

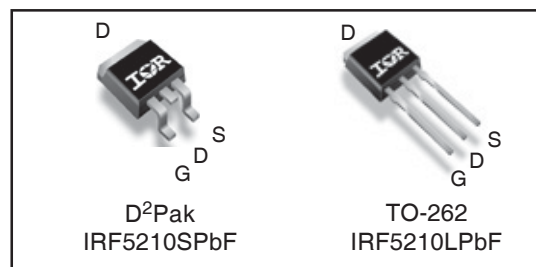
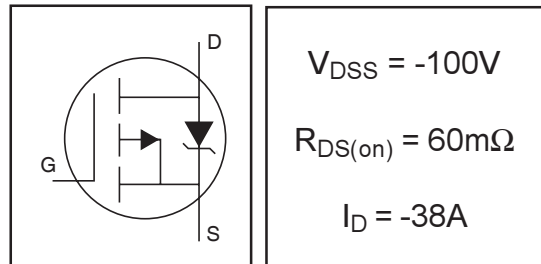
# IRF5210SPbF IRF5210LPbF

HEXFET® Power MOSFET

- Advanced Process Technology
- Ultra Low On-Resistance
- 150°C Operating Temperature
- Fast Switching
- Repetitive Avalanche Allowed up to  $T_{jmax}$
- Some Parameters are Different from IRF5210S/L
- P-Channel
- Lead-Free

## Description

Features of this design are a 150°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 a wide variety of other applications.



| G    | D     | S      |
|------|-------|--------|
| Gate | Drain | Source |

## Absolute Maximum Ratings

|                           | Parameter                                 | Max.         | Units |
|---------------------------|-------------------------------------------|--------------|-------|
| $I_D @ T_C = 25^\circ C$  | Continuous Drain Current, $V_{GS} @ -10V$ | -38          | A     |
| $I_D @ T_C = 100^\circ C$ | Continuous Drain Current, $V_{GS} @ -10V$ | -24          |       |
| $I_{DM}$                  | Pulsed Drain Current ①                    | -140         |       |
| $P_D @ T_A = 25^\circ C$  | Maximum Power Dissipation                 | 3.1          | W     |
| $P_D @ T_C = 25^\circ C$  | Maximum Power Dissipation                 | 170          |       |
|                           | Linear Derating Factor                    | 1.3          | W/°C  |
| $V_{GS}$                  | Gate-to-Source Voltage                    | $\pm 20$     | V     |
| $E_{AS}$                  | Single Pulse Avalanche Energy ②           | 120          | mJ    |
| $I_{AR}$                  | Avalanche Current ①                       | -23          | A     |
| $E_{AR}$                  | Repetitive Avalanche Energy ①             | 17           | mJ    |
| $dv/dt$                   | Peak Diode Recovery $dv/dt$ ③             | -7.4         | V/ns  |
| $T_J$                     | Operating Junction and                    | -55 to + 150 | °C    |
| $T_{STG}$                 | Storage Temperature Range                 |              |       |
|                           | Soldering Temperature, for 10 seconds     |              |       |

## Thermal Resistance

|                 | Parameter                                       | Typ. | Max. | Units |
|-----------------|-------------------------------------------------|------|------|-------|
| $R_{\theta JC}$ | Junction-to-Case                                | —    | 0.75 | °C/W  |
| $R_{\theta JA}$ | Junction-to-Ambient (PCB Mount, steady state) ⑤ | —    | 40   |       |

## 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    | -100 | —     | —    | V     | $V_{GS} = 0V, I_D = -250\mu A$                                              |
| $\Delta BV_{DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient  | —    | -0.11 | —    | V/°C  | Reference to $25^\circ\text{C}$ , $I_D = -1\text{mA}$                       |
| $R_{DS(on)}$                 | Static Drain-to-Source On-Resistance | —    | —     | 60   | mΩ    | $V_{GS} = 10V, I_D = -38A$ ④                                                |
| $V_{GS(th)}$                 | Gate Threshold Voltage               | -2.0 | —     | -4.0 | V     | $V_{DS} = V_{GS}, I_D = -250\mu A$                                          |
| $g_{fs}$                     | Forward Transconductance             | 9.5  | —     | —    | S     | $V_{DS} = -50V, I_D = -23A$                                                 |
| $I_{DSS}$                    | Drain-to-Source Leakage Current      | —    | —     | -50  | μA    | $V_{DS} = -100V, V_{GS} = 0V$                                               |
|                              |                                      | —    | —     | -250 |       | $V_{DS} = -80V, V_{GS} = 0V, T_J = 125^\circ\text{C}$                       |
| $I_{GSS}$                    | Gate-to-Source Forward Leakage       | —    | —     | 100  | nA    | $V_{GS} = 20V$                                                              |
|                              | Gate-to-Source Reverse Leakage       | —    | —     | -100 |       | $V_{GS} = -20V$                                                             |
| $Q_g$                        | Total Gate Charge                    | —    | 150   | 230  | nC    | $I_D = -23A$                                                                |
| $Q_{gs}$                     | Gate-to-Source Charge                | —    | 22    | 33   |       | $V_{DS} = -80V$                                                             |
| $Q_{gd}$                     | Gate-to-Drain ("Miller") Charge      | —    | 81    | 120  |       | $V_{GS} = -10V$ ④                                                           |
| $t_{d(on)}$                  | Turn-On Delay Time                   | —    | 14    | —    | ns    | $V_{DD} = -50V$                                                             |
| $t_r$                        | Rise Time                            | —    | 63    | —    |       | $I_D = -23A$                                                                |
| $t_{d(off)}$                 | Turn-Off Delay Time                  | —    | 72    | —    |       | $R_G = 2.4\Omega$                                                           |
| $t_f$                        | Fall Time                            | —    | 55    | —    |       | $V_{GS} = -10V$ ④                                                           |
| $L_D$                        | 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                    | —    | 2780  | —    | pF    | $V_{GS} = 0V$                                                               |
| $C_{oss}$                    | Output Capacitance                   | —    | 800   | —    |       | $V_{DS} = -25V$                                                             |
| $C_{rss}$                    | Reverse Transfer Capacitance         | —    | 430   | —    |       | $f = 1.0\text{MHz}$ , See Fig. 5                                            |

