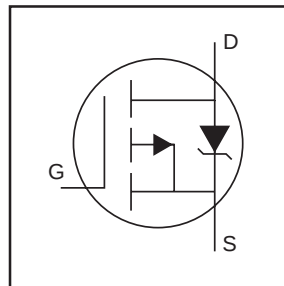


# IRFR/U5410

HEXFET® Power MOSFET

- Ultra Low On-Resistance
- P-Channel
- Surface Mount (IRFR5410)
- Straight Lead (IRFU5410)
- Advanced Process Technology
- Fast Switching
- Fully Avalanche Rated



$$V_{DS} = -100V$$

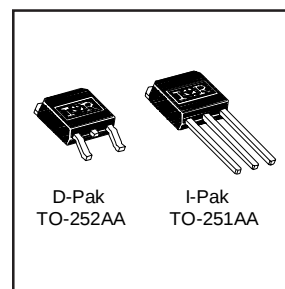
$$R_{DS(on)} = 0.205\Omega$$

$$I_D = -13A$$

## Description

Fifth Generation HEXFETs from International Rectifier utilize advanced processing techniques to achieve extremely low on-resistance per silicon area. This benefit, combined with the fast switching speed and ruggedized device design that HEXFET Power MOSFETs are well known for, provides the designer with an extremely efficient and reliable device for use in a wide variety of applications.

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.



D-Pak  
TO-252AA

I-Pak  
TO-251AA

## Absolute Maximum Ratings

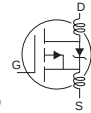
|                           | Parameter                                 | Max.                   | Units |
|---------------------------|-------------------------------------------|------------------------|-------|
| $I_D @ T_C = 25^\circ C$  | Continuous Drain Current, $V_{GS} @ -10V$ | -13                    | A     |
| $I_D @ T_C = 100^\circ C$ | Continuous Drain Current, $V_{GS} @ -10V$ | -8.2                   |       |
| $I_{DM}$                  | Pulsed Drain Current ①                    | -52                    |       |
| $P_D @ T_C = 25^\circ C$  | Power Dissipation                         | 66                     | W     |
|                           | Linear Derating Factor                    | 0.53                   | W/°C  |
| $V_{GS}$                  | Gate-to-Source Voltage                    | $\pm 20$               | V     |
| $E_{AS}$                  | Single Pulse Avalanche Energy②            | 194                    | mJ    |
| $I_{AR}$                  | Avalanche Current③                        | -8.4                   | A     |
| $E_{AR}$                  | Repetitive Avalanche Energy①              | 6.3                    | mJ    |
| $dv/dt$                   | Peak Diode Recovery $dv/dt$ ③             | -5.0                   | V/ns  |
| $T_J$                     | Operating Junction and                    | -55 to + 150           | °C    |
| $T_{STG}$                 | Storage Temperature Range                 |                        |       |
|                           | Soldering Temperature, for 10 seconds     | 300 (1.6mm from case ) |       |

## Thermal Resistance

|                 | Parameter                         | Typ. | Max. | Units |
|-----------------|-----------------------------------|------|------|-------|
| $R_{\theta JC}$ | Junction-to-Case                  | ---  | 1.9  | °C/W  |
| $R_{\theta JA}$ | Junction-to-Ambient (PCB mount)** | ---  | 50   |       |
| $R_{\theta JA}$ | Junction-to-Ambient               | ---  | 110  |       |

