

HEXFET® Power MOSFET

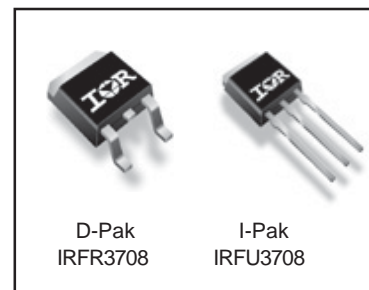
**Applications**

- High Frequency DC-DC Isolated Converters with Synchronous Rectification for Telecom and Industrial Use
- High Frequency Buck Converters for Computer Processor Power
- Lead-Free

<b>V<sub>DSS</sub></b>	<b>R<sub>DS(on)</sub> max</b>	<b>I<sub>D</sub></b>
<b>30V</b>	<b>12.5mΩ</b>	<b>61A<sup>④</sup></b>

**Benefits**

- Ultra-Low Gate Impedance
- Very Low R<sub>DS(on)</sub> at 4.5V V<sub>GS</sub>
- Fully Characterized Avalanche Voltage and Current



**Absolute Maximum Ratings**

Symbol	Parameter	Max.	Units
V <sub>DS</sub>	Drain-Source Voltage	30	V
V <sub>GS</sub>	Gate-to-Source Voltage	± 12	V
I <sub>D</sub> @ T <sub>A</sub> = 25°C	Continuous Drain Current, V <sub>GS</sub> @ 10V	61 <sup>④</sup>	A
I <sub>D</sub> @ T <sub>A</sub> = 70°C	Continuous Drain Current, V <sub>GS</sub> @ 10V	51 <sup>④</sup>	
I <sub>DM</sub>	Pulsed Drain Current <sup>①</sup>	244	
P <sub>D</sub> @ T <sub>A</sub> = 25°C	Maximum Power Dissipation <sup>③</sup>	87	W
P <sub>D</sub> @ T <sub>A</sub> = 70°C	Maximum Power Dissipation <sup>③</sup>	61	W
	Linear Derating Factor	0.58	W/°C
T <sub>J</sub> , T <sub>STG</sub>	Junction and Storage Temperature Range	-55 to + 175	°C

**Thermal Resistance**

	Parameter	Typ.	Max.	Units
R <sub>θJC</sub>	Junction-to-Case	—	1.73	°C/W
R <sub>θJA</sub>	Junction-to-Ambient (PCB mount)*	—	50	
R <sub>θJA</sub>	Junction-to-Ambient	—	110	

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

Notes ① through ④ are on page 9

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# IRFR/U3708PbF

International  
IR 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	30	—	—	V	$V_{GS} = 0V, I_D = 250\mu A$
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	0.028	—	V/°C	Reference to $25^\circ\text{C}, I_D = 1\text{mA}$
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	—	8.5	12.5	m $\Omega$	$V_{GS} = 10V, I_D = 15A$ ③
		—	10.0	14.0		$V_{GS} = 4.5V, I_D = 12A$ ③
		—	15.0	30.0		$V_{GS} = 2.8V, I_D = 7.5A$ ③
$V_{GS(th)}$	Gate Threshold Voltage	0.6	—	2.0	V	$V_{DS} = V_{GS}, I_D = 250\mu A$
$I_{DSS}$	Drain-to-Source Leakage Current	—	—	20	$\mu A$	$V_{DS} = 24V, V_{GS} = 0V$
		—	—	100		$V_{DS} = 24V, V_{GS} = 0V, T_J = 125^\circ\text{C}$
$I_{GSS}$	Gate-to-Source Forward Leakage	—	—	200	nA	$V_{GS} = 12V$
	Gate-to-Source Reverse Leakage	—	—	-200		$V_{GS} = -12V$

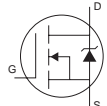
## Dynamic @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