## Source-Drain Ratings and Characteristics

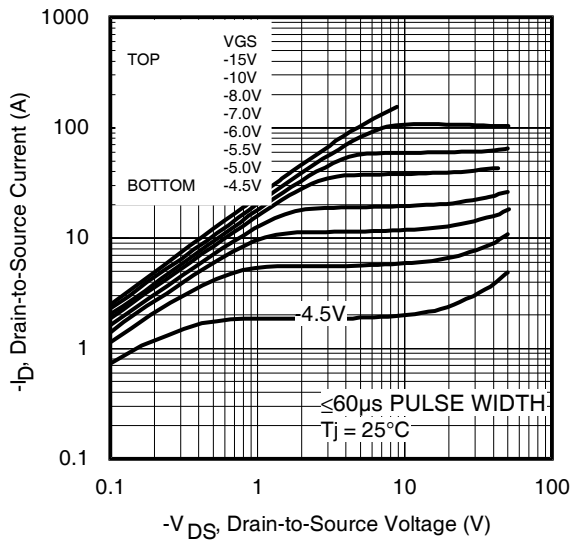
|          | Parameter                                 | Min.                                                                      | Typ. | Max. | Units | Conditions                                                              |
|----------|-------------------------------------------|---------------------------------------------------------------------------|------|------|-------|-------------------------------------------------------------------------|
| $I_S$    | Continuous Source Current<br>(Body Diode) | —                                                                         | —    | -38  | A     | MOSFET symbol<br>showing the<br>integral reverse<br>p-n junction diode. |
| $I_{SM}$ | Pulsed Source Current<br>(Body Diode) ①   | —                                                                         | —    | -140 |       |                                                                         |
| $V_{SD}$ | Diode Forward Voltage                     | —                                                                         | —    | -1.6 | V     | $T_J = 25^\circ\text{C}, I_S = -23A, V_{GS} = 0V$ ④                     |
| $t_{rr}$ | Reverse Recovery Time                     | —                                                                         | 170  | 260  | ns    | $T_J = 25^\circ\text{C}, I_F = -23A, V_{DD} = -25V$                     |
| $Q_{rr}$ | Reverse Recovery Charge                   | —                                                                         | 1180 | 1770 | nC    | $di/dt = -100A/\mu s$ ④                                                 |
| $t_{on}$ | Forward Turn-On Time                      | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S+L_D$ ) |      |      |       |                                                                         |

### Notes:

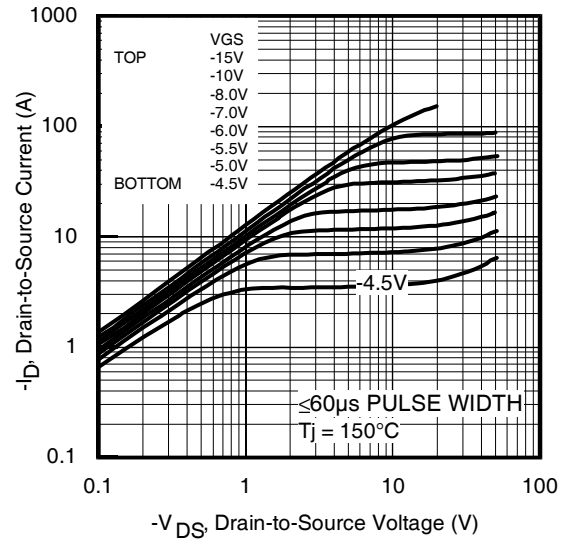
- ① Repetitive rating; pulse width limited by max. junction temperature. ( See fig. 11)
- ② Starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.46\text{mH}$   
 $R_G = 25\Omega$ ,  $I_{AS} = -23A$ . (See Figure 12)
- ③  $I_{SD} \leq -23A$ ,  $di/dt \leq -650A/\mu s$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  
 $T_J \leq 150^\circ\text{C}$ .

④ Pulse width  $\leq 300\mu s$ ; duty cycle  $\leq 2\%$ .

