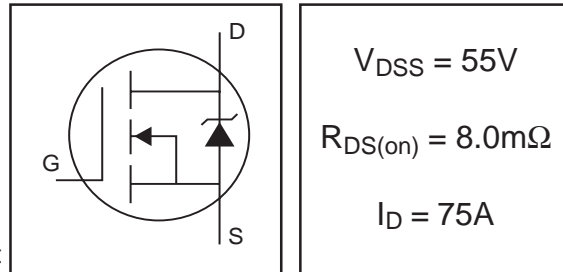


**Features**

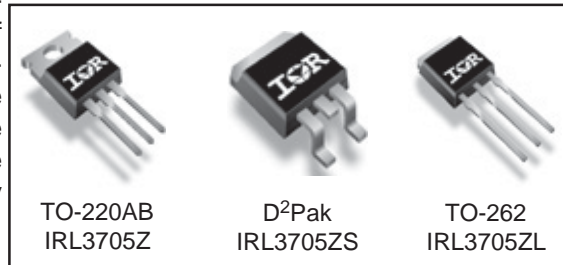
- Logic Level
- Advanced Process Technology
- Ultra Low On-Resistance
- 175°C Operating Temperature
- Fast Switching
- Repetitive Avalanche Allowed up to Tjmax
- Lead-Free

**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.



|                           |
|---------------------------|
| $V_{DSS} = 55V$           |
| $R_{DS(on)} = 8.0m\Omega$ |
| $I_D = 75A$               |



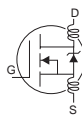
**Absolute Maximum Ratings**

|                              | Parameter  | Max.                     | Units |
|------------------------------|--|--------------------------|-------|
| $I_D @ T_C = 25^\circ C$     | Continuous Drain Current, $V_{GS} @ 10V$ (Silicon Limited) | 86                       | A     |
| $I_D @ T_C = 100^\circ C$    | Continuous Drain Current, $V_{GS} @ 10V$                   | 61                       |       |
| $I_D @ T_C = 25^\circ C$     | Continuous Drain Current, $V_{GS} @ 10V$ (Package Limited) | 75                       |       |
| $I_{DM}$                     | Pulsed Drain Current ①                                     | 340                      |       |
| $P_D @ T_C = 25^\circ C$     | Power Dissipation  | 130                      | W     |
|                              | Linear Derating Factor                                     | 0.88                     | W/°C  |
| $V_{GS}$                     | Gate-to-Source Voltage                                     | $\pm 16$                 | V     |
| $E_{AS}$ (Thermally limited) | Single Pulse Avalanche Energy ②                            | 120                      | mJ    |
| $E_{AS}$ (Tested )           | Single Pulse Avalanche Energy Tested Value ③               | 180                      |       |
| $I_{AR}$                     | 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                      | 300 (1.6mm from case )   |       |
|                              | Mounting Torque, 6-32 or M3 screw ⑦                        | 10 lbf•in (1.1N•m)       |       |

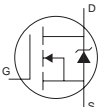
**Thermal Resistance**

|                 | Parameter                            | Typ. | Max. | Units |
|-----------------|--------------------------------------|------|------|-------|
| $R_{\theta JC}$ | Junction-to-Case                     | —    | 1.14 | °C/W  |
| $R_{\theta CS}$ | Case-to-Sink, Flat Greased Surface ⑧ | 0.50 | —    |       |
| $R_{\theta JA}$ | Junction-to-Ambient ⑨                | —    | 62   |       |
| $R_{\theta JA}$ | Junction-to-Ambient (PCB Mount) ⑩    | —    | 40   |       |