## 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                  | $V_{GS} = 0V$ , $I_D = -250\mu A$                                             |
| $\Delta V_{(BR)DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient  | —    | -0.12 | —     | $V/^\circ\text{C}$ | Reference to $25^\circ\text{C}$ , $I_D = -1.0mA$                              |
| $R_{DS(on)}$                    | Static Drain-to-Source On-Resistance | —    | —     | 0.205 | $\Omega$           | $V_{GS} = -10V$ , $I_D = -7.8A$ 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             | 3.2  | —     | —     | S                  | $V_{DS} = -50V$ , $I_D = -7.8A$                                               |
| $I_{DSS}$                       | Drain-to-Source Leakage Current      | —    | —     | -25   | $\mu A$            | $V_{DS} = -100V$ , $V_{GS} = 0V$                                              |
|                                 |                                      | —    | —     | -250  |                    | $V_{DS} = -80V$ , $V_{GS} = 0V$ , $T_J = 150^\circ\text{C}$                   |
| $I_{GSS}$                       | Gate-to-Source Forward Leakage       | —    | —     | 100   | nA                 | $V_{GS} = 20V$                                                                |
|                                 | Gate-to-Source Reverse Leakage       | —    | —     | -100  |                    | $V_{GS} = -20V$                                                               |
| $Q_g$                           | Total Gate Charge                    | —    | —     | 58    | nC                 | $I_D = -8.4A$                                                                 |
| $Q_{gs}$                        | Gate-to-Source Charge                | —    | —     | 8.3   |                    | $V_{DS} = -80V$                                                               |
| $Q_{gd}$                        | Gate-to-Drain ("Miller") Charge      | —    | —     | 32    |                    | $V_{GS} = -10V$ , See Fig. 6 and 13 ④ ⑥                                       |
| $t_{d(on)}$                     | Turn-On Delay Time                   | —    | 15    | —     | ns                 | $V_{DD} = 50V$                                                                |
| $t_r$                           | Rise Time                            | —    | 58    | —     |                    | $I_D = -8.4A$                                                                 |
| $t_{d(off)}$                    | Turn-Off Delay Time                  | —    | 45    | —     |                    | $R_G = 9.1\Omega$                                                             |
| $t_f$                           | Fall Time                            | —    | 46    | —     |                    | $R_D = 6.2\Omega$ , See Fig. 10 ④ ⑥                                           |
| $L_D$                           | Internal Drain Inductance            | —    | 4.5   | —     | nH                 | Between lead,<br>6mm (0.25in.)<br>from package<br>and center of die contact ⑤ |
| $L_S$                           | Internal Source Inductance           | —    | 7.5   | —     |                    |                                                                               |
| $C_{iss}$                       | Input Capacitance                    | —    | 760   | —     | pF                 | $V_{GS} = 0V$                                                                 |
| $C_{oss}$                       | Output Capacitance                   | —    | 260   | —     |                    | $V_{DS} = -25V$                                                               |
| $C_{rss}$                       | Reverse Transfer Capacitance         | —    | 170   | —     |                    | $f = 1.0MHz$ , See Fig. 5⑥                                                    |



## Source-Drain Ratings and Characteristics

|          | Parameter                              | Min.                                                                        | Typ. | Max. | Units | Conditions                                                     |
|----------|----------------------------------------|-----------------------------------------------------------------------------|------|------|-------|----------------------------------------------------------------|
| $I_S$    | Continuous Source Current (Body Diode) | —                                                                           | —    | -13  | A     | MOSFET symbol showing the integral reverse p-n junction diode. |
| $I_{SM}$ | Pulsed Source Current (Body Diode) ①   | —                                                                           | —    | -52  |       |                                                                |
| $V_{SD}$ | Diode Forward Voltage                  | —                                                                           | —    | -1.6 | V     | $T_J = 25^\circ\text{C}$ , $I_S = -7.8A$ , $V_{GS} = 0V$ ④     |
| $t_{rr}$ | Reverse Recovery Time                  | —                                                                           | 130  | 190  | ns    | $T_J = 25^\circ\text{C}$ , $I_F = -8.4A$                       |
| $Q_{rr}$ | Reverse Recovery Charge                | —                                                                           | 650  | 970  | nC    | $di/dt = 100A/\mu s$ ④ ⑥                                       |
| $t_{on}$ | 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  $T_J = 25^\circ\text{C}$ ,  $L = 6.4mH$   
 $R_G = 25\Omega$ ,  $I_{AS} = -7.8A$ . (See Figure 12)

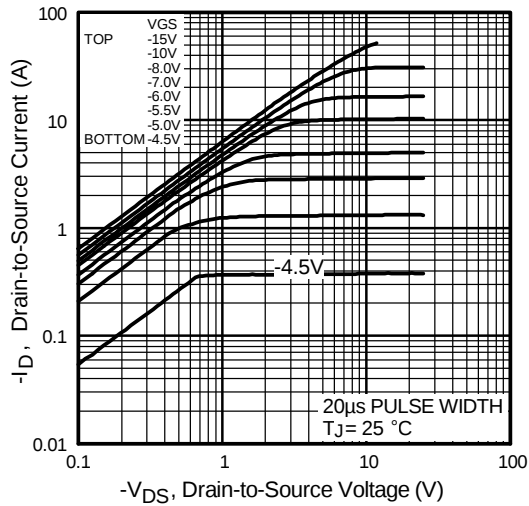
③  $I_{SD} \leq -7.8A$ ,  $di/dt \leq 200A/\mu s$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  
 $T_J \leq 150^\circ\text{C}$

