International Rectifier

IRLR/U2703PbF

HEXFET® Power MOSFET

- Logic-Level Gate Drive
- Ultra Low On-Resistance
- Surface Mount (IRLR2703)
- Straight Lead (IRLU2703)
- Advanced Process Technology
- Fast Switching
- Fully Avalanche Rated
- Lead-Free

Description

Fifth Generation HEXFETs from International Rectifier utilize advanced processing techniques to achieve the lowest possible 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 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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_D @ T_C = 25°C$</td>
<td>Continuous Drain Current, $V_{GS} @ 10V$</td>
<td>23</td>
</tr>
<tr>
<td>$I_D @ T_C = 100°C$</td>
<td>Continuous Drain Current, $V_{GS} @ 10V$</td>
<td>16</td>
</tr>
<tr>
<td>$I_{DM}$</td>
<td>Pulsed Drain Current</td>
<td>96 A</td>
</tr>
<tr>
<td>$P_D @ T_C = 25°C$</td>
<td>Power Dissipation</td>
<td>45</td>
</tr>
<tr>
<td>Linear Derating Factor</td>
<td>0.30</td>
<td>W/°C</td>
</tr>
<tr>
<td>$V_{GS}$</td>
<td>Gate-to-Source Voltage</td>
<td>± 16 V</td>
</tr>
<tr>
<td>$E_{AS}$</td>
<td>Single Pulse Avalanche Energy</td>
<td>77 mJ</td>
</tr>
<tr>
<td>$I_{AR}$</td>
<td>Avalanche Current</td>
<td>14 A</td>
</tr>
<tr>
<td>$E_{AR}$</td>
<td>Repetitive Avalanche Energy</td>
<td>4.5 mJ</td>
</tr>
<tr>
<td>$dv/dt$</td>
<td>Peak Diode Recovery $dv/dt$</td>
<td>5.0 V/ns</td>
</tr>
<tr>
<td>$T_J$</td>
<td>Operating Junction and Storage Temperature Range</td>
<td>-55 to +175 °C</td>
</tr>
</tbody>
</table>

Soldering Temperature, for 10 seconds 300 (1.6mm from case)

Thermal Resistance

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{JUC}$</td>
<td>Junction-to-Case</td>
<td>——</td>
<td>3.3</td>
</tr>
<tr>
<td>$R_{JUA}$</td>
<td>Case-to-Ambient (PCB mount)**</td>
<td>——</td>
<td>50</td>
</tr>
<tr>
<td>$R_{JUA}$</td>
<td>Junction-to-Ambient</td>
<td>——</td>
<td>110</td>
</tr>
</tbody>
</table>