## 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    | 55   | —     | —    | V     | V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA  |
| ΔV <sub>(BR)DSS</sub> /ΔT <sub>J</sub> | Breakdown Voltage Temp. Coefficient  | —    | 0.055 | —    | V/°C  | Reference to 25°C, I <sub>D</sub> = 1mA   |
| R <sub>DS(on)</sub>                    | Static Drain-to-Source On-Resistance | —    | 6.5   | 8.0  | mΩ    | V <sub>GS</sub> = 10V, I <sub>D</sub> = 52A ③   |
|  |                                      | —    | —     | 11   |       | V <sub>GS</sub> = 5.0V, I <sub>D</sub> = 43A ③  |
|  |                                      | —    | —     | 12   |       | V <sub>GS</sub> = 4.5V, I <sub>D</sub> = 30A ③  |
| V <sub>GS(th)</sub>                    | Gate Threshold Voltage               | 1.0  | —     | 3.0  | V     | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250μA                            |
| g <sub>fs</sub>                        | Forward Transconductance             | 150  | —     | —    | V     | V <sub>DS</sub> = 25V, I <sub>D</sub> = 52A   |
| I <sub>DSS</sub>                       | Drain-to-Source Leakage Current      | —    | —     | 20   | μA    | V <sub>DS</sub> = 55V, V <sub>GS</sub> = 0V   |
|  |                                      | —    | —     | 250  |       | V <sub>DS</sub> = 55V, V <sub>GS</sub> = 0V, T <sub>J</sub> = 125°C                   |
| I <sub>GSS</sub>                       | Gate-to-Source Forward Leakage       | —    | —     | 200  | nA    | V <sub>GS</sub> = 16V   |
|  | Gate-to-Source Reverse Leakage       | —    | —     | -200 |       | V <sub>GS</sub> = -16V  |
| Q <sub>g</sub>                         | Total Gate Charge                    | —    | 40    | 60   | nC    | I <sub>D</sub> = 43A  |
| Q <sub>gs</sub>                        | Gate-to-Source Charge                | —    | 12    | —    |       | V <sub>DS</sub> = 44V   |
| Q <sub>gd</sub>                        | Gate-to-Drain ("Miller") Charge      | —    | 21    | —    |       | V <sub>GS</sub> = 5.0V ③  |
| t <sub>d(on)</sub>                     | Turn-On Delay Time                   | —    | 17    | —    | ns    | V <sub>DD</sub> = 28V   |
| t <sub>r</sub>                         | Rise Time                            | —    | 240   | —    |       | I <sub>D</sub> = 43A  |
| t <sub>d(off)</sub>                    | Turn-Off Delay Time                  | —    | 26    | —    |       | R <sub>G</sub> = 4.3 Ω  |
| t <sub>f</sub>                         | Fall Time                            | —    | 83    | —    |       | V <sub>GS</sub> = 5.0V ③  |
| 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                    | —    | 2880  | —    | pF    | V <sub>GS</sub> = 0V  |
| C <sub>oss</sub>                       | Output Capacitance                   | —    | 420   | —    |       | V <sub>DS</sub> = 25V   |
| C <sub>riss</sub>                      | Reverse Transfer Capacitance         | —    | 220   | —    |       | f = 1.0MHz  |
| C <sub>oss</sub>                       | Output Capacitance                   | —    | 1500  | —    |       | V <sub>GS</sub> = 0V, V <sub>DS</sub> = 1.0V, f = 1.0MHz                              |
| C <sub>oss</sub>                       | Output Capacitance                   | —    | 330   | —    |       | V <sub>GS</sub> = 0V, V <sub>DS</sub> = 44V, f = 1.0MHz                               |
| C <sub>oss eff.</sub>                  | Effective Output Capacitance         | —    | 510   | —    |       | V <sub>GS</sub> = 0V, V <sub>DS</sub> = 0V to 44V ④                                   |

## Source-Drain Ratings and Characteristics

|                 | Parameter                                 | Min.   | Typ. | Max. | Units | Conditions  |
|-----------------|---|--|------|------|-------|---|
| I <sub>S</sub>  | Continuous Source Current<br>(Body Diode) | —  | —    | 75   | A     | MOSFET symbol<br>showing the<br>integral reverse<br>p-n junction diode.               |
| I <sub>SM</sub> | Pulsed Source Current<br>(Body Diode) ①   | —  | —    | 340  |       |  |
| V <sub>SD</sub> | Diode Forward Voltage                     | —  | —    | 1.3  | V     | T <sub>J</sub> = 25°C, I <sub>S</sub> = 52A, V <sub>GS</sub> = 0V ③                   |
| t <sub>rr</sub> | Reverse Recovery Time                     | —  | 16   | 24   | ns    | T <sub>J</sub> = 25°C, I <sub>F</sub> = 43A, V <sub>DD</sub> = 28V                    |
| Q <sub>rr</sub> | Reverse Recovery Charge                   | —  | 7.4  | 11   | 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 LS+LD) |      |      |       |   |