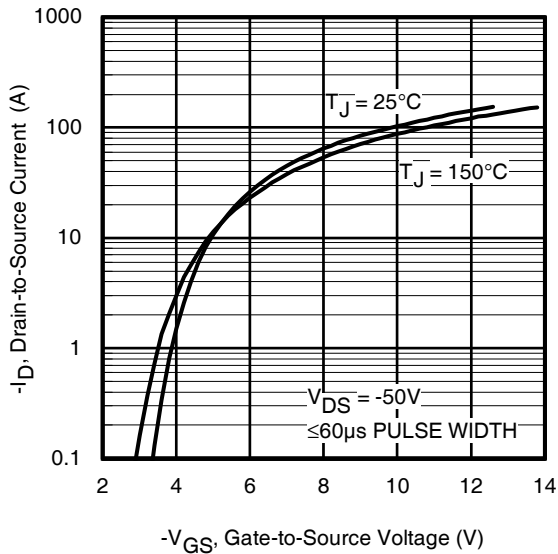
⑤ When mounted on 1" square PCB (FR-4 or G-10 Material). For recommended footprint and soldering techniques refer to application note #AN-994.



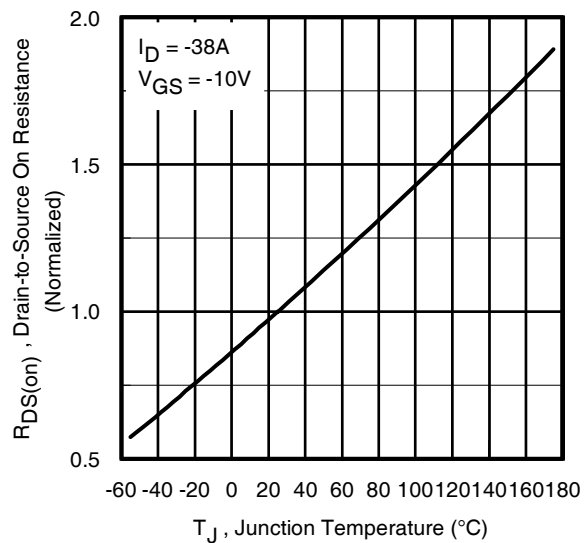
**Fig 1.** Typical Output Characteristics



**Fig 2.** Typical Output Characteristics



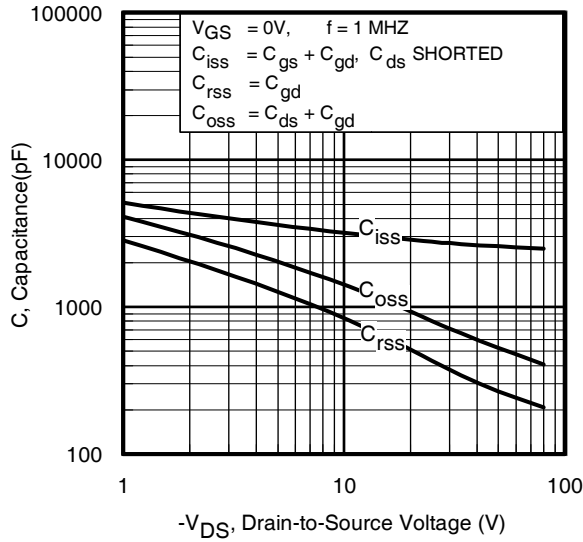
**Fig 3.** Typical Transfer Characteristics



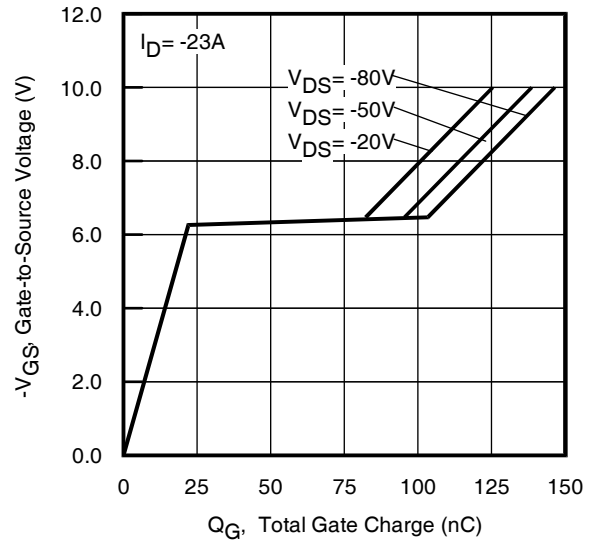
**Fig 4.** Normalized On-Resistance vs. Temperature

