r$                           | Rise Time                            | —    | 110   | —    |            | $I_D = 75A$                                                                 |
| $t_{d(off)}$                    | Turn-Off Delay Time                  | —    | 48    | —    | ns         | $R_G = 4.4\Omega$                                                           |
| $t_f$                           | Fall Time                            | —    | 82    | —    |            | $V_{GS} = 10V$ 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                    | —    | 4780  | —    |            | $V_{GS} = 0V$                                                               |
| $C_{oss}$                       | Output Capacitance                   | —    | 770   | —    |            | $V_{DS} = 25V$                                                              |
| $C_{rss}$                       | Reverse Transfer Capacitance         | —    | 410   | —    | pF         | $f = 1.0MHz$                                                                |
| $C_{oss}$                       | Output Capacitance                   | —    | 2730  | —    |            | $V_{GS} = 0V, V_{DS} = 1.0V, f = 1.0MHz$                                    |
| $C_{oss}$                       | Output Capacitance                   | —    | 600   | —    |            | $V_{GS} = 0V, V_{DS} = 44V, f = 1.0MHz$                                     |
| $C_{oss \text{ eff.}}$          | Effective Output Capacitance         | —    | 910   | —    |            | $V_{GS} = 0V, V_{DS} = 0V \text{ to } 44V$ ④                                |



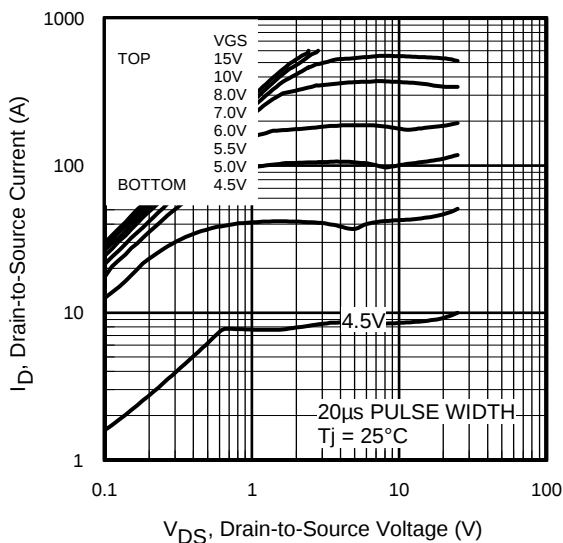
## Source-Drain Ratings and Characteristics

|          | Parameter                                 | Min.                                                                        | Typ. | Max. | Units | Conditions                                                              |
|----------|-------------------------------------------|-----------------------------------------------------------------------------|------|------|-------|-------------------------------------------------------------------------|
| $I_S$    | Continuous Source Current<br>(Body Diode) | —                                                                           | —    | 75   | A     | MOSFET symbol<br>showing the<br>integral reverse<br>p-n junction diode. |
| $I_{SM}$ | Pulsed Source Current<br>(Body Diode) ①   | —                                                                           | —    | 600  |       |                                                                         |
| $V_{SD}$ | Diode Forward Voltage                     | —                                                                           | —    | 1.3  | V     | $T_J = 25^\circ\text{C}, I_S = 75A, V_{GS} = 0V$ ③                      |
| $t_{rr}$ | Reverse Recovery Time                     | —                                                                           | 30   | 46   | ns    | $T_J = 25^\circ\text{C}, I_F = 75A, V_{DD} = 25V$                       |
| $Q_{rr}$ | Reverse Recovery Charge                   | —                                                                           | 30   | 45   | nC    | $di/dt = 100A/\mu s$ ③                                                  |
| $t_{on}$ | Forward Turn-On Time                      | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S + L_D$ ) |      |      |       |                                                                         |