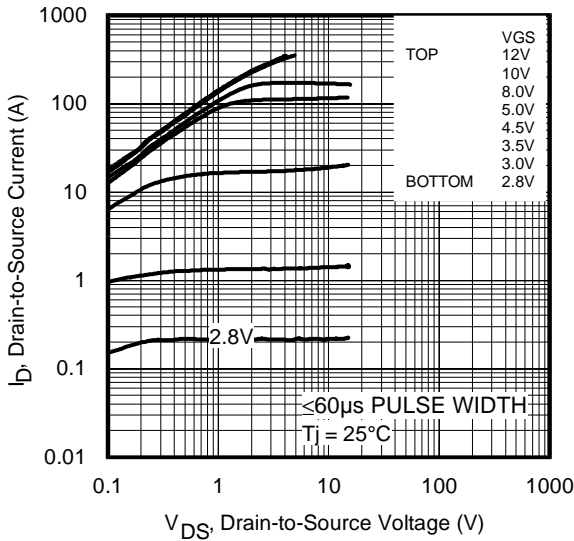


Fig 1. Typical Output Characteristics

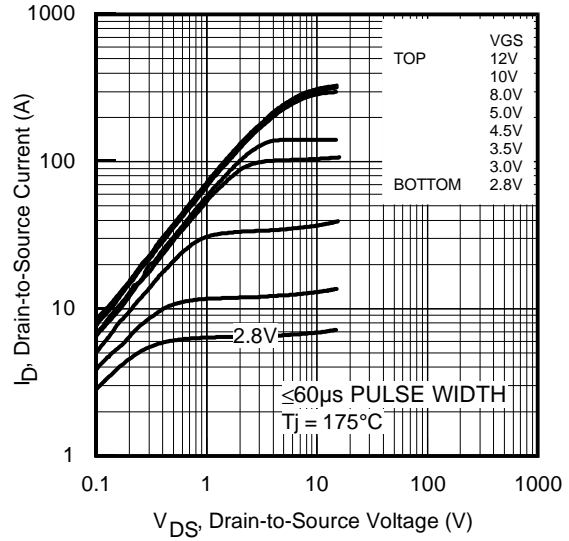


Fig 2. Typical Output Characteristics

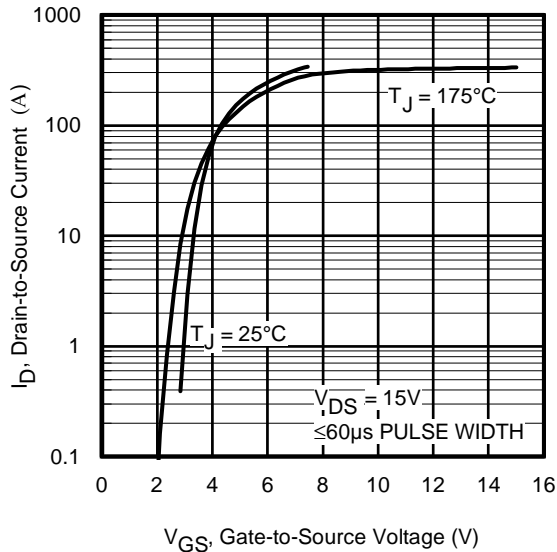


Fig 3. Typical Transfer Characteristics

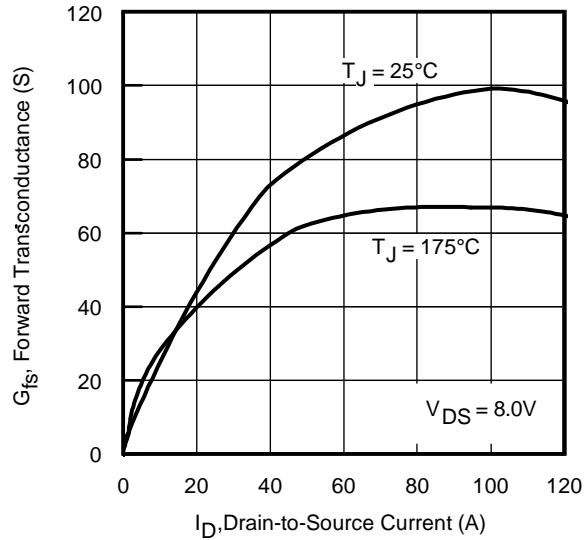
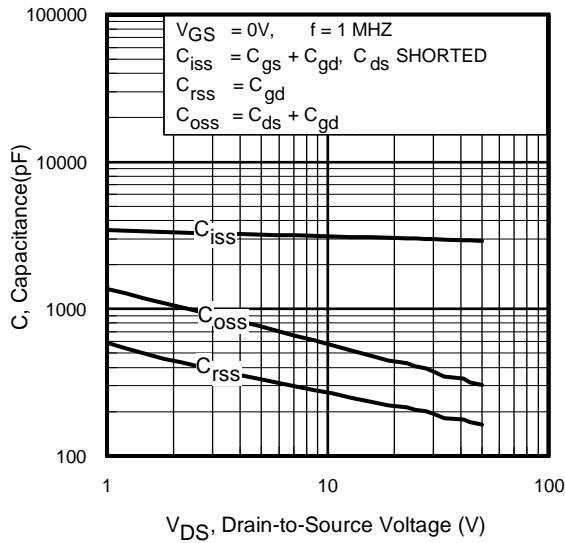
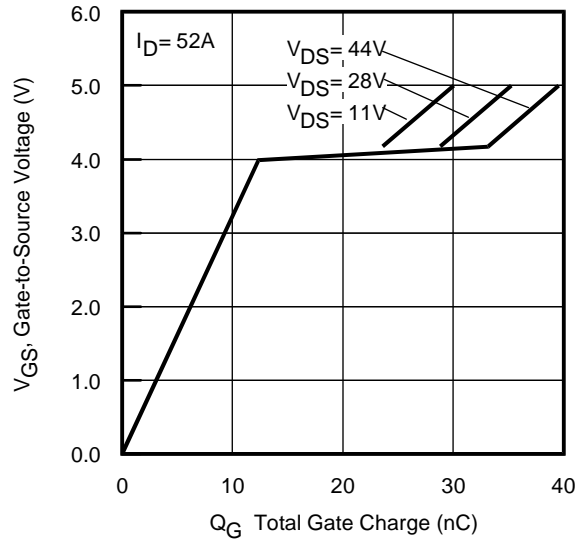