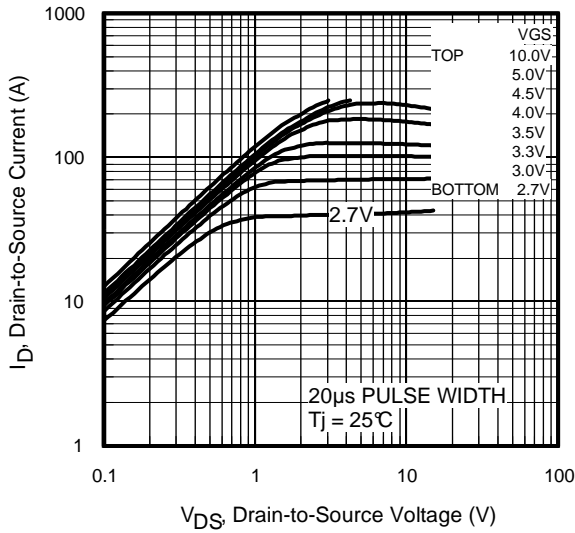
Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
$g_{fs}$	Forward Transconductance	49	—	—	S	$V_{DS} = 15V, I_D = 50A$
$Q_g$	Total Gate Charge	—	24	—	nC	$I_D = 24.8A$ $V_{DS} = 15V$ $V_{GS} = 4.5V$ ③
$Q_{gs}$	Gate-to-Source Charge	—	6.7	—		
$Q_{gd}$	Gate-to-Drain ("Miller") Charge	—	5.8	—		
$Q_{oss}$	Output Gate Charge	—	14	21		
$t_{d(on)}$	Turn-On Delay Time	—	7.2	—	ns	$V_{DD} = 15V$ $I_D = 24.8A$ $R_G = 0.6\Omega$ $V_{GS} = 4.5V$ ③
$t_r$	Rise Time	—	50	—		
$t_{d(off)}$	Turn-Off Delay Time	—	17.6	—		
$t_f$	Fall Time	—	3.7	—		
$C_{iss}$	Input Capacitance	—	2417	—	pF	$V_{GS} = 0V$ $V_{DS} = 15V$ $f = 1.0\text{MHz}$
$C_{oss}$	Output Capacitance	—	707	—		
$C_{rss}$	Reverse Transfer Capacitance	—	52	—		

## Avalanche Characteristics

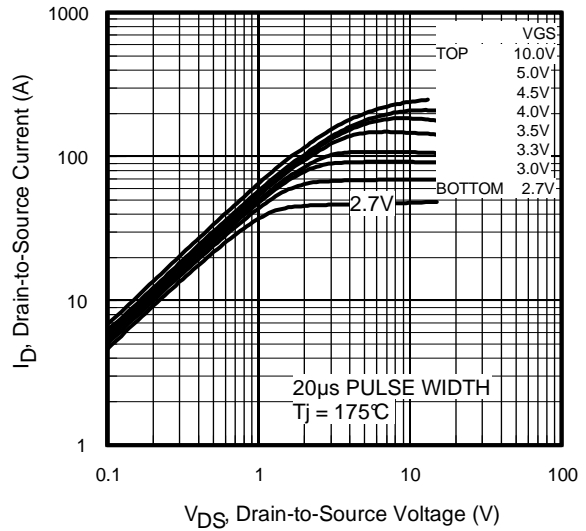
Symbol	Parameter	Typ.	Max.	Units
$E_{AS}$	Single Pulse Avalanche Energy②	—	213	mJ
$I_{AR}$	Avalanche Current①	—	62	A

## Diode Characteristics

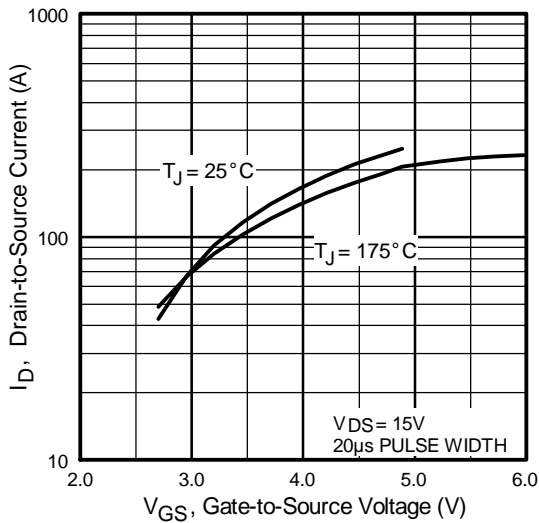
Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
$I_S$	Continuous Source Current (Body Diode)	—	—	61④	A	MOSFET symbol showing the integral reverse p-n junction diode. 
$I_{SM}$	Pulsed Source Current (Body Diode) ①	—	—	244		
$V_{SD}$	Diode Forward Voltage	—	0.88	1.3	V	$T_J = 25^\circ\text{C}, I_S = 31A, V_{GS} = 0V$ ③
		—	0.80	—		$T_J = 125^\circ\text{C}, I_S = 31A, V_{GS} = 0V$ ③
$t_{rr}$	Reverse Recovery Time	—	41	62	ns	$T_J = 25^\circ\text{C}, I_F = 31A, V_R = 20V$
$Q_{rr}$	Reverse Recovery Charge	—	64	96	nC	$di/dt = 100A/\mu s$ ③
$t_{rr}$	Reverse Recovery Time	—	43	65	ns	$T_J = 125^\circ\text{C}, I_F = 31A, V_R = 20V$
$Q_{rr}$	Reverse Recovery Charge	—	70	105	nC	$di/dt = 100A/\mu s$ ③