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

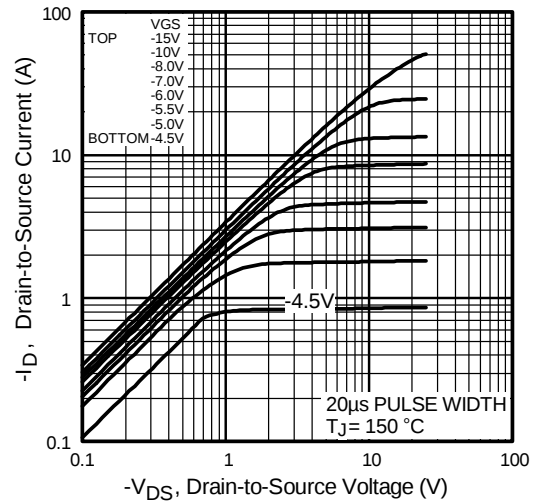
⑤ This is applied for I-PAK,  $L_S$  of D-PAK is measured between lead and center of die contact

⑥ Uses IRF9530N data and test conditions.

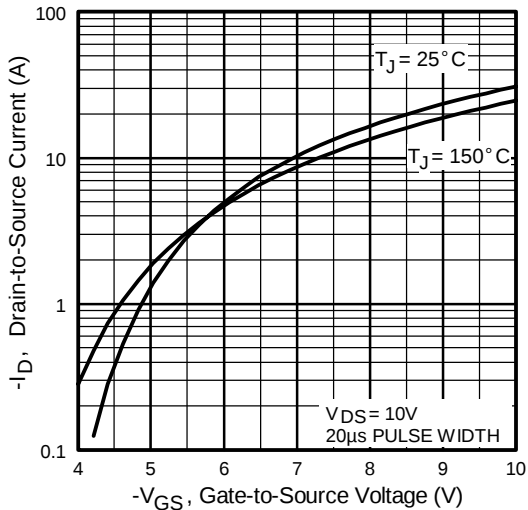
\*\* When mounted on 1" square PCB (FR-4 or G-10 Material) .  
For recommended footprint and soldering techniques refer to application note #AN-994



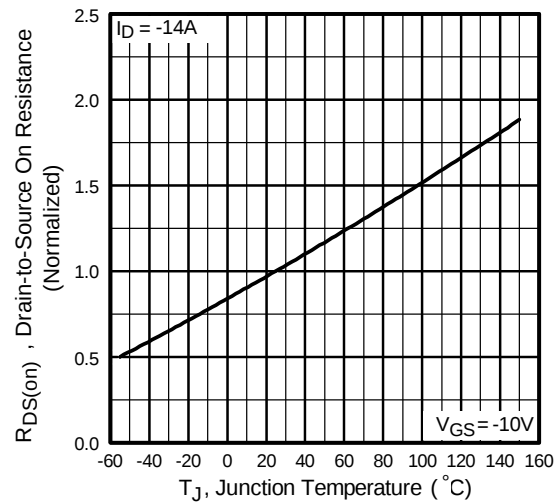
**Fig 1.** Typical Output Characteristics



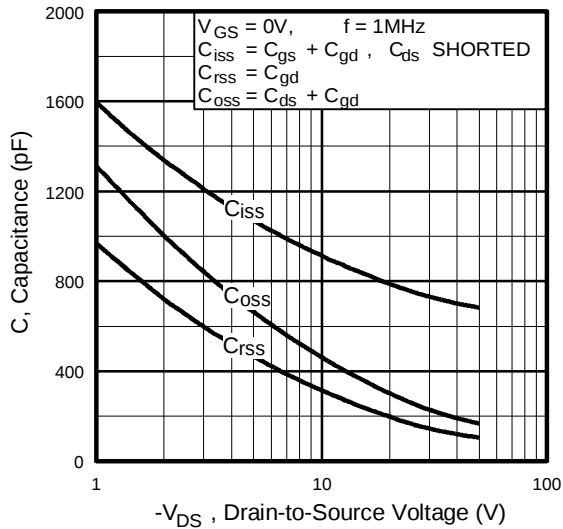
**Fig 2.** Typical Output Characteristics



