

# IRFR4620PbF IRFU4620PbF

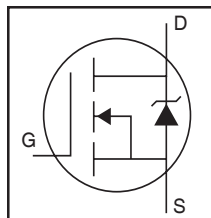
HEXFET® Power MOSFET

## Applications

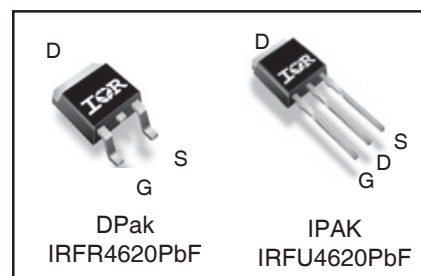
- High Efficiency Synchronous Rectification in SMPS
- Uninterruptible Power Supply
- High Speed Power Switching
- Hard Switched and High Frequency Circuits

## Benefits

- Improved Gate, Avalanche and Dynamic  $dV/dt$  Ruggedness
- Fully Characterized Capacitance and Avalanche SOA
- Enhanced body diode  $dV/dt$  and  $dI/dt$  Capability
- Lead-Free



|              |      |             |
|--------------|------|-------------|
| $V_{DSS}$    |      | <b>200V</b> |
| $R_{DS(on)}$ | typ. | <b>64mΩ</b> |
|              | max. | <b>78mΩ</b> |
| $I_D$        |      | <b>24A</b>  |



| <b>G</b> | <b>D</b> | <b>S</b> |
|----------|----------|----------|
| Gate     | Drain    | Source   |

## Absolute Maximum Ratings

| Symbol                            | Parameter  | Max.         | Units |
|-----------------------------------|--|--------------|-------|
| $I_D$ @ $T_C = 25^\circ\text{C}$  | Continuous Drain Current, $V_{GS}$ @ 10V                   | 24           | A     |
| $I_D$ @ $T_C = 100^\circ\text{C}$ | Continuous Drain Current, $V_{GS}$ @ 10V                   | 17           |       |
| $I_{DM}$                          | Pulsed Drain Current ①                                     | 100          |       |
| $P_D$ @ $T_C = 25^\circ\text{C}$  | Maximum Power Dissipation                                  | 144          | W     |
|                                   | Linear Derating Factor                                     | 0.96         | W/°C  |
| $V_{GS}$                          | Gate-to-Source Voltage                                     | $\pm 20$     | V     |
| $dv/dt$                           | Peak Diode Recovery ③                                      | 54           | V/ns  |
| $T_J$<br>$T_{STG}$                | Operating Junction and<br>Storage Temperature Range        | -55 to + 175 | °C    |
|                                   | Soldering Temperature, for 10 seconds<br>(1.6mm from case) | 300          |       |

## Avalanche Characteristics

|                              |                                 |                            |    |
|------------------------------|---------------------------------|----------------------------|----|
| $E_{AS}$ (Thermally limited) | Single Pulse Avalanche Energy ② | 113                        | mJ |
| $I_{AR}$                     | Avalanche Current ①             | See Fig. 14, 15, 22a, 22b, | A  |
| $E_{AR}$                     | Repetitive Avalanche Energy ①   |                            | mJ |

## Thermal Resistance

| Symbol          | Parameter                         | Typ. | Max.  | Units |
|-----------------|-----------------------------------|------|-------|-------|
| $R_{\theta JC}$ | Junction-to-Case ⑧                | —    | 1.045 | °C/W  |
| $R_{\theta JA}$ | Junction-to-Ambient (PCB Mount) ⑦ | —    | 50    |       |
| $R_{\theta JA}$ | Junction-to-Ambient               | —    | 110   |       |

## ORDERING INFORMATION:

See detailed ordering and shipping information on the last page of this data sheet.