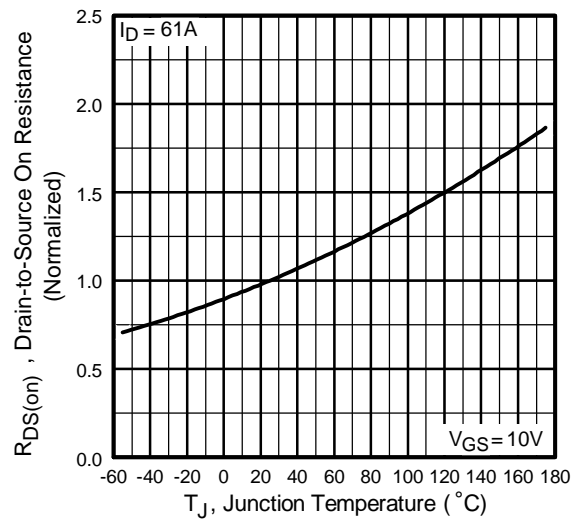
**Fig 1.** Typical Output Characteristics



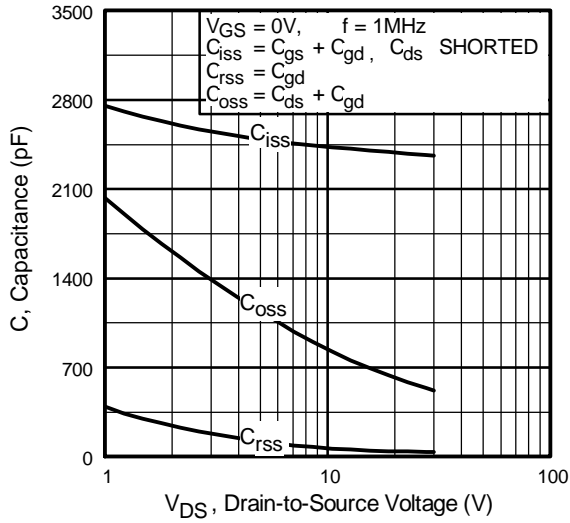
**Fig 2.** Typical Output Characteristics



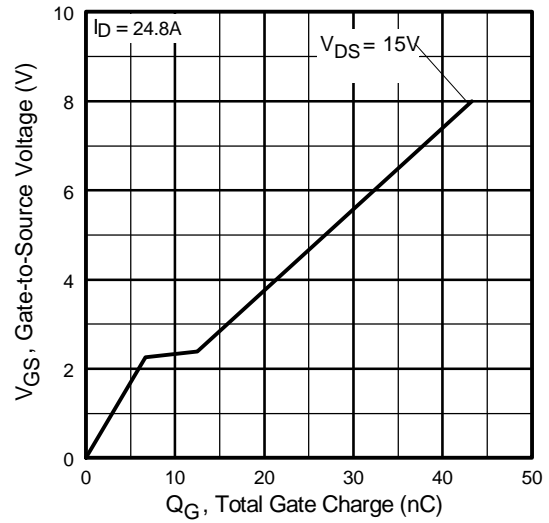
**Fig 3.** Typical Transfer Characteristics



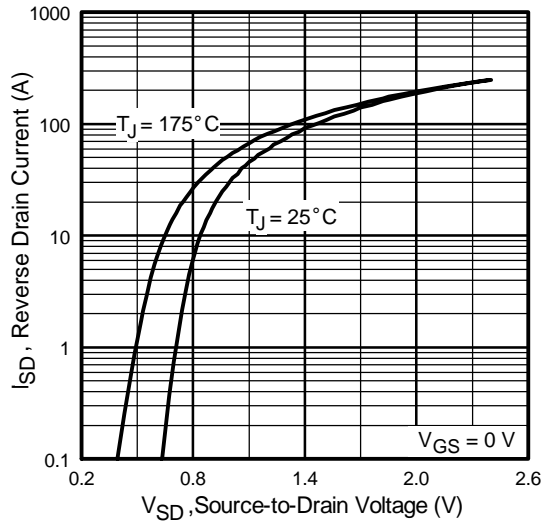
**Fig 4.** Normalized On-Resistance Vs. Temperature



