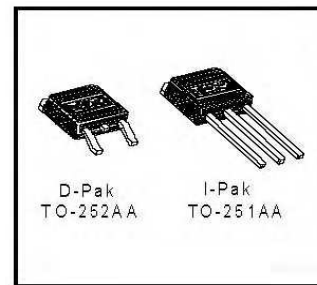
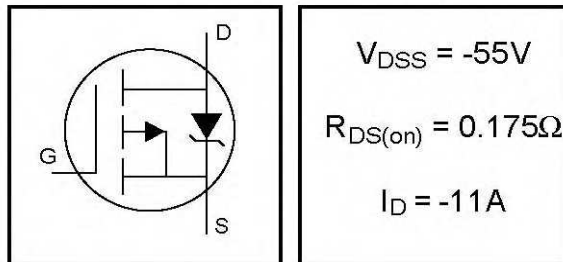


- Ultra Low On-Resistance
- P-Channel
- Surface Mount (IRFR9024NCPbF)
- Straight Lead (IRFU9024NCPbF)
- Advanced Process Technology
- Fast Switching
- Fully Avalanche Rated
- Lead-Free

HEXFET® Power MOSFET



Description

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

The D-Pak is designed for surface mounting using vapor phase, infrared, or wave soldering techniques. The straight lead version (IRFU series) is for through-hole mounting applications. Power dissipation levels up to 1.5 watts are possible in typical surface mount applications.

Absolute Maximum Ratings

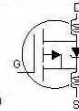
| | Parameter | Max. | Units |
|---------------------------|--|------------------------|-------|
| $I_D @ T_C = 25^\circ C$ | Continuous Drain Current, $V_{GS} @ -10V$ | -11 | A |
| $I_D @ T_C = 100^\circ C$ | Continuous Drain Current, $V_{GS} @ -10V$ | -8 | |
| I_{DM} | Pulsed Drain Current ① | -44 | |
| $P_D @ T_C = 25^\circ C$ | Power Dissipation | 38 | W |
| | Linear Derating Factor | 0.30 | W/C |
| V_{GS} | Gate-to-Source Voltage | ± 20 | V |
| E_{AS} | Single Pulse Avalanche Energy ② | 62 | mJ |
| I_{AR} | Avalanche Current ① | -6.6 | A |
| E_{AR} | Repetitive Avalanche Energy ① | 3.8 | mJ |
| dv/dt | Peak Diode Recovery dv/dt ③ | -10 | V/ns |
| T_J T_{STG} | Operating Junction and Storage Temperature Range | -55 to + 150 | °C |
| | Soldering Temperature, for 10 seconds | 300 (1.6mm from case) | |

Thermal Resistance

| | Parameter | Typ. | Max. | Units |
|-----------------|-----------------------------------|------|------|-------|
| $R_{\theta JC}$ | Junction-to-Case | --- | 3.3 | °C/W |
| $R_{\theta JA}$ | Junction-to-Ambient (PCB mount)** | --- | 50 | |
| $R_{\theta JA}$ | Junction-to-Ambient | --- | 110 | |