Notes ① through ⑧ are on page 11

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

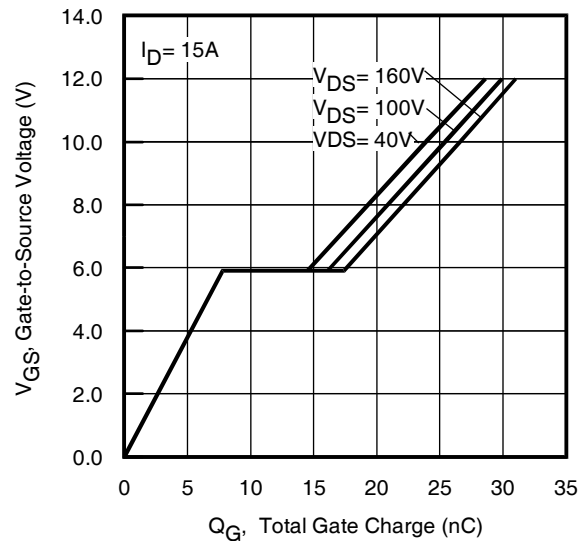
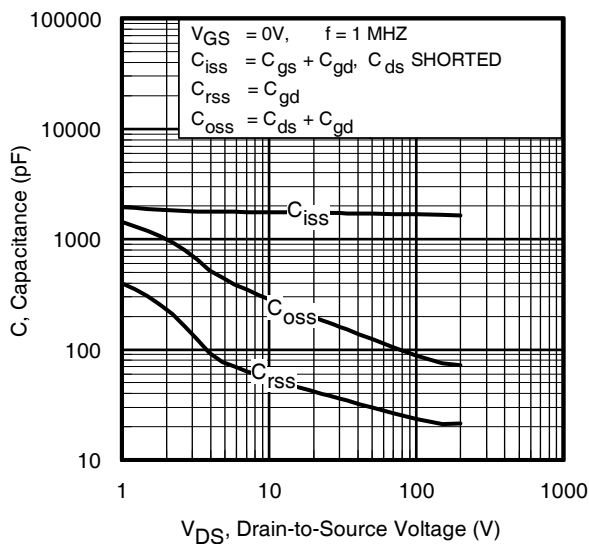
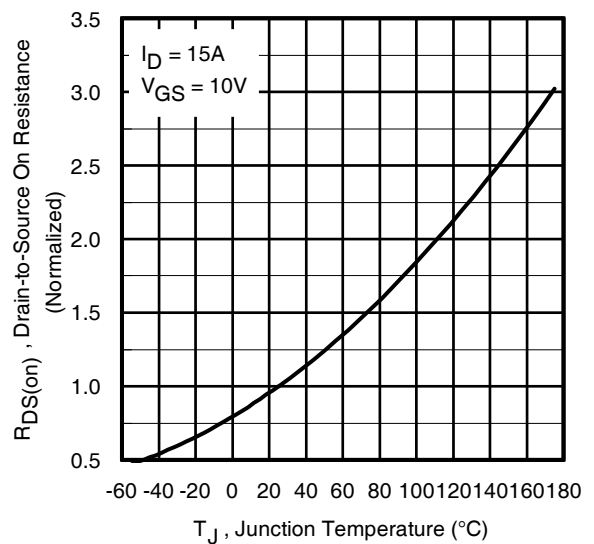
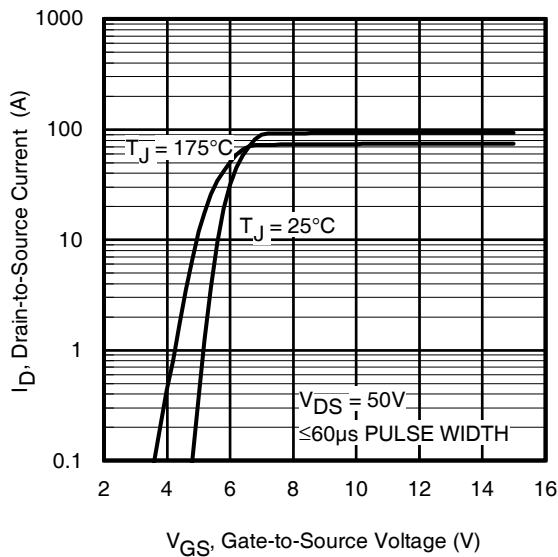
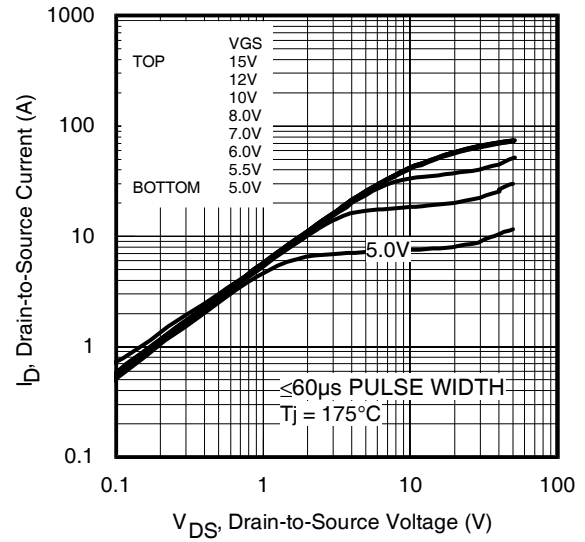
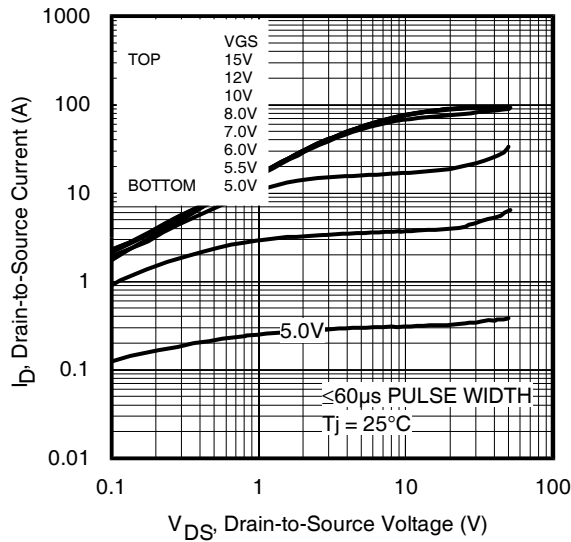
| Symbol                          | Parameter                            | Min. | Typ. | Max. | Units               | Conditions  |
|---------------------------------|--------------------------------------|------|------|------|---------------------|---|
| $V_{(BR)DSS}$                   | Drain-to-Source Breakdown Voltage    | 200  | —    | —    | V                   | $V_{GS} = 0V, I_D = 250\mu A$                         |
| $\Delta V_{(BR)DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient  | —    | 0.23 | —    | V/ $^\circ\text{C}$ | Reference to $25^\circ\text{C}$ , $I_D = 5mA$ ①       |
| $R_{DS(on)}$                    | Static Drain-to-Source On-Resistance | —    | 64   | 78   | m $\Omega$          | $V_{GS} = 10V, I_D = 15A$ ④                           |
| $V_{GS(th)}$                    | Gate Threshold Voltage               | 3.0  | —    | 5.0  | V                   | $V_{DS} = V_{GS}, I_D = 100\mu A$                     |
| $I_{DSS}$                       | Drain-to-Source Leakage Current      | —    | —    | 20   | $\mu A$             | $V_{DS} = 200V, V_{GS} = 0V$                          |
|                                 |                                      | —    | —    | 250  |                     | $V_{DS} = 200V, V_{GS} = 0V, T_J = 125^\circ\text{C}$ |
| $I_{GSS}$                       | Gate-to-Source Forward Leakage       | —    | —    | 100  | nA                  | $V_{GS} = 20V$  |
|                                 | Gate-to-Source Reverse Leakage       | —    | —    | -100 |                     | $V_{GS} = -20V$                                       |
| $R_{G(int)}$                    | Internal Gate Resistance             | —    | 2.6  | —    | $\Omega$            |   |

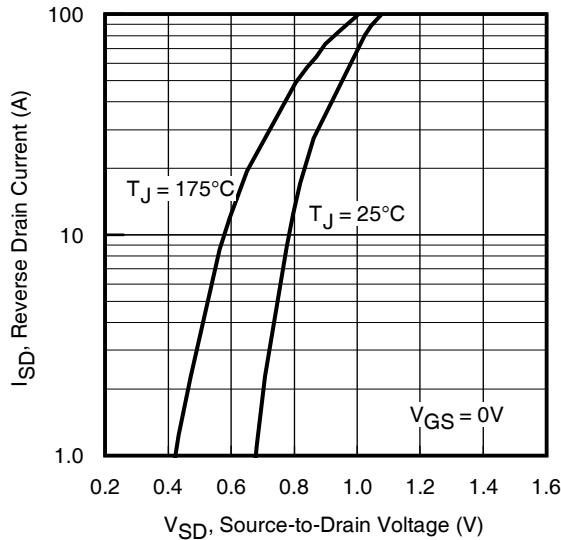
**Dynamic @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)**

