

# IRLR3110ZPbF IRLU3110ZPbF

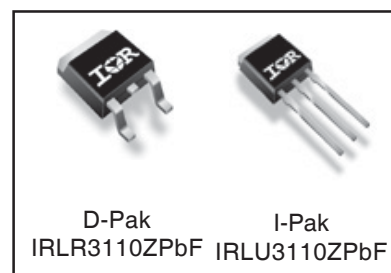
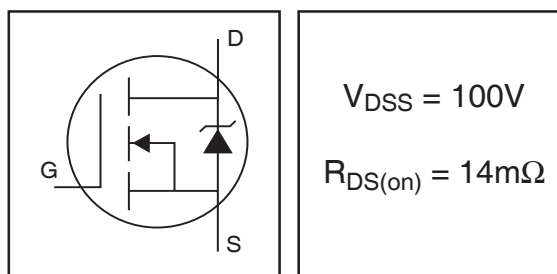
## Features

- Advanced Process Technology
- Ultra Low On-Resistance
- 175°C Operating Temperature
- Fast Switching
- Repetitive Avalanche Allowed up to  $T_{jmax}$

## Description

Specifically designed for Industrial 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 Industrial applications and a wide variety of other applications.

## HEXFET® Power MOSFET



## Absolute Maximum Ratings

|                                   | Parameter                                                  | Max.                      | Units |
|-----------------------------------|------------------------------------------------------------|---------------------------|-------|
| $I_D$ @ $T_C = 25^\circ\text{C}$  | Continuous Drain Current, $V_{GS}$ @ 10V (Silicon Limited) | 63                        | A     |
| $I_D$ @ $T_C = 100^\circ\text{C}$ | Continuous Drain Current, $V_{GS}$ @ 10V (Silicon Limited) | 45                        |       |
| $I_D$ @ $T_C = 25^\circ\text{C}$  | Continuous Drain Current, $V_{GS}$ @ 10V (Package Limited) | 42                        |       |
| $I_{DM}$                          | Pulsed Drain Current ①                                     | 250                       |       |
| $P_D$ @ $T_C = 25^\circ\text{C}$  | Power Dissipation                                          | 140                       | W     |
|                                   | Linear Derating Factor                                     | 0.95                      | W/°C  |
| $V_{GS}$                          | Gate-to-Source Voltage                                     | ±16                       | V     |
| $E_{AS}$ (Thermally limited)      | Single Pulse Avalanche Energy ②                            | 110                       | mJ    |
| $E_{AS}$ (Tested)                 | Single Pulse Avalanche Energy Tested Value ③               | 140                       |       |
| $I_{AR}$                          | 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                                  |                           |       |
|                                   | Reflow Soldering Temperature, for 10 seconds               |                           |       |
|                                   | Mounting Torque, 6-32 or M3 screw                          | 300<br>10 lbf•in (1.1N•m) |       |

## Thermal Resistance

|                 | Parameter                          | Typ. | Max. | Units |
|-----------------|------------------------------------|------|------|-------|
| $R_{\theta JC}$ | Junction-to-Case ⑥                 | —    | 1.05 | °C/W  |
| $R_{\theta JA}$ | Junction-to-Ambient (PCB mount) ⑦⑧ | —    | 40   |       |
| $R_{\theta JA}$ | Junction-to-Ambient ⑨              | —    | 110  |       |

HEXFET® is a registered trademark of International Rectifier.

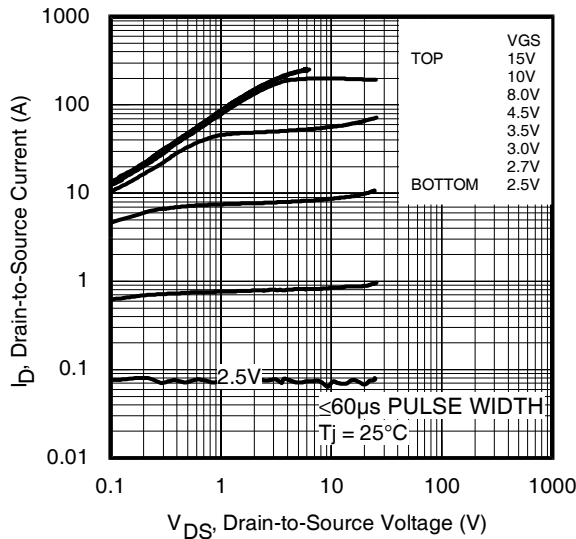
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**Electrical Characteristics @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)**