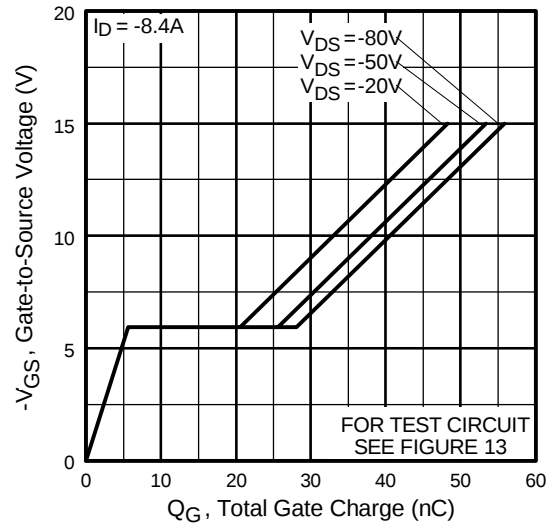
**Fig 3.** Typical Transfer Characteristics



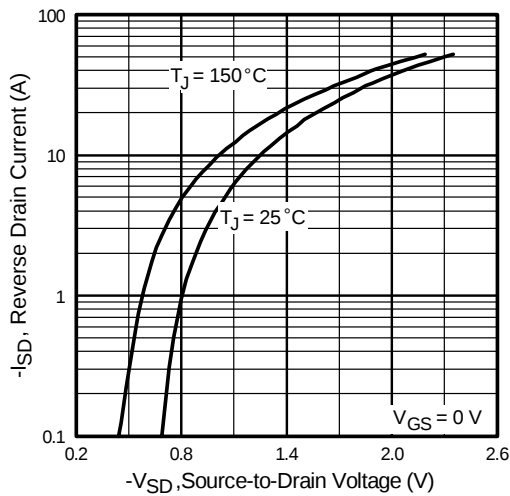
**Fig 4.** Normalized On-Resistance Vs. Temperature



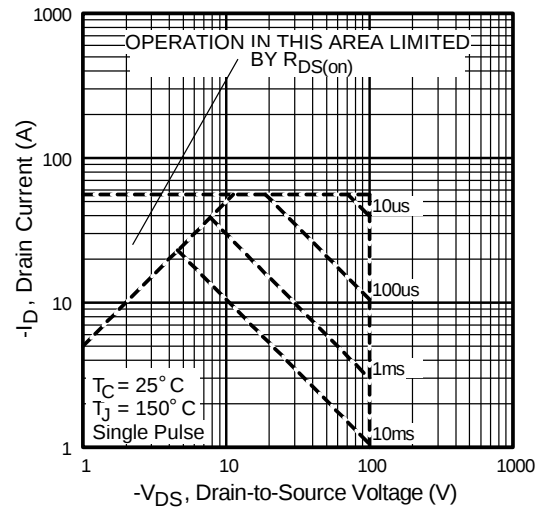
**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage



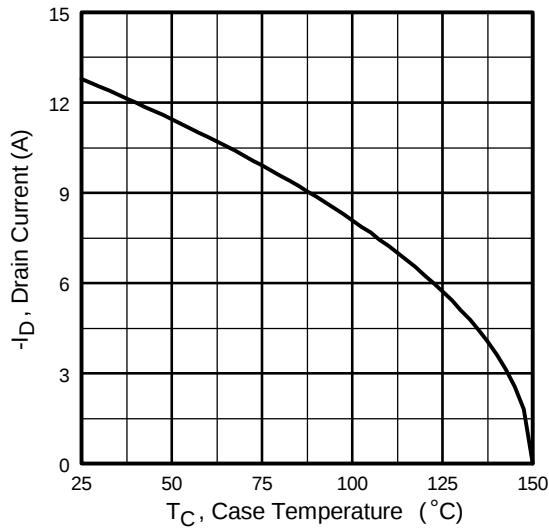
**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage



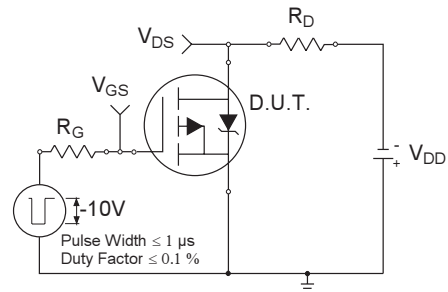
**Fig 7.** Typical Source-Drain Diode Forward Voltage