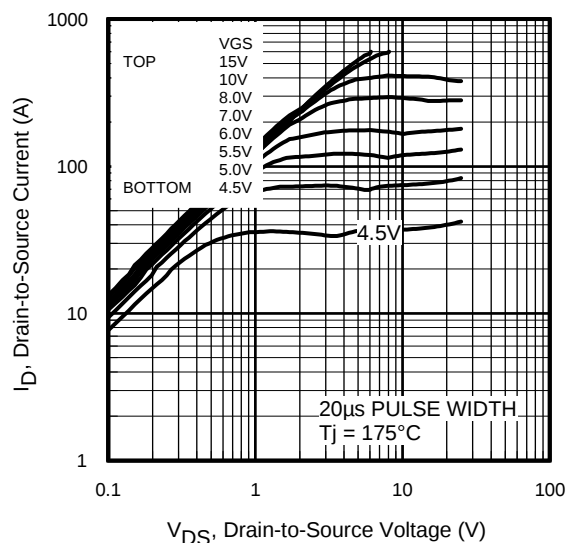


### Notes:

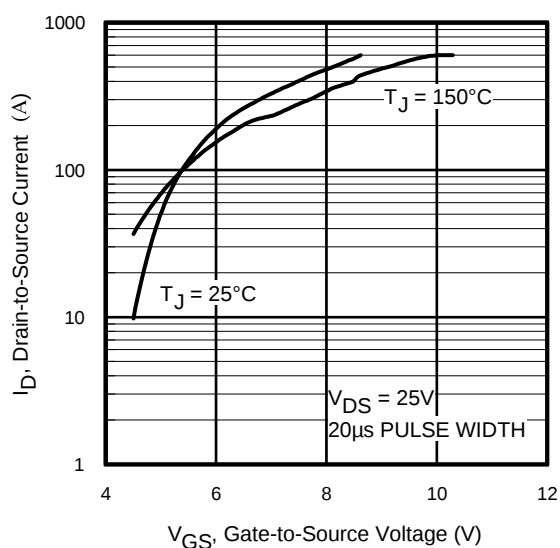
- ① Repetitive rating; pulse width limited by max. junction temperature. (See fig. 11).
- ② Limited by  $T_{Jmax}$ , starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.10mH$   
 $R_G = 25\Omega, I_{AS} = 75A, V_{GS} = 10V$ . Part not recommended for use above this value.
- ③ Pulse width  $\leq 1.0ms$ ; duty cycle  $\leq 2\%$ .
- ④  $C_{oss \text{ eff.}}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .
- ⑤ Limited by  $T_{Jmax}$ , see Fig.12a, 12b, 15, 16 for typical repetitive avalanche performance.
- ⑥ This value determined from sample failure population. 100% tested to this value in production.
- ⑦ 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.



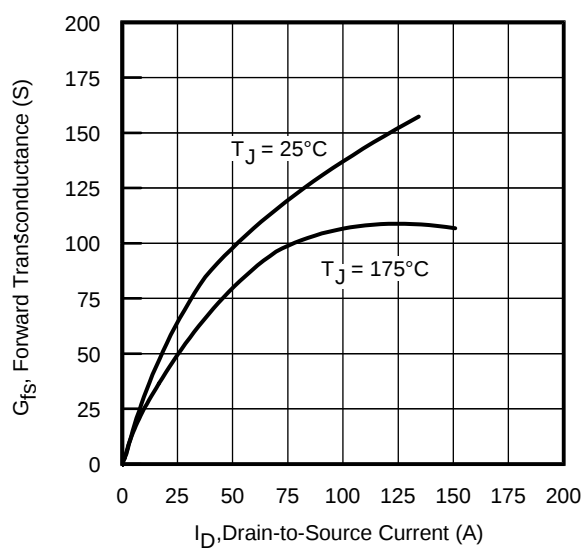
**Fig 1.** Typical Output Characteristics



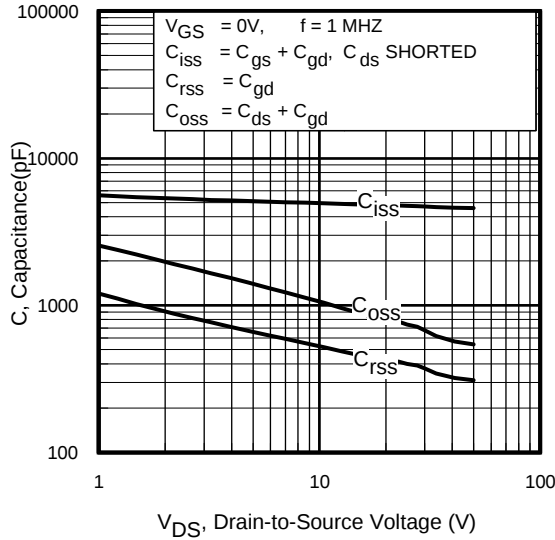
**Fig 2.** Typical Output Characteristics



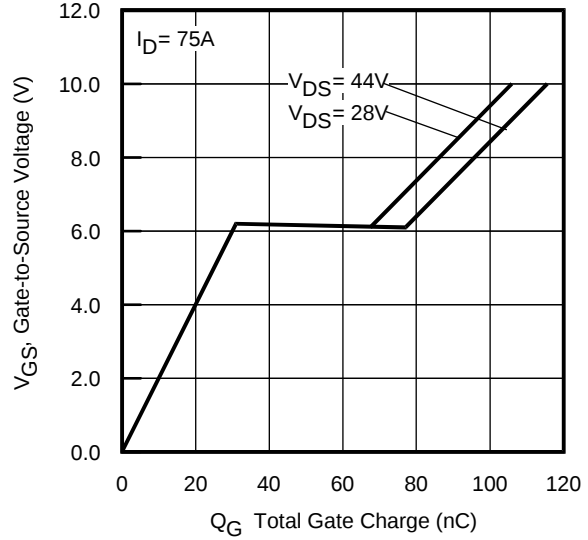
**Fig 3.** Typical Transfer Characteristics



