

# IRFR9014PbF

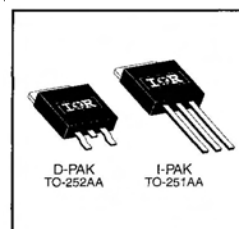
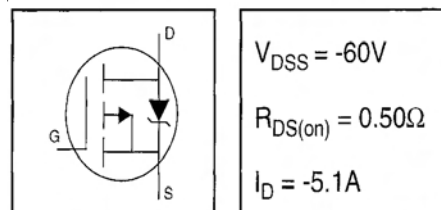
# IRFU9014PbF

- Dynamic dv/dt Rating
- Repetitive Avalanche Rated
- Surface Mount (IRFR9014)
- Straight Lead (IRFU9014)
- Available in Tape & Reel
- P-Channel
- Fast Switching
- Lead-Free

## Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.

The D-Pak is designed for surface mounting using vapor phase, infrared, or wave soldering techniques. The straight lead version (IRFU series) is for through-hole mounting applications. Power dissipation levels up to 1.5 watts are possible in typical surface mount applications.



## Absolute Maximum Ratings

|                             | Parameter                                  | Max.                  | Units |
|-----------------------------|--------------------------------------------|-----------------------|-------|
| $I_D$ @ $T_C = 25^\circ C$  | Continuous Drain Current, $V_{GS} @ -10 V$ | -5.1                  | A     |
| $I_D$ @ $T_C = 100^\circ C$ | Continuous Drain Current, $V_{GS} @ -10 V$ | -3.2                  |       |
| $I_{DM}$                    | Pulsed Drain Current ①                     | -20                   |       |
| $P_D$ @ $T_C = 25^\circ C$  | Power Dissipation                          | 25                    | W     |
| $P_D$ @ $T_A = 25^\circ C$  | Power Dissipation (PCB Mount)**            | 2.5                   |       |
|                             | Linear Derating Factor                     | 0.20                  | W/°C  |
|                             | Linear Derating Factor (PCB Mount)**       | 0.020                 |       |
| $V_{GS}$                    | Gate-to-Source Voltage                     | $\pm 20$              | V     |
| $E_{AS}$                    | Single Pulse Avalanche Energy ②            | 140                   | mJ    |
| $I_{AR}$                    | Avalanche Current ①                        | -5.1                  | A     |
| $E_{AR}$                    | Repetitive Avalanche Energy ①              | 2.5                   | mJ    |
| dv/dt                       | Peak Diode Recovery dv/dt ③                | -4.5                  | V/ns  |
| $T_J, T_{STG}$              | Junction and Storage Temperature Range     | -55 to +150           | °C    |
|                             | Soldering Temperature, for 10 seconds      | 260 (1.6mm from case) |       |

## Thermal Resistance

|                 | Parameter                         | Min. | Typ. | Max. | Units |
|-----------------|-----------------------------------|------|------|------|-------|
| $R_{\theta JC}$ | Junction-to-Case                  | —    | —    | 5.0  | °C/W  |
| $R_{\theta JA}$ | Junction-to-Ambient (PCB mount)** | —    | —    | 50   |       |
| $R_{\theta JA}$ | Junction-to-Ambient               | —    | —    | 110  |       |

\*\* When mounted on 1" square PCB (FR-4 or G-10 Material).

# IRFR/U9014PbF

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IR Rectifier

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

|                                 | Parameter                            | Min. | Typ.   | Max. | Units               | Test Conditions                                                     |
|---------------------------------|--------------------------------------|------|--------|------|---------------------|---------------------------------------------------------------------|
| $V_{(BR)DSS}$                   | Drain-to-Source Breakdown Voltage    | -60  | —      | —    | V                   | $V_{GS}=0V$ , $I_D=-250\mu A$                                       |
| $\Delta V_{(BR)DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient  | —    | -0.059 | —    | V/ $^\circ\text{C}$ | Reference to $25^\circ\text{C}$ , $I_D=-1mA$                        |
| $R_{DS(on)}$                    | Static Drain-to-Source On-Resistance | —    | —      | 0.50 | $\Omega$            | $V_{GS}=-10V$ , $I_D=-3.1A$ 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             | 1.4  | —      | —    | S                   | $V_{DS}=-25V$ , $I_D=-3.1A$ ④                                       |
| $I_{DSS}$                       | Drain-to-Source Leakage Current      | —    | —      | -100 | $\mu A$             | $V_{DS}=-60V$ , $V_{GS}=0V$                                         |
|                                 |                                      | —    | —      | -500 |                     | $V_{DS}=-48V$ , $V_{GS}=0V$ , $T_J=125^\circ\text{C}$               |
| $I_{GSS}$                       | Gate-to-Source Forward Leakage       | —    | —      | -100 | nA                  | $V_{GS}=-20V$                                                       |
|                                 | Gate-to-Source Reverse Leakage       | —    | —      | 100  |                     | $V_{GS}=20V$                                                        |
| $Q_g$                           | Total Gate Charge                    | —    | —      | 12   | nC                  | $I_D=-6.7A$                                                         |
| $Q_{gs}$                        | Gate-to-Source Charge                | —    | —      | 3.8  |                     | $V_{DS}=-48V$                                                       |
| $Q_{gd}$                        | Gate-to-Drain ("Miller") Charge      | —    | —      | 5.1  |                     | $V_{GS}=-10V$ See Fig. 6 and 13 ④                                   |
| $t_{d(on)}$                     | Turn-On Delay Time                   | —    | 11     | —    | ns                  | $V_{DD}=-30V$                                                       |
| $t_r$                           | Rise Time                            | —    | 63     | —    |                     | $I_D=-6.7A$                                                         |
| $t_{d(off)}$                    | Turn-Off Delay Time                  | —    | 9.6    | —    |                     | $R_G=24\Omega$                                                      |
| $t_f$                           | Fall Time                            | —    | 31     | —    |                     | $R_D=4.0\Omega$ See Figure 10 ④                                     |
| $L_D$                           | Internal Drain Inductance            | —    | 4.5    | —    | nH                  | Between lead, 6 mm (0.25in.) from package and center of die contact |
| $L_S$                           | Internal Source Inductance           | —    | 7.5    | —    |                     |                                                                     |
| $C_{iss}$                       | Input Capacitance                    | —    | 270    | —    | pF                  | $V_{GS}=0V$                                                         |
| $C_{oss}$                       | Output Capacitance                   | —    | 170    | —    |                     | $V_{DS}=-25V$                                                       |
| $C_{rss}$                       | Reverse Transfer Capacitance         | —    | 31     | —    |                     | $f=1.0MHz$ See Figure 5                                             |