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

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---------------------------------|--------------------------------------|------|-------|-------|----------|---|
| $V_{(BR)DSS}$ | Drain-to-Source Breakdown Voltage | -55 | — | — | V | $V_{GS} = 0V, I_D = -250\mu A$ |
| $\Delta V_{(BR)DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient | — | -0.05 | — | V/°C | Reference to 25°C , $I_D = -1mA$ |
| $R_{DS(on)}$ | Static Drain-to-Source On-Resistance | — | — | 0.175 | Ω | $V_{GS} = -10V, I_D = -6.6A$ ④ |
| $V_{GS(th)}$ | Gate Threshold Voltage | -2.0 | — | -4.0 | V | $V_{DS} = V_{GS}, I_D = -250\mu A$ |
| g_{fs} | Forward Transconductance | 2.5 | — | — | S | $V_{DS} = -25V, I_D = -7.2A$ ⑥ |
| I_{DSS} | Drain-to-Source Leakage Current | — | — | -25 | μA | $V_{DS} = -55V, V_{GS} = 0V$ |
| | | — | — | -250 | | $V_{DS} = -44V, V_{GS} = 0V, T_J = 150^\circ\text{C}$ |
| I_{GSS} | Gate-to-Source Forward Leakage | — | — | 100 | nA | $V_{GS} = 20V$ |
| | Gate-to-Source Reverse Leakage | — | — | -100 | | $V_{GS} = -20V$ |
| Q_g | Total Gate Charge | — | — | 19 | nC | $I_D = -7.2A$ |
| Q_{gs} | Gate-to-Source Charge | — | — | 5.1 | | $V_{DS} = -44V$ |
| Q_{gd} | Gate-to-Drain ("Miller") Charge | — | — | 10 | | $V_{GS} = -10V$, See Fig. 6 and 13 ④⑥ |
| $t_{d(on)}$ | Turn-On Delay Time | — | 13 | — | ns | $V_{DD} = -28V$ |
| t_r | Rise Time | — | 55 | — | | $I_D = -7.2A$ |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 23 | — | | $R_G = 24\Omega$ |
| t_f | Fall Time | — | 37 | — | | $R_D = 3.7\Omega$, See Fig. 10 ④⑥ |
| L_D | Internal Drain Inductance | — | 4.5 | — | nH | Between lead, 6mm (0.25in.) from package and center of die contact ⑤ |
| L_S | Internal Source Inductance | — | 7.5 | — | | |
| C_{iss} | Input Capacitance | — | 350 | — | pF | $V_{GS} = 0V$ |
| C_{oss} | Output Capacitance | — | 170 | — | | $V_{DS} = -25V$ |
| C_{riss} | Reverse Transfer Capacitance | — | 92 | — | | $f = 1.0MHz$, See Fig. 5⑥ |



Source-Drain Ratings and Characteristics

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|----------|--|---|------|------|-------|--|
| I_S | Continuous Source Current (Body Diode) | — | — | -11 | A | MOSFET symbol showing the integral reverse p-n junction diode. |
| I_{SM} | Pulsed Source Current (Body Diode) ① | — | — | -44 | | |
| V_{SD} | Diode Forward Voltage | — | — | -1.6 | V | $T_J = 25^\circ\text{C}, I_S = -7.2A, V_{GS} = 0V$ ④ |
| t_{rr} | Reverse Recovery Time | — | 47 | 71 | ns | $T_J = 25^\circ\text{C}, I_F = -7.2A$ |
| Q_{rr} | Reverse Recovery Charge | — | 84 | 130 | nC | $di/dt = 100A/\mu s$ ④⑥ |
| t_{on} | Forward Turn-On Time | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S + L_D$) | | | | |

Notes:

① Repetitive rating; pulse width limited by max. junction temperature. (See fig. 11)

② Starting $T_J = 25^\circ\text{C}$, $L = 2.8mH$
 $R_G = 25\Omega, I_{AS} = -6.6A$. (See Figure 12)

③ $I_{SD} \leq -6.6A, di/dt \leq 240A/\mu s, V_{DD} \leq V_{(BR)DSS}, T_J \leq 150^\circ\text{C}$

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

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

⑥ Uses IRF9Z24N data and test conditions.

** When mounted on 1" square PCB (FR-4 or G-10 Material) .

For recommended footprint and soldering techniques refer to application note #AN-994

