

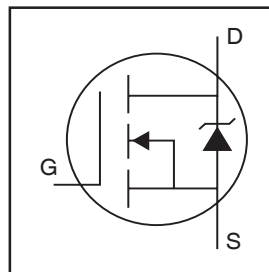
# IRLR2908PbF

# IRLU2908PbF

HEXFET® Power MOSFET

## Features

- Advanced Process Technology
- Ultra Low On-Resistance
- Dynamic dv/dt Rating
- 175°C Operating Temperature
- Fast Switching
- Repetitive Avalanche Allowed up to Tjmax
- Lead-Free



$$V_{DS} = 80V$$

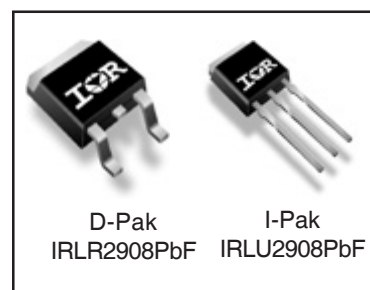
$$R_{DS(on)} = 28m\Omega$$

$$I_D = 30A$$

## Description

This HEXFET® Power MOSFET utilizes the latest processing techniques to achieve extremely low on-resistance per silicon area. Additional features of this HEXFET power MOSFET are a 175°C junction operating temperature, low R<sub>θJC</sub>, 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 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  
IRLR2908PbF

I-Pak  
IRLU2908PbF

## Absolute Maximum Ratings

|                           | Parameter                                                  | Max.                  | Units |
|---------------------------|------------------------------------------------------------|-----------------------|-------|
| $I_D @ T_C = 25^\circ C$  | Continuous Drain Current, $V_{GS} @ 10V$ (Silicon Limited) | 39                    | A     |
| $I_D @ T_C = 100^\circ C$ | Continuous Drain Current, $V_{GS} @ 10V$ (See Fig. 9)      | 28                    |       |
| $I_D @ T_C = 25^\circ C$  | Continuous Drain Current, $V_{GS} @ 10V$ (Package Limited) | 30                    |       |
| $I_{DM}$                  | Pulsed Drain Current ①                                     | 150                   |       |
| $P_D @ T_C = 25^\circ C$  | Maximum Power Dissipation                                  | 120                   | W     |
|                           | Linear Derating Factor                                     | 0.77                  | W/°C  |
| $V_{GS}$                  | Gate-to-Source Voltage                                     | $\pm 16$              | V     |
| $E_{AS}$                  | Single Pulse Avalanche Energy (Thermally Limited) ②        | 180                   | mJ    |
| $E_{AS} (tested)$         | Single Pulse Avalanche Energy Tested Value ②               | 250                   |       |
| $I_{AR}$                  | Avalanche Current ①                                        | See Fig.12a,12b,15,16 | A     |
| $E_{AR}$                  | Repetitive Avalanche Energy ⑥                              |                       | mJ    |
| dv/dt                     | Peak Diode Recovery dv/dt ③                                | 2.3                   | V/ns  |
| $T_J$                     | Operating Junction and                                     | -55 to + 175          | °C    |
| $T_{STG}$                 | Storage Temperature Range                                  |                       |       |
|                           | Soldering Temperature, for 10 seconds                      |                       |       |

## Thermal Resistance

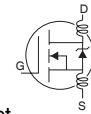
|                 | Parameter                         | Typ. | Max. | Units |
|-----------------|-----------------------------------|------|------|-------|
| $R_{\theta JC}$ | Junction-to-Case                  | —    | 1.3  | °C/W  |
| $R_{\theta JA}$ | Junction-to-Ambient (PCB Mount) ③ | —    | 40   |       |
| $R_{\theta JA}$ | Junction-to-Ambient               | —    | 110  |       |