## Source-Drain Ratings and Characteristics

|          | Parameter                              | Min.                                                                      | Typ.  | Max. | Units   | Test Conditions                                                |
|----------|----------------------------------------|---------------------------------------------------------------------------|-------|------|---------|----------------------------------------------------------------|
| $I_S$    | Continuous Source Current (Body Diode) | —                                                                         | —     | -5.1 | A       | MOSFET symbol showing the integral reverse p-n junction diode. |
| $I_{SM}$ | Pulsed Source Current (Body Diode) ①   | —                                                                         | —     | -20  |         |                                                                |
| $V_{SD}$ | Diode Forward Voltage                  | —                                                                         | —     | -5.5 | V       | $T_J=25^\circ\text{C}$ , $I_S=-5.1A$ , $V_{GS}=0V$ ④           |
| $t_{rr}$ | Reverse Recovery Time                  | —                                                                         | 80    | 160  | ns      | $T_J=25^\circ\text{C}$ , $I_F=-6.7A$                           |
| $Q_{rr}$ | Reverse Recovery Charge                | —                                                                         | 0.096 | 0.19 | $\mu C$ | $di/dt=100A/\mu s$ ④                                           |
| $t_{on}$ | Forward Turn-On Time                   | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S+L_D$ ) |       |      |         |                                                                |

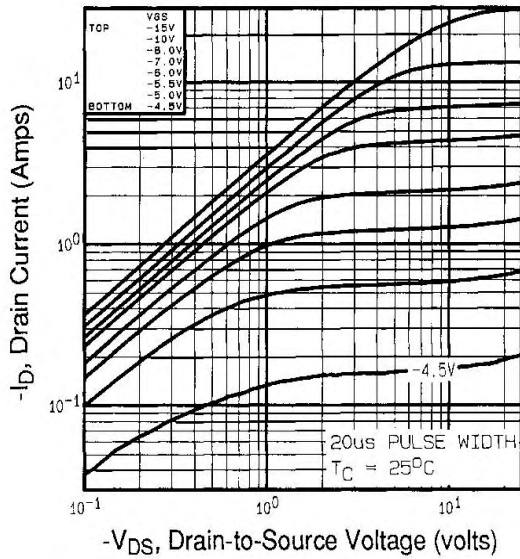
### Notes:

① Repetitive rating; pulse width limited by max. junction temperature (See Figure 11)

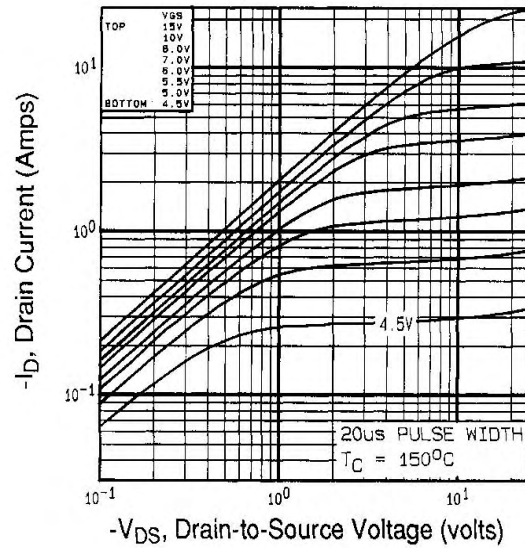
②  $V_{DD}=-25V$ , starting  $T_J=25^\circ\text{C}$ ,  $L=6.3mH$   
 $R_G=25\Omega$ ,  $I_{AS}=-5.1A$  (See Figure 12)