| Symbol                      | Parameter                                      | Min. | Typ. | Max. | Units | Conditions  |
|-----------------------------|--|------|------|------|-------|---|
| gfs                         | Forward Transconductance                       | 37   | —    | —    | S     | $V_{DS} = 50V, I_D = 15A$                                 |
| $Q_g$                       | Total Gate Charge                              | —    | 25   | 38   | nC    | $I_D = 15A$   |
| $Q_{gs}$                    | Gate-to-Source Charge                          | —    | 8.2  | —    |       | $V_{DS} = 100V$   |
| $Q_{gd}$                    | Gate-to-Drain ("Miller") Charge                | —    | 7.9  | —    |       | $V_{GS} = 10V$ ④  |
| $Q_{sync}$                  | Total Gate Charge Sync. ( $Q_g - Q_{gd}$ )     | —    | 17   | —    |       | $I_D = 15A, V_{DS} = 0V, V_{GS} = 10V$                    |
| $t_{d(on)}$                 | Turn-On Delay Time                             | —    | 13.4 | —    | ns    | $V_{DD} = 130V$   |
| $t_r$                       | Rise Time                                      | —    | 22.4 | —    |       | $I_D = 15A$   |
| $t_{d(off)}$                | Turn-Off Delay Time                            | —    | 25.4 | —    |       | $R_G = 7.3\Omega$   |
| $t_f$                       | Fall Time                                      | —    | 14.8 | —    |       | $V_{GS} = 10V$ ④  |
| $C_{iss}$                   | Input Capacitance                              | —    | 1710 | —    | pF    | $V_{GS} = 0V$   |
| $C_{oss}$                   | Output Capacitance                             | —    | 125  | —    |       | $V_{DS} = 50V$  |
| $C_{rss}$                   | Reverse Transfer Capacitance                   | —    | 30   | —    |       | $f = 1.0MHz$ (See Fig.5)                                  |
| $C_{oss \text{ eff. (ER)}}$ | Effective Output Capacitance (Energy Related)⑥ | —    | 113  | —    |       | $V_{GS} = 0V, V_{DS} = 0V \text{ to } 160V$ ⑥(See Fig.11) |
| $C_{oss \text{ eff. (TR)}}$ | Effective Output Capacitance (Time Related)⑤   | —    | 317  | —    |       | $V_{GS} = 0V, V_{DS} = 0V \text{ to } 160V$ ⑤             |

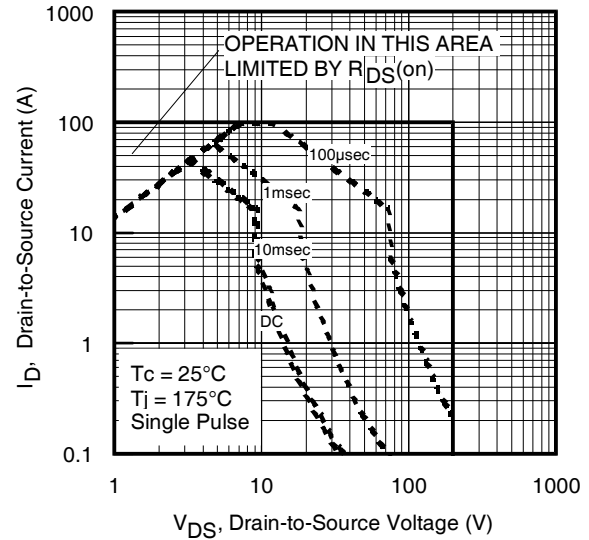
**Diode Characteristics**

| Symbol    | Parameter                                 | Min.   | Typ. | Max. | Units | Conditions  |
|-----------|---|--|------|------|-------|---|
| $I_S$     | Continuous Source Current<br>(Body Diode) | —  | —    | 24   | A     | MOSFET symbol<br>showing the<br>integral reverse<br>p-n junction diode. |
| $I_{SM}$  | Pulsed Source Current<br>(Body Diode) ①   | —  | —    | 100  |       |   |
| $V_{SD}$  | Diode Forward Voltage                     | —  | —    | 1.3  | V     | $T_J = 25^\circ\text{C}, I_S = 15A, V_{GS} = 0V$ ④                      |
| $t_{rr}$  | Reverse Recovery Time                     | —  | 78   | —    | ns    | $T_J = 25^\circ\text{C}$ $V_R = 100V,$                                  |
|           |   | —  | 99   | —    |       | $T_J = 125^\circ\text{C}$ $I_F = 15A$                                   |
| $Q_{rr}$  | Reverse Recovery Charge                   | —  | 294  | —    | nC    | $T_J = 25^\circ\text{C}$ $di/dt = 100A/\mu s$ ④                         |
|           |   | —  | 432  | —    |       | $T_J = 125^\circ\text{C}$   |
| $I_{RRM}$ | Reverse Recovery Current                  | —  | 7.6  | —    | A     | $T_J = 25^\circ\text{C}$  |
| $t_{on}$  | Forward Turn-On Time                      | Intrinsic turn-on time is negligible (turn-on is dominated by LS+LD) |      |      |       |   |

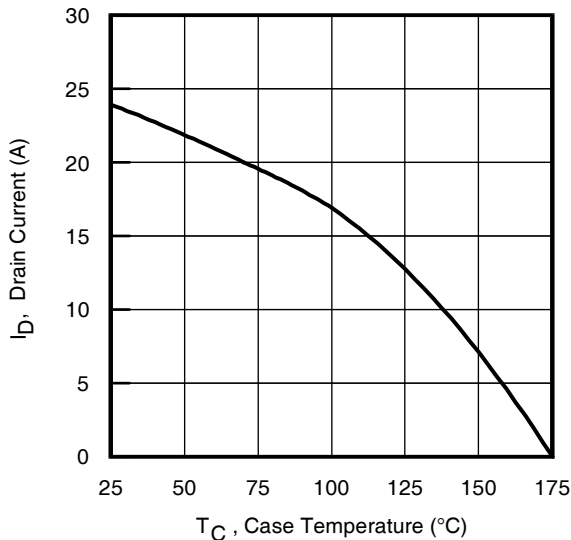




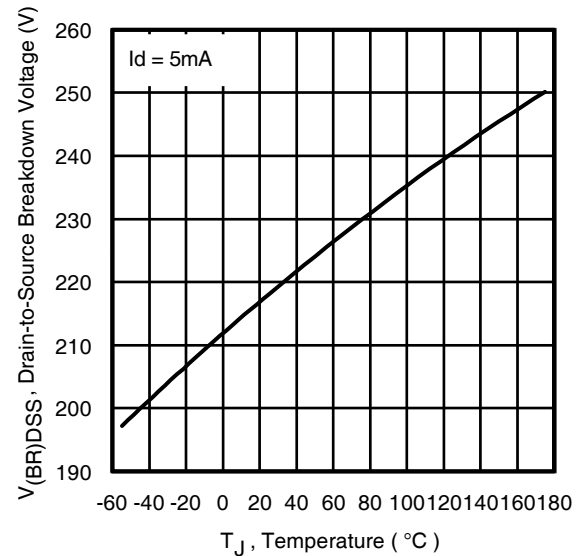
**Fig 7.** Typical Source-Drain Diode Forward Voltage