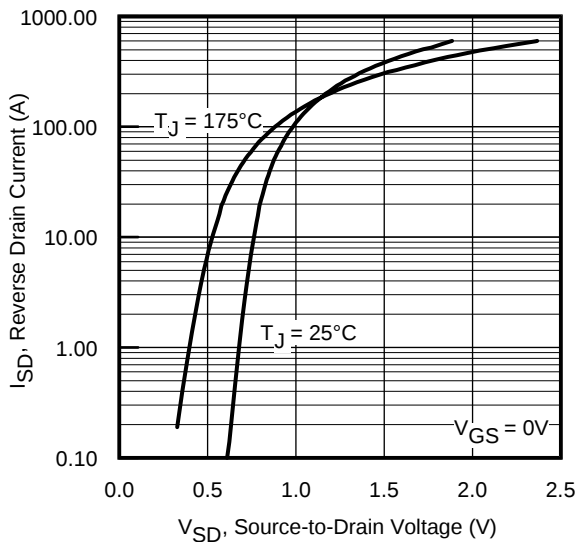
**Fig 4.** Typical Forward Transconductance vs. Drain Current



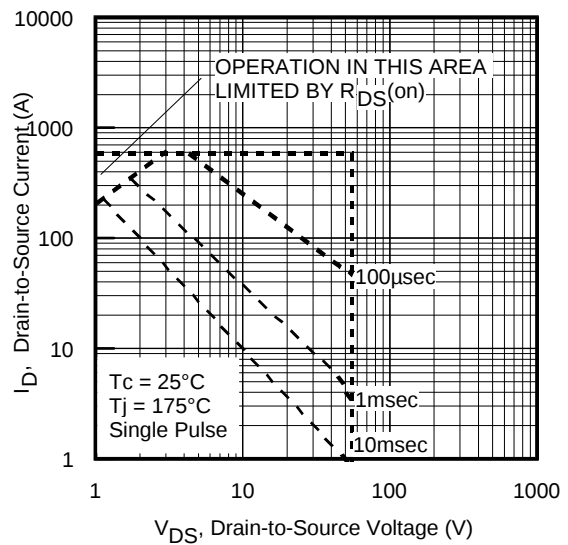
**Fig 5.** Typical Capacitance vs. Drain-to-Source Voltage



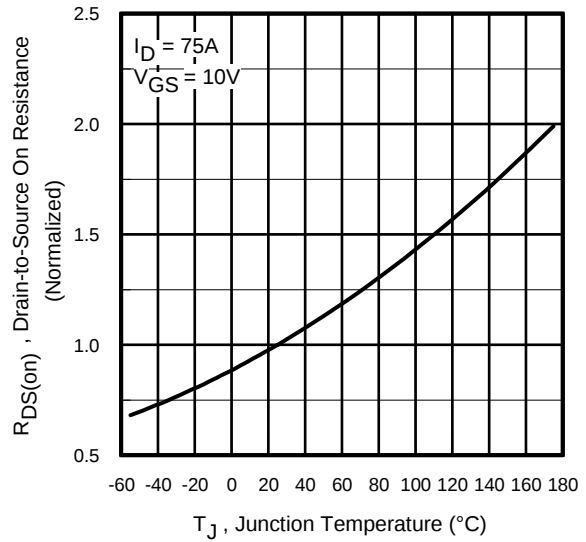
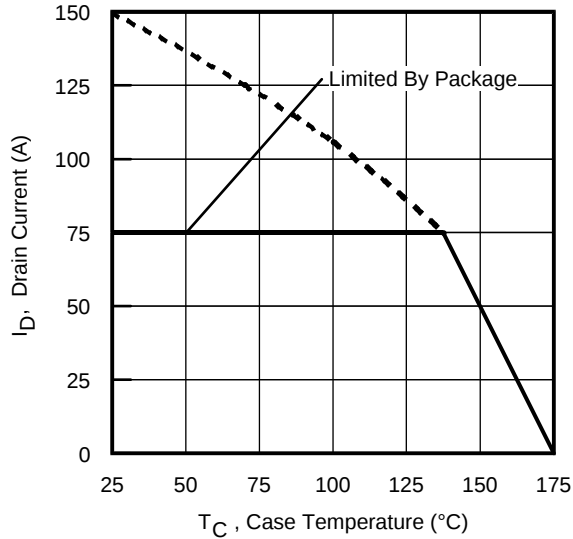
**Fig 6.** Typical Gate Charge vs. Gate-to-Source Voltage