③  $I_{SD}\leq -6.7A$ ,  $di/dt\leq 90A/\mu s$ ,  $V_{DD}\leq V_{(BR)DSS}$ ,  
 $T_J\leq 150^\circ\text{C}$

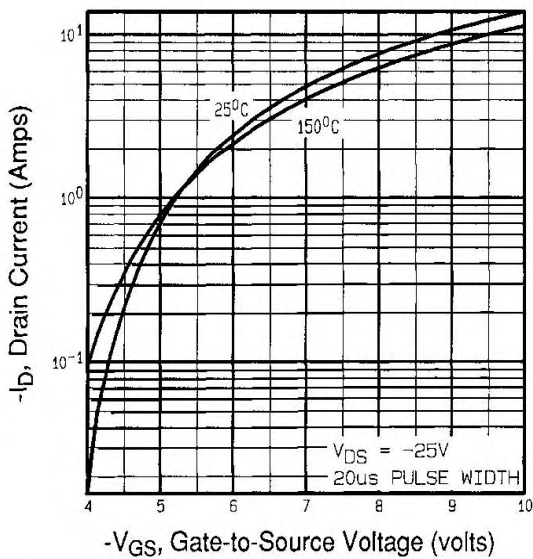
④ Pulse width  $\leq 300\mu s$ ; duty cycle  $\leq 2\%$ .



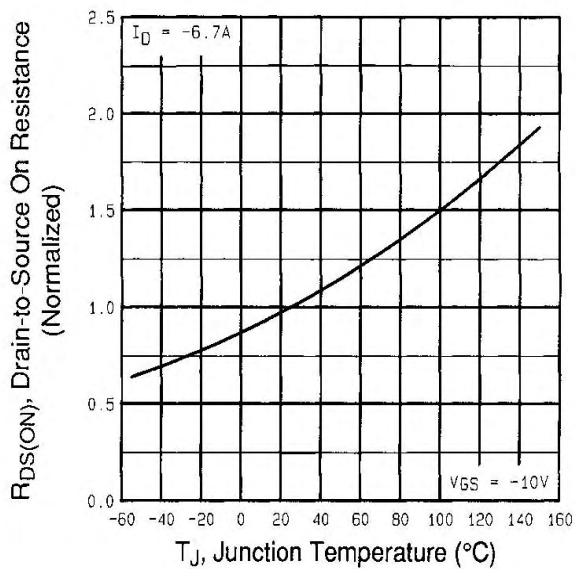
**Fig 1.** Typical Output Characteristics,  
 $T_C=25^\circ\text{C}$



**Fig 2.** Typical Output Characteristics,  
 $T_C=150^\circ\text{C}$



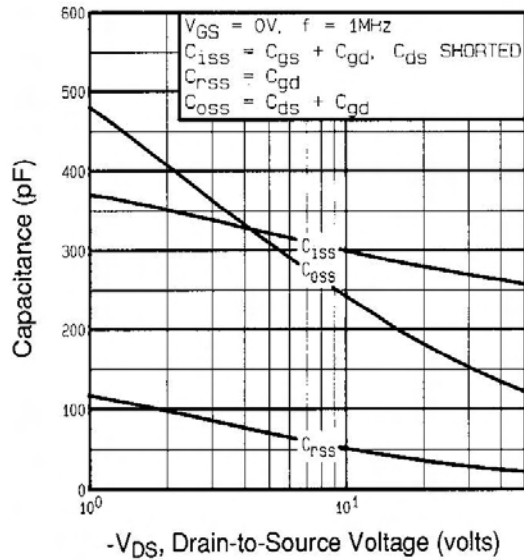
**Fig 3.** Typical Transfer Characteristics



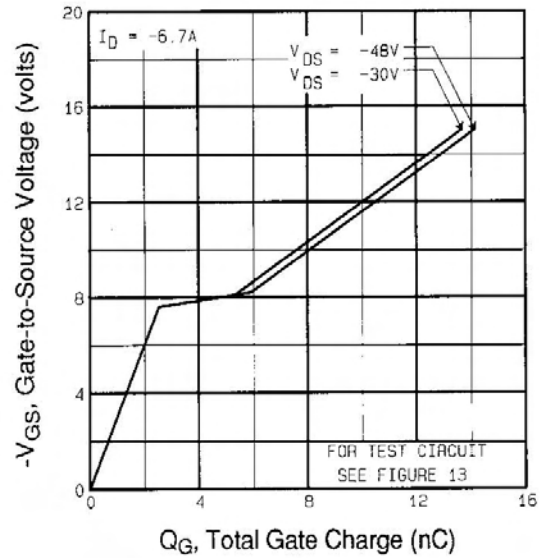
**Fig 4.** Normalized On-Resistance  
Vs. Temperature