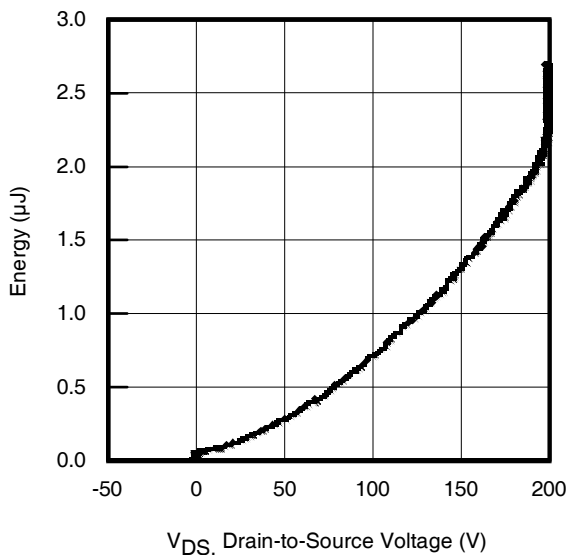
**Fig 8.** Maximum Safe Operating Area



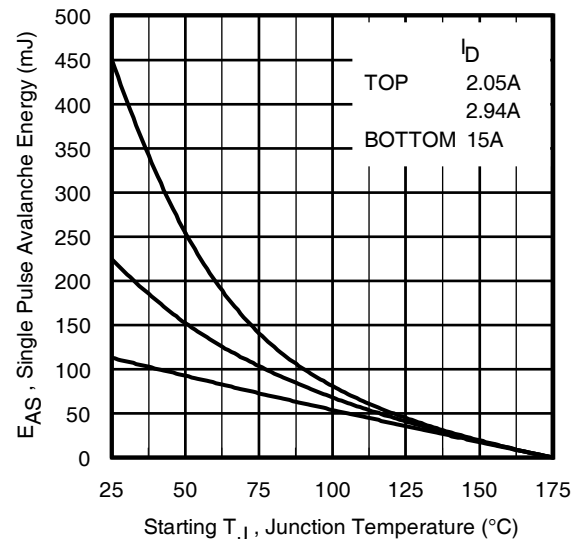
**Fig 9.** Maximum Drain Current vs. Case Temperature