# IRF5210S/LPbF

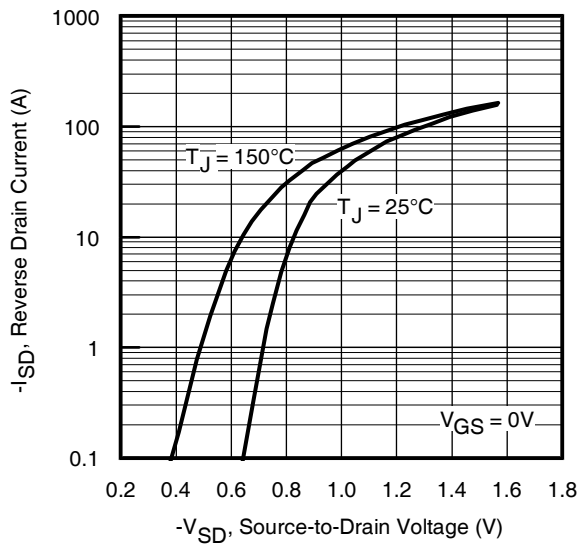
International  
**IR** Rectifier



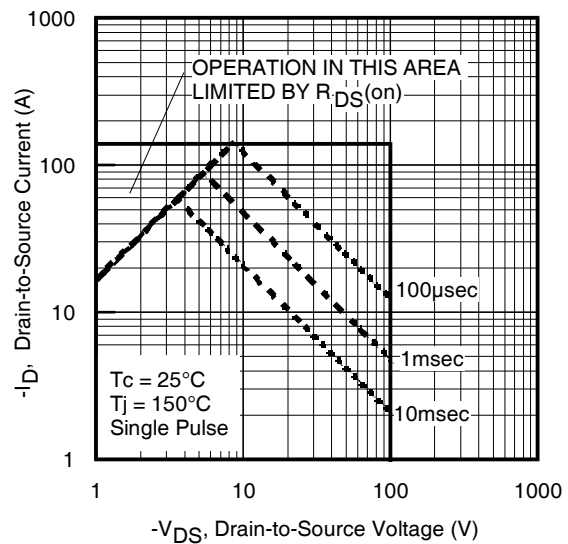
**Fig 5.** Typical Capacitance vs. Drain-to-Source Voltage



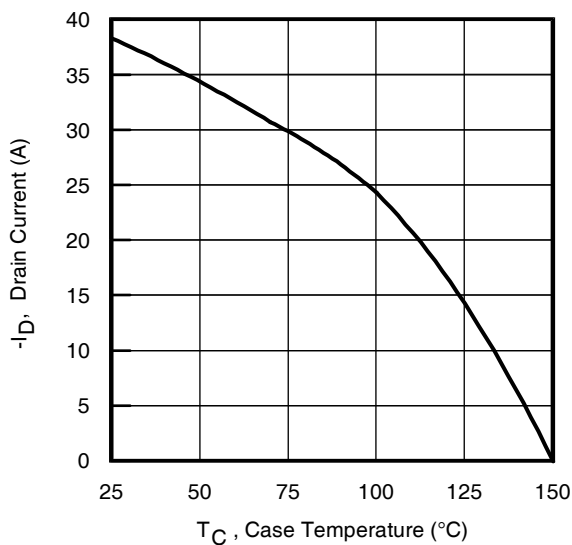
**Fig 6.** Typical Gate Charge vs. Gate-to-Source Voltage



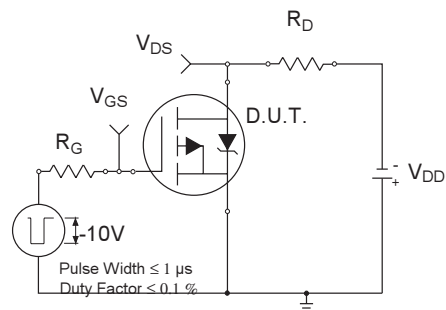
**Fig 7.** Typical Source-Drain Diode Forward Voltage



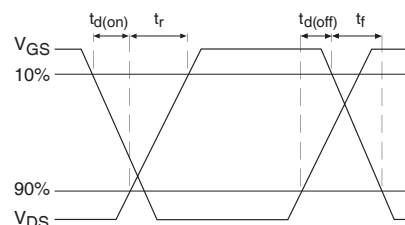
**Fig 8.** Maximum Safe Operating Area



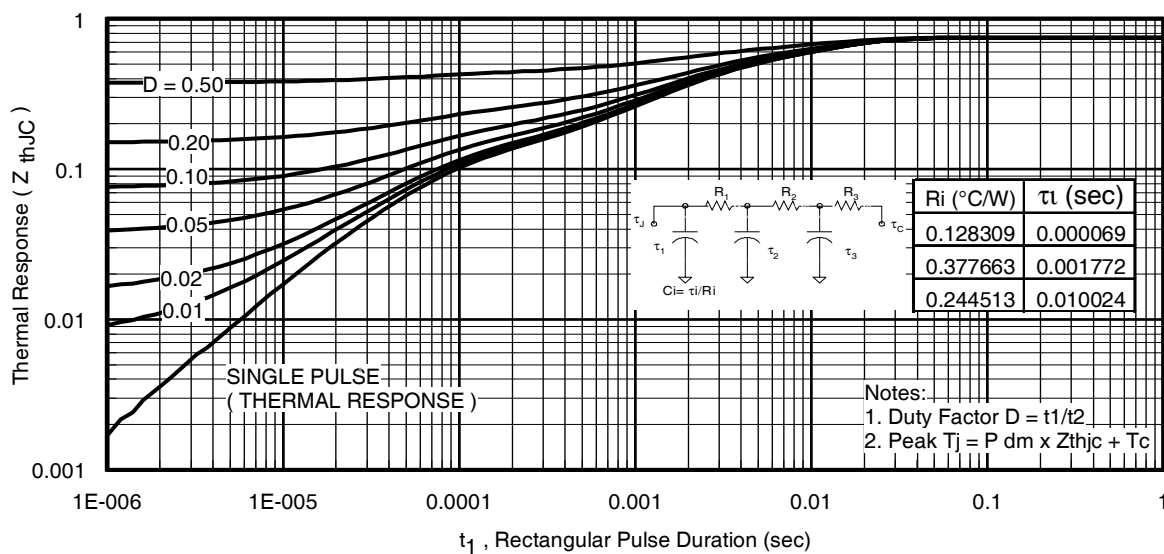
**Fig 9.** Maximum Drain Current vs. Case Temperature