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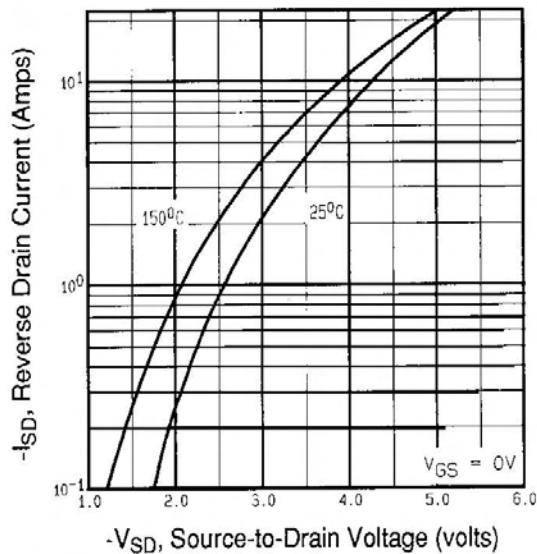
International  
**IR** Rectifier



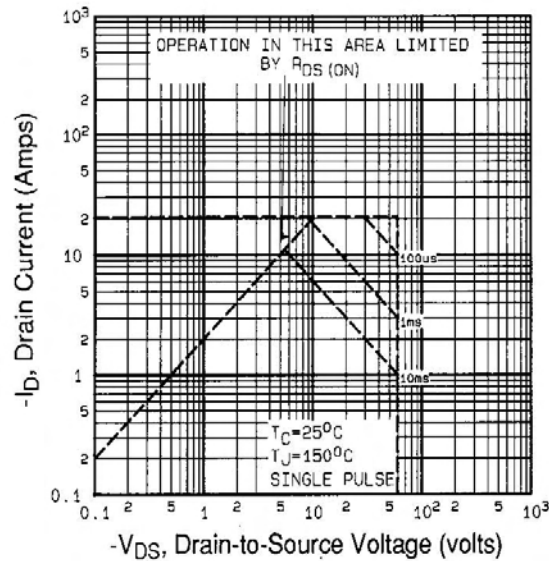
**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage



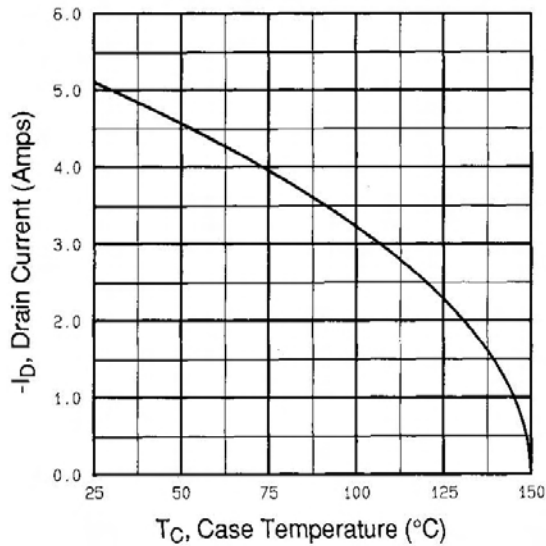
**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage



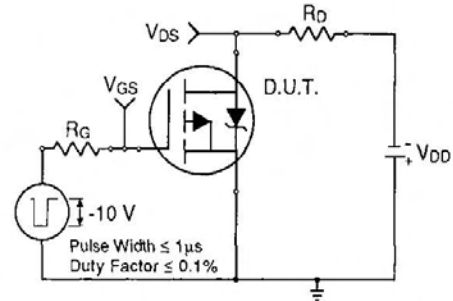
**Fig 7.** Typical Source-Drain Diode Forward Voltage



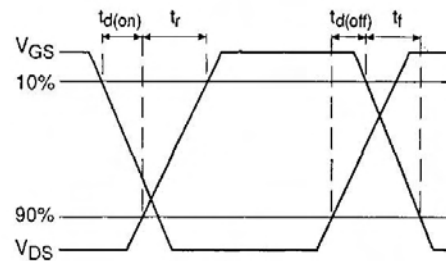
**Fig 8.** Maximum Safe Operating Area



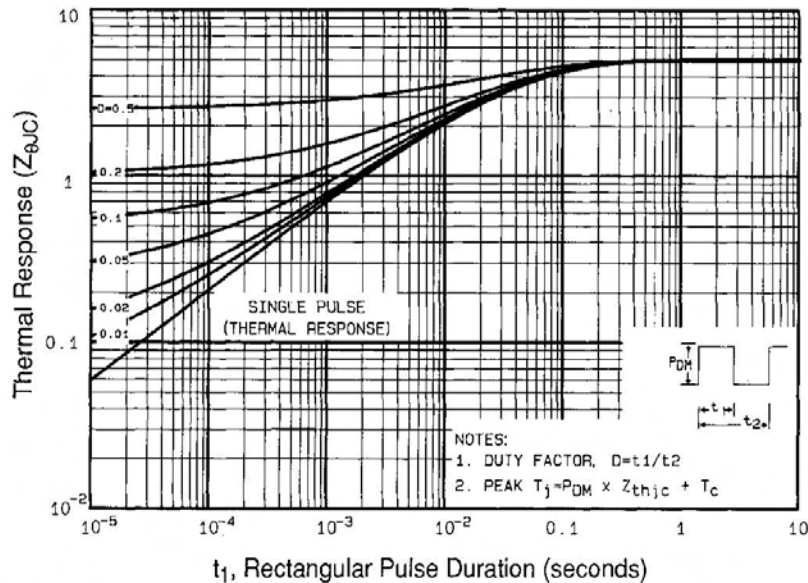
**Fig 9.** Maximum Drain Current Vs. Case Temperature