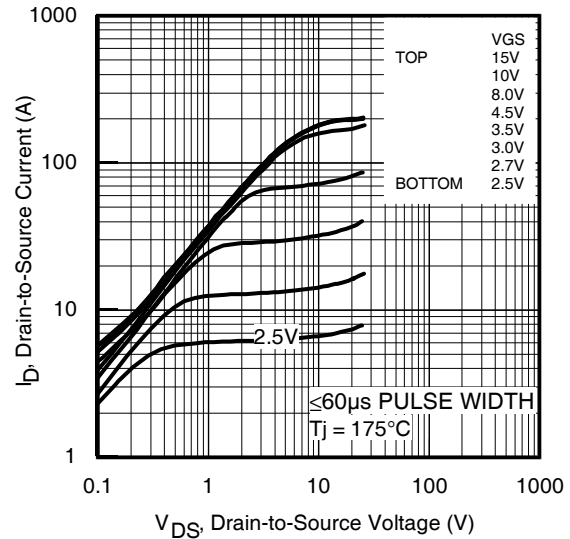
|                                 | Parameter                            | Min. | Typ.  | Max. | Units     | Conditions                                                                  |
|---------------------------------|--------------------------------------|------|-------|------|-----------|-----------------------------------------------------------------------------|
| $V_{(BR)DSS}$                   | 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  | —    | 0.077 | —    | V/°C      | Reference to $25^\circ\text{C}$ , $I_D = 1mA$                               |
| $R_{DS(on)}$                    | Static Drain-to-Source On-Resistance | —    | 11    | 14   | $m\Omega$ | $V_{GS} = 10V, I_D = 38A$ ③                                                 |
|                                 |                                      | —    | 12    | 16   |           | $V_{GS} = 4.5V, I_D = 32A$ ③                                                |
| $V_{GS(th)}$                    | Gate Threshold Voltage               | 1.0  | —     | 2.5  | V         | $V_{DS} = V_{GS}, I_D = 100\mu A$                                           |
| $g_{fs}$                        | Forward Transconductance             | 52   | —     | —    | S         | $V_{DS} = 25V, I_D = 38A$                                                   |
| $I_{DSS}$                       | Drain-to-Source Leakage Current      | —    | —     | 20   | $\mu A$   | $V_{DS} = 100V, V_{GS} = 0V$                                                |
|                                 |                                      | —    | —     | 250  |           | $V_{DS} = 100V, V_{GS} = 0V, T_J = 125^\circ\text{C}$                       |
| $I_{GSS}$                       | Gate-to-Source Forward Leakage       | —    | —     | 200  | nA        | $V_{GS} = 16V$                                                              |
|                                 | Gate-to-Source Reverse Leakage       | —    | —     | -200 |           | $V_{GS} = -16V$                                                             |
| $Q_g$                           | Total Gate Charge                    | —    | 34    | 48   | nC        | $I_D = 38A$                                                                 |
| $Q_{gs}$                        | Gate-to-Source Charge                | —    | 10    | —    |           | $V_{DS} = 50V$                                                              |
| $Q_{gd}$                        | Gate-to-Drain ("Miller") Charge      | —    | 15    | —    |           | $V_{GS} = 4.5V$ ③                                                           |
| $t_{d(on)}$                     | Turn-On Delay Time                   | —    | 24    | —    | ns        | $V_{DD} = 50V$                                                              |
| $t_r$                           | Rise Time                            | —    | 110   | —    |           | $I_D = 38A$                                                                 |
| $t_{d(off)}$                    | Turn-Off Delay Time                  | —    | 33    | —    |           | $R_G = 3.7\Omega$                                                           |
| $t_f$                           | Fall Time                            | —    | 48    | —    |           | $V_{GS} = 4.5V$ ③                                                           |
| $L_D$                           | 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                    | —    | 3980  | —    | pF        | $V_{GS} = 0V$                                                               |
| $C_{oss}$                       | Output Capacitance                   | —    | 310   | —    |           | $V_{DS} = 25V$                                                              |
| $C_{rss}$                       | Reverse Transfer Capacitance         | —    | 130   | —    |           | $f = 1.0MHz$                                                                |
| $C_{oss}$                       | Output Capacitance                   | —    | 1820  | —    |           | $V_{GS} = 0V, V_{DS} = 1.0V, f = 1.0MHz$                                    |
| $C_{oss}$                       | Output Capacitance                   | —    | 170   | —    |           | $V_{GS} = 0V, V_{DS} = 80V, f = 1.0MHz$                                     |
| $C_{oss \text{ eff.}}$          | Effective Output Capacitance         | —    | 320   | —    |           | $V_{GS} = 0V, V_{DS} = 0V \text{ to } 80V$ ④                                |