# IRLR/U2908PbF

International  
Rectifier

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

|                              | Parameter                            | Min. | Typ.  | Max. | Units | Conditions                                                                  |
|------------------------------|--------------------------------------|------|-------|------|-------|-----------------------------------------------------------------------------|
| $V_{(BR)DSS}$                | Drain-to-Source Breakdown Voltage    | 80   | —     | —    | V     | $V_{GS} = 0V, I_D = 250\mu A$                                               |
| $\Delta BV_{DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient  | —    | 0.085 | —    | V/°C  | Reference to $25^\circ\text{C}, I_D = 1mA$                                  |
| $R_{DS(on)}$                 | Static Drain-to-Source On-Resistance | —    | 22.5  | 28   | mΩ    | $V_{GS} = 10V, I_D = 23A$ ④                                                 |
|                              |                                      | —    | 25    | 30   |       | $V_{GS} = 4.5V, I_D = 20A$ ④                                                |
| $V_{GS(th)}$                 | Gate Threshold Voltage               | 1.0  | —     | 2.5  | V     | $V_{DS} = V_{GS}, I_D = 250\mu A$                                           |
| $g_{fs}$                     | Forward Transconductance             | 35   | —     | —    | S     | $V_{DS} = 25V, I_D = 23A$                                                   |
| $I_{DSS}$                    | Drain-to-Source Leakage Current      | —    | —     | 20   | μA    | $V_{DS} = 80V, V_{GS} = 0V$                                                 |
|                              |                                      | —    | —     | 250  |       | $V_{DS} = 80V, V_{GS} = 0V, T_J = 125^\circ\text{C}$                        |
| $I_{GSS}$                    | Gate-to-Source Forward Leakage       | —    | —     | 200  | nA    | $V_{GS} = 16V$                                                              |
|                              | Gate-to-Source Reverse Leakage       | —    | —     | -200 |       | $V_{GS} = -16V$                                                             |
| $Q_g$                        | Total Gate Charge                    | —    | 22    | 33   | nC    | $I_D = 23A$                                                                 |
| $Q_{gs}$                     | Gate-to-Source Charge                | —    | 6.0   | 9.1  |       | $V_{DS} = 64V$                                                              |
| $Q_{gd}$                     | Gate-to-Drain ("Miller") Charge      | —    | 11    | 17   |       | $V_{GS} = 4.5V$                                                             |
| $t_{d(on)}$                  | Turn-On Delay Time                   | —    | 12    | —    | ns    | $V_{DD} = 40V$                                                              |
| $t_r$                        | Rise Time                            | —    | 95    | —    |       | $I_D = 23A$                                                                 |
| $t_{d(off)}$                 | Turn-Off Delay Time                  | —    | 36    | —    |       | $R_G = 8.3\Omega$                                                           |
| $t_f$                        | Fall Time                            | —    | 55    | —    |       | $V_{GS} = 4.5V$ 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                    | —    | 1890  | —    | pF    | $V_{GS} = 0V$                                                               |
| $C_{oss}$                    | Output Capacitance                   | —    | 260   | —    |       | $V_{DS} = 25V$                                                              |
| $C_{rss}$                    | Reverse Transfer Capacitance         | —    | 35    | —    |       | $f = 1.0MHz$ , See Fig. 5                                                   |
| $C_{oss}$                    | Output Capacitance                   | —    | 1920  | —    |       | $V_{GS} = 0V, V_{DS} = 1.0V, f = 1.0MHz$                                    |
| $C_{oss}$                    | Output Capacitance                   | —    | 170   | —    |       | $V_{GS} = 0V, V_{DS} = 64V, f = 1.0MHz$                                     |
| $C_{oss \text{ eff.}}$       | Effective Output Capacitance         | —    | 310   | —    |       | $V_{GS} = 0V, V_{DS} = 0V \text{ to } 64V$                                  |

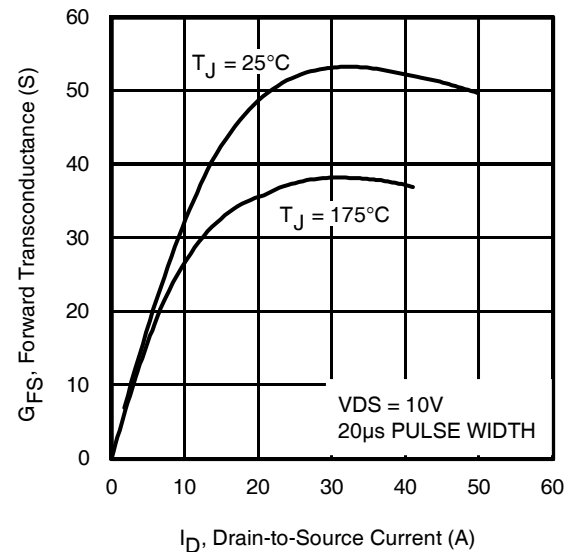
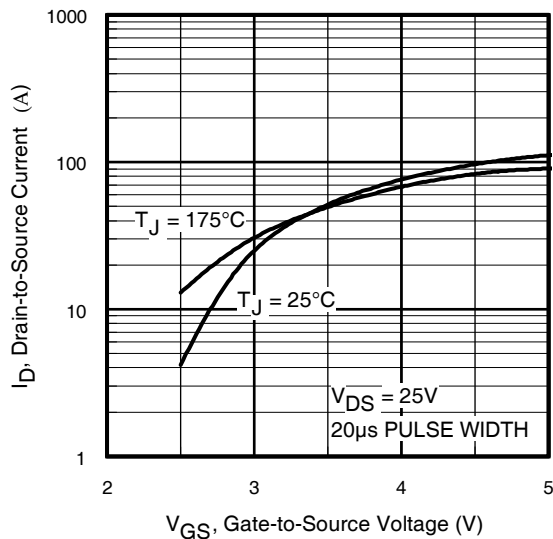
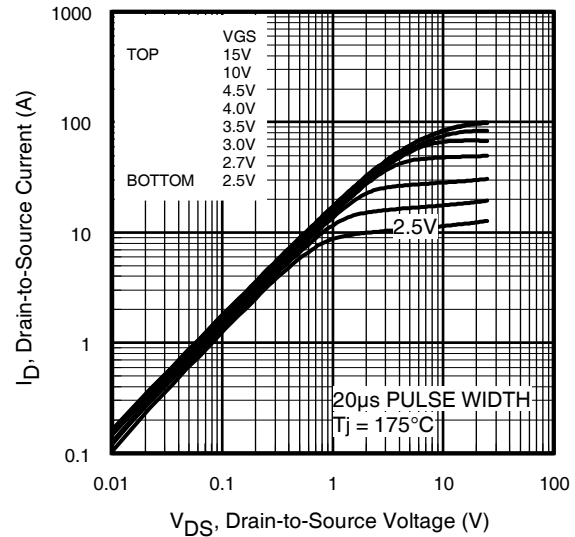
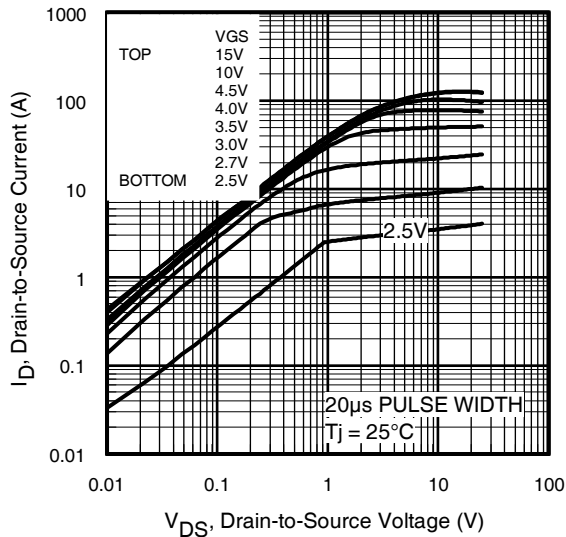