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



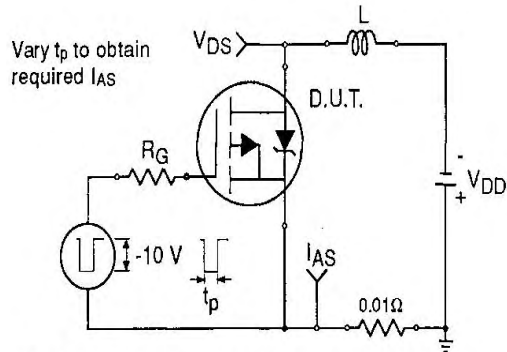
**Fig 10b.** Switching Time Waveforms



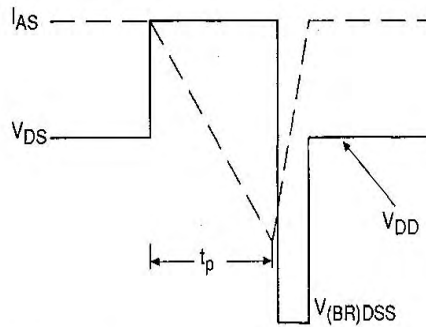
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

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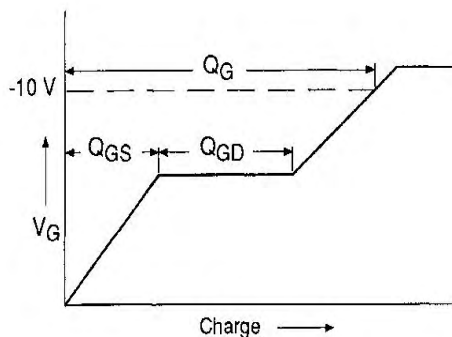
International  
IR Rectifier



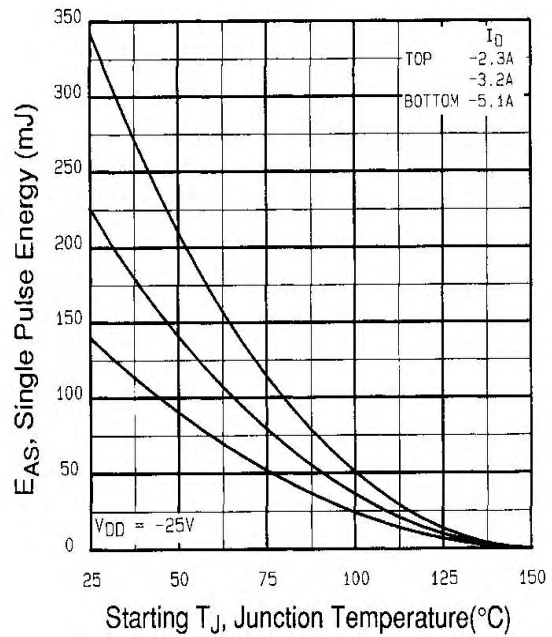
**Fig 12a.** Unclamped Inductive Test Circuit



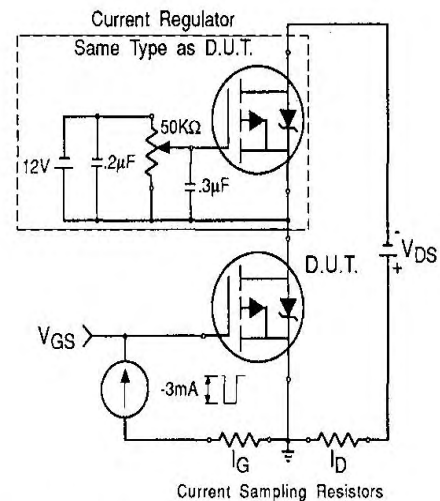
**Fig 12b.** Unclamped Inductive Waveforms