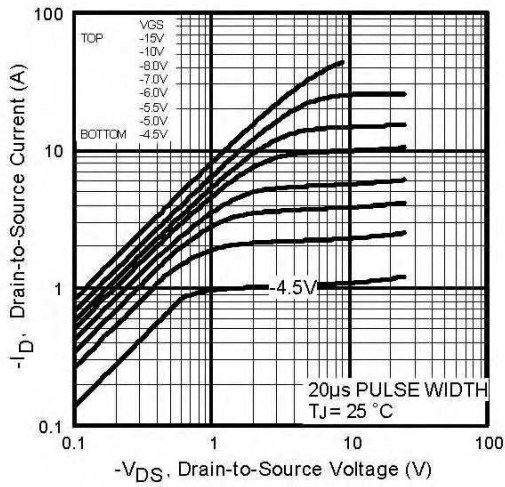


Fig 1. Typical Output Characteristics

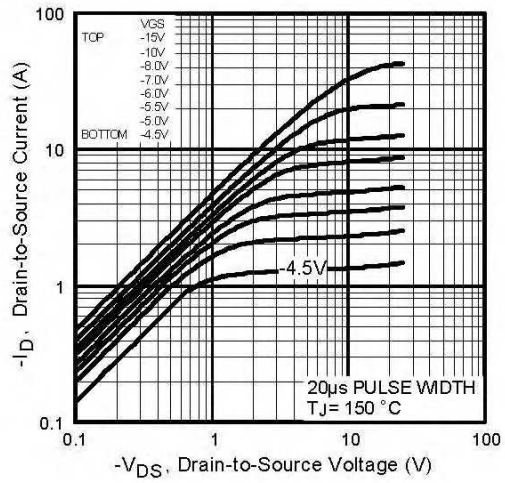


Fig 2. Typical Output Characteristics

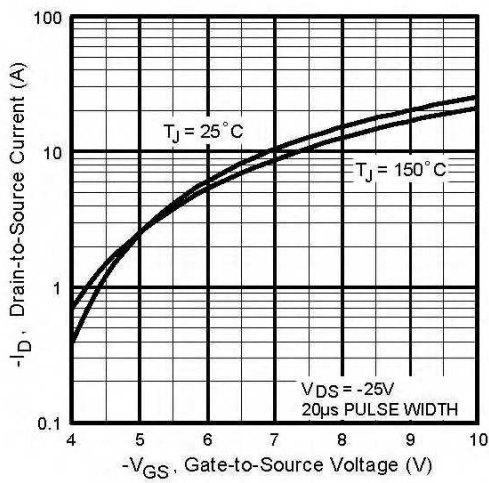


Fig 3. Typical Transfer Characteristics

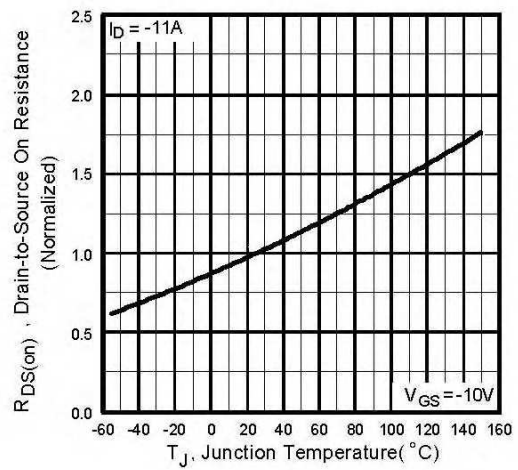


Fig 4. Normalized On-Resistance Vs. Temperature

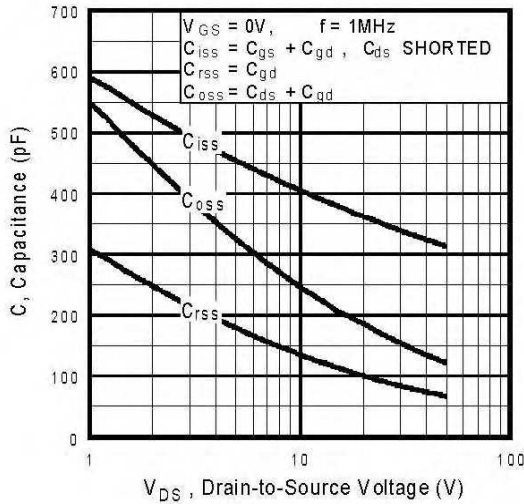


