

International IR Rectifier

- Surface Mount (IRFR2405)
- Straight Lead (IRFU2405)
- Advanced Process Technology
- Dynamic dv/dt Rating
- Fast Switching
- Fully Avalanche Rated
- Lead-Free

Description

Seventh Generation HEXFET® Power MOSFETs 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 |
|---------------------------------|---|-----------------------|-------|
| $I_D @ T_C = 25^\circ\text{C}$ | Continuous Drain Current, $V_{GS} @ 10\text{V}$ | 56@ | A |
| $I_D @ T_C = 100^\circ\text{C}$ | Continuous Drain Current, $V_{GS} @ 10\text{V}$ | 40@ | |
| I_{DM} | Pulsed Drain Current ① | 220 | |
| $P_D @ T_C = 25^\circ\text{C}$ | Power Dissipation | 110 | W |
| | Linear Derating Factor | 0.71 | W/°C |
| V_{GS} | Gate-to-Source Voltage | ± 20 | V |
| E_{AS} | Single Pulse Avalanche Energy② | 130 | mJ |
| I_{AR} | Avalanche Current① | 34 | A |
| E_{AR} | Repetitive Avalanche Energy① | 11 | mJ |
| dv/dt | Peak Diode Recovery dv/dt ③ | 5.0 | V/ns |
| T_J | Operating Junction and | -55 to + 175 | °C |
| T_{STG} | Storage Temperature Range | | |
| | Soldering Temperature, for 10 seconds | 300 (1.6mm from case) | |

Thermal Resistance

| | Parameter | Typ. | Max. | Units |
|-----------------|----------------------------------|------|------|-------|
| $R_{\theta JC}$ | Junction-to-Case | — | 1.4 | °C/W |
| $R_{\theta JA}$ | Junction-to-Ambient (PCB mount)* | — | 50 | |
| $R_{\theta JA}$ | 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

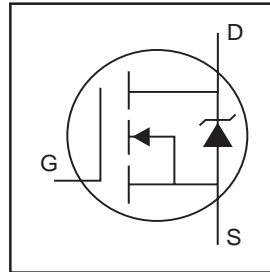
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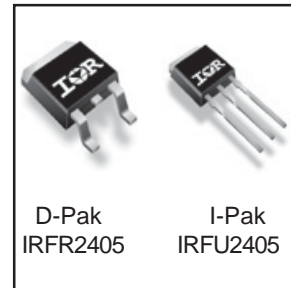
IRFR2405PbF

IRFU2405PbF

HEXFET® Power MOSFET



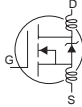
| |
|----------------------------|
| $V_{DSS} = 55\text{V}$ |
| $R_{DS(on)} = 0.016\Omega$ |
| $I_D = 56\text{A} @$ |