**Source-Drain Ratings and Characteristics**

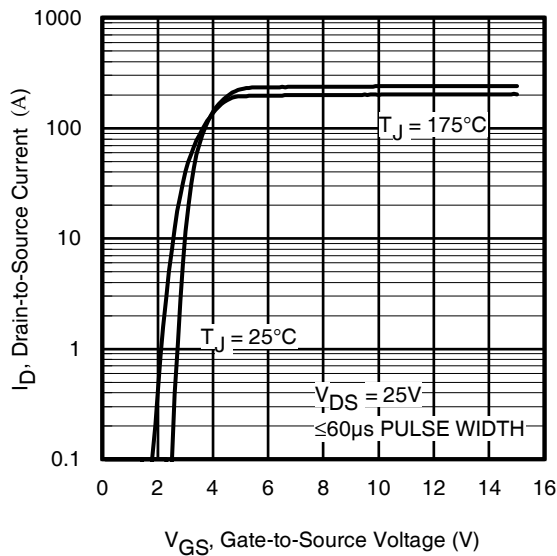
|          | Parameter                                 | Min.                                                                      | Typ. | Max. | Units | Conditions                                                              |
|----------|-------------------------------------------|---------------------------------------------------------------------------|------|------|-------|-------------------------------------------------------------------------|
| $I_S$    | Continuous Source Current<br>(Body Diode) | —                                                                         | —    | 63   | A     | MOSFET symbol<br>showing the<br>integral reverse<br>p-n junction diode. |
| $I_{SM}$ | Pulsed Source Current<br>(Body Diode) ①   | —                                                                         | —    | 250  |       |                                                                         |
| $V_{SD}$ | Diode Forward Voltage                     | —                                                                         | —    | 1.3  | V     | $T_J = 25^\circ\text{C}, I_S = 38A, V_{GS} = 0V$ ③                      |
| $t_{rr}$ | Reverse Recovery Time                     | —                                                                         | 34   | 51   | ns    | $T_J = 25^\circ\text{C}, I_F = 38A, V_{DD} = 50V$                       |
| $Q_{rr}$ | Reverse Recovery Charge                   | —                                                                         | 42   | 63   | nC    | $di/dt = 100A/\mu s$ ③                                                  |
| $t_{on}$ | Forward Turn-On Time                      | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S+L_D$ ) |      |      |       |                                                                         |



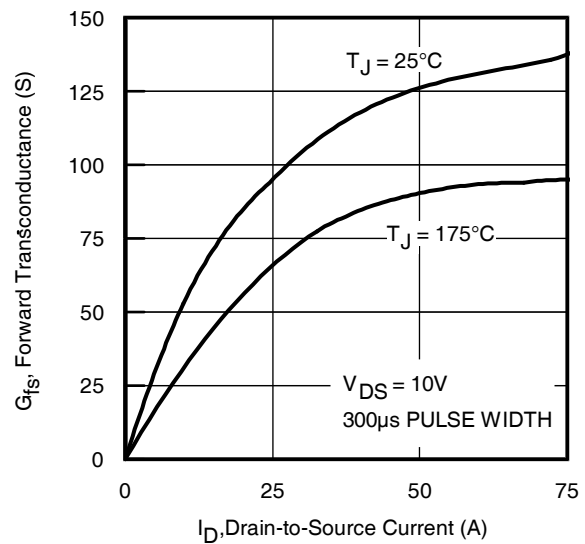
**Fig 1.** Typical Output Characteristics



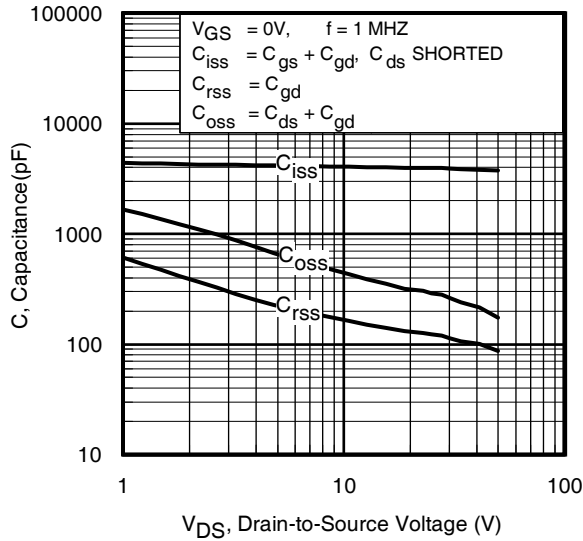
**Fig 2.** Typical Output Characteristics



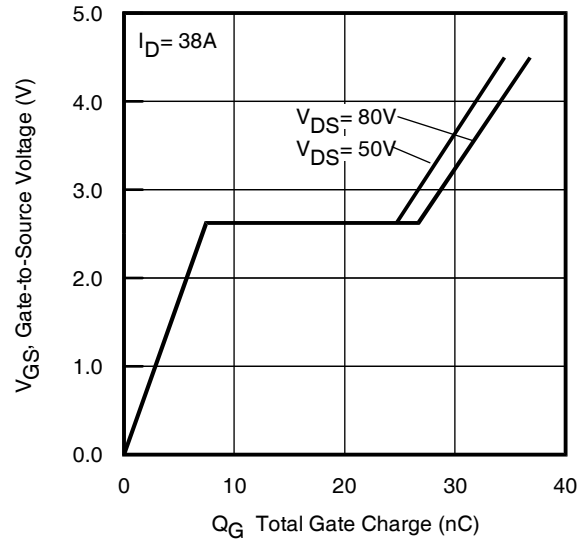
**Fig 3.** Typical Transfer Characteristics