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

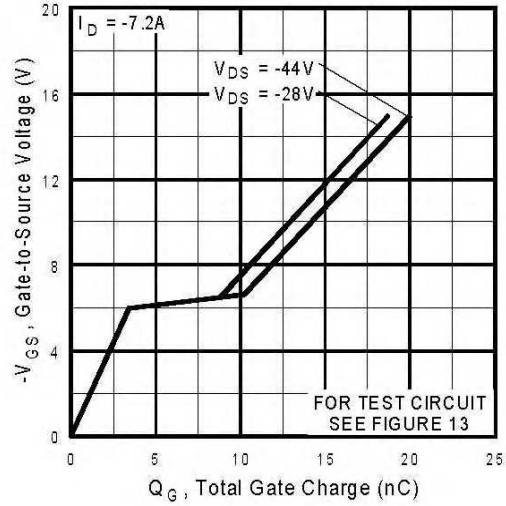


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

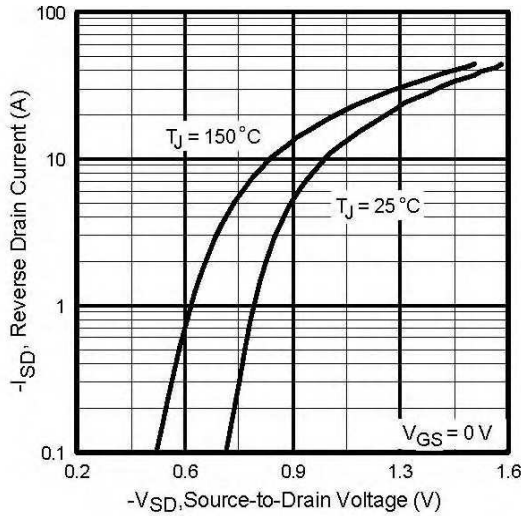


Fig 7. Typical Source-Drain Diode Forward Voltage

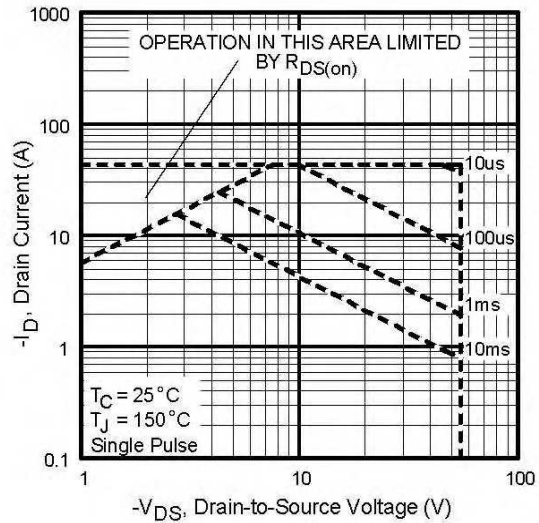


Fig 8. Maximum Safe Operating Area

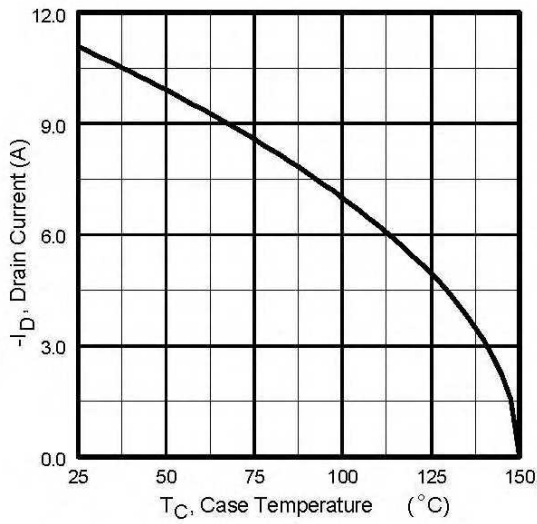