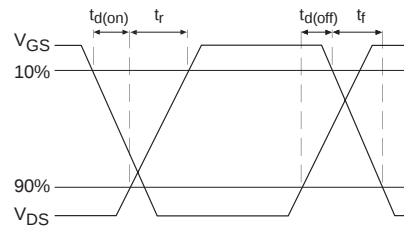
**Fig 8.** Maximum Safe Operating Area



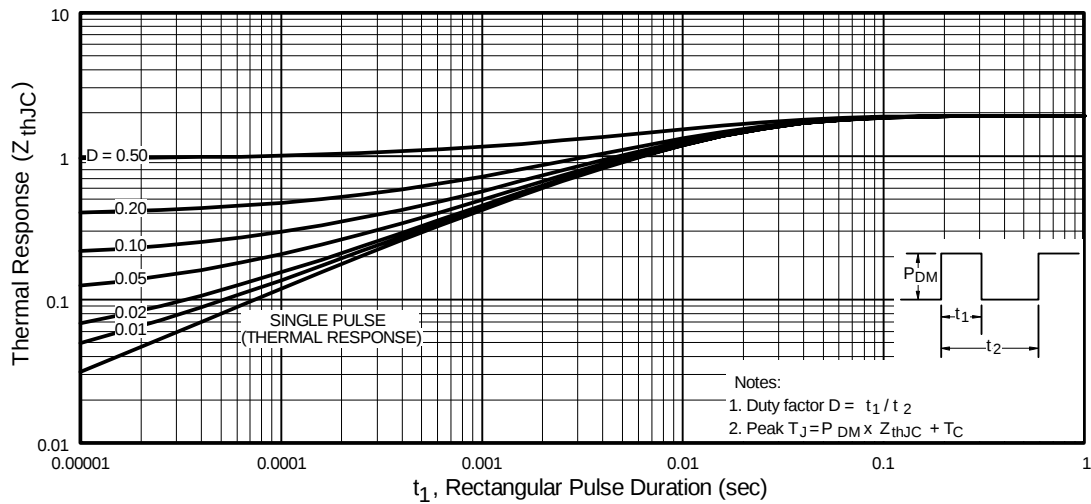
**Fig 9.** Maximum Drain Current Vs. Case Temperature



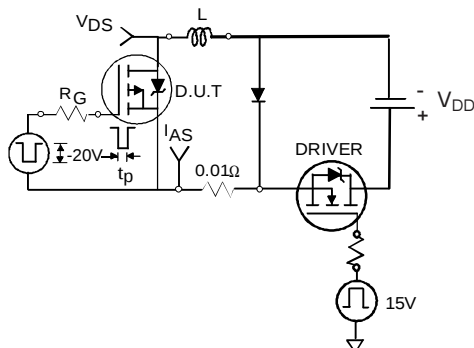
**Fig 10a.** Switching Time Test Circuit



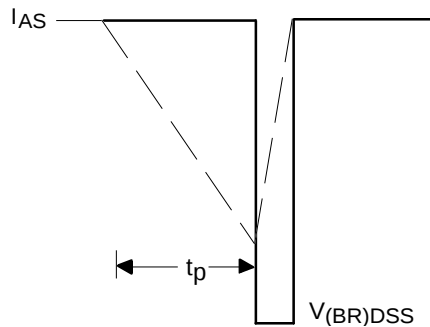
**Fig 10b.** Switching Time Waveforms



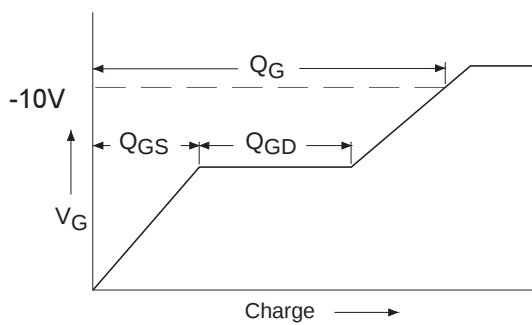
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case