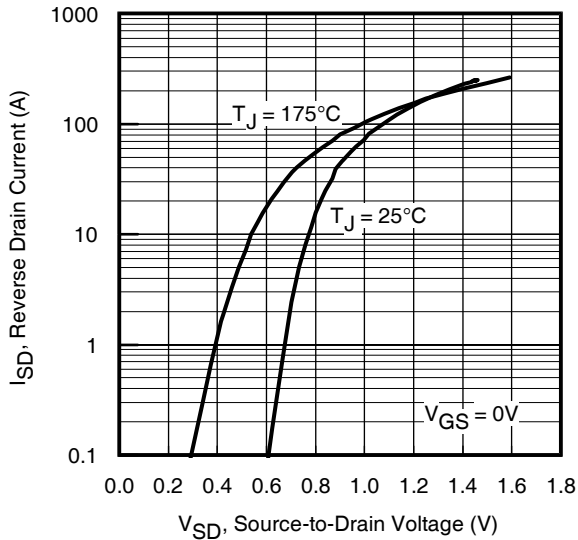
**Fig 4.** Typical Forward Transconductance vs. Drain Current



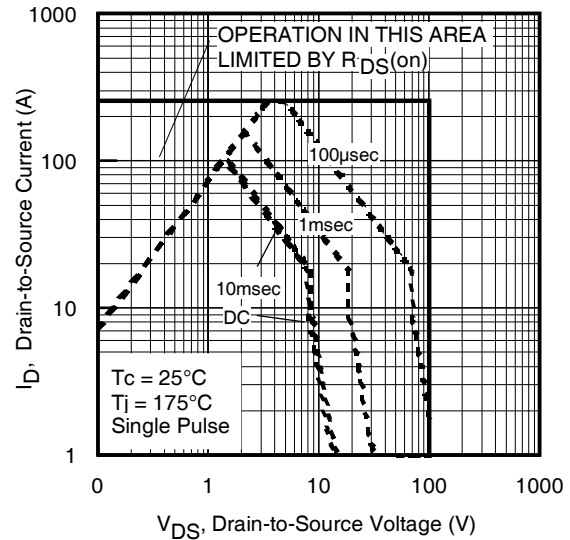
**Fig 5.** Typical Capacitance vs. Drain-to-Source Voltage



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



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



**Fig 8.** Maximum Safe Operating Area

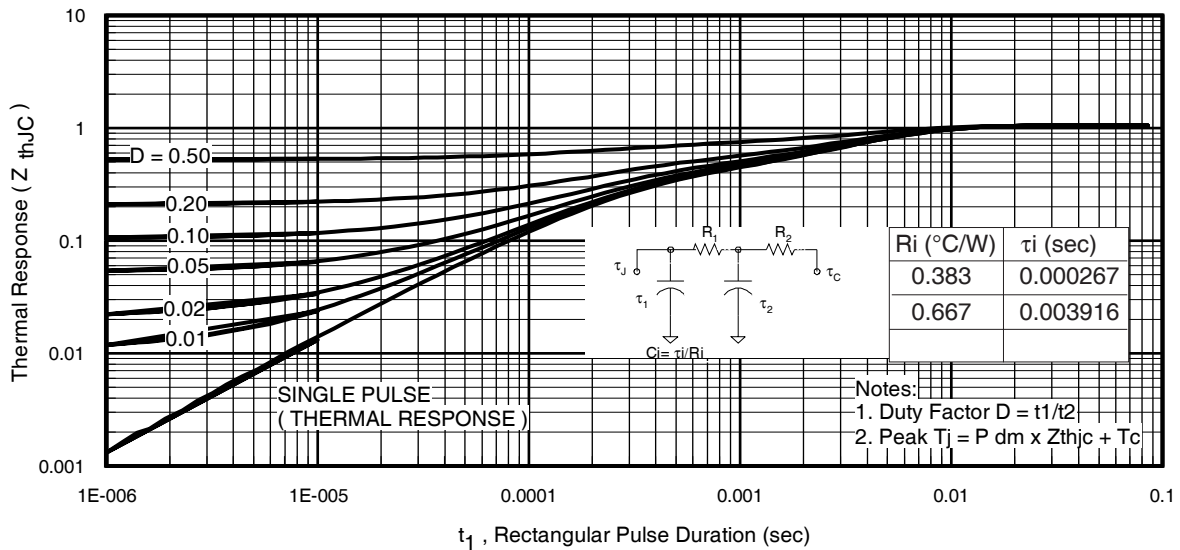
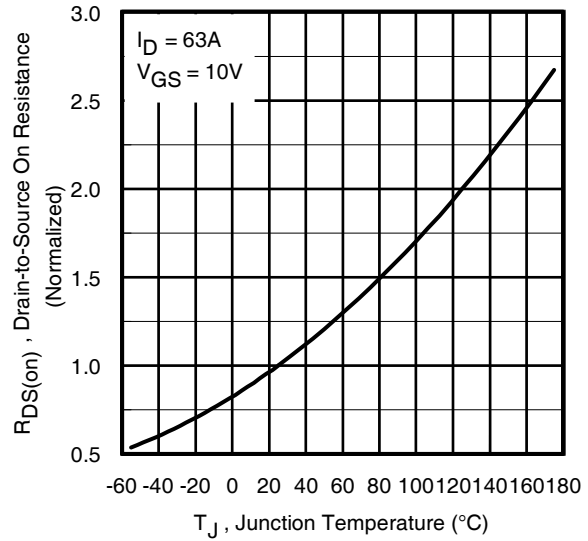
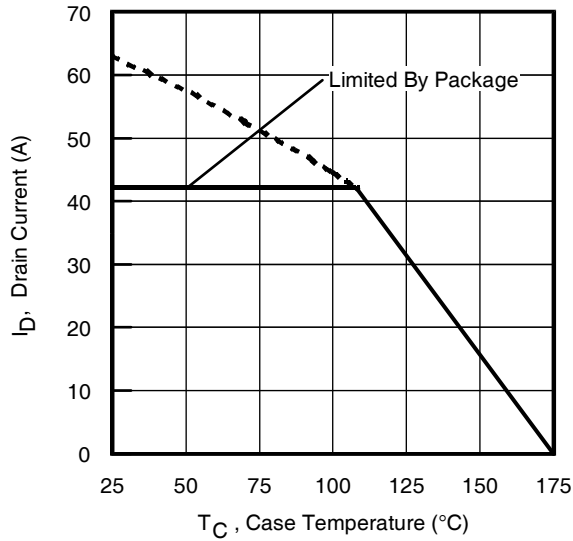
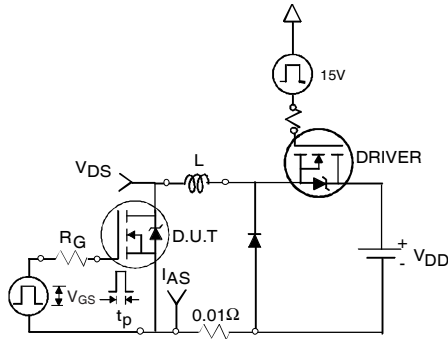