D-Pak
IRFR2405

I-Pak
IRFU2405

Electrical Characteristics @ T_J = 25°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 = 250μA |
| ΔV _{(BR)DSS/ΔT_J} | Breakdown Voltage Temp. Coefficient | — | 0.052 | — | V/°C | Reference to 25°C, I _D = 1mA |
| R _{DS(on)} | Static Drain-to-Source On-Resistance | — | 0.0118 | 0.016 | Ω | V _{GS} = 10V, I _D = 34A ④ |
| V _{GS(th)} | Gate Threshold Voltage | 2.0 | — | 4.0 | V | V _{DS} = 10V, I _D = 250μA |
| g _{fs} | Forward Transconductance | 30 | — | — | S | V _{DS} = 25V, I _D = 34A |
| I _{DSS} | Drain-to-Source Leakage Current | — | — | 20 | μA | V _{DS} = 55V, V _{GS} = 0V |
| | | — | — | 250 | | V _{DS} = 44V, V _{GS} = 0V, T _J = 150°C |
| I _{GSS} | Gate-to-Source Forward Leakage | — | — | 200 | nA | V _{GS} = 20V |
| | Gate-to-Source Reverse Leakage | — | — | -200 | | V _{GS} = -20V |
| Q _g | Total Gate Charge | — | 70 | 110 | nC | I _D = 34A |
| Q _{gs} | Gate-to-Source Charge | — | 16 | 23 | | V _{DS} = 44V |
| Q _{gd} | Gate-to-Drain ("Miller") Charge | — | 19 | 29 | | V _{GS} = 10V ④ |
| t _{d(on)} | Turn-On Delay Time | — | 15 | — | ns | V _{DD} = 28V |
| t _r | Rise Time | — | 130 | — | | I _D = 34A |
| t _{d(off)} | Turn-Off Delay Time | — | 55 | — | | R _G = 6.8Ω |
| t _f | Fall Time | — | 78 | — | | V _{GS} = 10V ④ |
| L _D | Internal Drain Inductance | — | 4.5 | — | nH | Between lead, 6mm (0.25in.) from package and center of die contact |
| L _S | Internal Source Inductance | — | 7.5 | — | |  |
| C _{iss} | Input Capacitance | — | 2430 | — | pF | V _{GS} = 0V |
| C _{oss} | Output Capacitance | — | 470 | — | | V _{DS} = 25V |
| C _{rss} | Reverse Transfer Capacitance | — | 100 | — | | f = 1.0MHz, See Fig. 5 |
| C _{oss} | Output Capacitance | — | 2040 | — | | V _{GS} = 0V, V _{DS} = 1.0V, f = 1.0MHz |
| C _{oss} | Output Capacitance | — | 350 | — | | V _{GS} = 0V, V _{DS} = 44V, f = 1.0MHz |
| C _{oss eff.} | Effective Output Capacitance ⑤ | — | 350 | — | | V _{GS} = 0V, V _{DS} = 0V to 44V |

Source-Drain Ratings and Characteristics

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|-----------------|---|--|------|------|-------|---|
| I _S | Continuous Source Current (Body Diode) | — | — | 56 ⑥ | A | MOSFET symbol showing the integral reverse p-n junction diode. |
| I _{SM} | Pulsed Source Current (Body Diode) ① | — | — | 220 | | |
| V _{SD} | Diode Forward Voltage | — | — | 1.3 | V | T _J = 25°C, I _S = 34A, V _{GS} = 0V ④ |
| t _{rr} | Reverse Recovery Time | — | 62 | 93 | ns | T _J = 25°C, I _F = 34A |
| Q _{rr} | Reverse Recovery Charge | — | 170 | 260 | nC | di/dt = 100A/μs ④ |
| 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.
- ② Starting T_J = 25°C, L = 0.22mH
R_G = 25Ω, I_{AS} = 34A.
- ③ I_{SD} ≤ 34A, di/dt ≤ 190A/μs, V_{DD} ≤ V_{(BR)DSS},
T_J ≤ 175°C

- ④ Pulse width ≤ 300μs; duty cycle ≤ 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_{DS}
- ⑥ Calculated continuous current based on maximum allowable junction temperature. Package limitation current is 30A