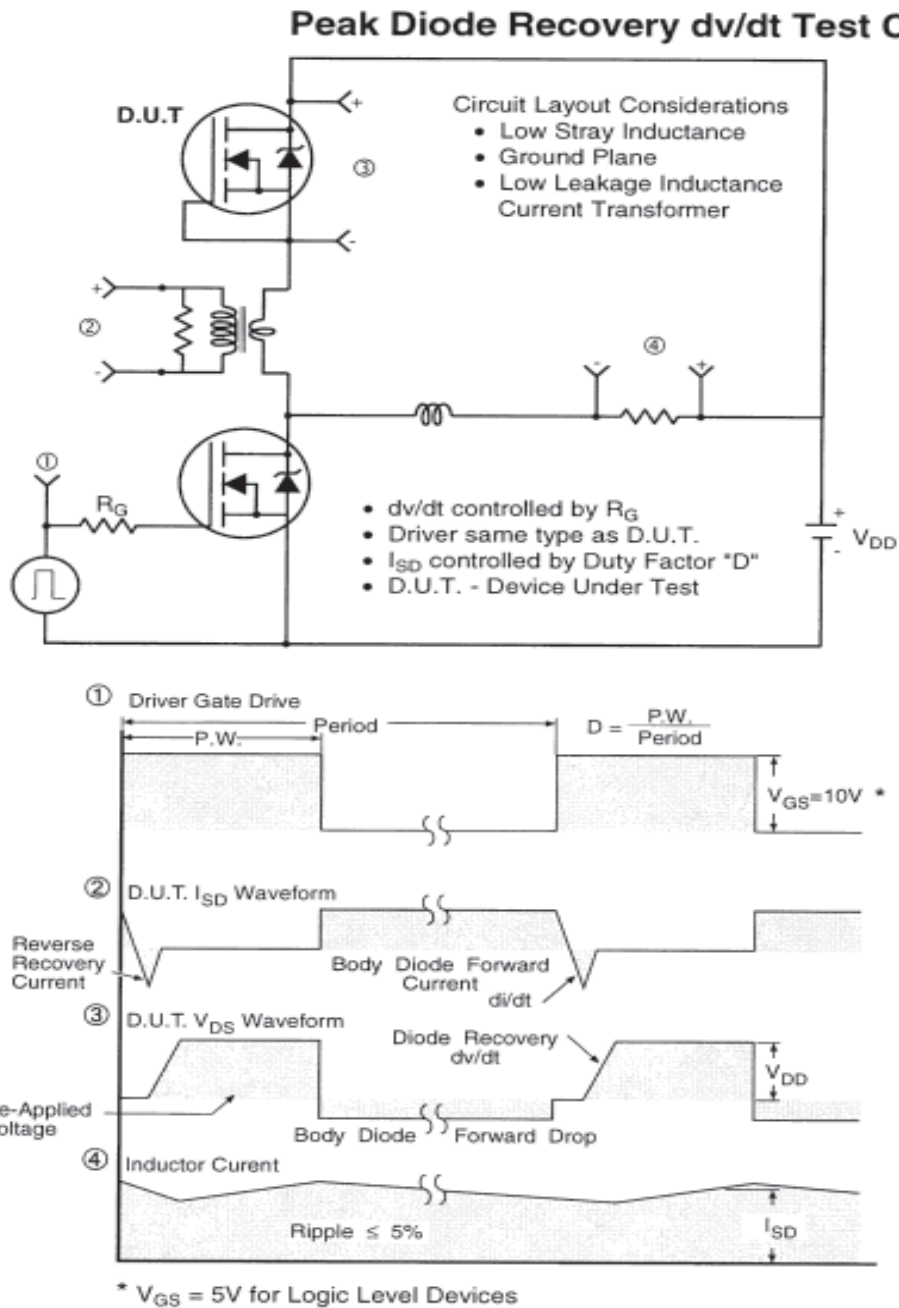
**Fig 13a.** Basic Gate Charge Waveform



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



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



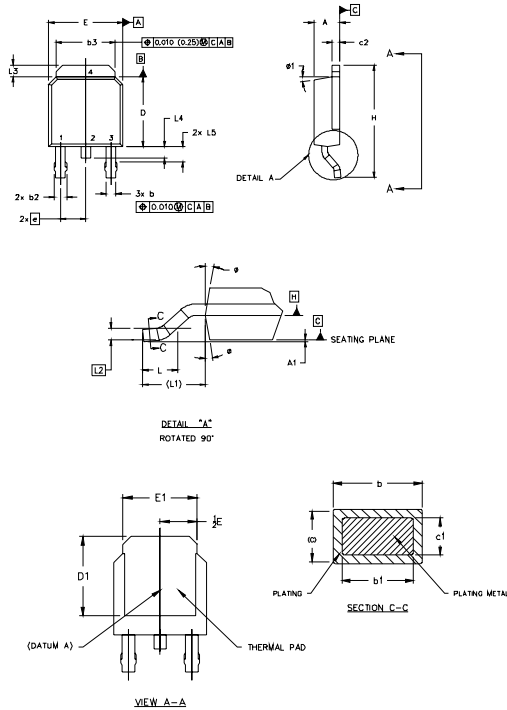
**Fig 14.** For N-Channel HEXFETS

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## D-Pak (TO-252AA) Package Outline

Dimensions are shown in millimeters (inches)