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

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

www.irf.com

12/6/04
### Electrical Characteristics @ TJ = 25°C (unless otherwise specified)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{(BR)DSS}$</td>
<td>30</td>
<td>——</td>
<td>——</td>
<td>V</td>
<td>$V_{GS} = 0V, I_D = 250\mu A$</td>
</tr>
<tr>
<td>$\Delta V_{(BR)DSS}/\Delta T_J$</td>
<td>——</td>
<td>0.030</td>
<td>——</td>
<td>V/°C</td>
<td>Reference to 25°C, $I_D = 1mA$</td>
</tr>
<tr>
<td>$R_{DS(ON)}$</td>
<td>——</td>
<td>0.045</td>
<td>——</td>
<td>Ω</td>
<td>$V_{GS} = 10V, I_D = 14A$</td>
</tr>
<tr>
<td></td>
<td>——</td>
<td>0.065</td>
<td>——</td>
<td>Ω</td>
<td>$V_{GS} = 4.5V, I_D = 12A$</td>
</tr>
<tr>
<td>$V_{GS(th)}$</td>
<td>1.0</td>
<td>——</td>
<td>——</td>
<td>V</td>
<td>$V_{DS} = V_{GS}, I_D = 250\mu A$</td>
</tr>
<tr>
<td>$g_m$</td>
<td>6.4</td>
<td>——</td>
<td>——</td>
<td>S</td>
<td>$V_{DS} = 25V, I_D = 14A$</td>
</tr>
<tr>
<td>$I_{DSS}$</td>
<td>——</td>
<td>25</td>
<td>——</td>
<td>μA</td>
<td>$V_{DS} = 30V, V_{GS} = 0V$</td>
</tr>
<tr>
<td></td>
<td>——</td>
<td>250</td>
<td>——</td>
<td>μA</td>
<td>$V_{DS} = 24V, V_{GS} = 0V, T_J = 150°C$</td>
</tr>
<tr>
<td>$I_{GSS}$</td>
<td>——</td>
<td>100</td>
<td>——</td>
<td>nA</td>
<td>$V_{GS} = 16V$</td>
</tr>
<tr>
<td></td>
<td>——</td>
<td>-100</td>
<td>——</td>
<td>nA</td>
<td>$V_{GS} = -16V$</td>
</tr>
<tr>
<td>$Q_g$</td>
<td>——</td>
<td>15</td>
<td>——</td>
<td>nC</td>
<td>$I_D = 14A$</td>
</tr>
<tr>
<td>$Q_{gs}$</td>
<td>——</td>
<td>4.6</td>
<td>——</td>
<td>nC</td>
<td>$V_{DS} = 24V$</td>
</tr>
<tr>
<td>$Q_{gd}$</td>
<td>——</td>
<td>9.3</td>
<td>——</td>
<td>nC</td>
<td>$V_{DS} = 4.5V$, See Fig. 6 and 13 ℃</td>
</tr>
<tr>
<td>$I_{(on)}$</td>
<td>8.5</td>
<td>——</td>
<td>——</td>
<td>ns</td>
<td>$V_{DD} = 15V$</td>
</tr>
<tr>
<td>$t_r$</td>
<td>140</td>
<td>——</td>
<td>——</td>
<td>ns</td>
<td>$R_D = 12Ω, V_{GS} = 4.5V$, See Fig. 6 and 13 ℃</td>
</tr>
<tr>
<td>$t_{(off)}$</td>
<td>12</td>
<td>——</td>
<td>——</td>
<td>ns</td>
<td>$R_O = 1Ω$, See Fig. 10 ℃</td>
</tr>
<tr>
<td>$I_D$</td>
<td>4.5</td>
<td>——</td>
<td>——</td>
<td>nH</td>
<td>Between lead, 6mm (0.25in.) from package and center of die contact ℃</td>
</tr>
<tr>
<td>$L_S$</td>
<td>7.5</td>
<td>——</td>
<td>——</td>
<td>——</td>
<td>——</td>
</tr>
<tr>
<td>$C_{iss}$</td>
<td>450</td>
<td>——</td>
<td>——</td>
<td>pF</td>
<td>$V_{GS} = 0V$</td>
</tr>
<tr>
<td>$C_{oss}$</td>
<td>210</td>
<td>——</td>
<td>——</td>
<td>pF</td>
<td>$V_{DS} = 25V$</td>
</tr>
<tr>
<td>$C_{rss}$</td>
<td>110</td>
<td>——</td>
<td>——</td>
<td>pF</td>
<td>$f = 1.0MHz$, See Fig. 5 ℃</td>
</tr>
</tbody>
</table>

### Source-Drain Ratings and Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Units</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_S$</td>
<td>Continuous Source Current (Body Diode)</td>
<td>——</td>
<td>23 ℃</td>
<td>A</td>
<td>MOSFET symbol showing the integral reverse p-n junction diode.</td>
</tr>
<tr>
<td>$I_{SM}$</td>
<td>Pulsed Source Current (Body Diode) ℃</td>
<td>——</td>
<td>96</td>
<td>——</td>
<td>——</td>
</tr>
<tr>
<td>$V_{SD}$</td>
<td>Diode Forward Voltage</td>
<td>——</td>
<td>1.3</td>
<td>V</td>
<td>$T_J = 25°C, I_S = 14A, V_{GS} = 0V$</td>
</tr>
<tr>
<td>$t_r$</td>
<td>Reverse Recovery Time</td>
<td>——</td>
<td>65</td>
<td>ns</td>
<td>$T_J = 25°C, I_F = 14A$</td>
</tr>
<tr>
<td>$Q_{rr}$</td>
<td>Reverse RecoveryCharge</td>
<td>——</td>
<td>140</td>
<td>210</td>
<td>nC</td>
</tr>
<tr>
<td>$t_{on}$</td>
<td>Forward Turn-On Time</td>
<td>Intrinsic turn-on time is negligible (turn-on is dominated by $L_S+L_D$)</td>
<td>——</td>
<td>——</td>
<td>——</td>
</tr>
</tbody>
</table>

**Notes:**

1. Repetitive rating; pulse width limited by max. junction temperature. (See fig. 11)
2. $V_{DD} = 15V$, starting $T_J = 25°C$, $L = 570μH$
3. $R_S = 25Ω$, $I_{AS} = 14A$. (See Figure 12)
4. $I_{SD} ≤ 14A$, $d/dt ≤ 140A/μs$, $V_{DD} ≤ V_{(BR)DSS}$, $T_J ≤ 175°C$
5. Pulse width ≤ 300μs; duty cycle ≤ 2%.

5. Calculated continuous current based on maximum allowable junction temperature; Package limitation current = 20A.
6. This is applied for I-PAK, $L_S$ of D-PAK is measured between lead and center of die contact.
7. Uses IRL2703 data and test conditions.