**Fig 10.** Drain-to-Source Breakdown Voltage



**Fig 11.** Typical  $C_{OSS}$  Stored Energy



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

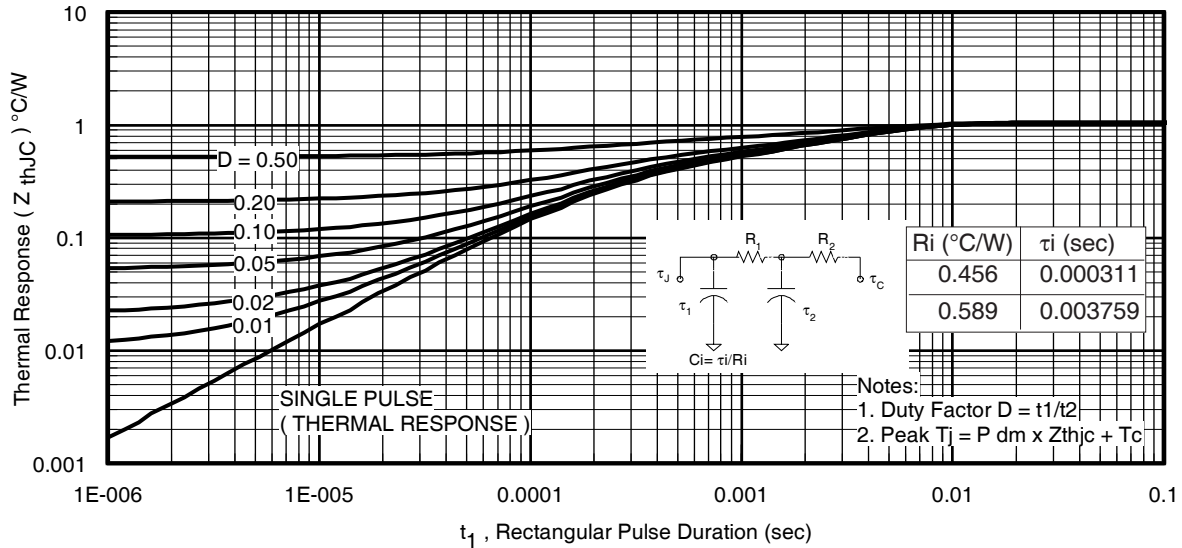


Fig 13. Maximum Effective Transient Thermal Impedance, Junction-to-Case

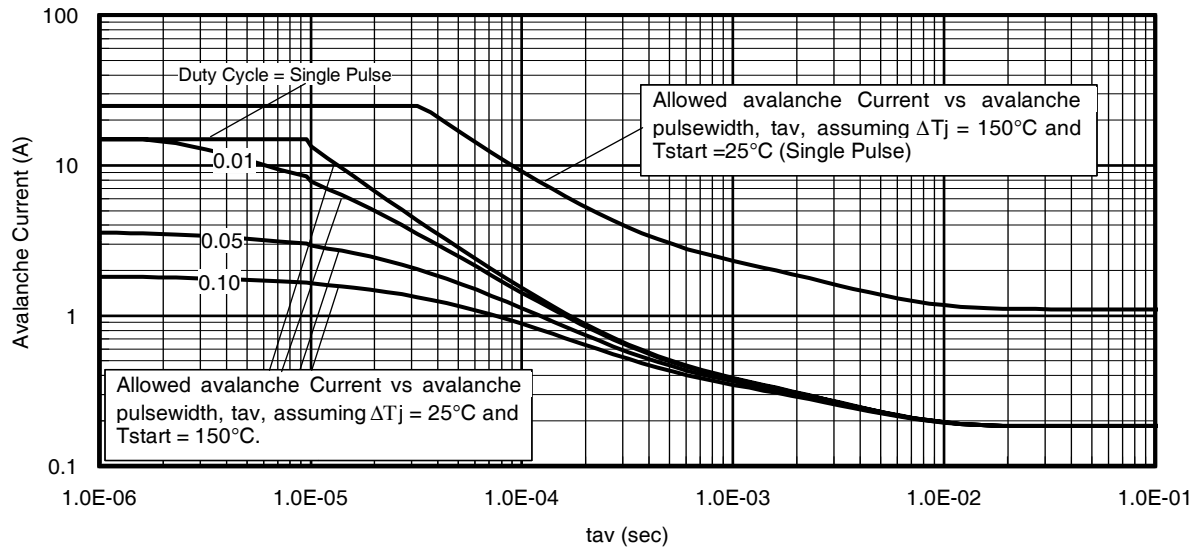


Fig 14. Typical Avalanche Current vs. Pulsewidth

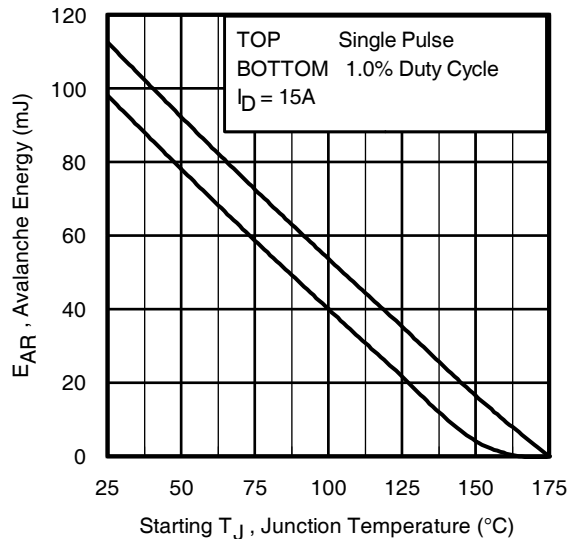


Fig 15. Maximum Avalanche Energy vs. Temperature

Notes on Repetitive Avalanche Curves, Figures 14, 15:  
(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 16a, 16b.
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 14, 15).  
 $t_{av}$  = Average time in avalanche.  
 $D$  = Duty cycle in avalanche =  $t_{av} \cdot f$   
 $Z_{thJC}(D, t_{av})$  = Transient thermal resistance, see Figures 13)