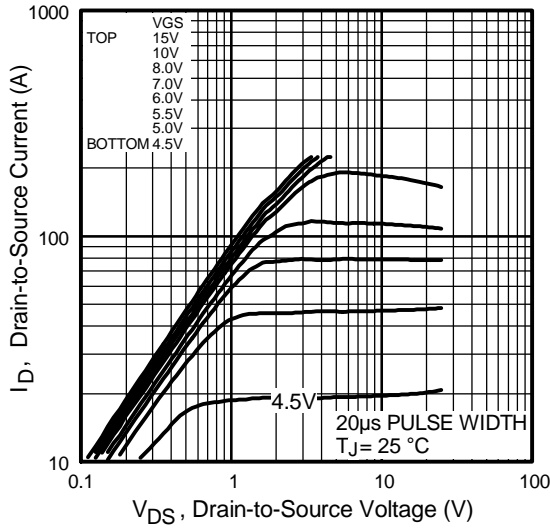


Fig 1. Typical Output Characteristics

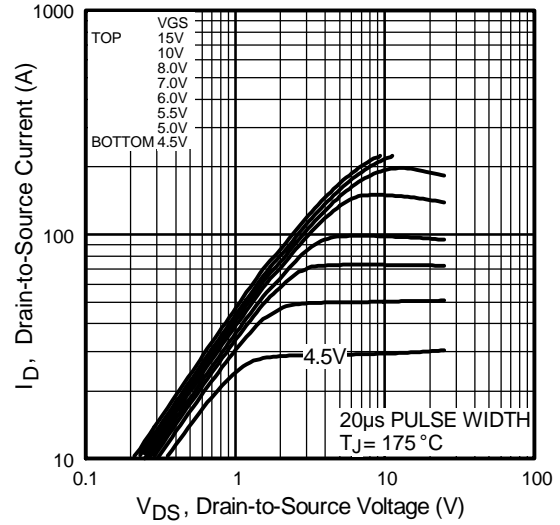


Fig 2. Typical Output Characteristics

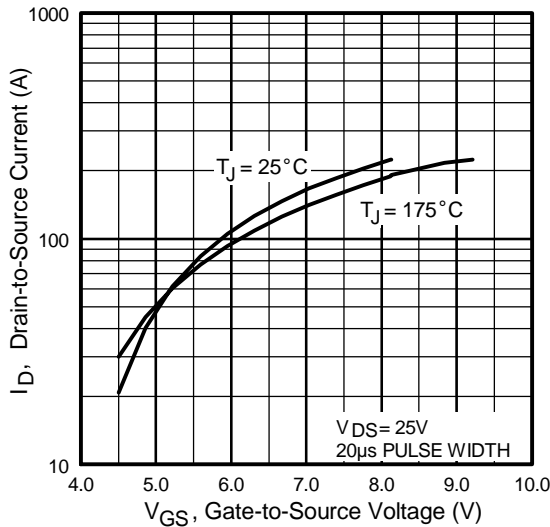


Fig 3. Typical Transfer Characteristics

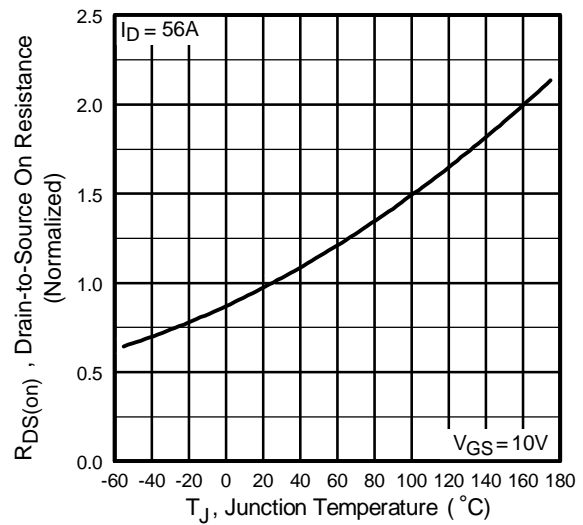


Fig 4. Normalized On-Resistance Vs. Temperature

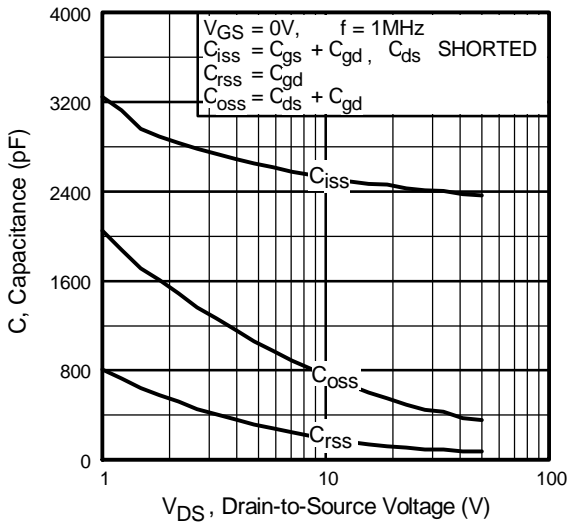