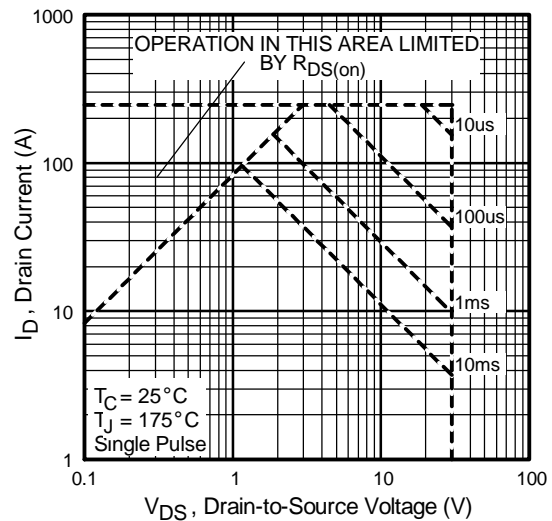
**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage



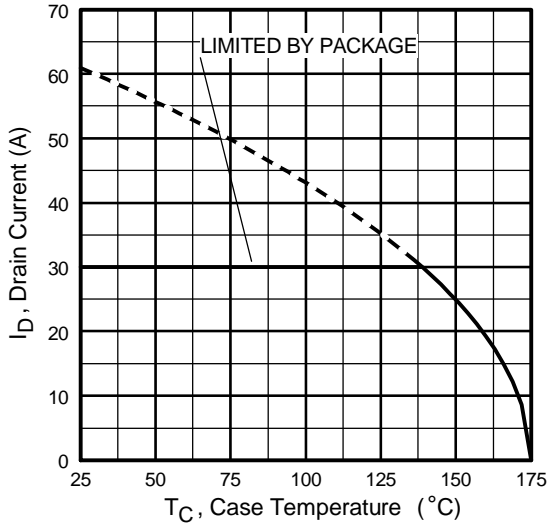
**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage



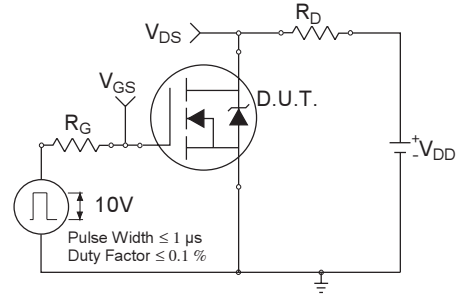
**Fig 7.** Typical Source-Drain Diode Forward Voltage