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

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

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

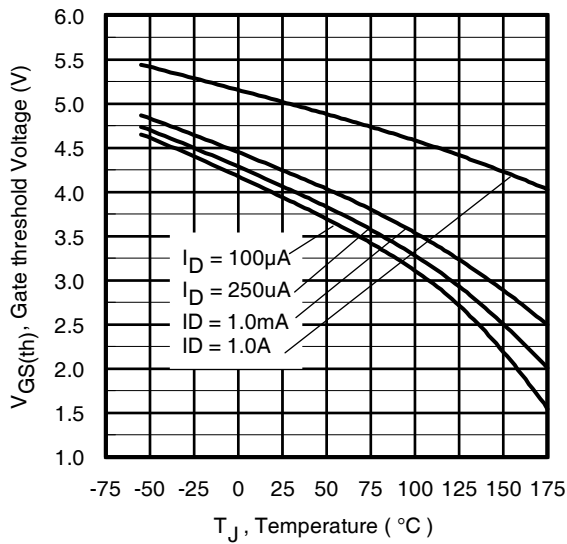


Fig 16. Threshold Voltage vs. Temperature

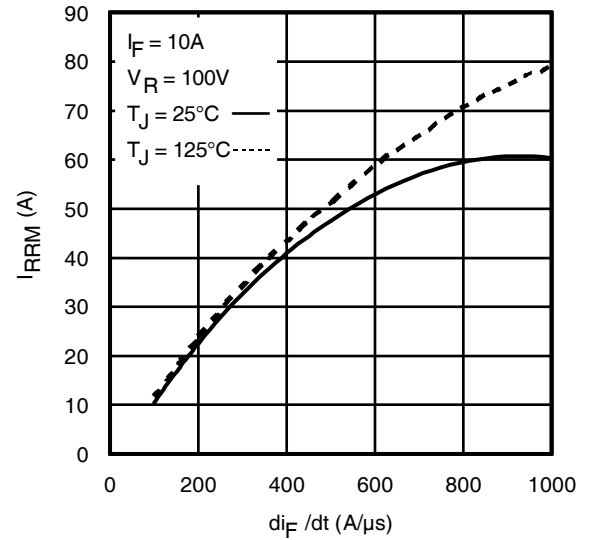


Fig. 17 - Typical Recovery Current vs.  $di_F/dt$

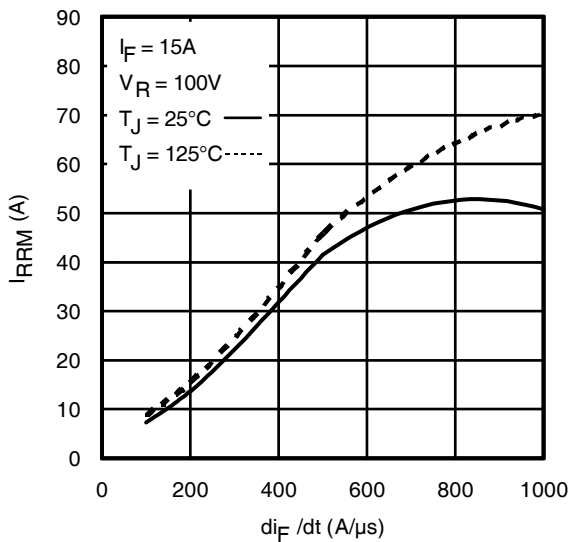


Fig. 18 - Typical Recovery Current vs.  $di_F/dt$

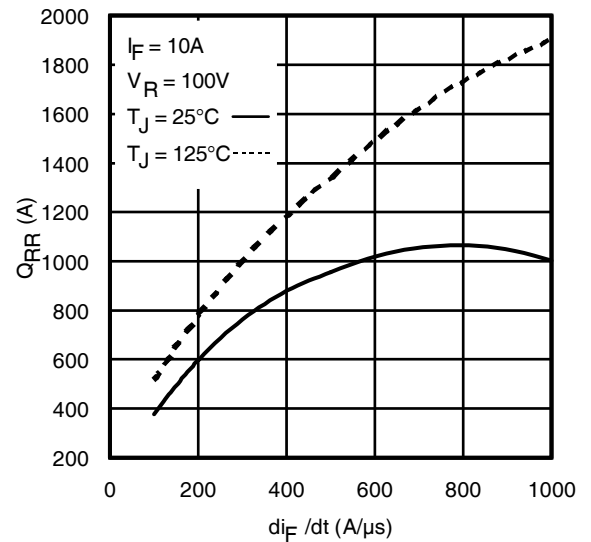


Fig. 19 - Typical Stored Charge vs.  $di_F/dt$

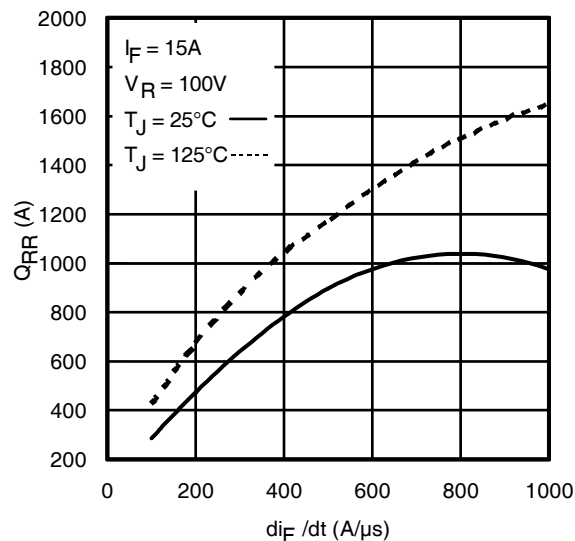
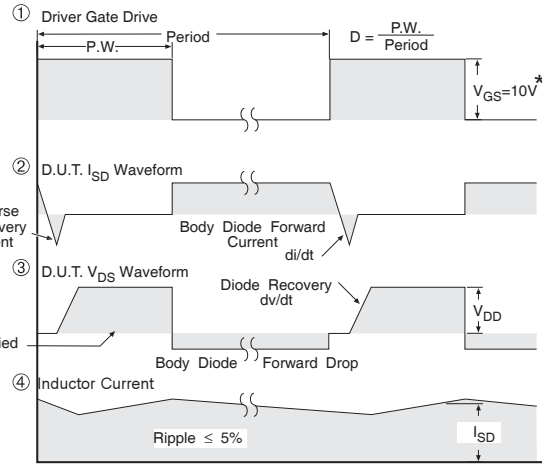
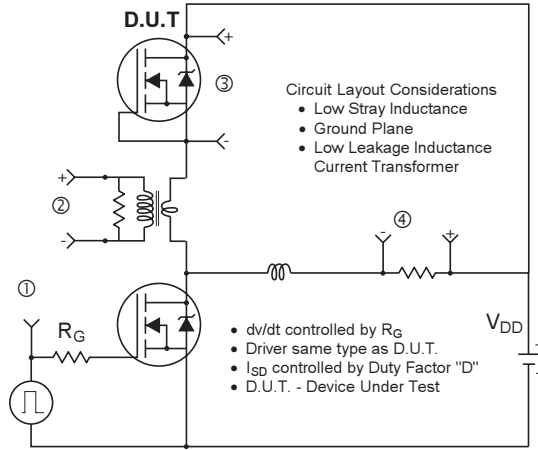
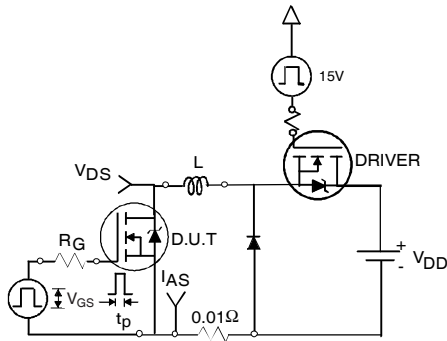


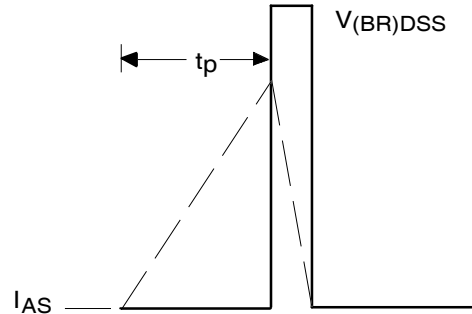
Fig. 20 - Typical Stored Charge vs.  $di_F/dt$



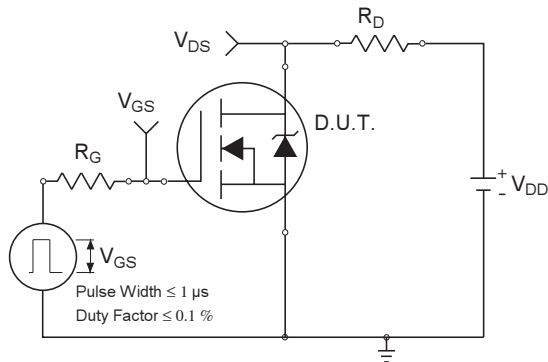
**Fig 21. Peak Diode Recovery  $dv/dt$  Test Circuit for N-Channel HEXFET® Power MOSFETs**



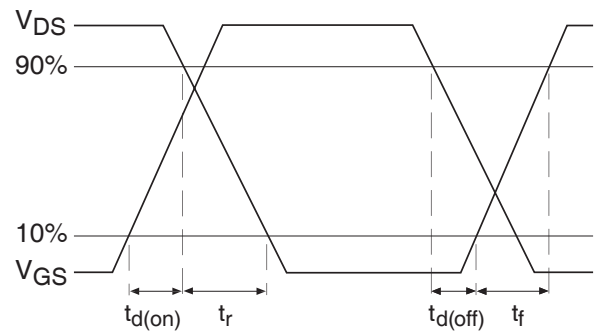
**Fig 22a. Unclamped Inductive Test Circuit**



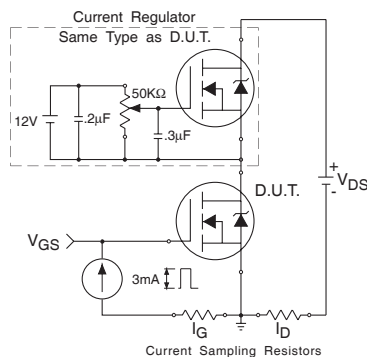
**Fig 22b. Unclamped Inductive Waveforms**



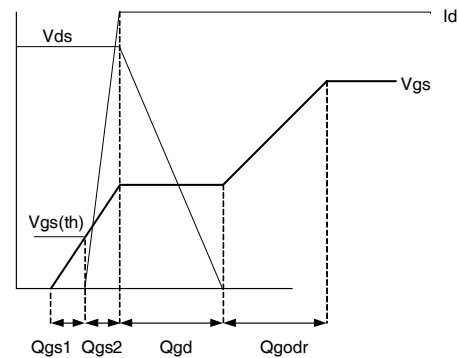
**Fig 23a. Switching Time Test Circuit**