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

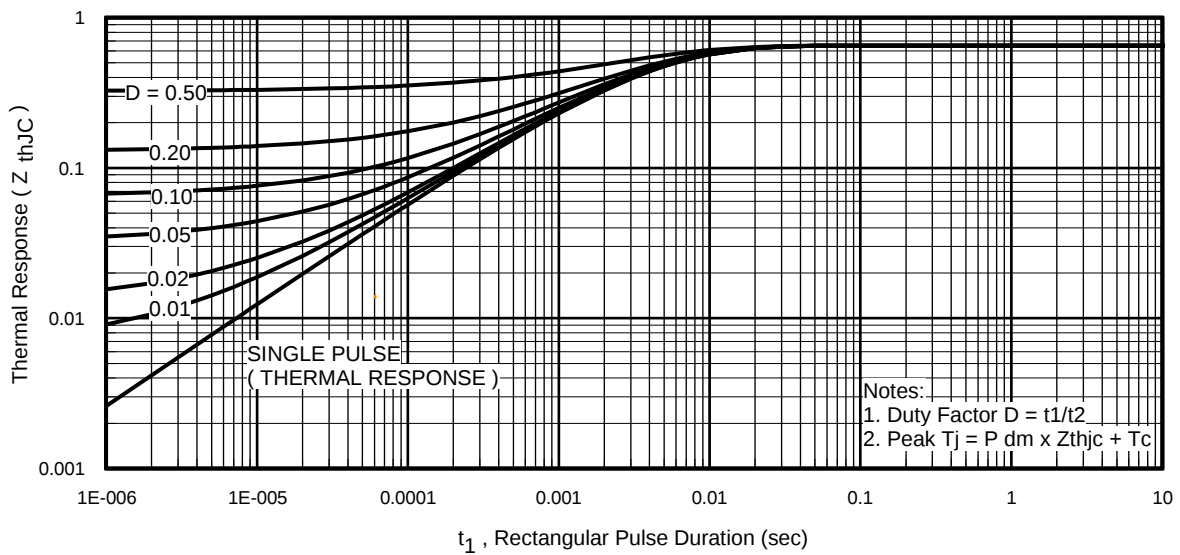


**Fig 8.** Maximum Safe Operating Area

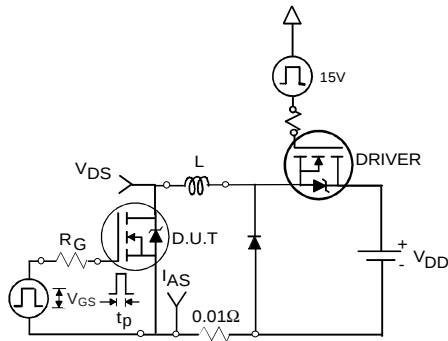


**Fig 9.** Maximum Drain Current vs. Case Temperature

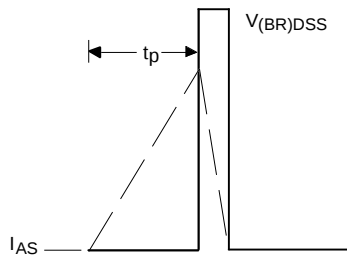
**Fig 10.** Normalized On-Resistance vs. Temperature



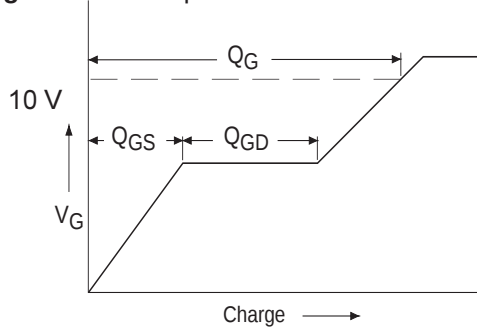
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case



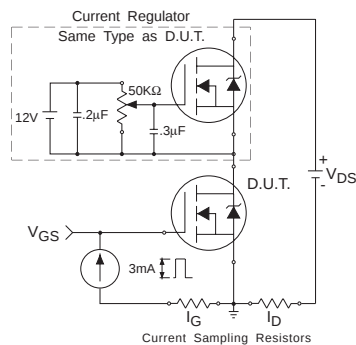
**Fig 12a.** Unclamped Inductive Test Circuit



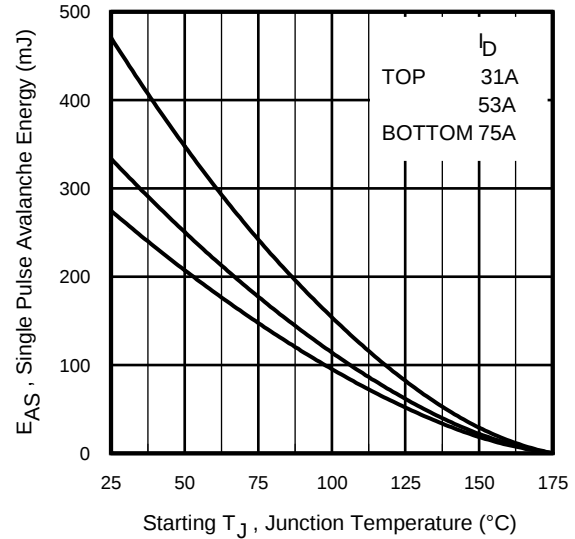
**Fig 12b.** Unclamped Inductive Waveforms