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

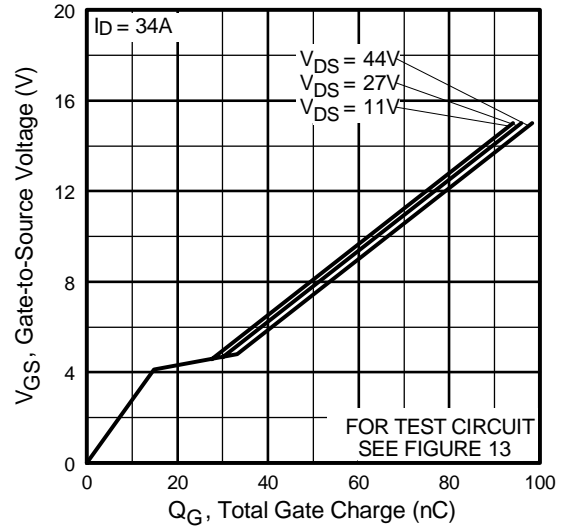


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

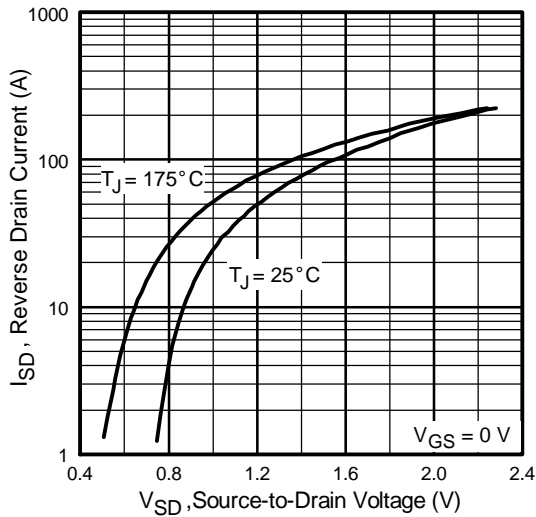


Fig 7. Typical Source-Drain Diode Forward Voltage

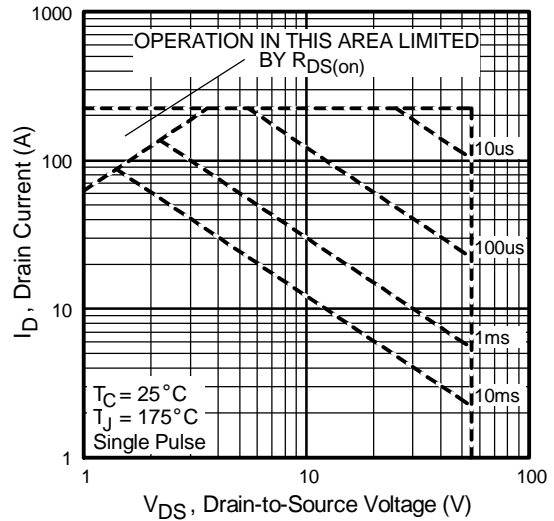


Fig 8. Maximum Safe Operating Area

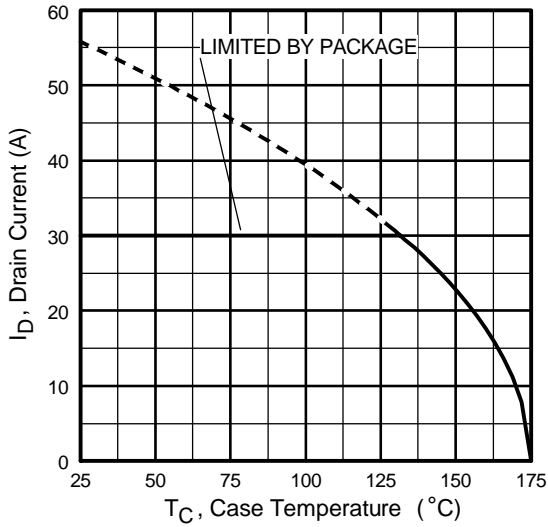