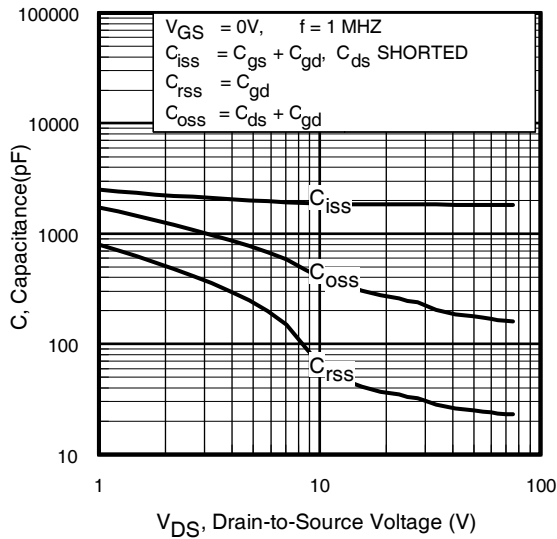
## Diode Characteristics

|          | Parameter                                 | Min.                                                                      | Typ. | Max. | Units | Conditions                                                              |
|----------|-------------------------------------------|---------------------------------------------------------------------------|------|------|-------|-------------------------------------------------------------------------|
| $I_S$    | Continuous Source Current<br>(Body Diode) | —                                                                         | —    | 39   | A     | MOSFET symbol<br>showing the<br>integral reverse<br>p-n junction diode. |
| $I_{SM}$ | Pulsed Source Current<br>(Body Diode) ①   | —                                                                         | —    | 150  |       |                                                                         |
| $V_{SD}$ | Diode Forward Voltage                     | —                                                                         | —    | 1.3  | V     | $T_J = 25^\circ\text{C}, I_S = 23A, V_{GS} = 0V$ ④                      |
| $t_{rr}$ | Reverse Recovery Time                     | —                                                                         | 75   | 110  | ns    | $T_J = 25^\circ\text{C}, I_F = 23A, V_{DD} = 25V$                       |
| $Q_{rr}$ | Reverse Recovery Charge                   | —                                                                         | 210  | 310  | nC    | $di/dt = 100A/\mu s$ ④                                                  |
| $t_{on}$ | Forward Turn-On Time                      | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S+L_D$ ) |      |      |       |                                                                         |

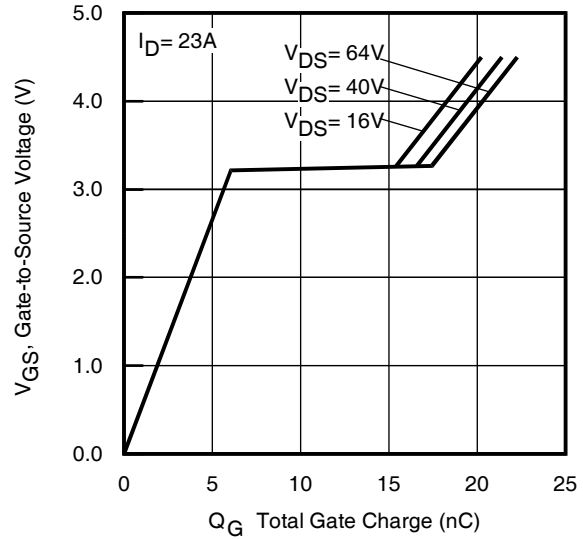
Notes ① through ③ are on page 11

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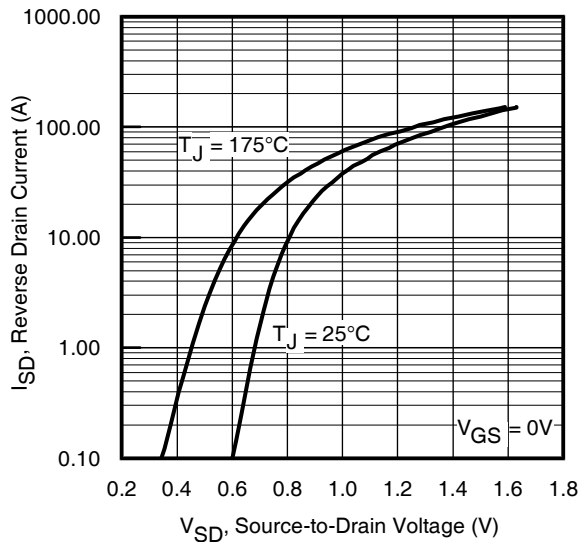