Fig 9. Maximum Drain Current Vs. Case Temperature

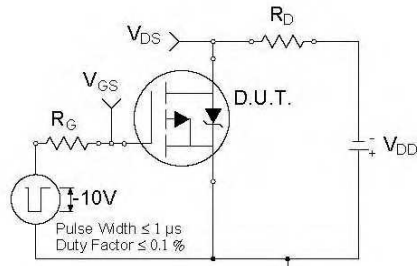


Fig 10a. Switching Time Test Circuit

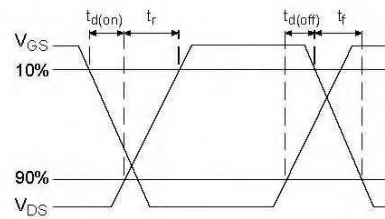


Fig 10b. Switching Time Waveforms

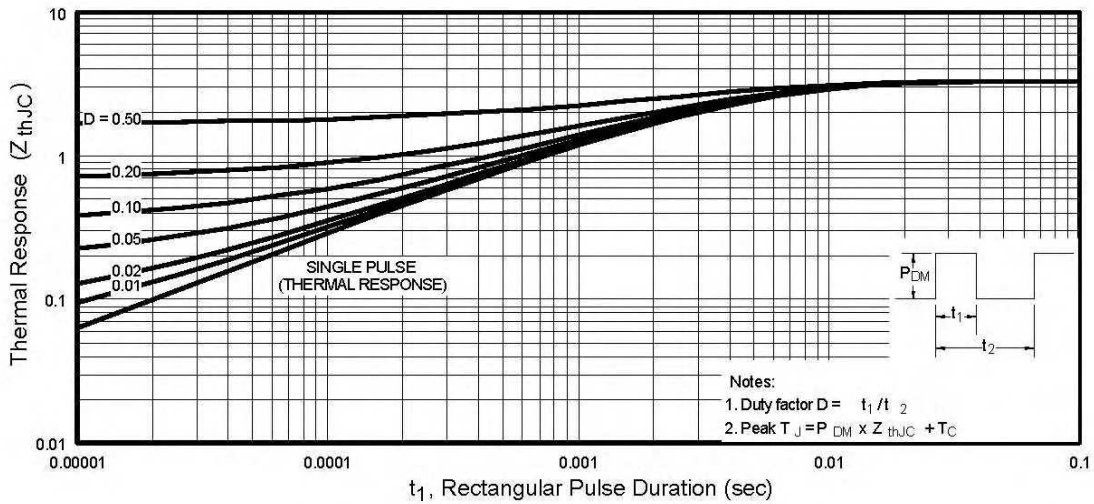


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

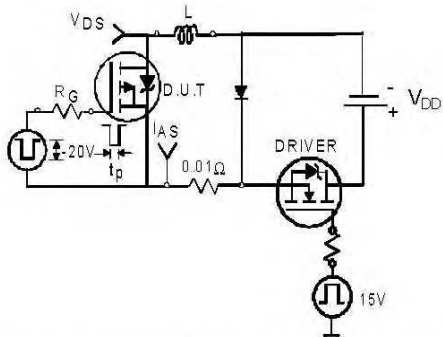