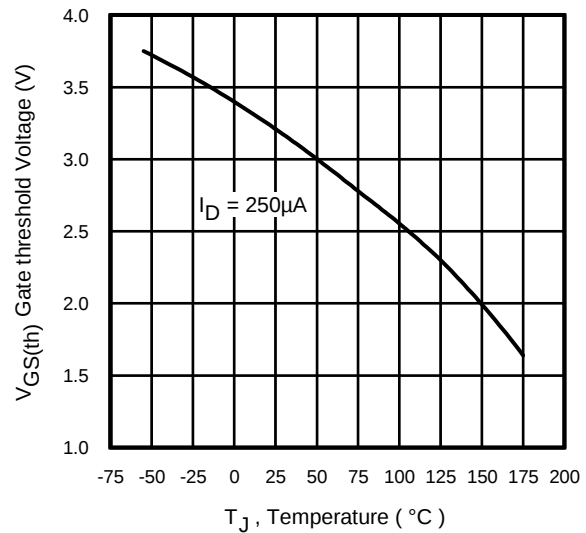
**Fig 13a.** Basic Gate Charge Waveform



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



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



**Fig 14.** Threshold Voltage vs. Temperature

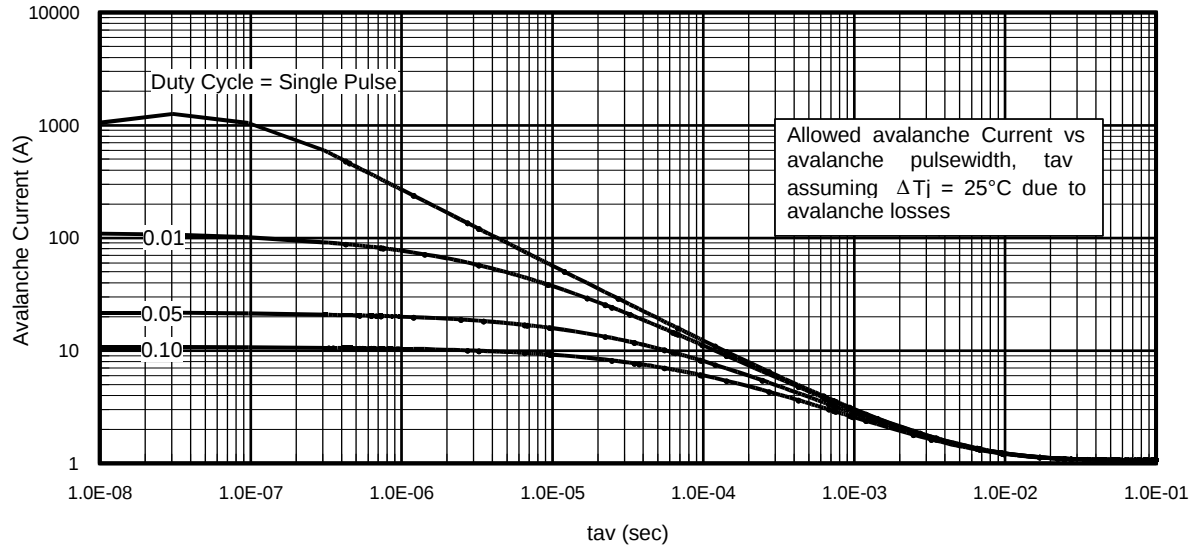


Fig 15. Typical Avalanche Current vs. Pulsewidth

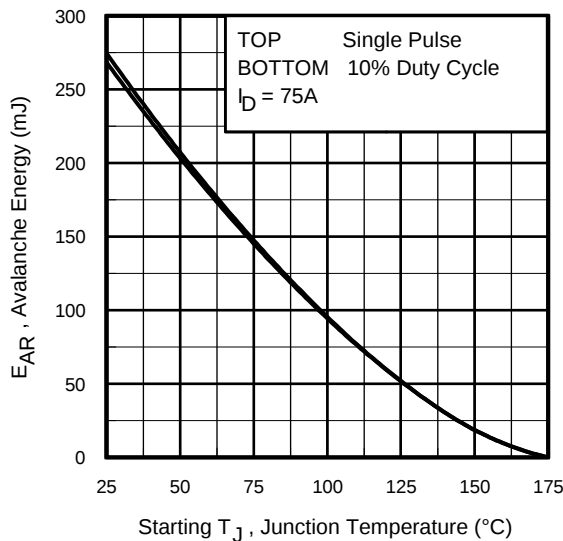


Fig 16. Maximum Avalanche Energy vs. Temperature

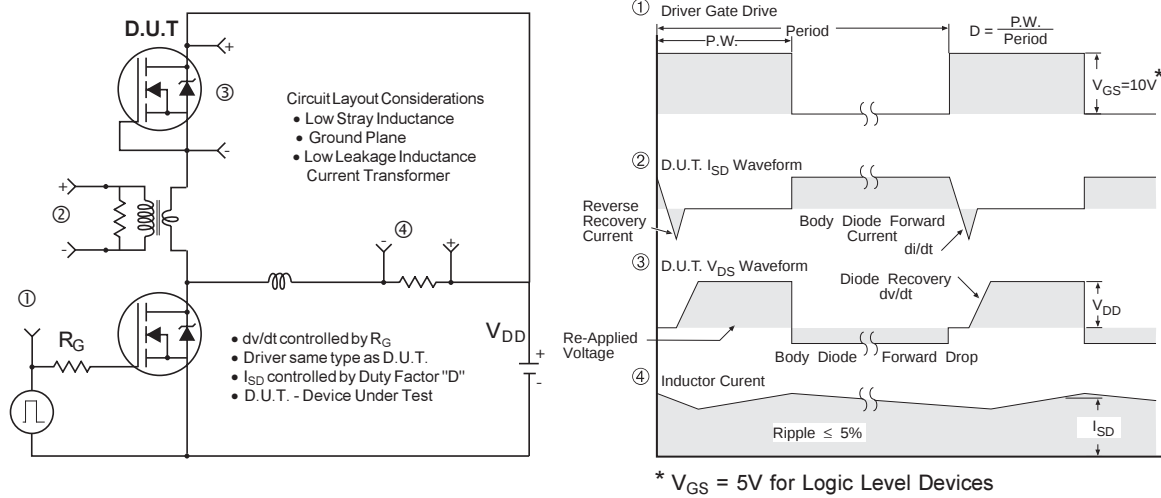
**Notes on Repetitive Avalanche Curves , Figures 15, 16:**  
(For further info, see AN-1005 at [www.irf.com](http://www.irf.com))

1. Avalanche failures assumption:  
Purely a thermal phenomenon and failure occurs at a temperature far in excess of  $T_{jmax}$ . This is validated for every part type.
2. Safe operation in Avalanche is allowed as long as  $T_{jmax}$  is not exceeded.