Fig 4. Typical Forward Transconductance vs. Drain Current

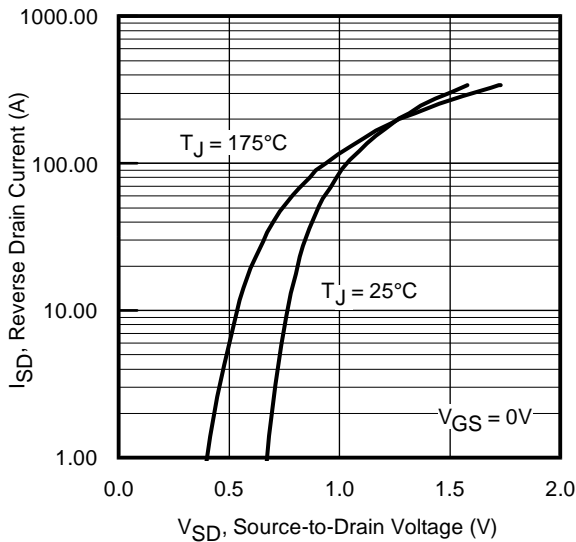
# IRL3705Z/S/LPbF



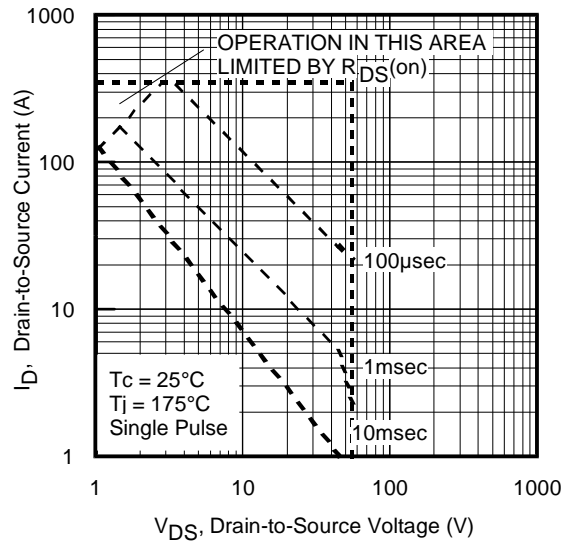
**Fig 5.** Typical Capacitance vs. Drain-to-Source Voltage



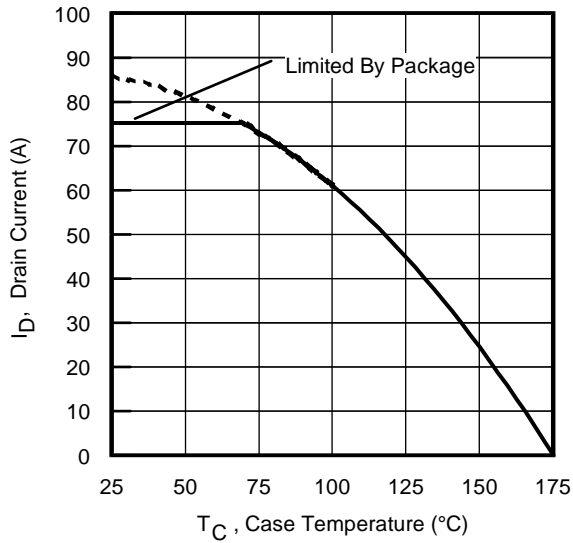
**Fig 6.** Typical Gate Charge vs. Gate-to-Source Voltage



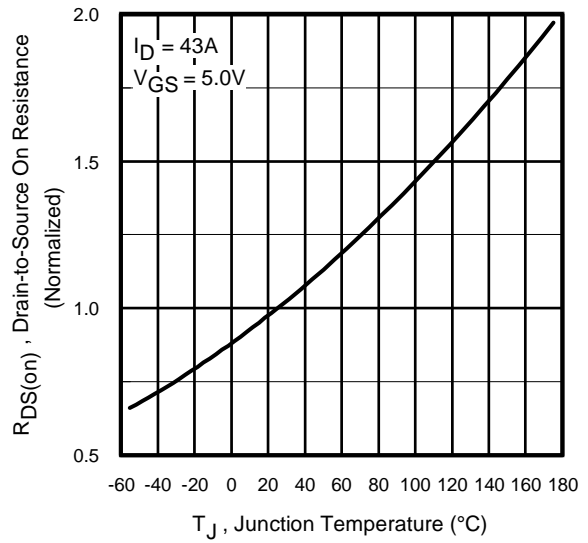
**Fig 7.** Typical Source-Drain Diode Forward Voltage