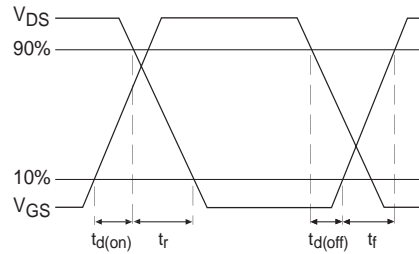
**Fig 8.** Maximum Safe Operating Area



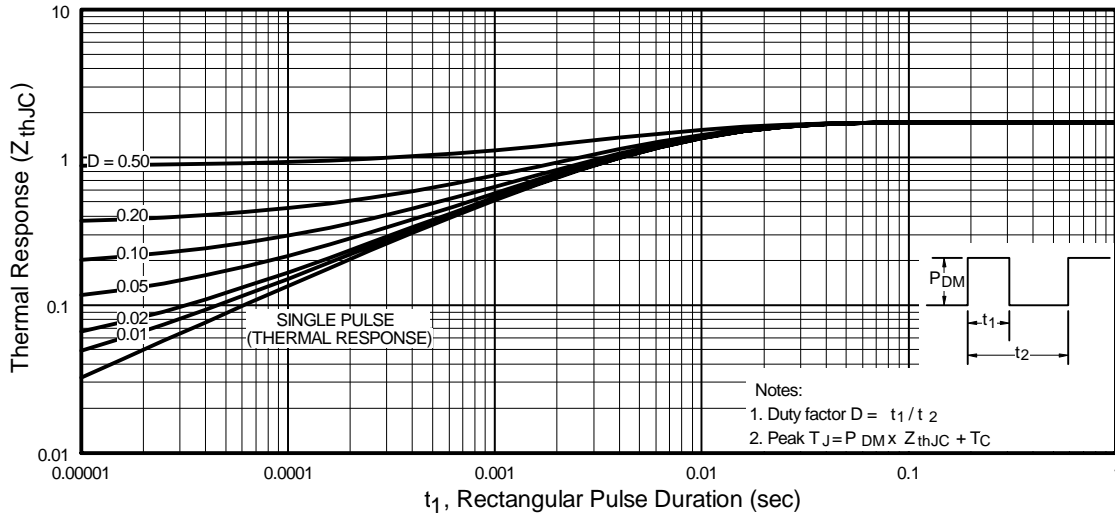
**Fig 9.** Maximum Drain Current Vs. Case Temperature



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



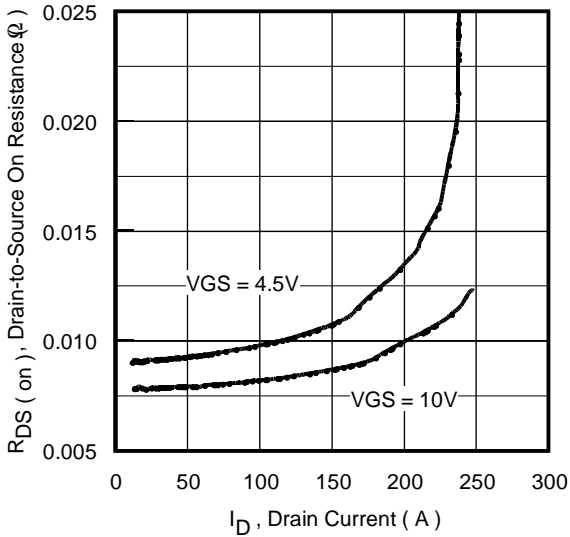
**Fig 10b.** Switching Time Waveforms



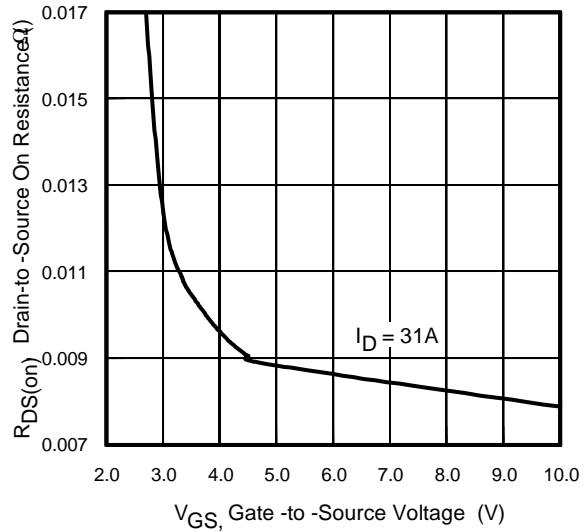
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

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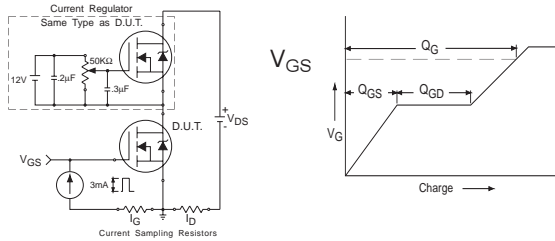
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**IR** Rectifier



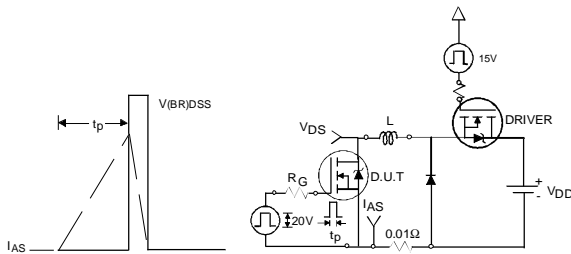
**Fig 12.** On-Resistance Vs. Drain Current