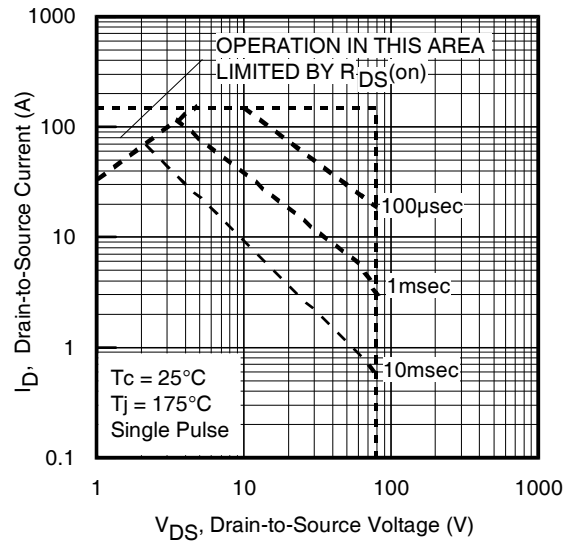
**Fig 5.** Typical Capacitance vs. Drain-to-Source Voltage



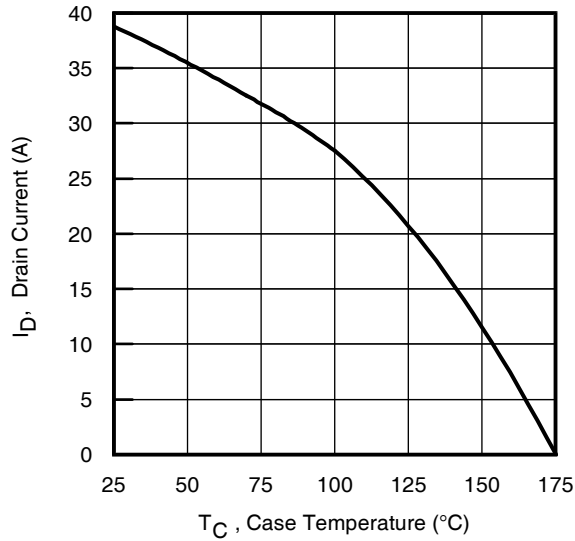
**Fig 6.** Typical Gate Charge vs. Gate-to-Source Voltage



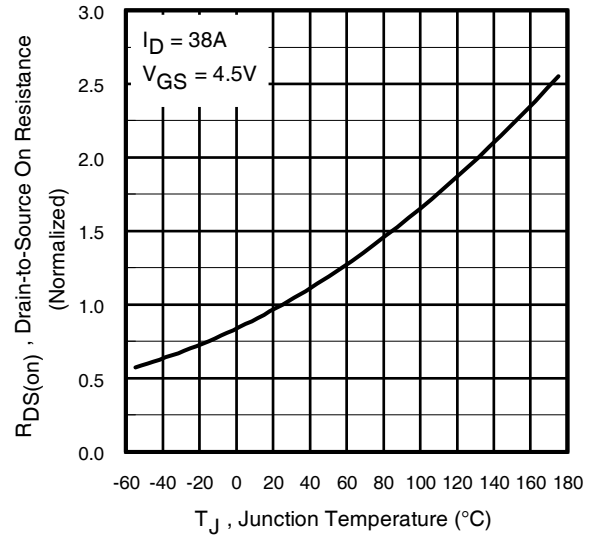
**Fig 7.** Typical Source-Drain Diode Forward Voltage