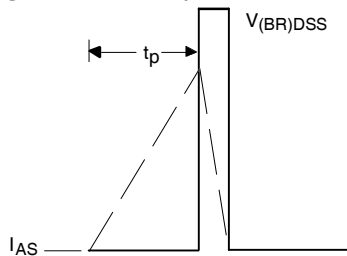
Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

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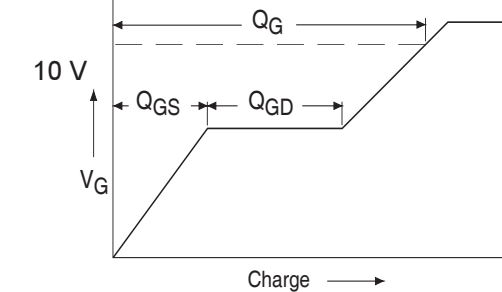
International  
**IR** Rectifier



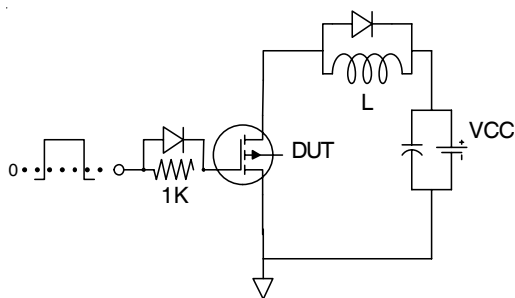
**Fig 12a.** Unclamped Inductive Test Circuit