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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

Ciss = Cgs + Cgd,
Coss = Cgs
Crss = Cgs + Cgd

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

QG, Total Gate Charge (nC)

VGS, Gate-to-Source Voltage (V)

Fig 7. Typical Source-Drain Diode
Forward Voltage

max

VGS = 0V

fig 13

FOR TEST CIRCUIT

VDS = 24V,
VDS = 15V

TJ = 175°C
TJ = 25°C

I0, Reverse Drain Current (A)

VSD, Source-to-Drain Voltage (V)

0.4 0.8 1.2 1.6 2.0 2.4

TJ = 175°C
TJ = 25°C

I0, Drain Current (A)

VDS, Drain-to-Source Voltage (V)

1 10 100

Fig 8. Maximum Safe Operating Area

VDS = 10µs

10ms

1ms

10µs

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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

Notes:
1. Duty factor $D = \frac{t_1}{t_2}$
2. Peak $T_J = P_{DM} \times Z_{thJC} + T_C$
Fig 12a. Unclamped Inductive Test Circuit

Fig 12b. Unclamped Inductive Waveforms

Fig 12c. Maximum Avalanche Energy Vs. Drain Current

Fig 13a. Basic Gate Charge Waveform

Fig 13b. Gate Charge Test Circuit
Peak Diode Recovery $dv/dt$ Test Circuit

- **Circuit Layout Considerations**
  - Low Stray Inductance
  - Ground Plane
  - Low Leakage Inductance

- **D.U.T.**

- $dv/dt$ controlled by $R_S$
- Driver same type as D.U.T.
- $I_{SD}$ controlled by Duty Factor "D"
- D.U.T. - Device Under Test

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**Fig 14.** For N-Channel HEXFETS
D-Pak (TO-252AA) Package Outline

Dimensions are shown in millimeters (inches)

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

INTERNATIONAL RECTIFIER LOGO

PART NUMBER

DATE CODE

YEAR 9 = 1999

WEEK 16

LINE A

PART NUMBER

DATE CODE

P = DESIGNATES LEAD-FREE PRODUCT (OPTIONAL)

YEAR 9 = 1999

WEEK 16

A = ASSEMBLY SITE CODE

www.irf.com
I-Pak (TO-251AA) Package Outline

Dimensions are shown in millimeters (inches)

NOTES:
2. DIMENSIONS ARE SHOWN IN MILLIMETERS (INCHES).
3. DIMENSIONS DO NOT INCLUDE MOLD FLASH OR MOLD HAVING SHALL NOT EXCEED 0.25MM (0.010) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMITIES OF THE PLASTIC BODY.
4. TOLERANCE A CONTAINS WITHIN DIMENSIONS 4, 12, 13, 15, 21.
5. LEAD DIMENSION UNCONTROLLED IN X.
6. DIMENSIONS AT ALTERNATE TO SHEET METAL, ONLY.
7. CUTTING CONFORMS TO JISCO OUTLINE TO-251AA.
8. CONTROLLING DIMENSION - INCHES.

<table>
<thead>
<tr>
<th>LEAD ASSIGNMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. - GATE</td>
</tr>
<tr>
<td>2. - EARTH</td>
</tr>
<tr>
<td>3. - SOURCE</td>
</tr>
<tr>
<td>4. - EARTH</td>
</tr>
</tbody>
</table>

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

EXAMPLE: THIS IS AN IRFU120 WITH ASSEMBLY LOT CODE 6878 ASSEMBLED ON WW 19, 1999 IN THE ASSEMBLY LINE "A".

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

OR

PART NUMBER
DATE CODE YEAR 9 = 1999 WEEK 19 LINE A

INTERNATIONAL RECTIFIER LOGO
ASSEMBLY LOT CODE
IRFU120
56 78

INTERNATIONAL RECTIFIER LOGO
ASSEMBLY LOT CODE
IRFU120
919A
56 78

www.irf.com
D-Pak (TO-252AA) Tape & Reel Information
Dimensions are shown in millimeters (inches)

TR
16.3 (.641) 15.7 (.619)
12.1 (.476) 11.9 (.469)
FEED DIRECTION
NOTES:
1. CONTROLLING DIMENSION: MILLIMETER.
2. ALL DIMENSIONS ARE SHOWN IN MILLIMETERS (INCHES).
3. OUTLINE CONFORMS TO EIA-481 & EIA-541.

TRL
16.3 (.641) 15.7 (.619)
8.1 (.318) 7.3 (.312)
FEED DIRECTION

13 INCH

NOTES:
1. OUTLINE CONFORMS TO EIA-481.

16 mm

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/