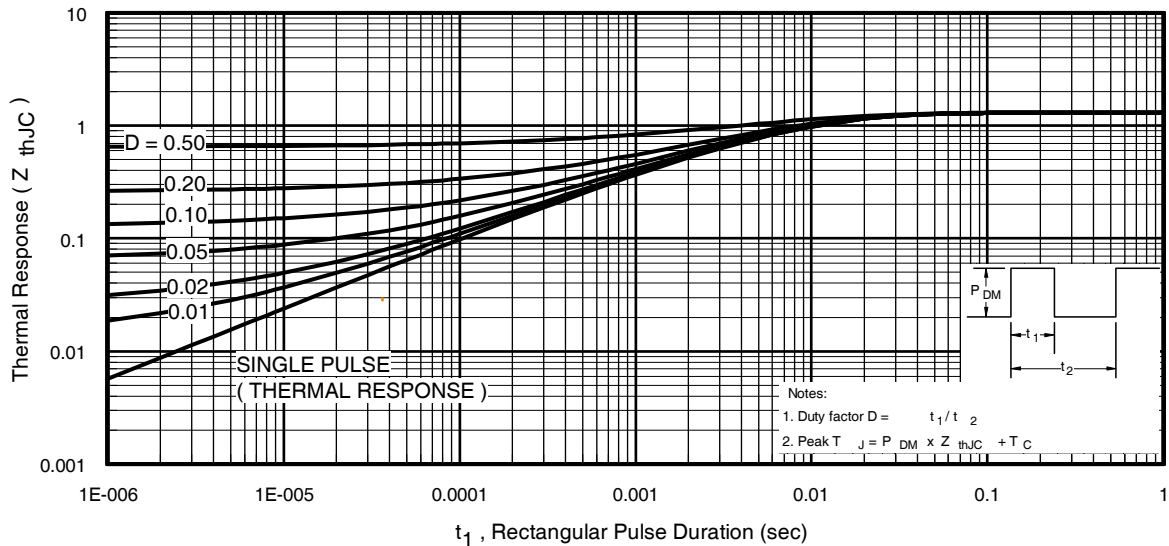
**Fig 8.** Maximum Safe Operating Area



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



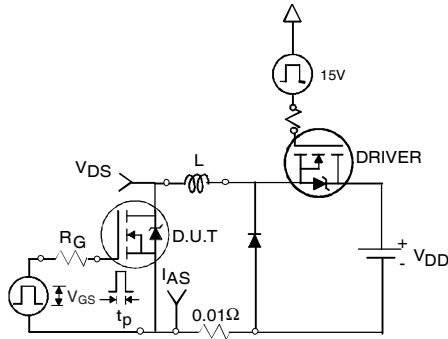
**Fig 10.** Normalized On-Resistance vs. Temperature



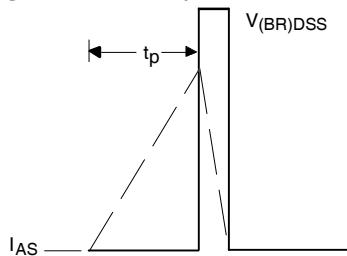
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

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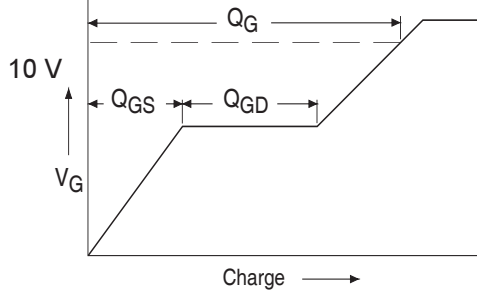
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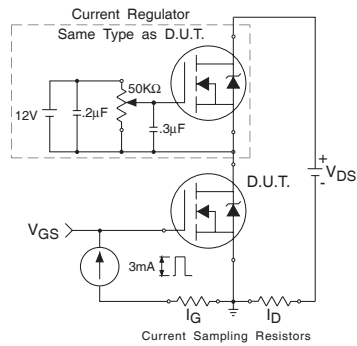
**Fig 12a.** Unclamped Inductive Test Circuit



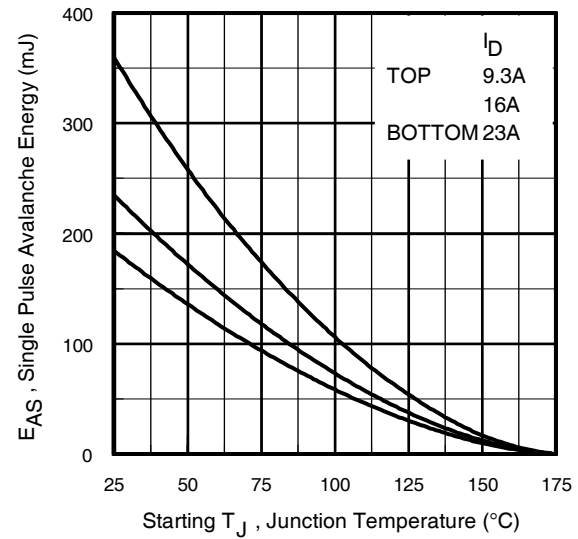
**Fig 12b.** Unclamped Inductive Waveforms