**Fig 12b.** Unclamped Inductive Waveforms

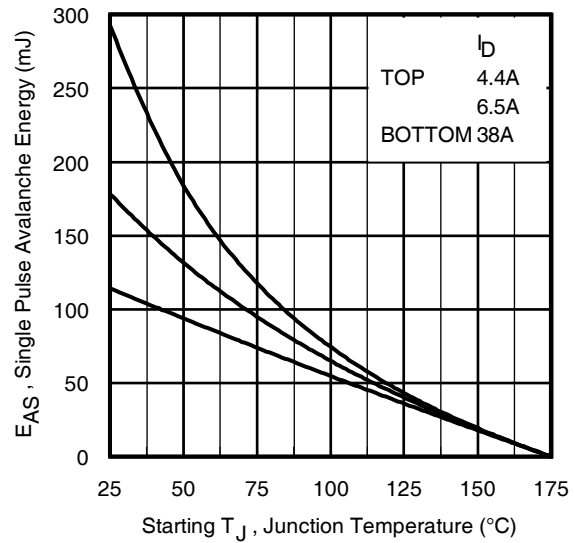


**Fig 13a.** Basic Gate Charge Waveform

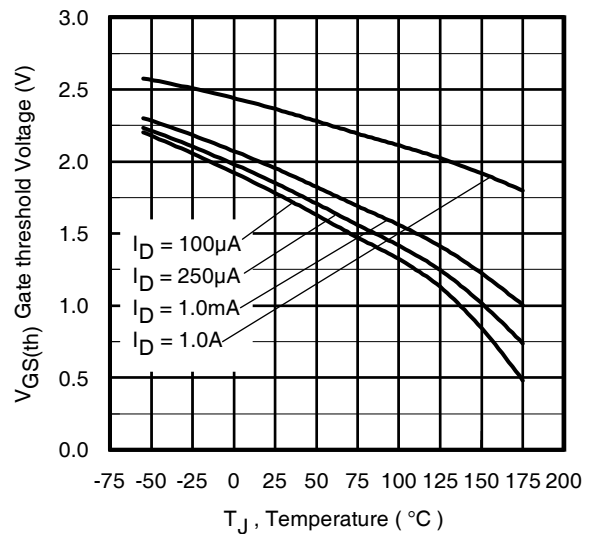


**Fig 13b.** Gate Charge Test Circuit

6



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



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

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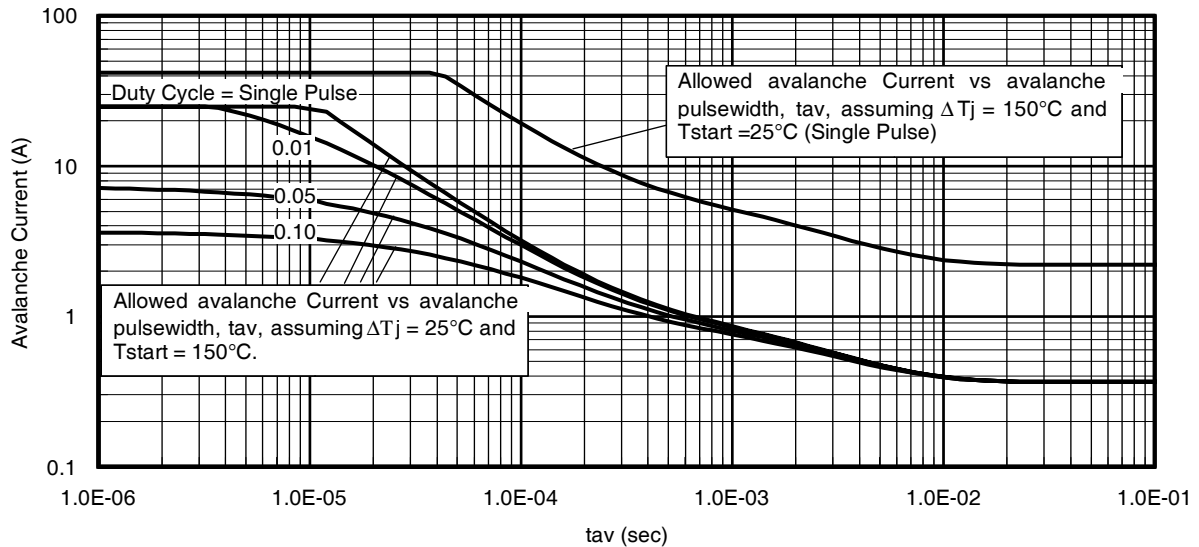