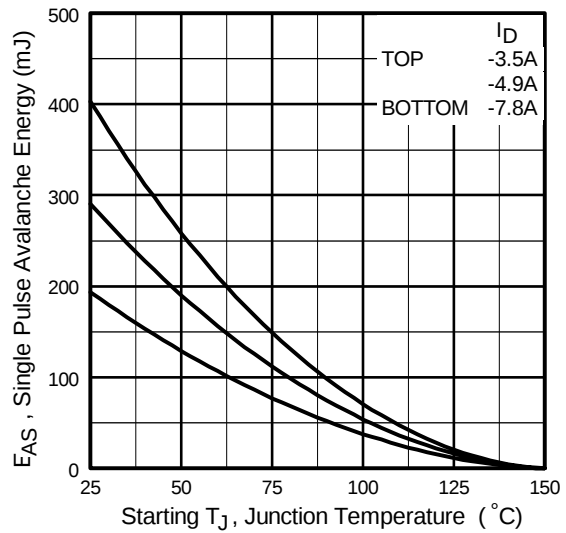
**Fig 12a.** Unclamped Inductive Test Circuit



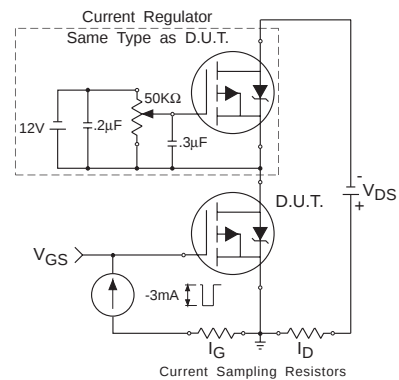
**Fig 12b.** Unclamped Inductive Waveforms