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



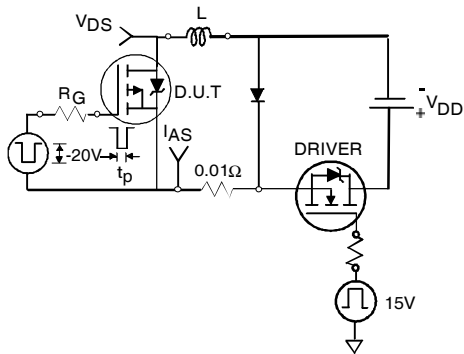
**Fig 10b.** Switching Time Waveforms



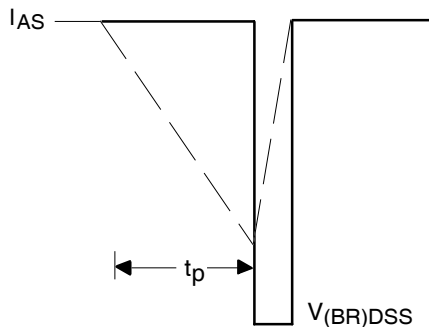
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

# IRF5210S/LPbF

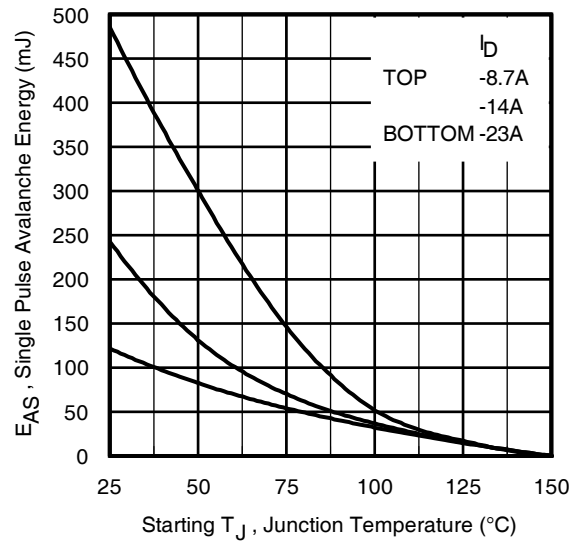
International  
**IR** Rectifier



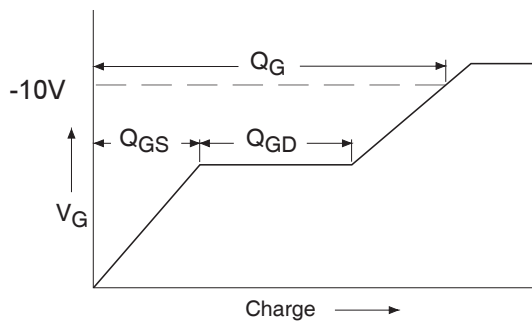
**Fig 12a.** Unclamped Inductive Test Circuit



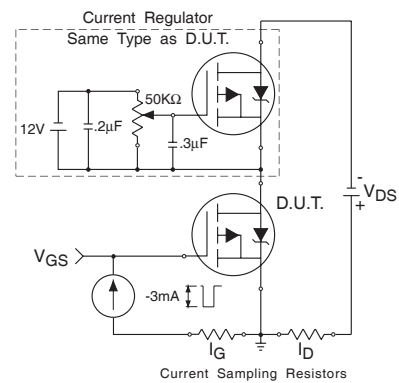
**Fig 12b.** Unclamped Inductive Waveforms