Fig 15. Typical Avalanche Current vs. Pulsewidth

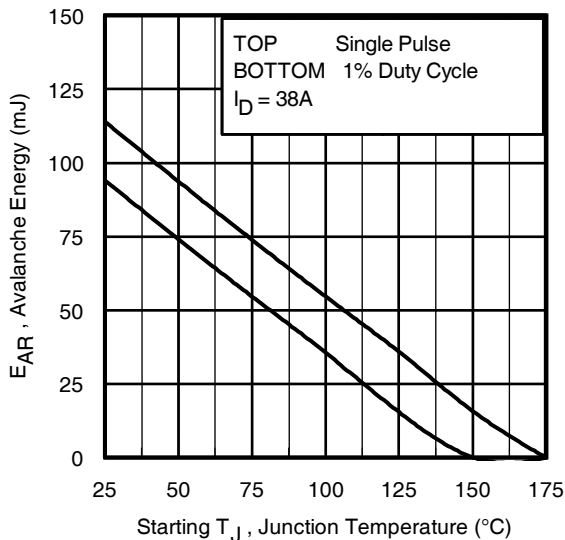


Fig 16. Maximum Avalanche Energy vs. Temperature

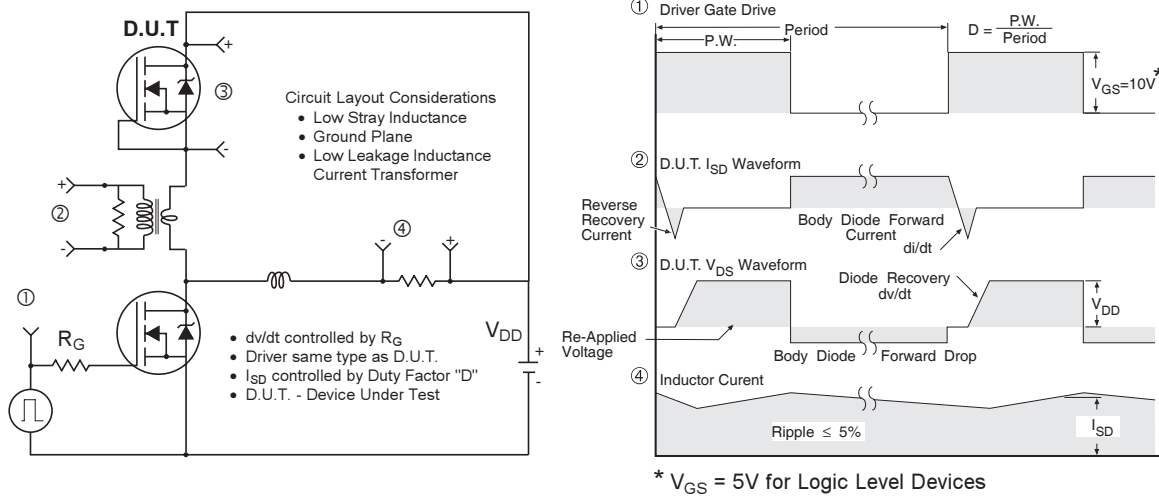
**Notes on Repetitive Avalanche Curves , Figures 15, 16:**  
(For further info, see AN-1005 at [www.irf.com](http://www.irf.com))

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 neither  $T_{jmax}$  nor  $I_{av}$  (max) is 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)

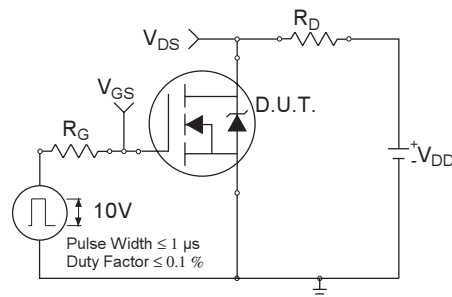
$$P_{D(ave)} = 1/2 (1.3 \cdot BV \cdot I_{av}) = \Delta T / Z_{thJC}$$

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

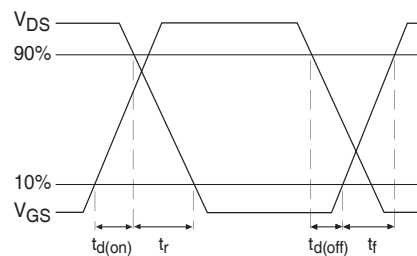
$$E_{AS(AR)} = P_{D(ave)} \cdot t_{av}$$



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



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

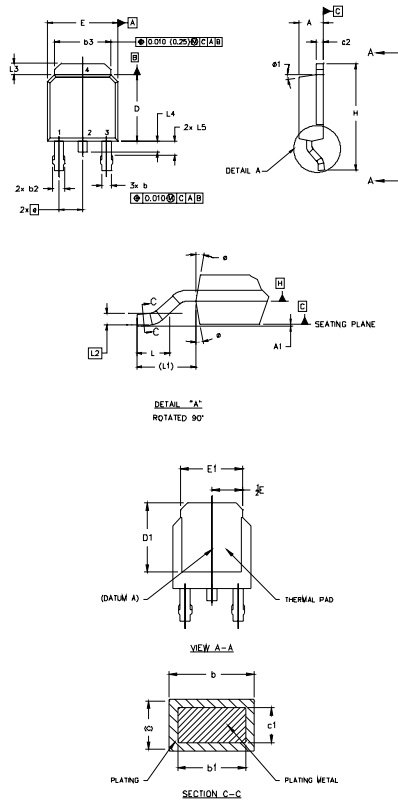


**Fig 18b. Switching Time Waveforms**



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

IRLR/U3110ZPbF



- 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 [0.254] FROM THE LEAD TIP.
  - 6.0 DIMENSION D & E DO NOT INCLUDE WOLD FLASH. WOLD 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  | 5<br><br>5 |
| A1     |             | 0.13  |           | .005  |            |
| b      | 0.64        | 0.89  | .025      | .035  |            |
| b1     | 0.64        | 0.79  | .025      | 0.031 |            |
| b2     | 0.76        | 1.14  | .030      | .045  |            |
| b3     | 4.95        | 5.46  | .195      | .215  |            |
| c      | 0.46        | 0.61  | .018      | .024  |            |
| c1     | 0.41        | 0.56  | .016      | .022  |            |
| c2     | .046        | 0.89  | .018      | .035  |            |
| D      | 5.97        | 6.22  | .235      | .245  |            |
| 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  |            |
| ø      | 0"          | 10"   | 0"        | 0"    | 3          |
| ø1     | 0"          | 15"   | 0"        | 15"   |            |