Fig 9. Maximum Drain Current Vs. Case Temperature



Fig 10a. Switching Time Test Circuit

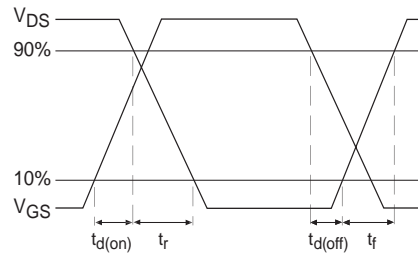


Fig 10b. Switching Time Waveforms

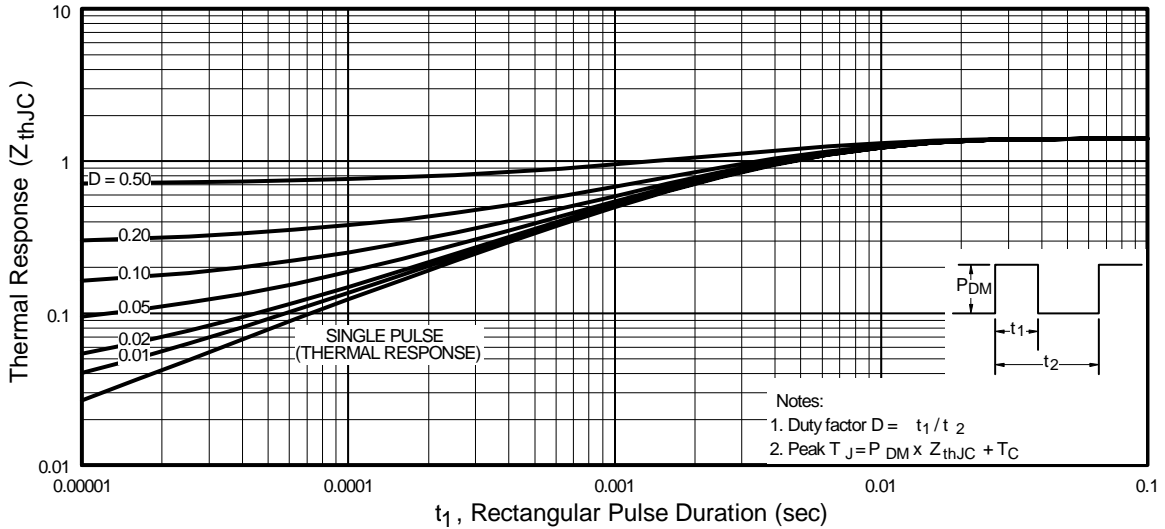


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

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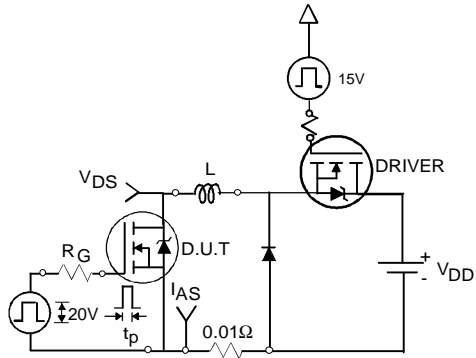