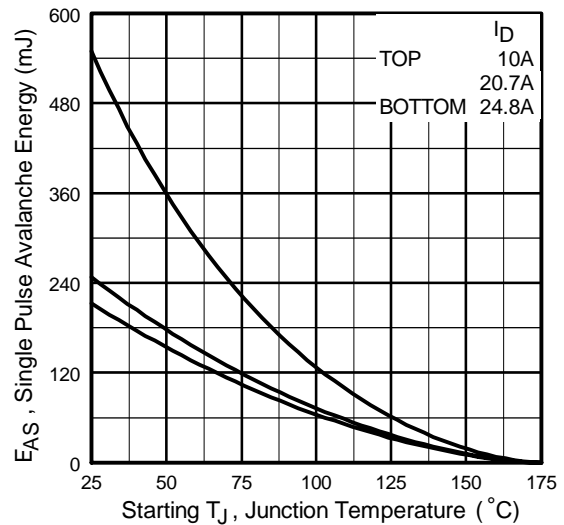
**Fig 13.** On-Resistance Vs. Gate Voltage



**Fig 14a&b.** Gate Charge Test Circuit and Waveform



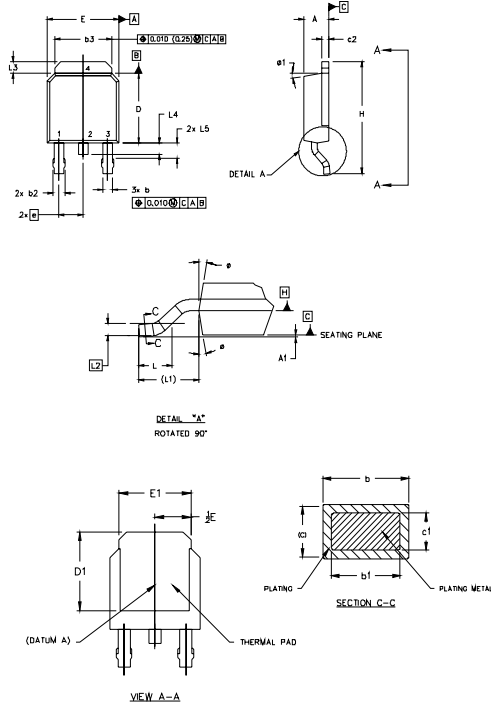
**Fig 15a&b.** Unclamped Inductive Test circuit and Waveforms



**Fig 15c.** Maximum Avalanche Energy Vs. Drain Current

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

Dimensions are shown in millimeters (inches)



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

SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	2.18	2.59	.086	.094	
A1		0.13		.005	
b	0.64	0.89	.025	.035	
b1	0.64	0.79	.025	.031	5
b2	0.76	1.14	.030	.045	
b3	4.95	5.46	.195	.215	
c	0.46	0.61	.018	.024	5
c1	0.41	0.66	.016	.022	5
c2	.046	0.89	.018	.035	5
D	5.97	6.22	.235	.245	6
D1	5.21	-	.205	-	4
E	6.35	6.73	.250	.265	6
E1	4.32	-	.170	-	4
e	2.29		.090 BSC		
H	9.40	10.41	.370	.410	
L	1.40	1.78	.055	.070	
L1	2.74 REF.		.108 REF.		
L2	.0051 BSC		.020 BSC		
L3	0.89	1.27	.035	.050	
L4		1.02		.040	
L5	1.14	1.52	.045	.060	3
ø	0"	10"	0"	10"	
ø1	0"	15"	0"	15"	

**LEAD ASSIGNMENTS**

**HEXFET**

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

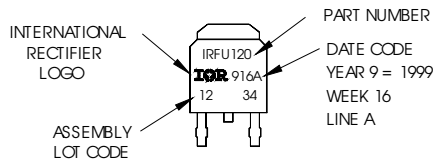
**IGBTs, CoPACK**

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

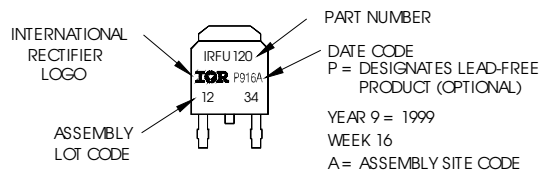
## D-Pak (TO-252AA) Part Marking Information

EXAMPLE: THIS IS AN IRFR120  
WITH ASSEMBLY  
LOT CODE 1234  
ASSEMBLED ON WW 16, 1999  
IN THE ASSEMBLY LINE "A"