3. Equation below based on circuit and waveforms shown in Figures 12a, 12b.
4.  $P_{D(ave)}$  = Average power dissipation per single avalanche pulse.
5. BV = Rated breakdown voltage (1.3 factor accounts for voltage increase during avalanche).
6.  $I_{av}$  = Allowable avalanche current.
7.  $\Delta T$  = Allowable rise in junction temperature, not to exceed  $T_{jmax}$  (assumed as 25°C in Figure 15, 16).  
 $t_{av}$  = Average time in avalanche.  
 $D$  = Duty cycle in avalanche =  $t_{av} \cdot f$   
 $Z_{thJC}(D, t_{av})$  = Transient thermal resistance, see figure 11)

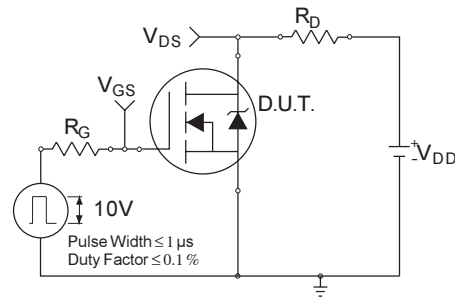
$$P_{D(ave)} = 1/2 (1.3 \cdot BV \cdot I_{av}) = \Delta T / Z_{thJC}$$

$$I_{av} = 2\Delta T / [1.3 \cdot BV \cdot Z_{th}]$$

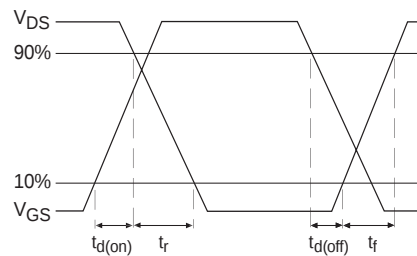
$$E_{AS(AR)} = P_{D(ave)} \cdot t_{av}$$