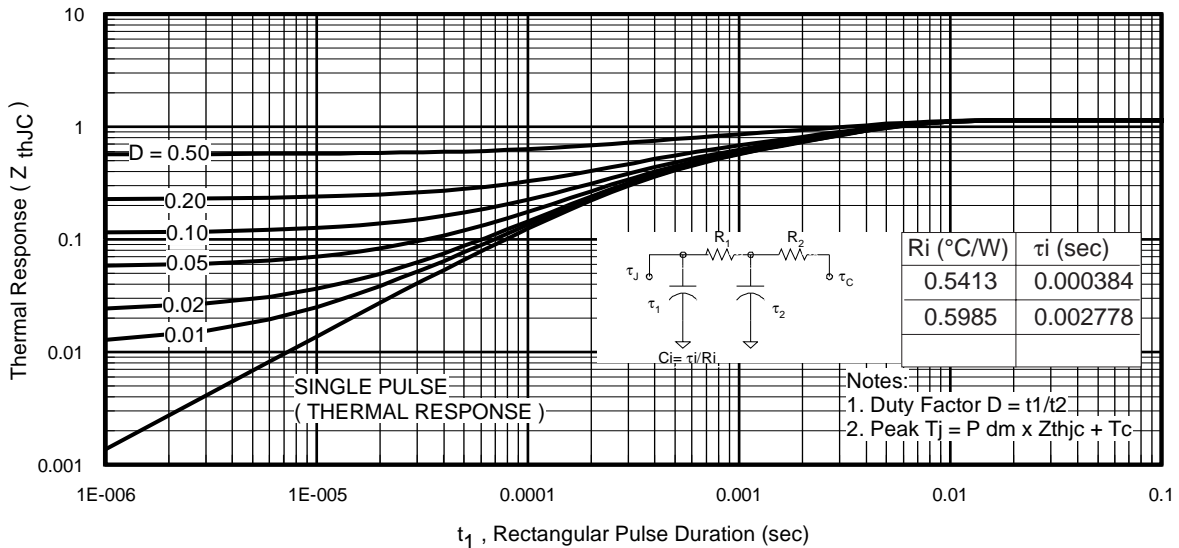
**Fig 8.** Maximum Safe Operating Area



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



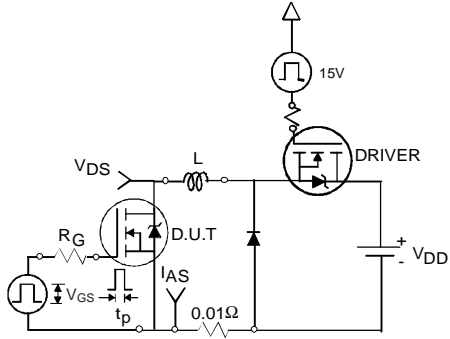
**Fig 10.** Normalized On-Resistance vs. Temperature



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

# IRL3705Z/S/LPbF

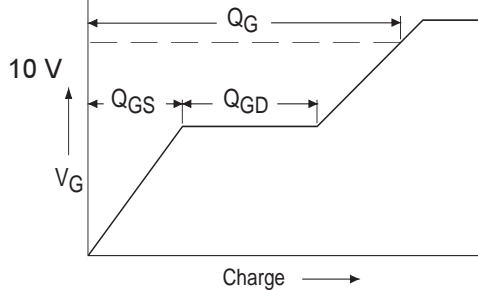
International  
**IR** Rectifier



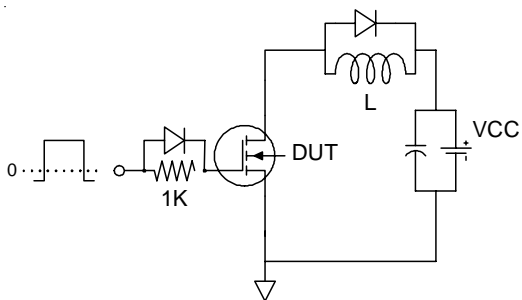
**Fig 12a.** Unclamped Inductive Test Circuit



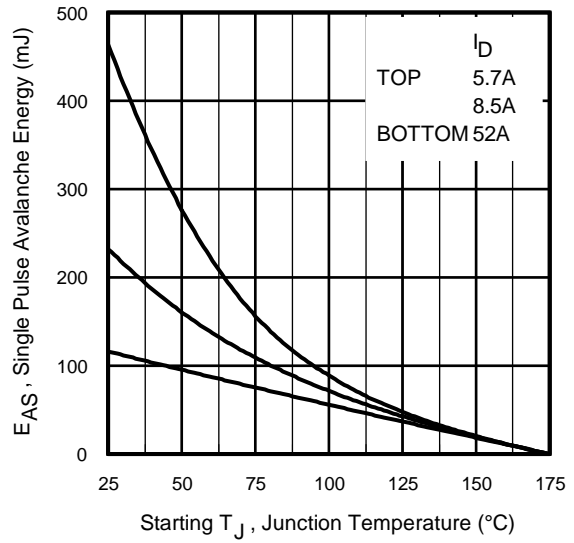
**Fig 12b.** Unclamped Inductive Waveforms