**Fig 13.** Maximum Avalanche Energy vs. Drain Current

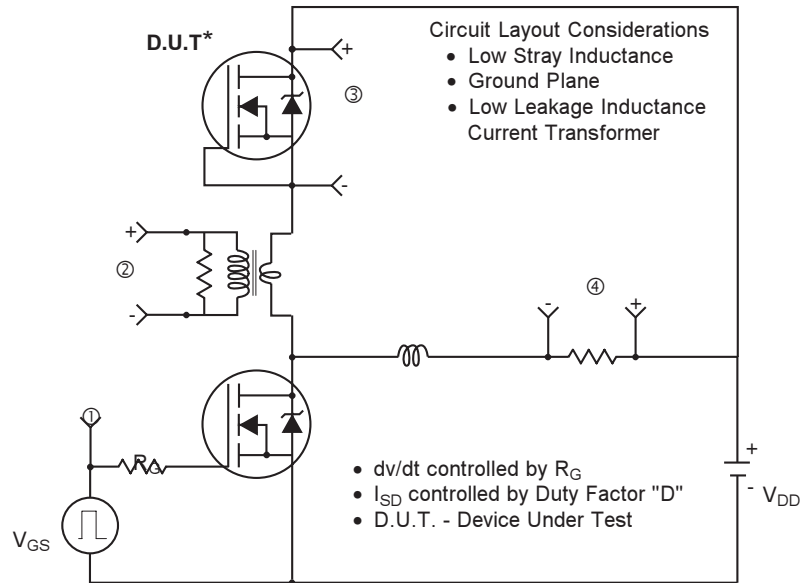


**Fig 14a.** Basic Gate Charge Waveform

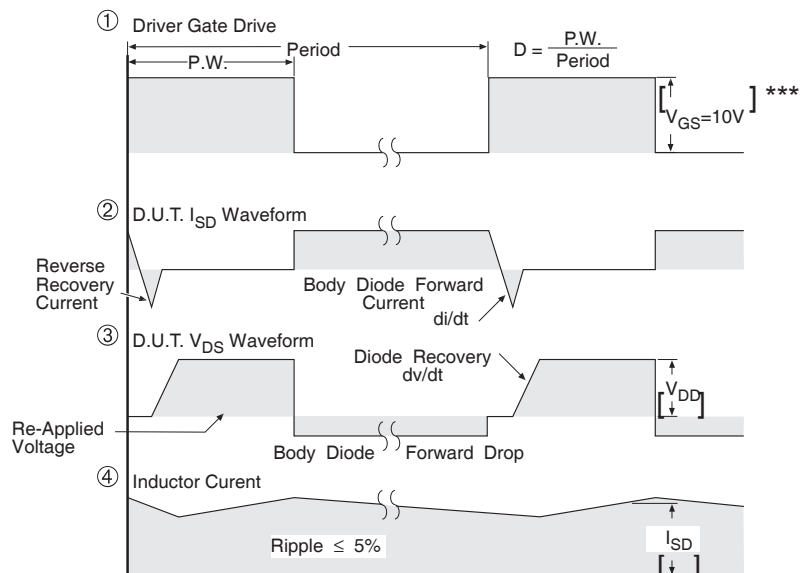


**Fig 14b.** Gate Charge Test Circuit

## Peak Diode Recovery dv/dt Test Circuit



\* Reverse Polarity of D.U.T for P-Channel



\*\*\*  $V_{GS} = 5.0V$  for Logic Level and 3V Drive Devices

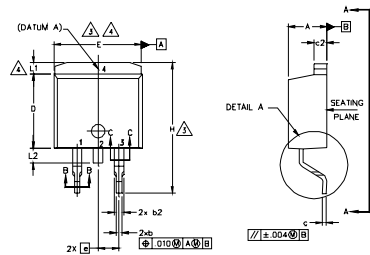
**Fig 15. For P-Channel HEXFETS**

# IRF5210S/LPbF

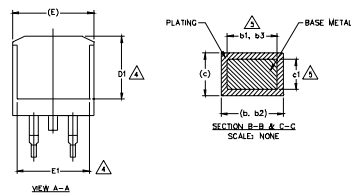
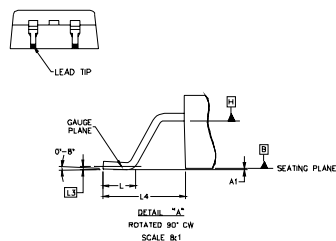
## D<sup>2</sup>Pak (TO-263AB) Package Outline

Dimensions are shown in millimeters (inches)

International  
**IR** Rectifier



- 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 BASE 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.



| SYMBOL | DIMENSIONS  |       |          |      | NOTES |
|--------|-------------|-------|----------|------|-------|
|        | MILLIMETERS |       | INCHES   |      |       |
|        | MIN.        | MAX.  | MIN.     | MAX. |       |
|        |             |       |          |      |       |
| A      | 4.06        | 4.83  | .160     | .190 |       |
| A1     | 0.00        | 0.254 | .000     | .010 |       |
| b      | 0.51        | 0.99  | .020     | .039 |       |
| b1     | 0.51        | 0.89  | .020     | .035 | 5     |
| b2     | 1.14        | 1.78  | .045     | .070 |       |
| b3     | 1.14        | 1.73  | .045     | .068 | 6     |
| c      | 0.38        | 0.74  | .015     | .029 |       |
| c1     | 0.38        | 0.58  | .015     | .023 | 5     |
| c2     | 1.14        | 1.65  | .045     | .065 |       |
| D      | 8.38        | 9.65  | .330     | .380 | 3     |
| D1     | 6.86        | -     | .270     | -    | 4     |
| E      | 9.65        | 10.67 | .380     | .420 | 3,4   |
| E1     | 6.22        | -     | .245     | -    | 4     |
| e      | 2.54 BSC    |       | .100 BSC |      |       |
| H      | 14.61       | 15.58 | .575     | .625 |       |
| L      | 1.78        | 2.79  | .070     | .110 |       |
| L1     | -           | 1.65  | -        | .066 | 4     |
| L2     | 1.27        | 1.78  | -        | .070 |       |
| L3     | 0.25 BSC    |       | .010 BSC |      |       |
| L4     | 4.78        | 5.28  | .188     | .208 |       |