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



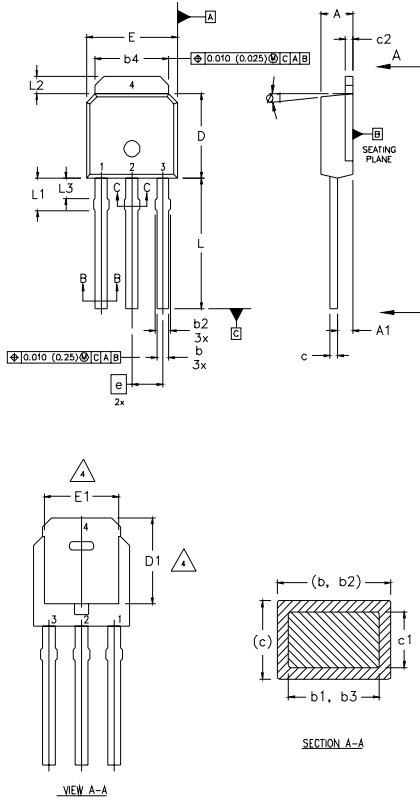
OR



# IRFR/U3708PbF

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

Dimensions are shown in millimeters (inches)



**NOTES:**

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

**LEAD ASSIGNMENTS**

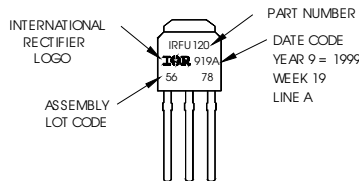
**HEXFEEET**

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

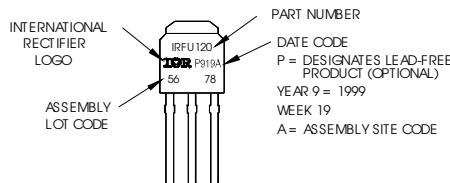
SYMBOL	MILLIMETERS		INCHES		NOTES
	MIN.	MAX.	MIN.	MAX.	
A	2.18	2.39	0.086	.094	
A1	0.89	1.14	0.035	0.045	
b	0.64	0.89	0.025	0.035	
b1	0.64	0.79	0.025	0.031	4
b2	0.76	1.14	0.030	0.045	
b3	0.76	1.04	0.030	0.041	
b4	5.00	5.46	0.195	0.215	4
c	0.46	0.61	0.018	0.024	
c1	0.41	0.56	0.016	0.022	
c2	0.46	0.86	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, 1999 IN THE ASSEMBLY LINE "A"  
**Note:** 'P' in assembly line position indicates 'Lead-Free'



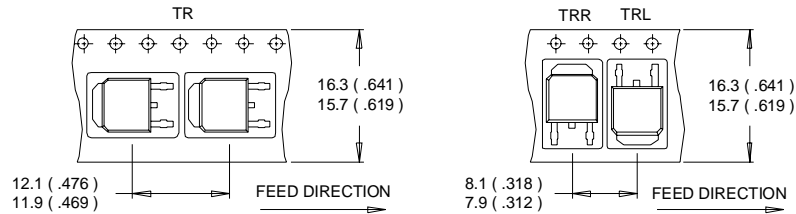
**OR**





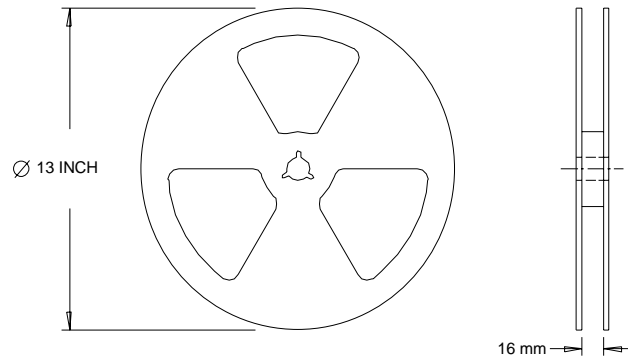
## D-Pak (TO-252AA) Tape & Reel Information

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.
- ② Starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.7 \text{ mH}$   
 $R_G = 25\Omega$ ,  $I_{AS} = 24.8 \text{ A}$ .
- ③ Pulse width  $\leq 300\mu\text{s}$ ; duty cycle  $\leq 2\%$ .
- ④ Calculated continuous current based on maximum allowable junction temperature. Package limitation current is 30A.

Data and specifications subject to change without notice.

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