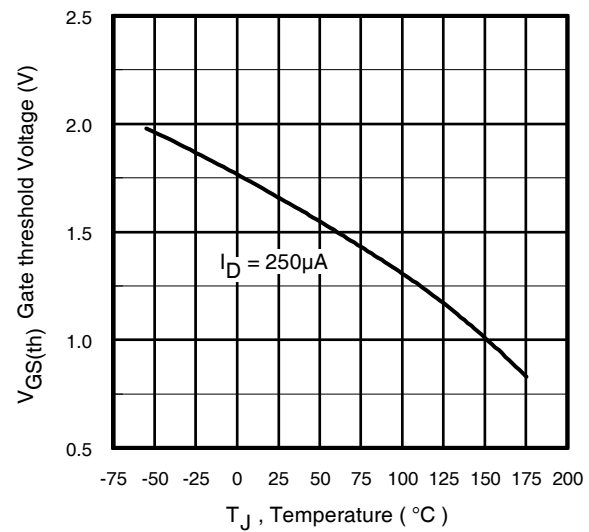
**Fig 13a.** Basic Gate Charge Waveform



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



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



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

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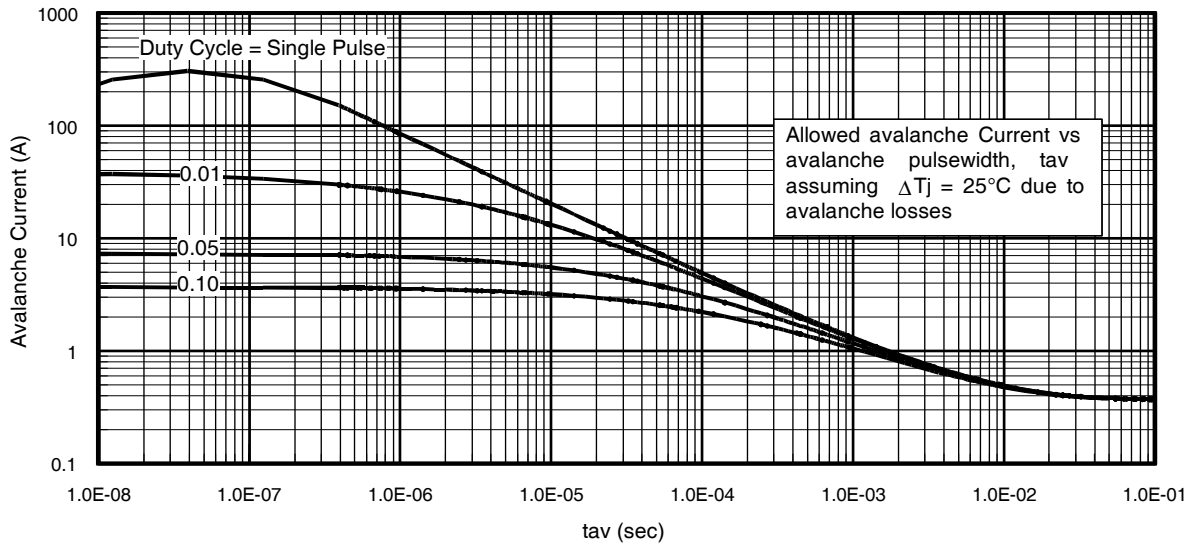


Fig 15. Typical Avalanche Current vs. Pulsewidth

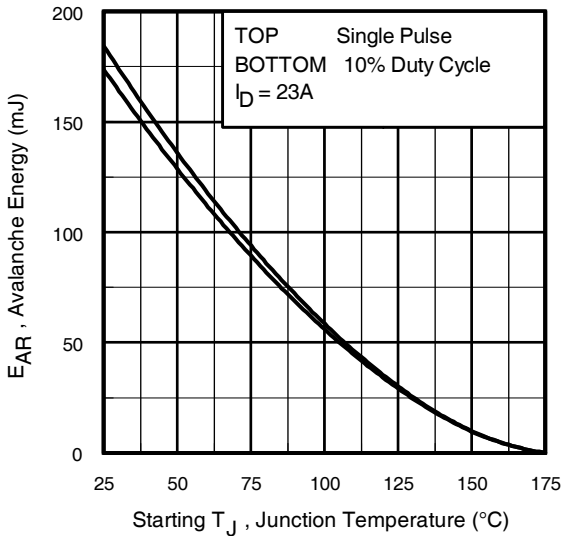


Fig 16. Maximum Avalanche Energy vs. Temperature

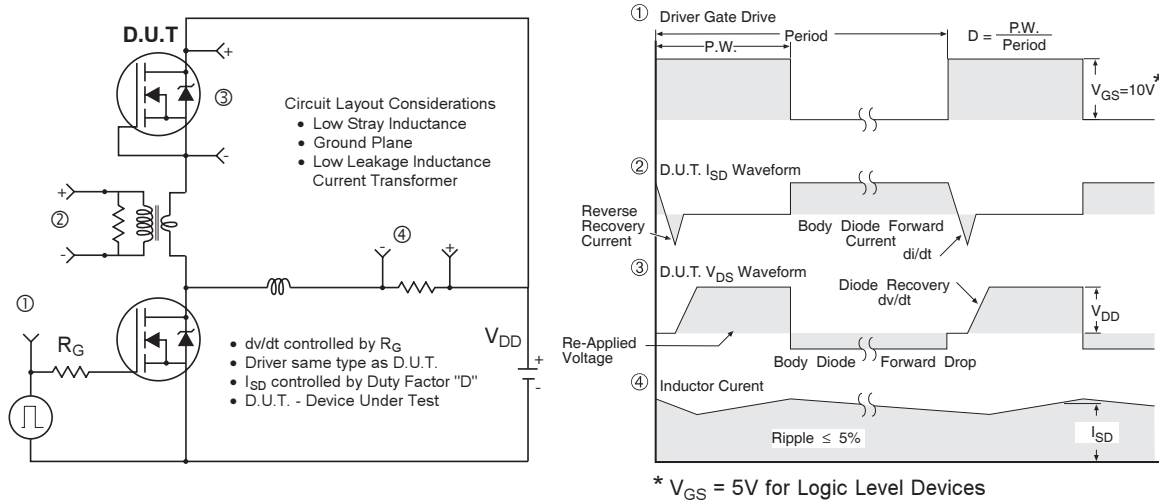
**Notes on Repetitive Avalanche Curves , Figures 15, 16:**  
(For further info, see AN-1005 at [www.irf.com](http://www.irf.com))

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)

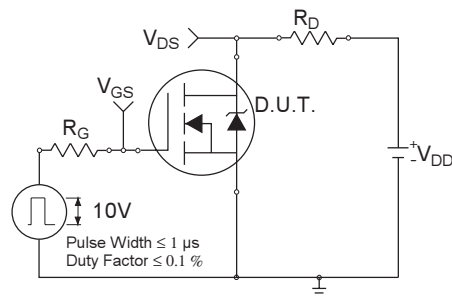
$$P_{D(ave)} = 1/2 (1.3 \cdot BV \cdot I_{av}) = \Delta T / Z_{thJC}$$