- NOTES:
- 1.0 DIMENSIONING AND TOLERANCING PER ASME Y14.5 M- 1994.
  - 2.0 DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS]
  - 3.0 LEAD DIMENSION UNCONTROLLED IN L5
  - 4.0 DIMENSION D1 AND E1 ESTABLISH A MINIMUM MOUNTING SURFACE FOR THERMAL PAD.
  - 5.0 SECTION C-C DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN .005 [0.127] AND .010 [0.2540] FROM THE LEAD TIP.
  - 6.0 DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
  - 7.0 OUTLINE CONFORMS TO JEDEC OUTLINE TO-252AA.

| SYMBOL | DIMENSIONS  |       |           |       | NOTES |
|--------|-------------|-------|-----------|-------|-------|
|        | MILLIMETERS |       | INCHES    |       |       |
|        | MIN.        | MAX.  | MIN.      | MAX.  |       |
| A      | 2.18        | 2.39  | .086      | .094  |       |
| A1     |             | 0.13  |           | .005  |       |
| b      | 0.64        | 0.89  | .025      | .035  | 5     |
| b1     | 0.64        | 0.79  | .025      | 0.031 | 5     |
| b2     | 0.76        | 1.14  | .030      | .040  |       |
| b3     | 4.95        | 5.46  | .195      | .215  |       |
| c      | 0.46        | 0.61  | .018      | .024  | 5     |
| c1     | 0.41        | 0.56  | .016      | .022  | 5     |
| c2     | .046        | 0.89  | .018      | .035  | 5     |
| D      | 5.97        | 6.22  | .235      | .245  | 6     |
| D1     | 5.21        | -     | .205      | -     | 4     |
| E      | 6.35        | 6.73  | .250      | .265  | 6     |
| E1     | 4.32        | -     | .170      | -     | 4     |
| e      | 2.29        |       | .090 BSC  |       |       |
| H      | 9.40        | 10.41 | .370      | .410  |       |
| L      | 1.40        | 1.78  | .055      | .070  |       |
| L1     | 2.74 REF.   |       | .108 REF. |       |       |
| L2     | 0.051 BSC   |       | .020 BSC  |       |       |
| L3     | 0.89        | 1.27  | .035      | .050  |       |
| L4     |             | 1.02  |           | .040  |       |
| L5     | 1.14        | 1.52  | .045      | .060  | 3     |
| ø      | 0"          | 10"   | 0"        | 10"   |       |
| ø1     | 0"          | 15"   | 0"        | 15"   |       |

LEAD ASSIGNMENTS

HEXFEET

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

IGBTs, CoPACK

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

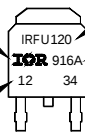
## D-Pak (TO-252AA) Part Marking Information

EXAMPLE: THIS IS AN IRFR120  
WITH ASSEMBLY  
LOT CODE 1234  
ASSEMBLED ON VW16, 1999  
IN THE ASSEMBLY LINE "A"

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

INTERNATIONAL  
RECTIFIER  
LOGO

ASSEMBLY  
LOT CODE

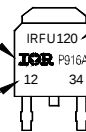


PART NUMBER  
DATE CODE  
YEAR 9 = 1999  
WEEK 16  
LINE A

OR

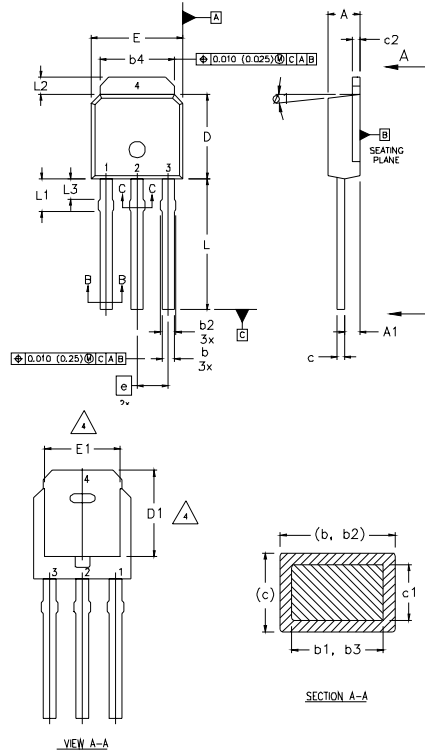
INTERNATIONAL  
RECTIFIER  
LOGO

ASSEMBLY  
LOT CODE



PART NUMBER  
DATE CODE  
P = DESIGNATES LEAD-FREE  
PRODUCT (OPTIONAL)  
YEAR 9 = 1999  
WEEK 16  
A = ASSEMBLY SITE CODE

## I-Pak (TO-251AA) Package Out (lineDimensions are shown in millimeters (inches)



### NOTES:

- 1 DIMENSIONING AND TOLERANCING PER ASME Y14.5 M- 1994.
- 2 DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
- 3 DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
- 4 THERMAL PAD CONTOUR OPTION WITHIN DIMENSION b4, L2, E1 & D1.
- 5 LEAD DIMENSION UNCONTROLLED IN L3.
- 6 DIMENSION b1, b3 APPLY TO BASE METAL ONLY.
- 7 OUTLINE CONFORMS TO JEDEC OUTLINE TO-251AA.
- 8 CONTROLLING DIMENSION : INCHES.