**Fig 23b. Switching Time Waveforms**



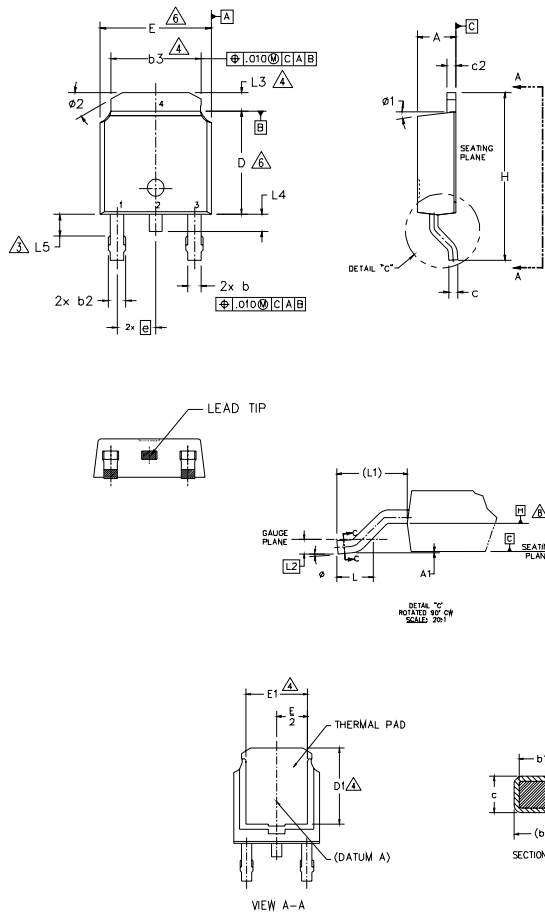
**Fig 24a. Gate Charge Test Circuit**



**Fig 24b. Gate Charge Waveform**

# 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 | 7     |
| A1     | —           | 0.13  | —         | .005 |       |
| b      | 0.64        | 0.89  | .025      | .035 |       |
| b1     | 0.65        | 0.79  | .025      | .031 |       |
| b2     | 0.76        | 1.14  | .030      | .045 | 4     |
| b3     | 4.95        | 5.46  | .195      | .215 |       |
| c      | 0.46        | 0.61  | .018      | .024 |       |
| c1     | 0.41        | 0.56  | .016      | .022 |       |
| c2     | 0.46        | 0.89  | .018      | .035 | 7     |
| D      | 5.97        | 6.22  | .235      | .245 |       |
| D1     | 5.21        | —     | .205      | —    |       |
| E      | 6.35        | 6.73  | .250      | .265 |       |
| 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. |      | 4     |
| L2     | 0.51 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"  |       |
| ø2     | 25"         | 35"   | 25"       | 35"  |       |

## LEAD ASSIGNMENTS

## HEXFET

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

## IGBT & CoPAK

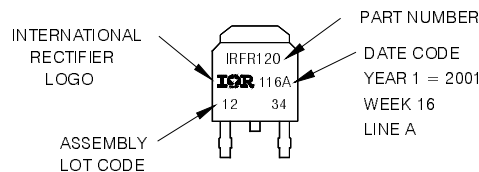
- 1.- GATE
- 2.- COLLECTOR
- 3.- EMITTER
- 4.- COLLECTOR

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

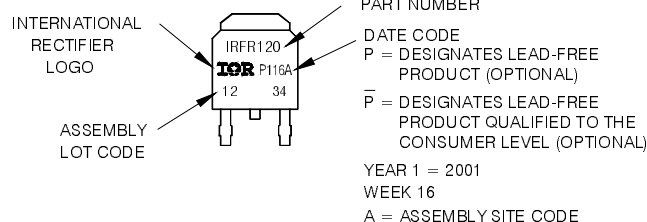
EXAMPLE: THIS IS AN IRFR120  
WITH ASSEMBLY  
LOT CODE 1234  
ASSEMBLED ON WW 16, 2001  
IN THE ASSEMBLY LINE 'A'

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

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



OR

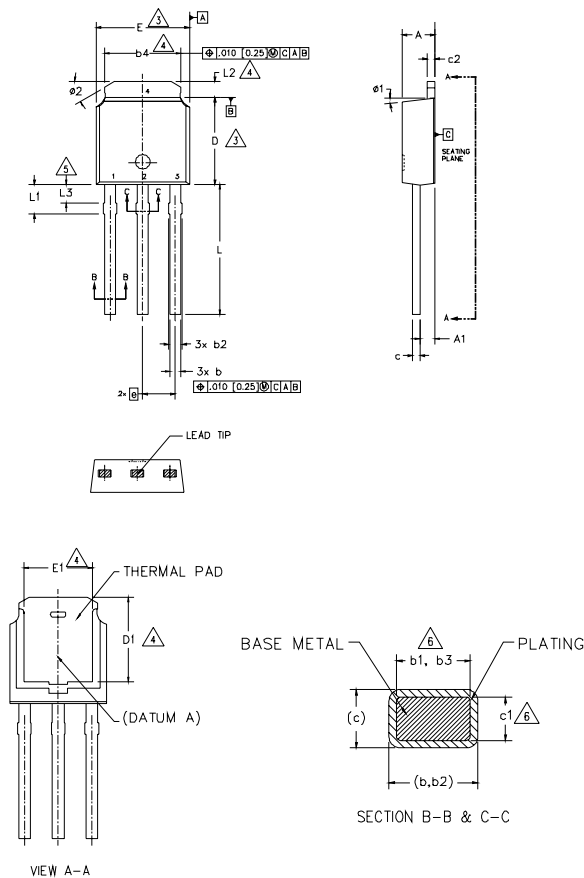


Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>



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

Dimensions are shown in millimeters (inches)



### NOTES:

- 1.- DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
- 2.- DIMENSION ARE SHOWN IN INCHES [MILLIMETERS].
- 3.- 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.
- 4.- THERMAL PAD CONTOUR OPTION WITHIN DIMENSION b4, L2, E1 & D1.
- 5.- LEAD DIMENSION UNCONTROLLED IN L3.
- 6.- DIMENSION b1, b3 & c1 APPLY TO BASE METAL ONLY.
- 7.- OUTLINE CONFORMS TO JEDEC OUTLINE TO-251AA (Date 06/02).
- 8.- CONTROLLING DIMENSION : INCHES.

| SYM<br>BOL | 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 | 6     |
| b1         | 0.65        | 0.79 | .025     | .031 |       |
| 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 |       |
| L2         | 0.89        | 1.27 | .035     | .050 | 4     |
| L3         | 1.14        | 1.52 | .045     | .060 | 5     |
| ø1         | 0"          | 15"  | 0"       | 15"  |       |
| ø2         | 25"         | 35"  | 25"      | 35"  |       |