Fig 12a. Unclamped Inductive Test Circuit

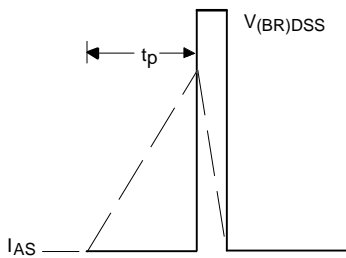


Fig 12b. Unclamped Inductive Waveforms

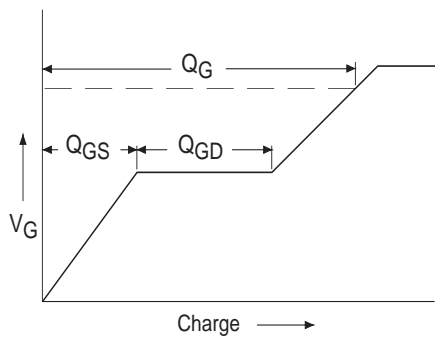


Fig 13a. Basic Gate Charge Waveform

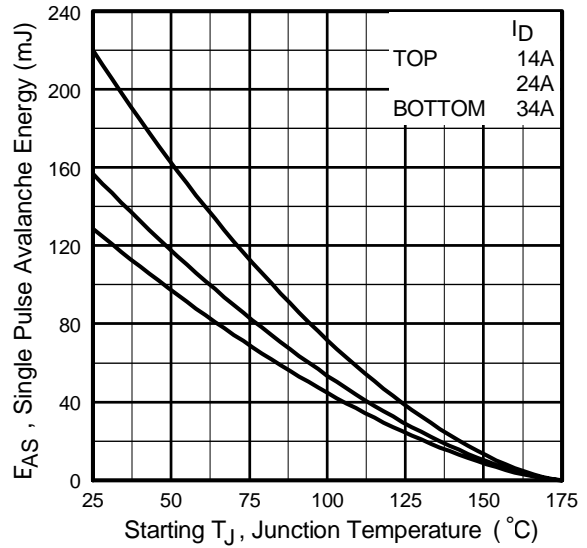


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

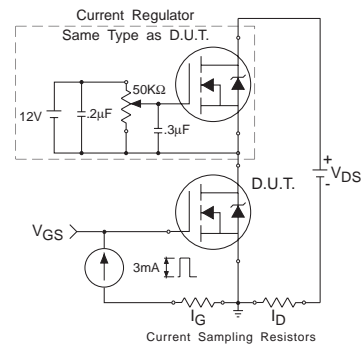


Fig 13b. Gate Charge Test Circuit

Peak Diode Recovery dv/dt Test Circuit



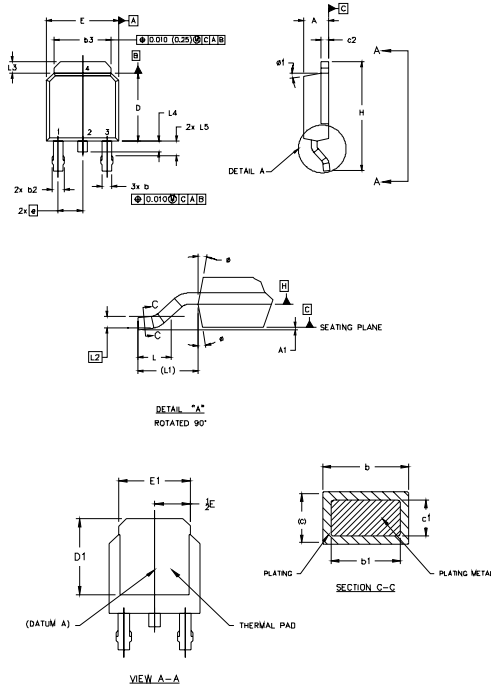
* $V_{GS} = 5V$ for Logic Level Devices

Fig 14. For N-Channel HEXFET® Power MOSFETs

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D-Pak (TO-252AA) Package Outline



- 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 | MILLIMETERS | | INCHES | | NOTES |
|--------|-------------|-------|-----------|-------|-------|
| | MIN. | MAX. | MIN. | MAX. | |
| A | 2.18 | 2.39 | .086 | .094 | |
| A1 | | 0.13 | | .005 | |
| b | 0.64 | 0.89 | .025 | .035 | 5 |
| b1 | 0.64 | 0.79 | .025 | 0.031 | 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 | 0.56 | .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 | 6.75 | .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 | 3 |
| a | 0" | 10" | 0" | 10" | |
| ø1 | 0" | 15" | 0" | 15" | |

LEAD ASSIGNMENTS

HEXFET

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

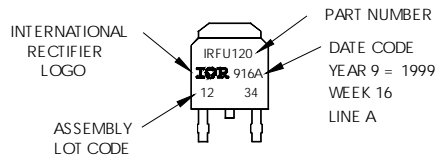
IGBTs, CoPACK

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

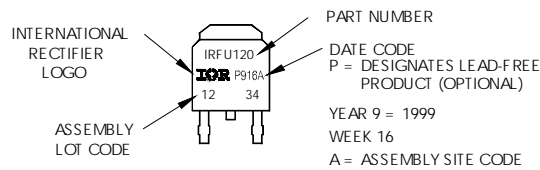
D-Pak (TO-252AA) Part Marking Information