Fig 12a. Unclamped Inductive Test Circuit

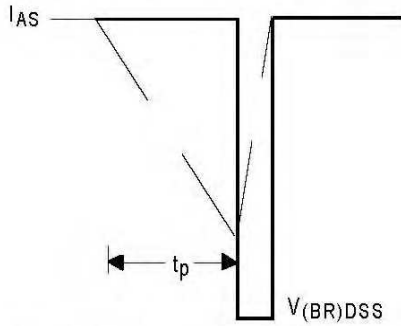


Fig 12b. Unclamped Inductive Waveforms

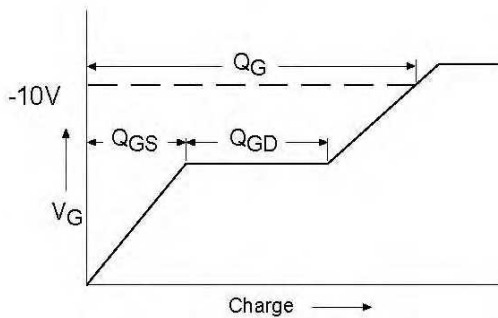


Fig 13a. Basic Gate Charge Waveform

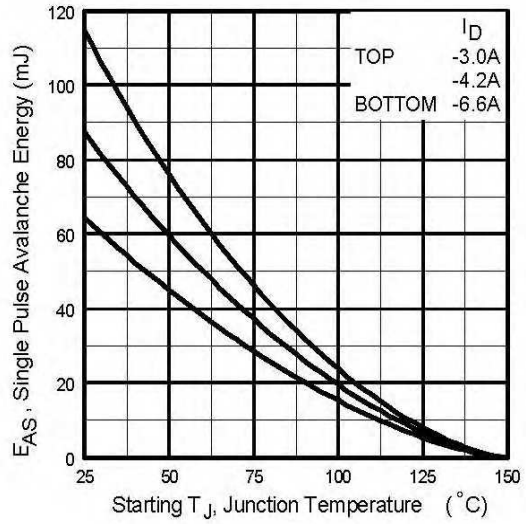


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

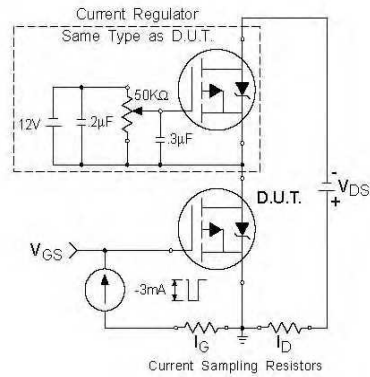
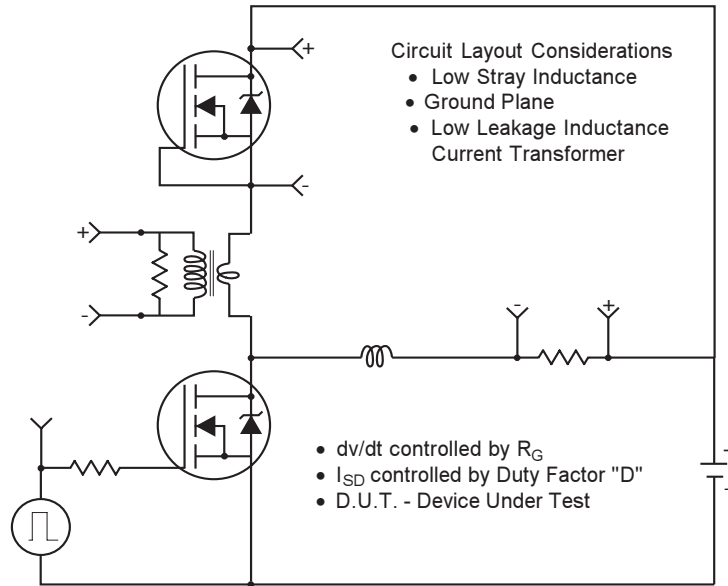