LEAD ASSIGNMENTS

HXFEXT

1.- GATE

2.- DRAIN

3.- SOURCE

4.- DRAIN

ICBTS, 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 WW 16, 2001  
IN THE ASSEMBLY LINE 'A'

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

INTERNATIONAL  
RECTIFIER  
LOGO

INTERNATIONAL  
RECTIFIER  
LOGO

ASSEMBLY  
LOT CODE

PART NUMBER

DATE CODE  
YEAR 1 = 2001  
WEEK 16  
LINE A

OR

INTERNATIONAL  
RECTIFIER  
LOGO



PART NUMBER

DATE CODE  
P = DESIGNATES LEAD-FREE  
PRODUCT (OPTIONAL)

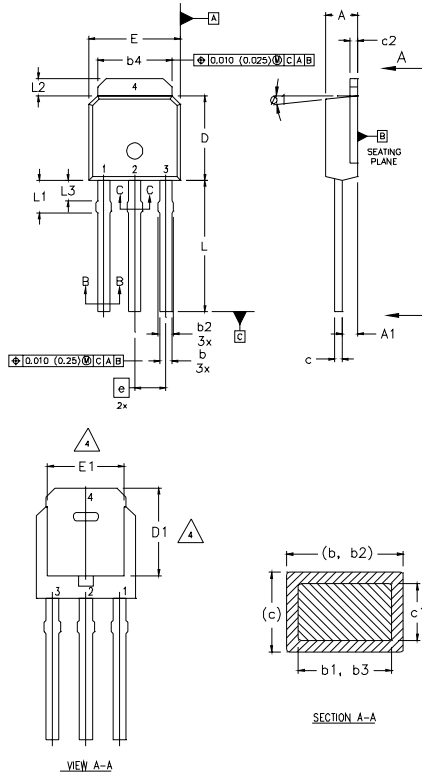
YEAR 1 = 2001  
WEEK 16  
A = ASSEMBLY SITE CODE

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

# IRLR/U3110ZPbF

International  
**IR** Rectifier

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



### 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

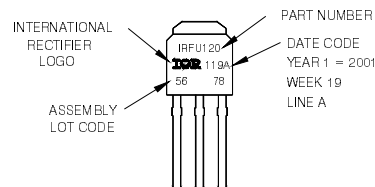
- 1.- GATE
- 2.- DRAIN
- 3.- SOURCE
- 4.- DRAIN

| 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     | Ø           | 15°  | Ø         | 15°   |       |

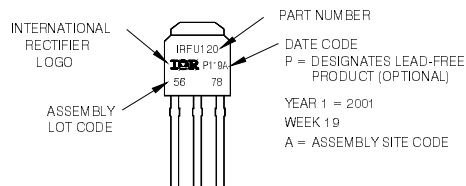
## I-Pak (TO-251AA) Part Marking Information

EXAMPLE: THIS IS AN IRFU120  
WITH ASSEMBLY  
LOT CODE 5678  
ASSEMBLED ON WW 19, 2001  
IN THE ASSEMBLY LINE 'A'

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



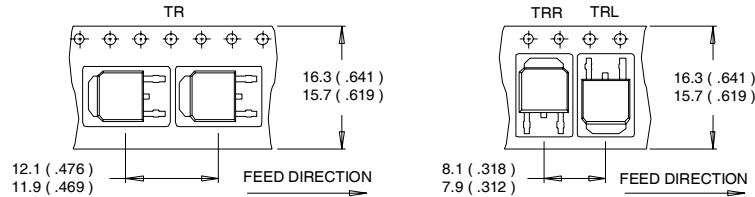
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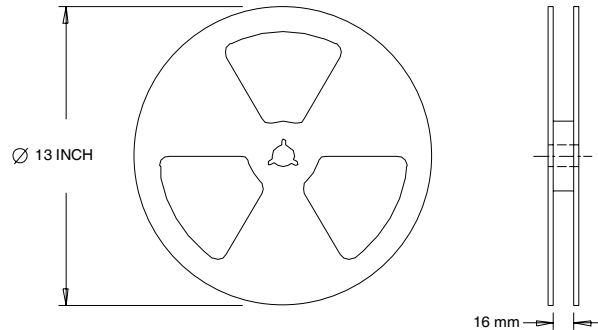
Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>

## 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  $T_J = 25^\circ\text{C}$ ,  $L = 0.16\text{mH}$ ,  $R_G = 25\Omega$ ,  $I_{AS} = 38\text{A}$ ,  $V_{GS} = 10\text{V}$ . Part not recommended for use above this value.
- ③ Pulse width  $\leq 1.0\text{ms}$ ; 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 When mounted on 1" square PCB (FR-4 or G-10 Material).
- ⑧  $R_\theta$  is measured at  $T_J$  approximately  $90^\circ\text{C}$ .

Data and specifications subject to change without notice.  
This product has been designed for the Industrial market.  
Qualification Standards can be found on IR's Web site.

International  
**IR** Rectifier

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