**Fig 17. Peak Diode Recovery  $dv/dt$  Test Circuit for N-Channel HEXFET® Power MOSFETs**



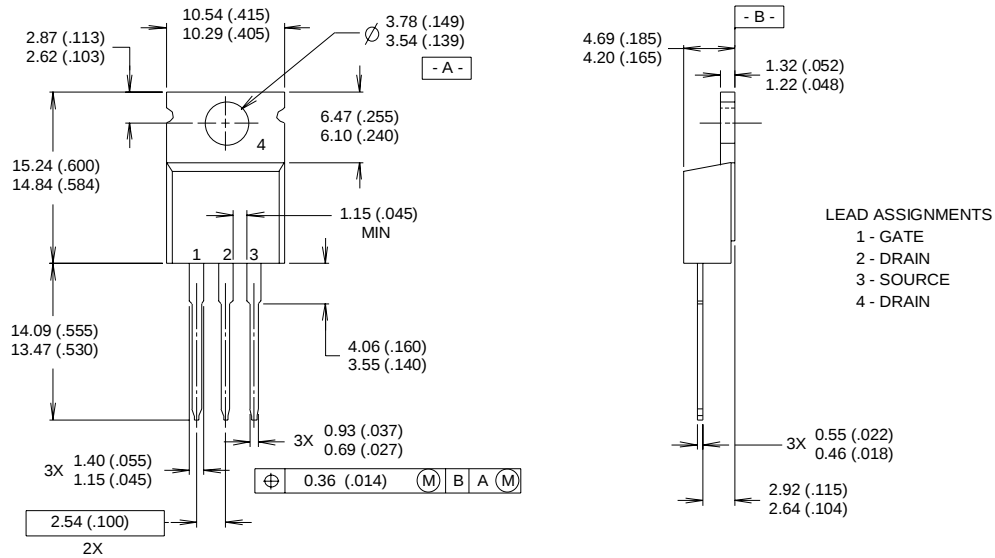
**Fig 18a. Switching Time Test Circuit**



**Fig 18b. Switching Time Waveforms**

## TO-220AB Package Outline

Dimensions are shown in millimeters (inches)

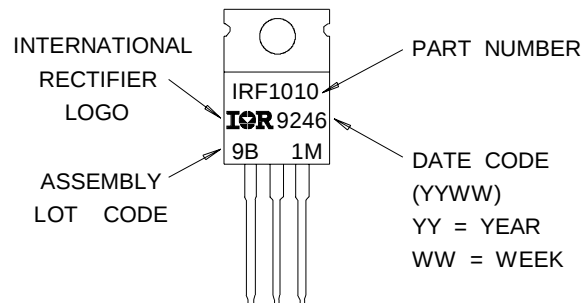


### NOTES:

- 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.

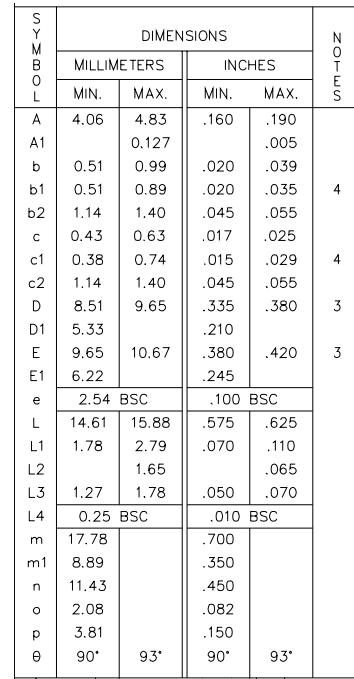
## TO-220AB Part Marking Information

EXAMPLE : THIS IS AN IRF1010  
WITH ASSEMBLY  
LOT CODE 9B1M



International  
**IOR** Rectifier

Dimensions are shown in millimeters (inches)

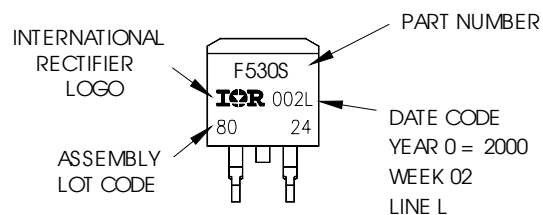


| <u>HEXFET</u> | <u>IGBTs, CoPACK</u> | <u>DIODES</u> |
|---------------|----------------------|---------------|
| 1.- GATE      | 1.- GATE             | 1.- ANODE *   |
| 2.- DRAIN     | 2.- COLLECTOR        | 2.- CATHODE   |
| 3.- SOURCE    | 3.- EMITTER          | 3.- ANODE     |

\* PART DEPENDENT.