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

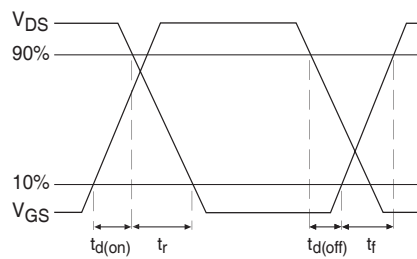
$$E_{AS(AR)} = P_{D(ave)} \cdot t_{av}$$



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



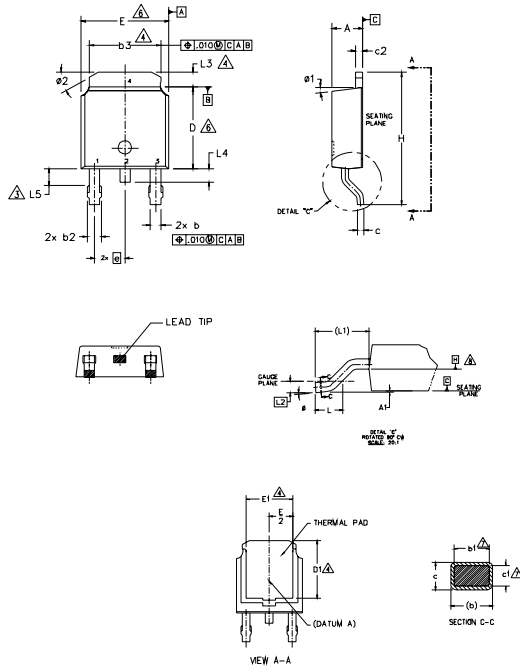
**Fig 18a. Switching Time Test Circuit**



**Fig 18b. Switching Time Waveforms**

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

Dimensions are shown in millimeters (inches)



### NOTES:

- 1.- DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
- 2.- DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS]
- 3.- LEAD DIMENSION UNCONTROLLED IN L5.
- 4.- DIMENSION D1, E1, L3 & b3 ESTABLISH A MINIMUM MOUNTING SURFACE FOR THERMAL PAD.
- 5.- SECTION C-C DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN .005 AND 0.10 [0.13 AND 0.25] FROM THE LEAD TIP.
- 6.- DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005 [0.13] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
- 7.- DIMENSION b1 & c1 APPLIED TO BASE METAL ONLY.
- 8.- DATUM A & B TO BE DETERMINED AT DATUM PLANE H.
- 9.- 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 |       |
| b1     | 0.65        | 0.79  | .025      | .031 | 7     |
| b2     | 0.76        | 1.14  | .030      | .045 |       |
| b3     | 4.95        | 5.46  | .195      | .215 | 4     |
| c      | 0.46        | 0.61  | .018      | .024 |       |
| c1     | 0.41        | 0.56  | .016      | .022 | 7     |
| c2     | 0.46        | 0.89  | .018      | .035 |       |
| 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 BSC    |       | .090 BSC  |      |       |
| H      | 9.40        | 10.41 | .370      | .410 |       |
| L      | 1.40        | 1.78  | .055      | .070 |       |
| L1     | 2.74 BSC    |       | .108 REF. |      |       |
| L2     | 0.51 BSC    |       | .020 BSC  |      |       |
| L3     | 0.89        | 1.27  | .035      | .050 | 4     |
| L4     | —           | 1.02  | —         | .040 |       |
| L5     | 1.14        | 1.52  | .045      | .060 | 3     |
| ø      | 0" 10"      |       | 0" 10"    |      |       |
| ø1     | 0" 15"      |       | 0" 15"    |      |       |
| ø2     | 25" 35"     |       | 25" 35"   |      |       |

### LEAD ASSIGNMENTS

### HEXFET

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

### IGBT & CoPAK

- 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 WW16, 2001  
IN THE ASSEMBLY LINE "A"

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

"P" in assembly line position indicates  
"Lead-Free" qualification to the consumer-level

OR

INTERNATIONAL  
RECTIFIER  
LOGO

ASSEMBLY  
LOT CODE

INTERNATIONAL  
RECTIFIER  
LOGO

ASSEMBLY  
LOT CODE

PART NUMBER

DATE CODE

YEAR 1 = 2001

WEEK 16

LINE A

PART NUMBER

DATE CODE

P = DESIGNATES LEAD-FREE

PRODUCT (OPTIONAL)

P = DESIGNATES LEAD-FREE

PRODUCT QUALIFIED TO THE

CONSUMER LEVEL (OPTIONAL)

YEAR 1 = 2001

WEEK 16

A = ASSEMBLY SITE CODE

### Notes:

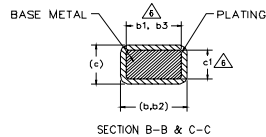
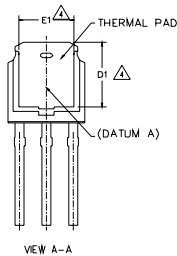
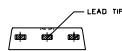
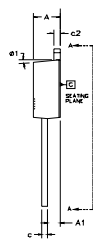
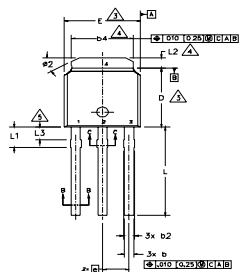
1. For an Automotive Qualified version of this part please see <http://www.irf.com/product-info/automotive/>
2. For the most current drawing please refer to IR website at <http://www.irf.com/package/>

# IRLR/U2908PbF

International  
**IR** Rectifier

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

Dimensions are shown in millimeters (inches)



### NOTES:

1.- DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994

2.- DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS]

△ DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005 [0.13] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.