### LEAD ASSIGNMENTS

#### HEXFET

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

#### IGBTs, CoPACK

- 1.- GATE
- 2, 4.- COLLECTOR
- 3.- EMITTER

#### DIODES

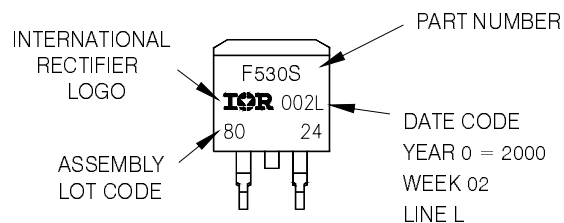
- 1.- ANODE \*
- 2, 4.- CATHODE
- 3.- ANODE

\* PART DEPENDENT.

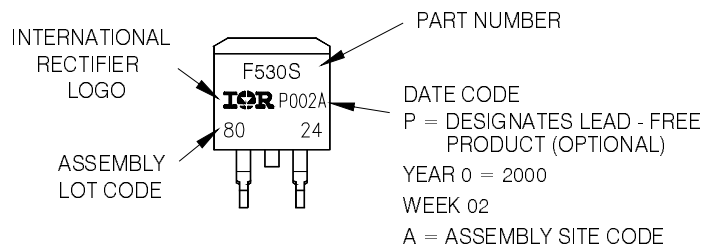
## D<sup>2</sup>Pak (TO-263AB) Part Marking Information

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"



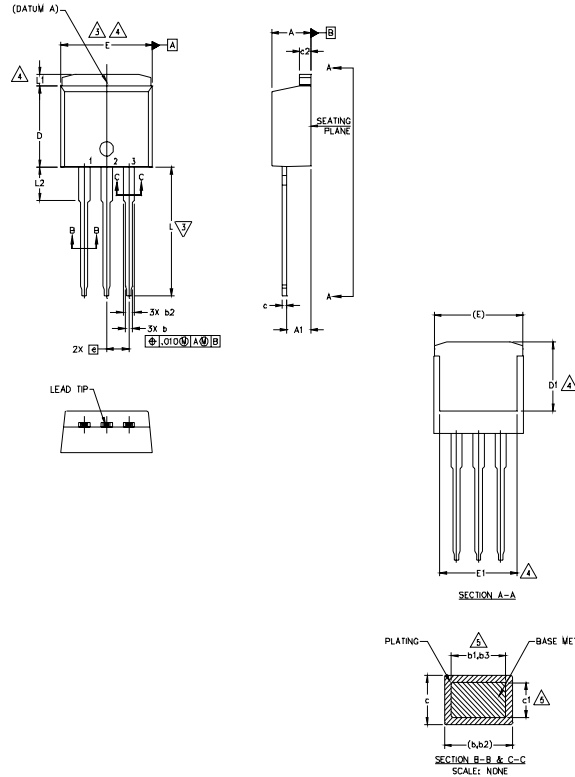
OR



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

## TO-262 Package Outline

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.
4. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.
5. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
6. CONTROLLING DIMENSION: INCH.
7. OUTLINE CONFORM TO JEDEC TO-262 EXCEPT A1(max.), b(min.), AND D1(min.) WHERE DIMENSIONS DERIVED THE ACTUAL PACKAGE OUTLINE.

| SYMBOL | DIMENSIONS  |       |          |      | NOTES |
|--------|-------------|-------|----------|------|-------|
|        | MILLIMETERS |       | INCHES   |      |       |
|        | MIN.        | MAX.  | MIN.     | MAX. |       |
| A      | 4.06        | 4.83  | .160     | .190 |       |
| A1     | 2.03        | 3.02  | .080     | .119 |       |
| b      | 0.51        | 0.99  | .020     | .039 | 5     |
| b1     | 0.51        | 0.89  | .020     | .035 |       |
| b2     | 1.14        | 1.78  | .045     | .070 |       |
| b3     | 1.14        | 1.73  | .045     | .068 | 5     |
| c      | 0.38        | 0.74  | .015     | .029 |       |
| c1     | 0.38        | 0.58  | .015     | .023 | 5     |
| c2     | 1.14        | 1.65  | .045     | .065 |       |
| D      | 8.38        | 9.65  | .330     | .380 | 3     |
| D1     | 6.86        | —     | .270     | —    | 4     |
| E      | 9.65        | 10.67 | .380     | .420 | 3, 4  |
| E1     | 6.22        | —     | .245     | —    | 4     |
| e      | 2.54 BSC    |       | .100 BSC |      |       |
| L      | 13.46       | 14.10 | .530     | .555 |       |
| L1     | —           | 1.65  | —        | .065 | 4     |
| L2     | 3.56        | 3.71  | .140     | .146 |       |