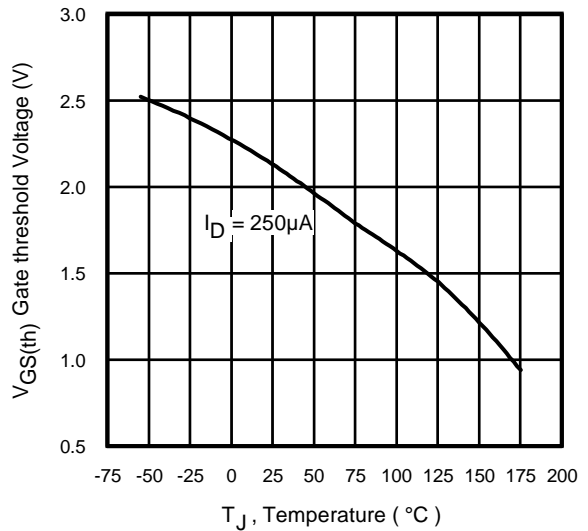
**Fig 13a.** Basic Gate Charge Waveform



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



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



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

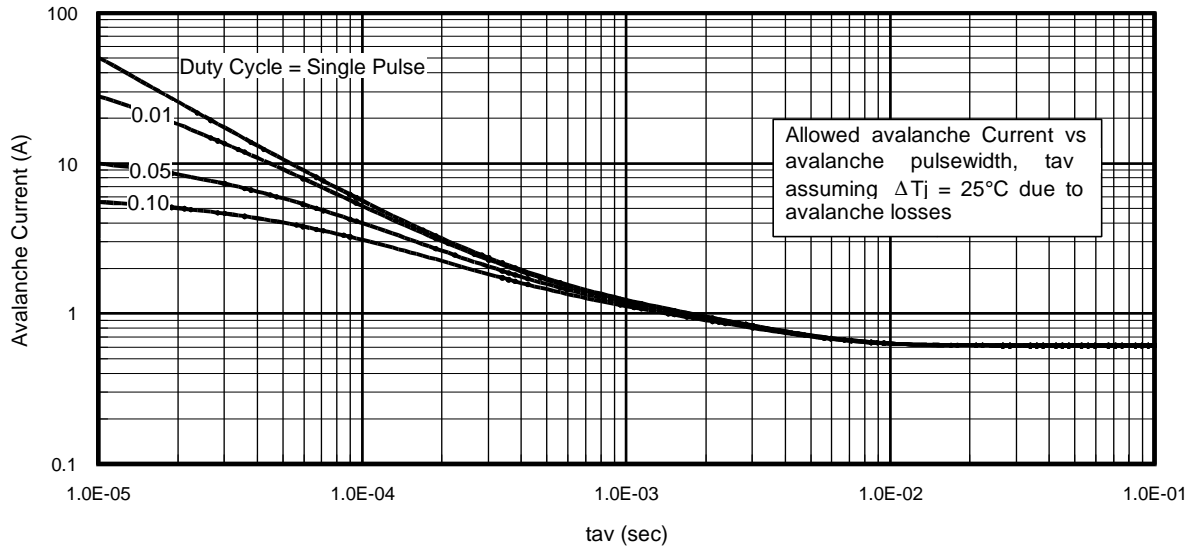


Fig 15. Typical Avalanche Current vs.Pulsewidth

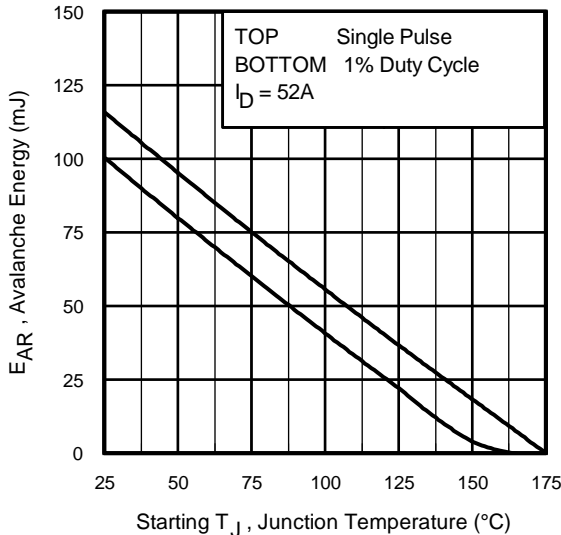


Fig 16. Maximum Avalanche Energy vs. Temperature

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

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)

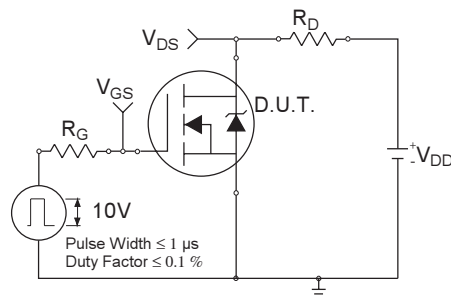
$$P_{D(ave)} = 1/2 ( 1.3 \cdot BV \cdot I_{av} ) = \Delta T / Z_{thJC}$$