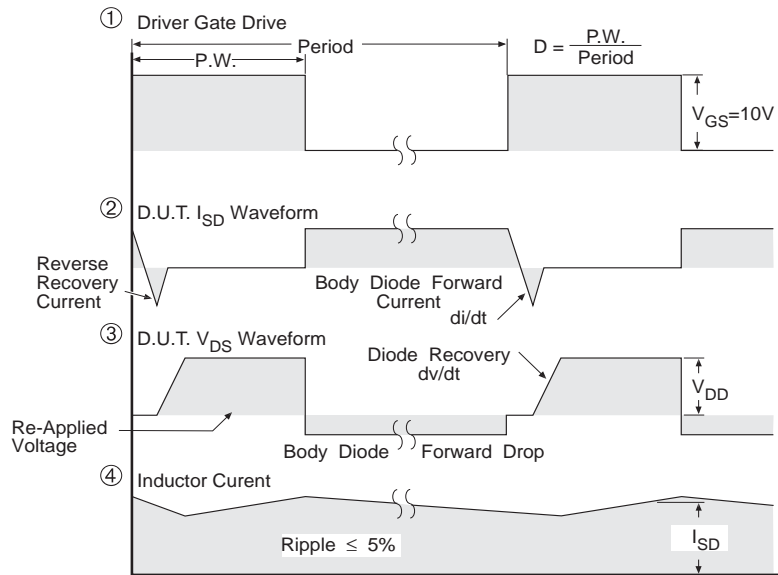
Fig 13b. Gate Charge Test Circuit

Peak Diode Recovery dv/dt Test Circuit



* Reverse Polarity for P-Channel

** Use P-Channel Driver for P-Channel Measurements



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

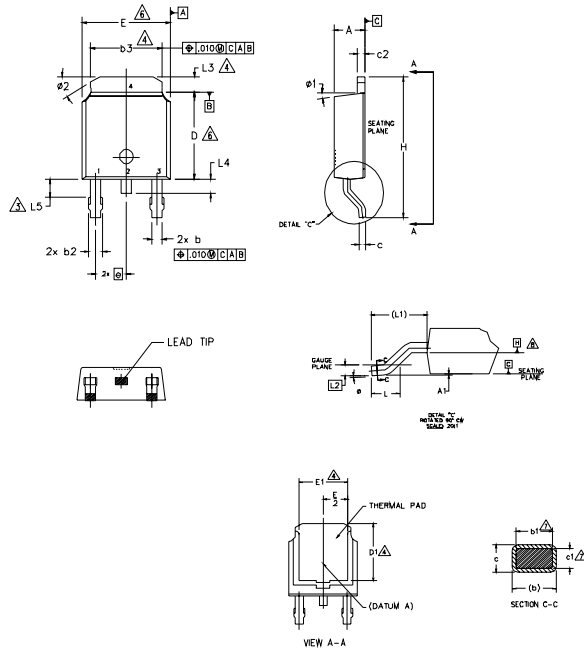
Fig 14 For P Channel HEXFETS

IRFR/U9024NCPbF

International
IR Rectifier

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.

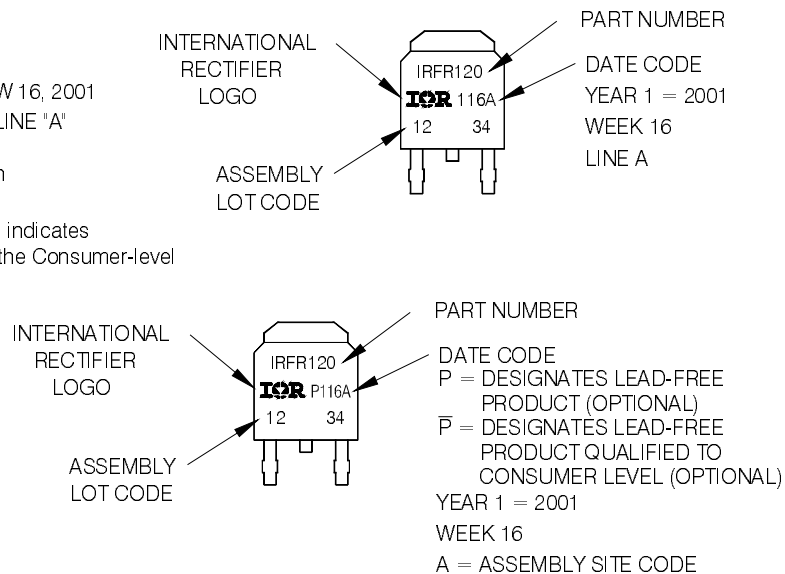
| SYMBOL | DIMENSIONS | | | | NOTES |
|--------|-------------|-------|-----------|------|---|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 2.18 | 2.39 | .086 | .094 | 7 |
| A1 | - | 0.13 | - | .005 | |
| b | 0.64 | 0.89 | .025 | .035 | |
| b1 | 0.65 | 0.79 | .025 | .031 | |
| b2 | 0.76 | 1.14 | .030 | .045 | |
| 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 | |
| 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 BSC | | .090 BSC | | LEAD ASSIGNMENTS |
| 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 | | HEXFET 1.- GATE 2.- DRAIN 3.- SOURCE 4.- DRAIN |
| L3 | 0.89 | 1.27 | .035 | .050 | |
| L4 | - | 1.02 | - | .040 | |
| L5 | 1.14 | 1.52 | .045 | .060 | |
| ø | 0" | 10" | 0" | 10" | |
| ø1 | 0" | 15" | 0" | 15" | IGBT & CoPAK 1.- GATE 2.- COLLECTOR 3.- EMITTER 4.- COLLECTOR |
| ø2 | 25" | 35" | 25" | 35" | |