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

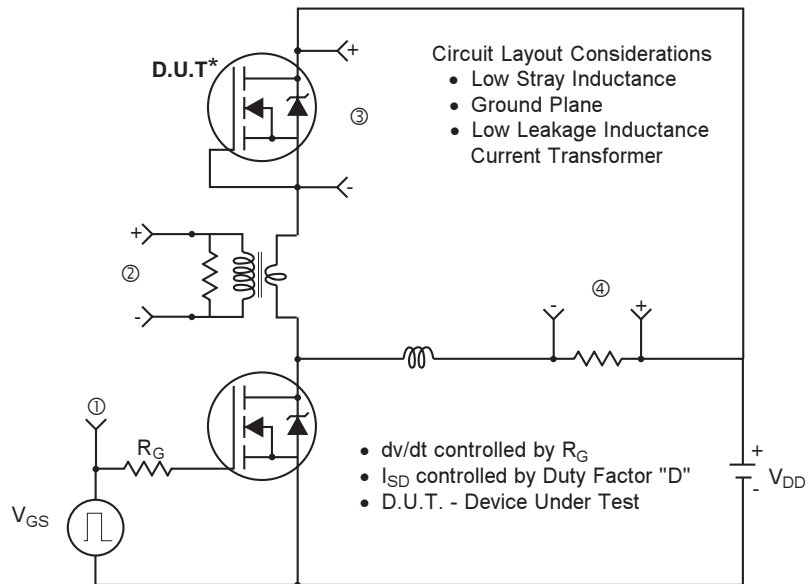


**Fig 12c.** Maximum Avalanche Energy Vs. Drain Current

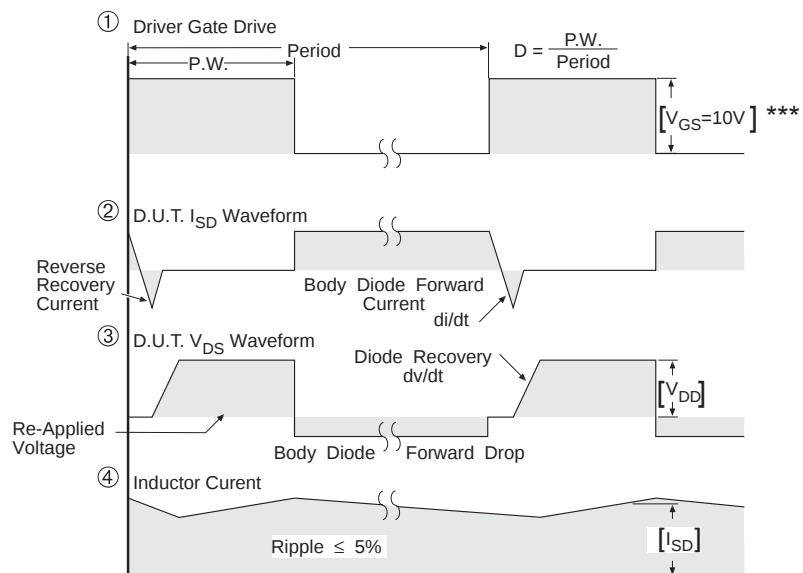


**Fig 13b.** Gate Charge Test Circuit

## Peak Diode Recovery dv/dt Test Circuit



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



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

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

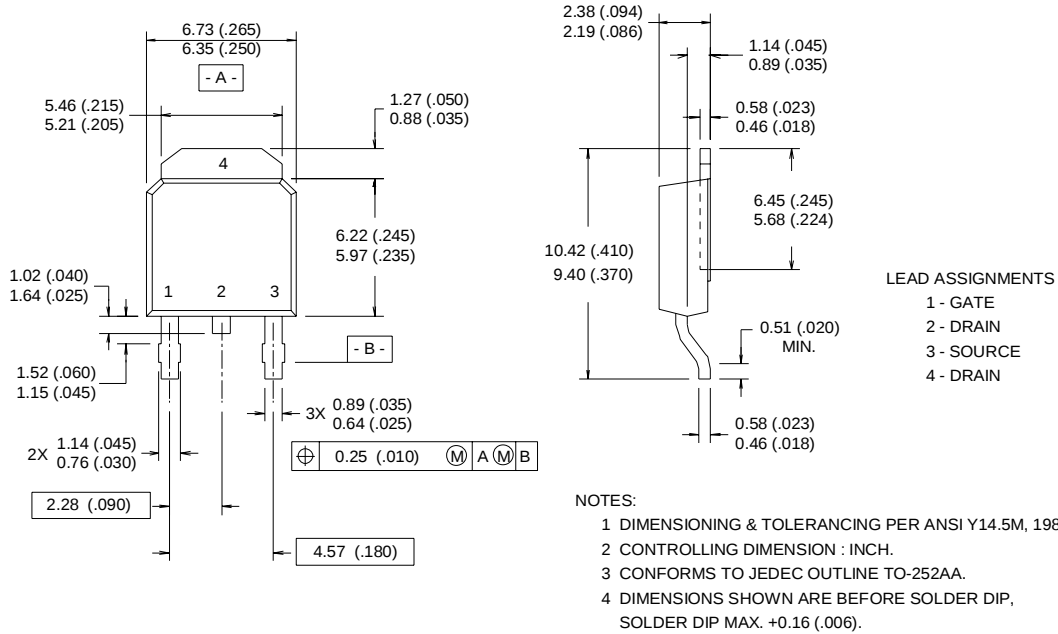
# IRFR/U5410

International  
**IOR** Rectifier

## Package Outline

### TO-252AA Outline

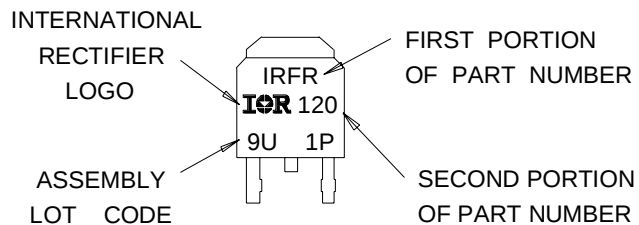
Dimensions are shown in millimeters (inches)



## Part Marking Information

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

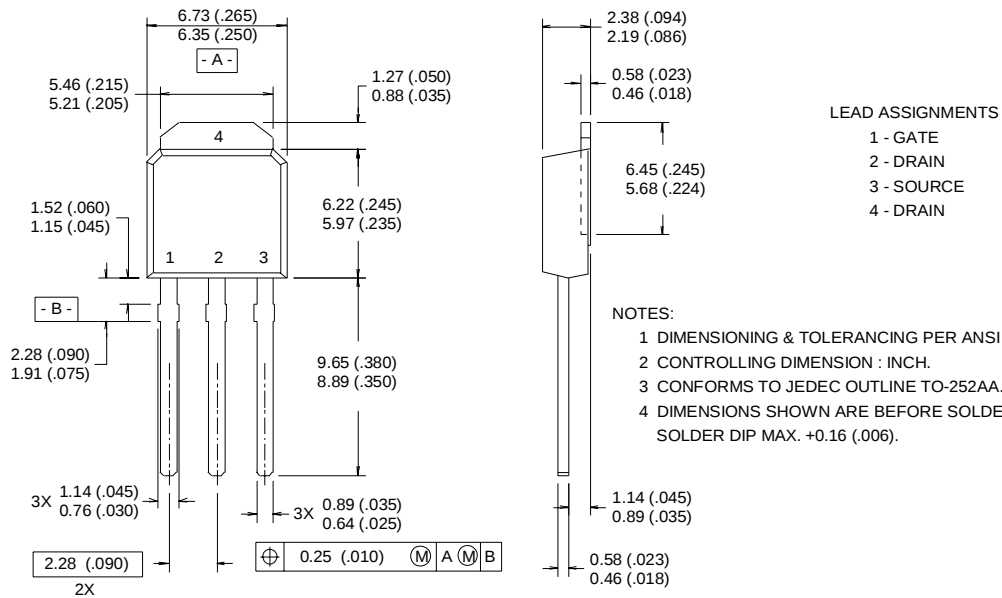
EXAMPLE : THIS IS AN IRFR120  
WITH ASSEMBLY  
LOT CODE 9U1P