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

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



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



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

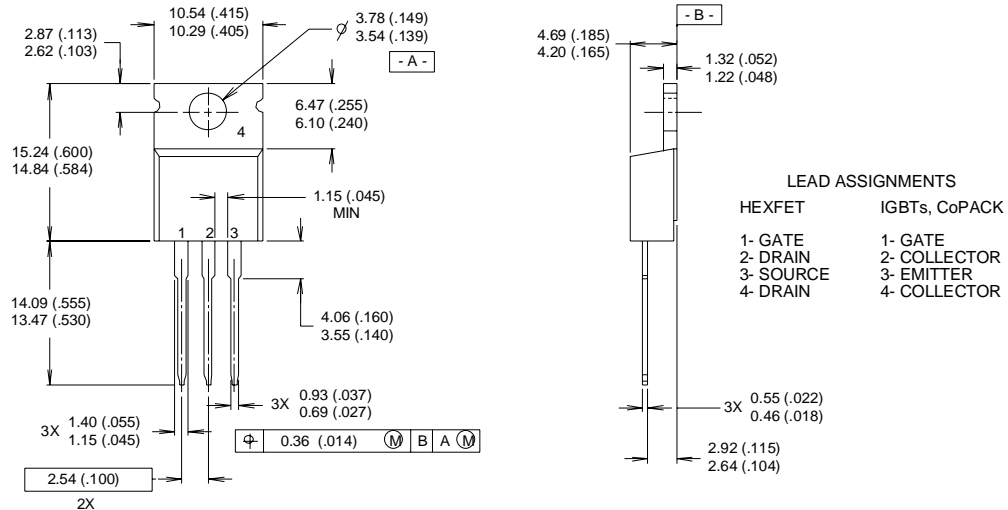


**Fig 18b. Switching Time Waveforms**



## TO-220AB Package Outline

Dimensions are shown in millimeters (inches)



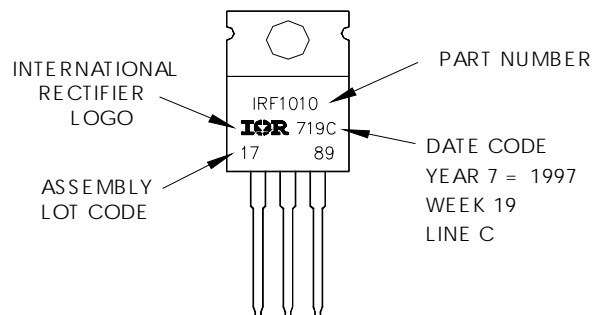
**NOTES:**

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

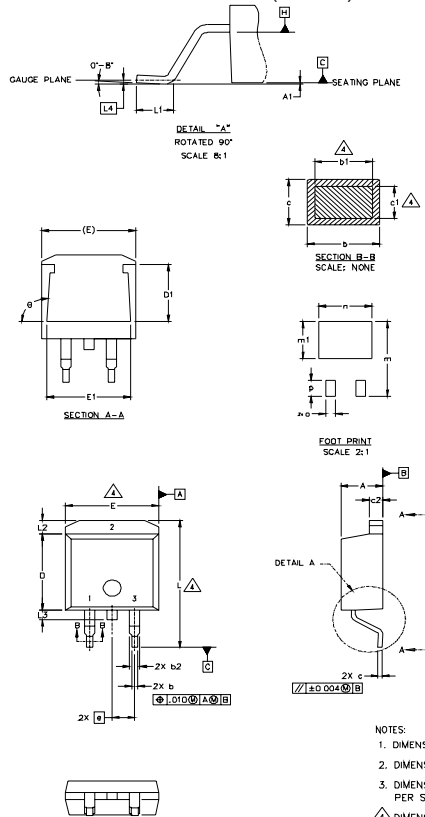


# IRL3705Z/S/LPbF

International  
**IR** Rectifier

## 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 | 4     |
| b1     | 0.51        | 0.89  | .020     | .035 |       |
| b2     | 1.14        | 1.40  | .045     | .055 |       |
| c      | 0.43        | 0.63  | .017     | .025 | 4     |
| c1     | 0.38        | 0.74  | .015     | .029 |       |
| 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     | 6.22        |       | .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     |      |       |
| θ      | 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.

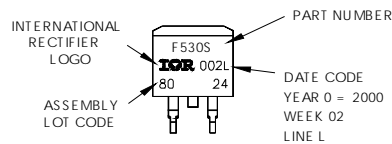
### NOTES:

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 [.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.