### LEAD ASSIGNMENTS

### HEXFET

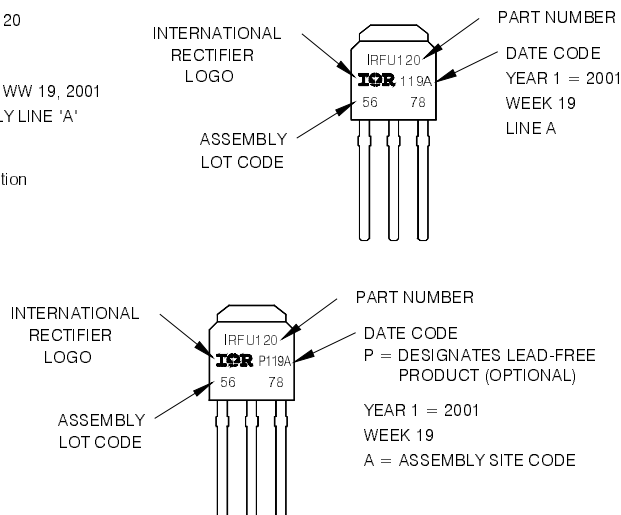
- 1.- GATE
- 2.- DRAIN
- 3.- SOURCE
- 4.- DRAIN

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

EXAMPLE: THIS IS AN 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

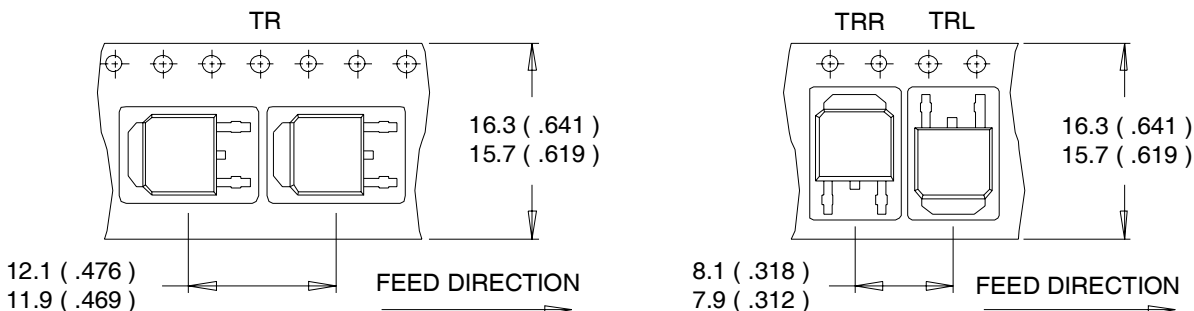
OR



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

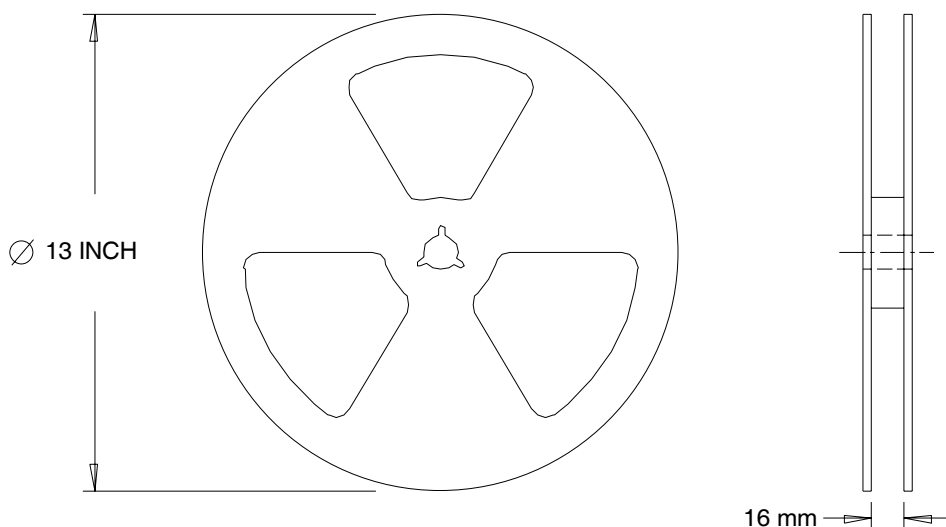
## D-Pak (TO-252AA) Tape & Reel Information

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.

| Orderable part number | Package Type | Standard Pack |          | Note |
|-----------------------|--------------|---------------|----------|------|
|                       |              | Form          | Quantity |      |
| IRFR4620PbF           | D-PAK        | Tube/Bulk     | 75       |      |
| IRFR4620TRPbF         | D-PAK        | Tape and Reel | 2000     |      |
| IRFU4620PbF           | I-PAK        | Tube/Bulk     | 75       |      |

### Qualification Information<sup>†</sup>

|                            |  |  |
|----------------------------|--|--|
| Qualification level        | Industrial <sup>††</sup>   |  |
|                            | (per JEDEC JESD47F <sup>†††</sup> guidelines)  |  |
|                            | Comments: This family of products has passed JEDEC's Industrial qualification. IR's Consumer qualification level is granted by extension of the higher Industrial level. |  |
| Moisture Sensitivity Level | D-PAK  | MSL1<br>(per JEDEC J-STD-020D <sup>†††</sup> ) |
|                            | I-PAK  | Not applicable                                 |
| RoHS Compliant             | Yes  |  |

† Qualification standards can be found at International Rectifier's web site <http://www.irf.com/product-info/reliability>

†† Higher qualification ratings may be available should the user have such requirements. Please contact your International Rectifier sales representative for further information: <http://www.irf.com/whoto-call/salesrep/>

††† Applicable version of JEDEC standard at the time of product release.

### Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Limited by  $T_{Jmax}$ , starting  $T_J = 25^\circ\text{C}$ ,  $L = 1.0\text{mH}$   
 $R_G = 25\Omega$ ,  $I_{AS} = 15\text{A}$ ,  $V_{GS} = 10\text{V}$ . Part not recommended for use above this value.
- ③  $I_{SD} \leq 15\text{A}$ ,  $di/dt \leq 634\text{A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_J \leq 175^\circ\text{C}$ .
- ④ Pulse width  $\leq 400\mu\text{s}$ ; duty cycle  $\leq 2\%$ .
- ⑤  $C_{oss}$  eff. (TR) 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  $C_{oss}$  eff. (ER) is a fixed capacitance that gives the same energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .
- ⑦ When mounted on 1" square PCB (FR-4 or G-10 Material). For recommended footprint and soldering techniques refer to application note #AN-994.
- ⑧  $R_\theta$  is measured at  $T_J$  approximately  $90^\circ\text{C}$

Data and specifications subject to change without notice

International  
**IR** Rectifier

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