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"

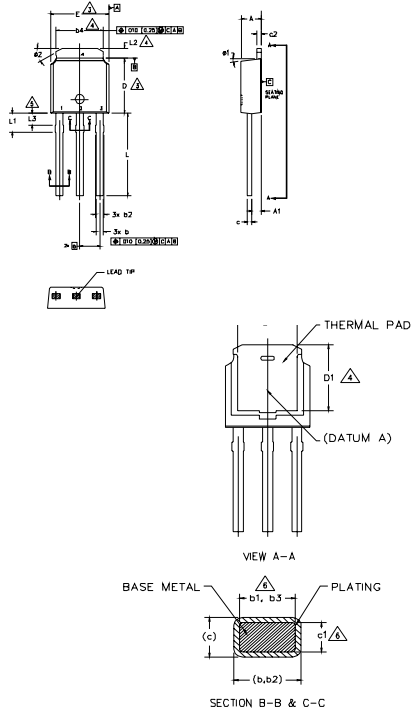
Note: "P" in assembly line position
indicates "Lead-Free"
"P̄" in assembly line position indicates
"Lead-Free" qualification to the Consumer-level

OR



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]
- △ 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.

| S Y M B O L | DIMENSIONS | | | | N O T E S |
|----------------------------|-------------|------|----------|------|-----------------------|
| | 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 | .075 | .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

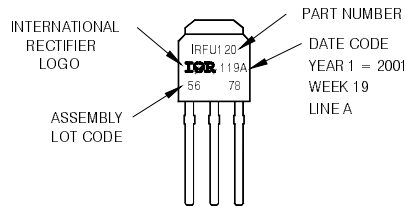
HEXFET

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

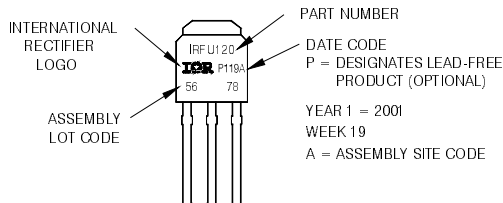
I-Pak (TO-251AA) Part Marking Information

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

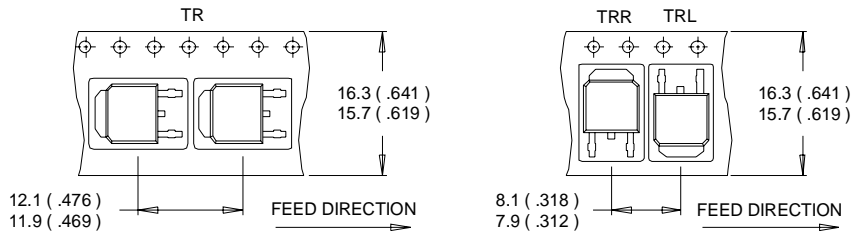


IRFR/U9024NCPbF

International
IR Rectifier

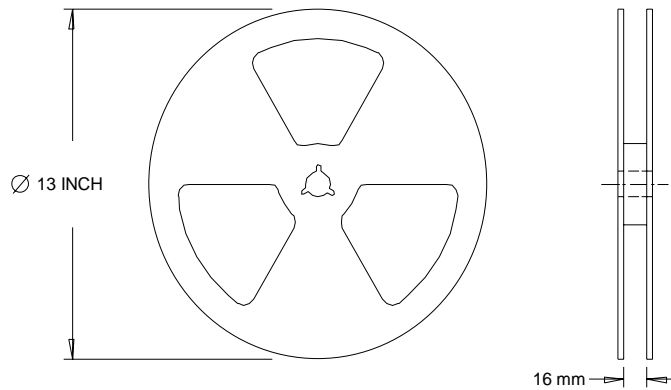
D-Pak (TO-252AA) Tape & Reel Information

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.

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

International
IR Rectifier

IR WORLD HEADQUARTERS: 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105
TAC Fax: (310) 252-7903

Visit us at www.irf.com for sales contact information. 05/2006

www.irf.com

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