### LEAD ASSIGNMENTS

#### HEXFET

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

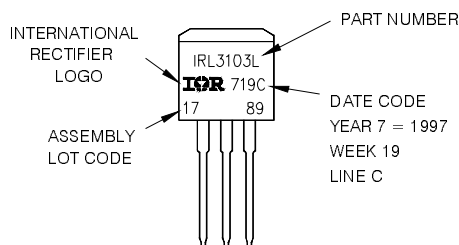
#### IGBTs, CoPACK

1. GATE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

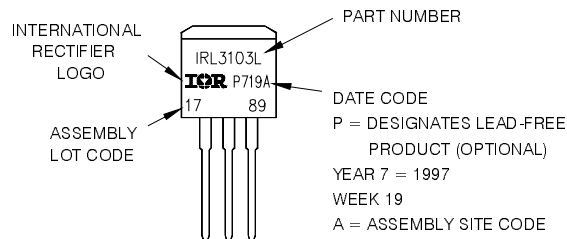
## TO-262 Part Marking Information

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



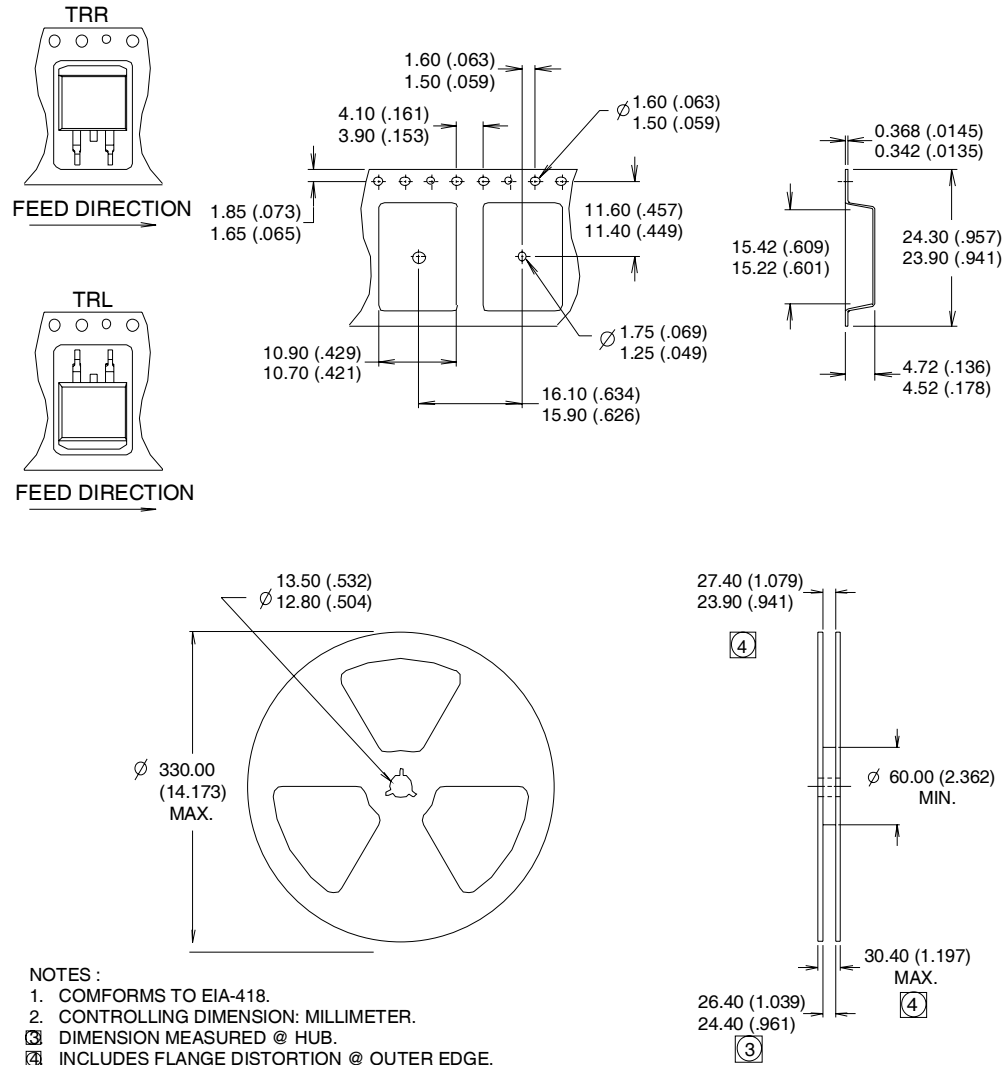
Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>  
[www.irf.com](http://www.irf.com)

# IRF5210S/LPbF

International  
**IR** Rectifier

## D<sup>2</sup>Pak (TO-263AB) Tape & Reel Information

Dimensions are shown in millimeters (inches)



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

Data and specifications subject to change without notice.  
This product has been designed and qualified for the Industrial 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. 08/09

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