△ THERMAL PAD CONTOUR OPTION WITHIN DIMENSION b4, L2, E1 & D1.

△ LEAD DIMENSION UNCONTROLLED IN L3.

△ DIMENSION b1, b3 & c1 APPLY TO BASE METAL ONLY.

7.- OUTLINE CONFORMS TO JEDEC OUTLINE TO-251AA (Date 06/02).

8.- CONTROLLING DIMENSION : INCHES.

| SYMBOL | DIMENSIONS  |      |          |      | NOTES |
|--------|-------------|------|----------|------|-------|
|        | MILLIMETERS |      | INCHES   |      |       |
|        | MIN.        | MAX. | MIN.     | MAX. |       |
| A      | 2.18        | 2.39 | .086     | .094 |       |
| A1     | 0.89        | 1.14 | .035     | .045 |       |
| b      | 0.64        | 0.89 | .025     | .035 |       |
| b1     | 0.65        | 0.79 | .025     | .031 | 6     |
| b2     | 0.76        | 1.14 | .030     | .045 |       |
| b3     | 0.76        | 1.04 | .030     | .041 | 6     |
| b4     | 4.95        | 5.46 | .195     | .215 | 4     |
| c      | 0.46        | 0.61 | .018     | .024 |       |
| c1     | 0.41        | 0.56 | .016     | .022 | 6     |
| c2     | 0.46        | 0.89 | .018     | .035 |       |
| D      | 5.97        | 6.22 | .235     | .245 | 3     |
| D1     | 5.21        | -    | .205     | -    | 4     |
| E      | 6.35        | 6.73 | .250     | .265 | 3     |
| E1     | 4.32        | -    | .170     | -    | 4     |
| e      | 2.29 BSC    |      | .090 BSC |      |       |
| L      | 8.89        | 9.65 | .350     | .380 |       |
| L1     | 1.91        | 2.29 | .045     | .090 | 4     |
| L2     | 0.89        | 1.27 | .035     | .050 |       |
| L3     | 1.14        | 1.52 | .045     | .060 | 5     |
| ø1     | 0"          | 15"  | 0"       | 15"  |       |
| ø2     | 25"         | 35"  | 25"      | 35"  |       |

### LEAD ASSIGNMENTS

### HEXFET

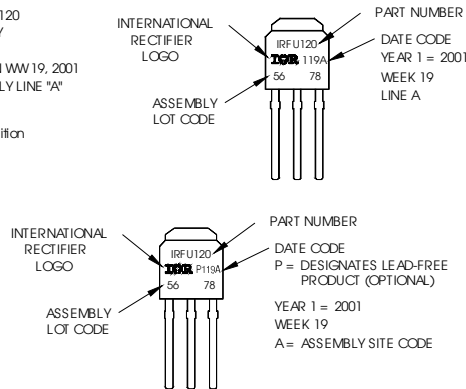
- 1.- GATE
- 2.- DRAIN
- 3.- SOURCE
- 4.- DRAIN

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

EXAMPLE: THIS IS AN IRLU120  
WITH ASSEMBLY  
LOT CODE 5678  
ASSEMBLED ON WW19, 2001  
IN THE ASSEMBLY LINE "A"

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

OR

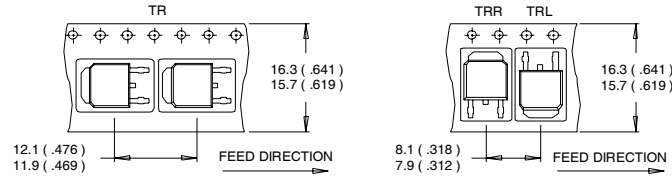


### Notes:

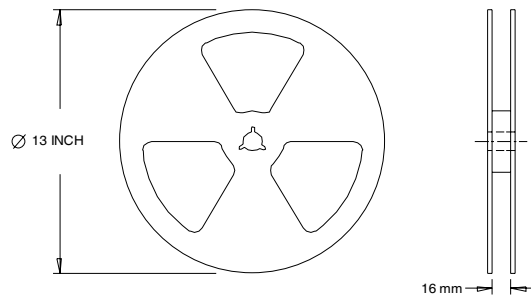
1. For an Automotive Qualified version of this part please see <http://www.irf.com/product-info/auto/>
2. For the most current drawing please refer to IR website at <http://www.irf.com/package/>

## 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.

### Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature. (See fig. 11).
- ② Limited by  $T_{Jmax}$ , starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.71\text{mH}$ ,  $R_G = 25\Omega$ ,  $I_{AS} = 23\text{A}$ ,  $V_{GS} = 10\text{V}$ . Part not recommended for use above this value.
- ③  $I_{SD} \leq 23\text{A}$ ,  $di/dt \leq 400\text{A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_J \leq 175^\circ\text{C}$ .
- ④ Pulse width  $\leq 1.0\text{ms}$ ; duty cycle  $\leq 2\%$ .
- ⑤  $C_{oss}$  eff. is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .
- ⑥ Limited by  $T_{Jmax}$ , see Fig.12a, 12b, 15, 16 for typical repetitive avalanche performance.
- ⑦ This value determined from sample failure population. 100% tested to this value in production.
- ⑧ When mounted on 1" square PCB (FR-4 or G-10 Material). For recommended footprint and soldering techniques refer to application note #AN-994.

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

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