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"

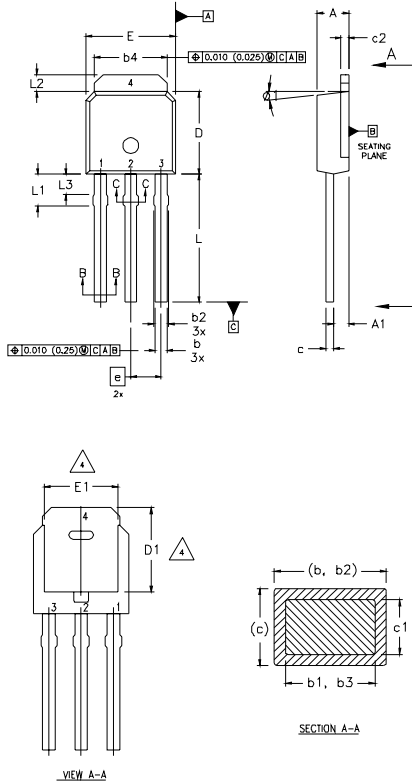


OR



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

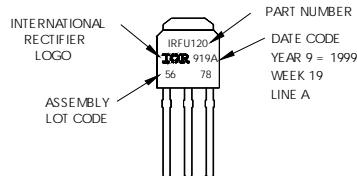
- 1.- GATE
- 2.- DRAIN
- 3.- SOURCE
- 4.- DRAIN

| SYMBOL | 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 | 0.35 | |
| 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 | 0.35 | |
| 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 | 0" | 15" | 0" | 15" | |

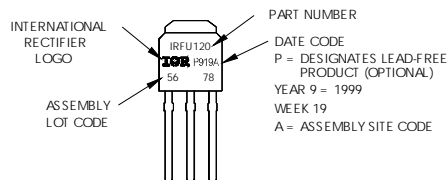
I-Pak (TO-251AA) Part Marking Information

EXAMPLE: THIS IS AN IRFU120
WITH ASSEMBLY
LOT CODE 5678
ASSEMBLED ON WW19, 1999
IN THE ASSEMBLY LINE "A"

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



OR

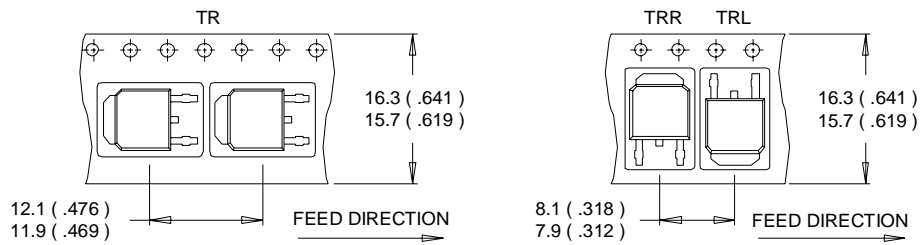


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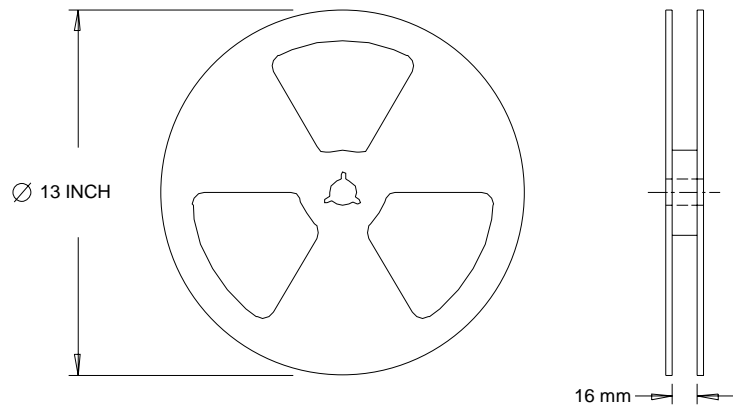
D-Pak (TO-252AA) Tape & Reel Information

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.

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TAC Fax: (310) 252-7903

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