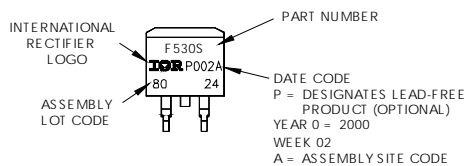
## D<sup>2</sup>Pak Part Marking Information

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"

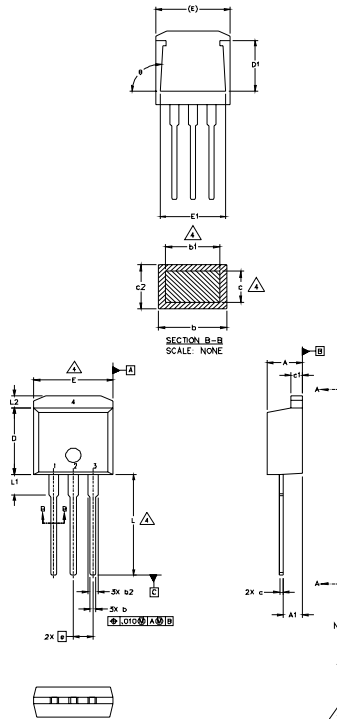


**OR**



## 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 |       |
| A1     | 2.03        | 2.92  | .080     | .115 |       |
| b      | 0.51        | 0.99  | .020     | .039 | 4     |
| 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 |       |

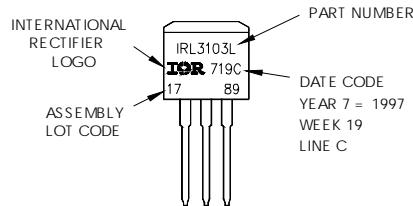
### LEAD ASSIGNMENTS

| HEXFET     | IGBT          |
|------------|---------------|
| 1.- GATE   | 1 - GATE      |
| 2.- DRAIN  | 2 - COLLECTOR |
| 3.- SOURCE | 3 - EMITTER   |
| 4.- DRAIN  |               |

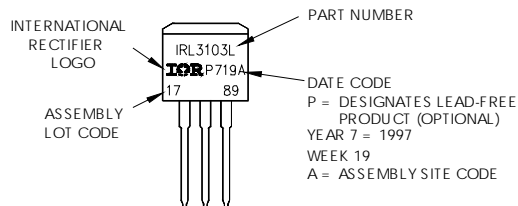
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
  2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES]
  3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 (.005") PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
  4. DIMENSION 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"  
 Note: "P" in assembly line  
 position indicates "Lead-Free"



**OR**

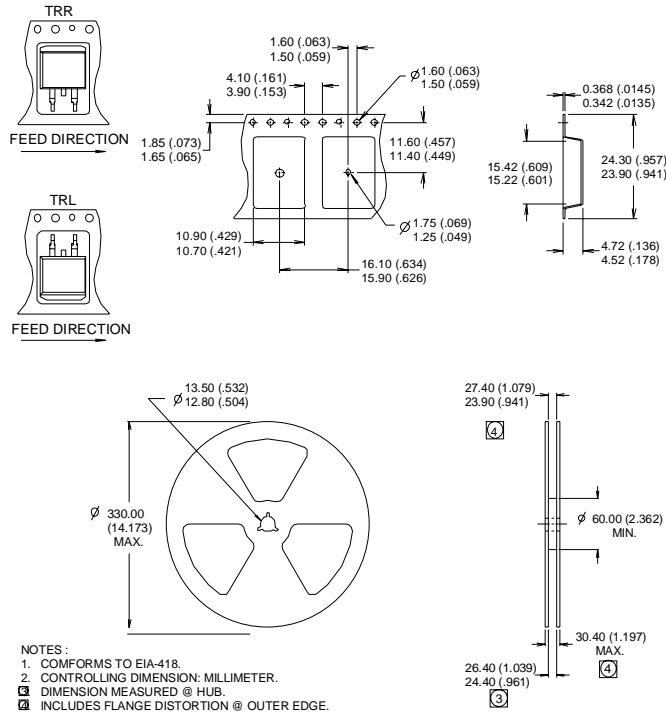


# IRL3705Z/S/LPbF

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

International  
**IR** Rectifier

Dimensions are shown in millimeters (inches)



### Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature. (See fig. 11).
- ② Limited by  $T_{Jmax}$ , starting  $T_J = 25^\circ C$ ,  $L = 0.09mH$ ,  $R_G = 25\Omega$ ,  $I_{AS} = 52A$ ,  $V_{GS} = 10V$ . Part not recommended for use above this value.
- ③ Pulse width  $\leq 1.0ms$ ; duty cycle  $\leq 2\%$ .
- ④  $C_{OSS}$  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 only applied to TO-220AB package.
- ⑧ 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.
- ⑨  $R_\theta$  is measured at  $T_J$  of approximately  $90^\circ C$ .

**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]market.  
Qualification Standards can be found on IR's Web site.

International  
**IR** Rectifier

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Visit us at [www.irf.com](http://www.irf.com) for sales contact information. 07/04

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