### LEAD ASSIGNMENTS

#### HEXFET

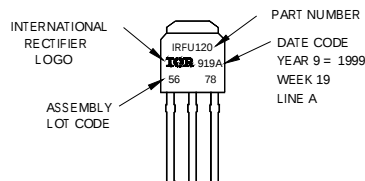
- 1.- GATE
- 2.- DRAIN
- 3.- SOURCE
- 4.- DRAIN

| SYMBOL | DIMENSIONS  |      |           |       | NOTES |
|--------|-------------|------|-----------|-------|-------|
|        | MILLIMETERS |      | INCHES    |       |       |
|        | MIN.        | MAX. | MIN.      | MAX.  |       |
| A      | 2.18        | 2.39 | 0.086     | .094  |       |
| A1     | 0.89        | 1.14 | 0.035     | 0.045 |       |
| b      | 0.64        | 0.89 | 0.025     | 0.035 |       |
| b1     | 0.64        | 0.79 | 0.025     | 0.031 | 4     |
| b2     | 0.76        | 1.14 | 0.030     | 0.045 |       |
| b3     | 0.76        | 1.04 | 0.030     | 0.041 |       |
| b4     | 5.00        | 5.46 | 0.195     | 0.215 | 4     |
| c      | 0.46        | 0.61 | 0.018     | 0.024 |       |
| c1     | 0.41        | 0.56 | 0.016     | 0.022 |       |
| c2     | .046        | 0.86 | 0.018     | 0.035 |       |
| D      | 5.97        | 6.22 | 0.235     | 0.245 | 3, 4  |
| D1     | 5.21        | —    | 0.205     | —     | 4     |
| E      | 6.35        | 6.73 | 0.250     | 0.265 | 3, 4  |
| E1     | 4.32        | —    | 0.170     | —     | 4     |
| e      | 2.29        |      | 0.090 BSC |       |       |
| L      | 8.89        | 9.60 | 0.350     | 0.380 |       |
| L1     | 1.91        | 2.29 | 0.075     | 0.090 |       |
| L2     | 0.89        | 1.27 | 0.035     | 0.050 | 4     |
| L3     | 1.14        | 1.52 | 0.045     | 0.060 | 5     |
| ø1     | 0"          | 15"  | 0"        | 15"   |       |

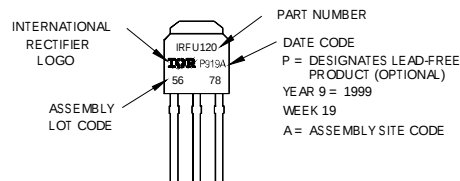
## I-Pak (TO-251AA) Part Marking Information

EXAMPLE: THIS IS AN IRFU120  
WITH ASSEMBLY  
LOT CODE 5678  
ASSEMBLED ON WW 19, 1999  
IN THE ASSEMBLY LINE "A"

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



OR

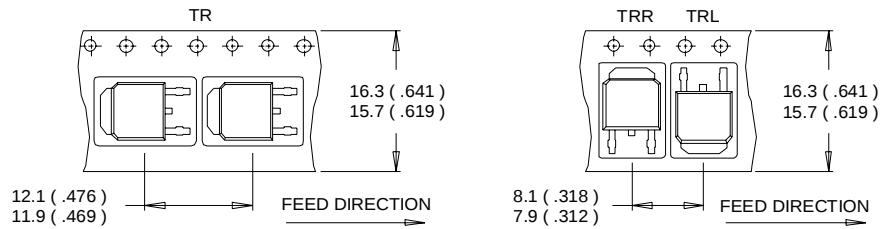


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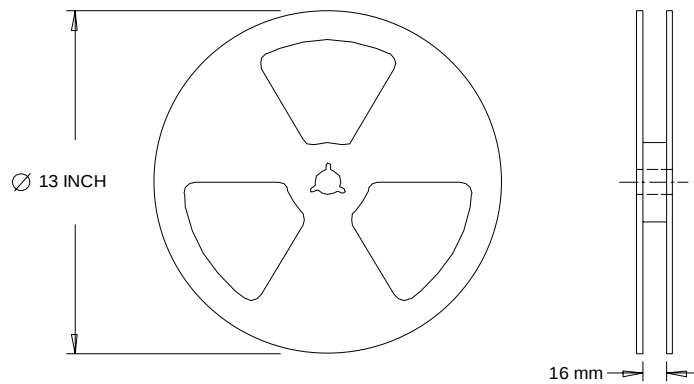
International  
**IOR** Rectifier

## D-Pak (TO-252AA) Tape & Reel Information

Dimensions are shown in millimeters (inches)



- NOTES :
1. CONTROLLING DIMENSION : MILLIMETER.
  2. ALL DIMENSIONS ARE SHOWN IN MILLIMETERS ( INCHES ).
  3. OUTLINE CONFORMS TO EIA-481 & EIA-541.



- NOTES :
1. OUTLINE CONFORMS TO EIA-481.

Data and specifications subject to change without notice.

International  
**IOR** Rectifier

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

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