## Package Outline

### TO-251AA Outline

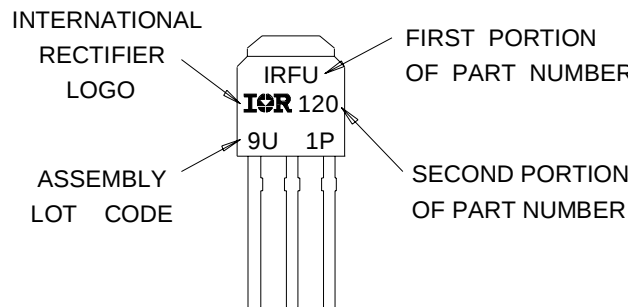
Dimensions are shown in millimeters (inches)



## Part Marking Information

### TO-251AA (I-Pak)

EXAMPLE : THIS IS AN IRFU120  
WITH ASSEMBLY  
LOT CODE 9U1P

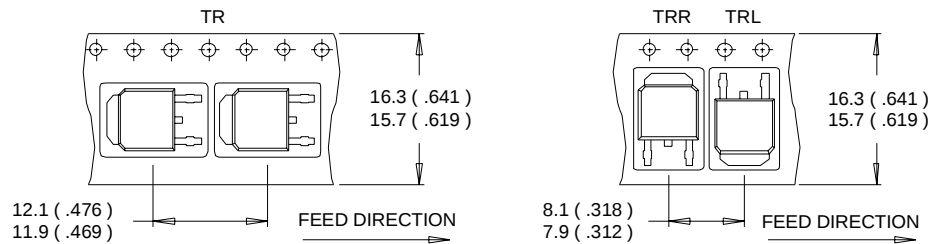


# IRFR/U5410

International  
**IR** Rectifier

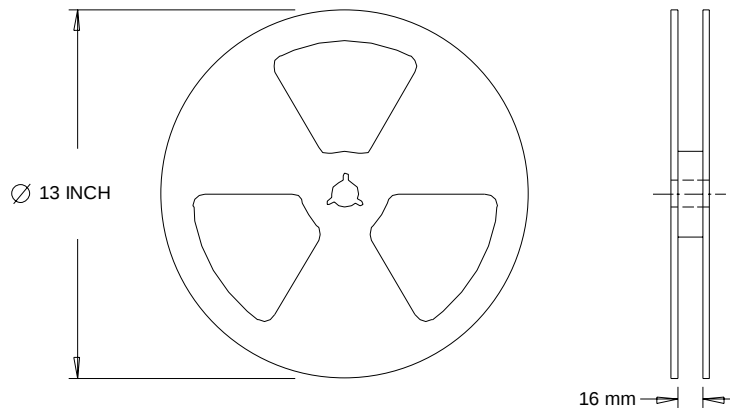
## Tape & Reel Information

TO-252AA



### 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.

International  
**IR** Rectifier

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**IR GERMANY:** Saalburgstrasse 157, 61350 Bad Homburg Tel: ++ 49 6172 96590

**IR ITALY:** Via Liguria 49, 10071 Borgaro, Torino Tel: ++ 39 11 451 0111

**IR FAR EAST:** K&H Bldg., 2F, 30-4 Nishi-Ikebukuro 3-Chome, Toshima-Ku, Tokyo Japan 171 Tel: 81 3 3983 0086

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**IR TAIWAN:** 16 Fl. Suite D. 207, Sec. 2, Tun Haw South Road, Taipei, 10673, Taiwan Tel: 886-2-2377-9936

<http://www.irf.com/>

Data and specifications subject to change without notice. 8/98