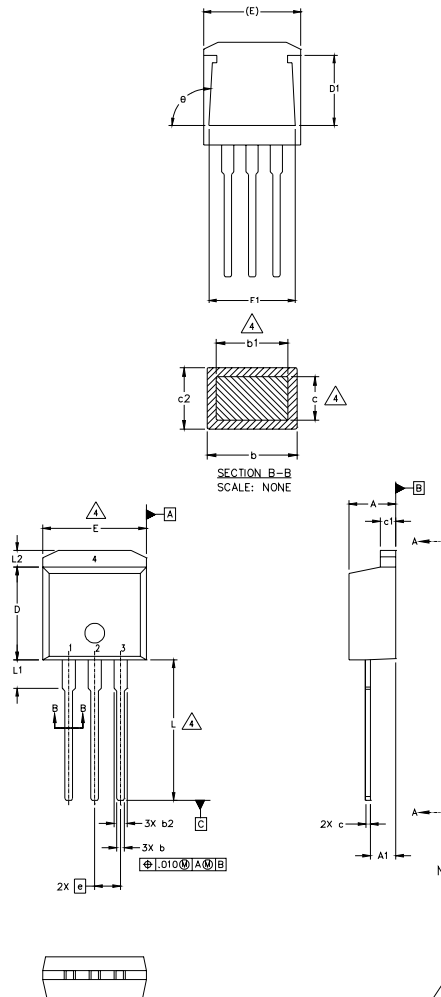
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [ .005" ] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
4. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
5. CONTROLLING DIMENSION: INCH.

EXAMPLE: THIS IS AN IRF530S WITH  
LOT CODE 8024  
ASSEMBLED ON WW02, 2000  
IN THE ASSEMBLY LINE "L"



## 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 | 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 |       |

### LEAD ASSIGNMENTS

#### HEXFET

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

#### JGBT

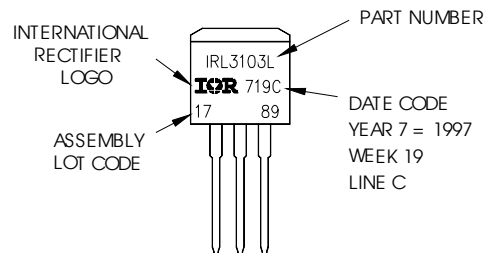
- 1- GATE
- 2- COLLECTOR
- 3- EMITTER

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

## TO-262 Part Marking Information

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

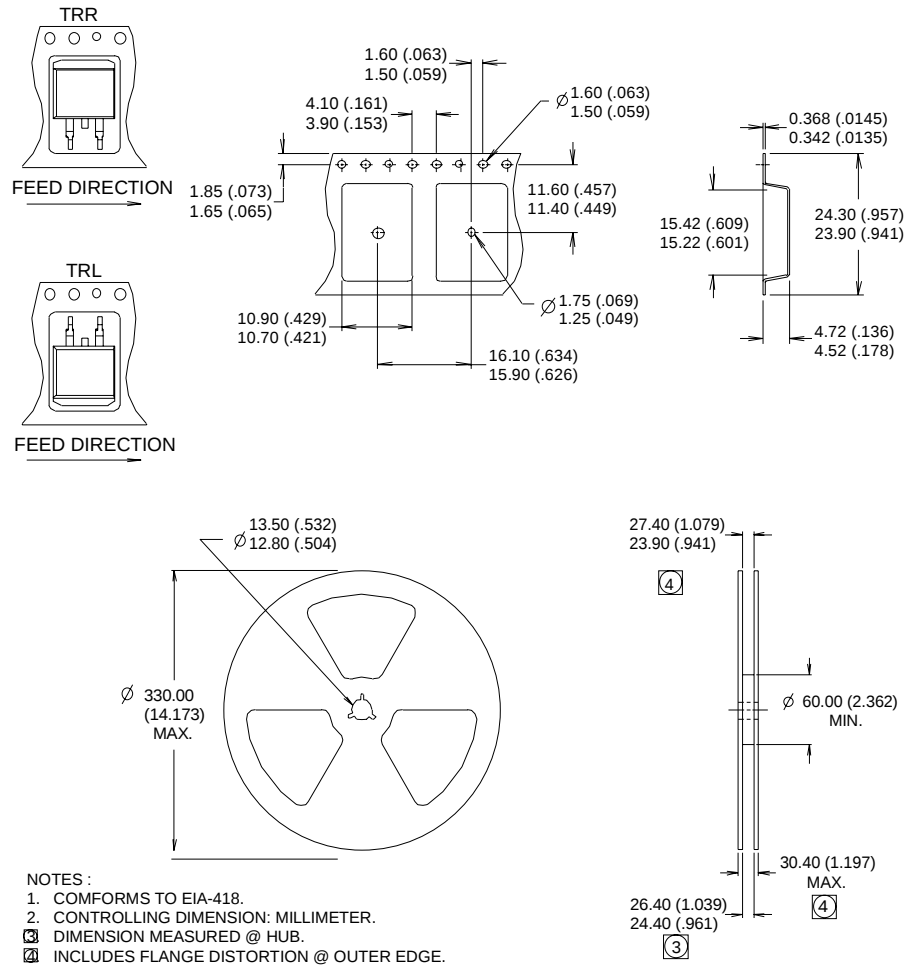


# IRF1405Z/S/L

International  
**IR** Rectifier

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

Dimensions are shown in millimeters (inches)



**TO-220AB packages are 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] market.  
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. 08/03

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