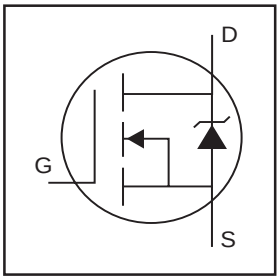
International
IOR Rectifier

PD - 91644A

# IRL1004S
# IRL1004L

HEXFET® Power MOSFET

- Logic-Level Gate Drive
- Advanced Process Technology
- Ultra Low On-Resistance
- Dynamic dv/dt Rating
- 175°C Operating Temperature
- Fast Switching
- Fully Avalanche Rated




$V_{DSS}$ = 40V

$R_{DS(on)}$ = 0.0065Ω

$I_D$ = 130A⑤

## Description

Fifth 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 $D^2Pak$ is a surface mount power package capable of accommodating die sizes up to HEX-4. It provides the highest power capability and the lowest possible on-resistance in any existing surface mount package. The $D^2Pak$ is suitable for high current applications because of its low internal connection resistance and can dissipate up to 2.0W in a typical surface mount application.
The through-hole version (IRL1004L) is available for low-profile application.

$D^2Pak$
IRL1004S

TO-262
IRL1004L

## Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---|---|---|---|
| $I_D$ @ $T_C$ = 25°C | Continuous Drain Current, $V_{GS}$ @ 10V⑥ | 130 ⑤ | A |
| $I_D$ @ $T_C$ = 100°C | Continuous Drain Current, $V_{GS}$ @ 10V⑥ | 92 ⑤ | |
| $I_{DM}$ | Pulsed Drain Current ①⑥ | 520 | |
| $P_D$ @$T_A$ = 25°C | Power Dissipation | 3.8 | W |
| $P_D$ @$T_C$ = 25°C | Power Dissipation | 200 | W |
| | Linear Derating Factor | 1.3 | W/°C |
| $V_{GS}$ | Gate-to-Source Voltage | ± 16 | V |
| $E_{AS}$ | Single Pulse Avalanche Energy⑥ | 700 | mJ |
| $I_{AR}$ | Avalanche Current① | 78 | A |
| $E_{AR}$ | Repetitive Avalanche Energy① | 20 | mJ |
| dv/dt | Peak Diode Recovery dv/dt ③⑥ | 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 | —— | 0.75 | °C/W |
| $R_{\theta JA}$ | Junction-to-Ambient ( PCB Mounted,steady-state)* | —— | 40 | |



12/29/99

## Electrical Characteristics @ $T_J$ = 25°C (unless otherwise specified)

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-to-Source Breakdown Voltage | 40 | — | — | V | $V_{GS}$ = 0V, $I_D$ = 250µA |
| $\Delta V_{(BR)DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient | — | 0.04 | — | V/°C | Reference to 25°C, $I_D$ = 1mA |
| $R_{DS(on)}$ | Static Drain-to-Source On-Resistance | — | — | 0.0065 | Ω | $V_{GS}$ = 10V, $I_D$ = 78A ④ |
| | | — | — | 0.009 | | $V_{GS}$ = 4.5V, $I_D$ = 65A ④ |
| $V_{GS(th)}$ | Gate Threshold Voltage | 1.0 | — | | V | $V_{DS}$ = $V_{GS}$, $I_D$ = 250µA |
| $g_{fs}$ | Forward Transconductance | 63 | — | — | S | $V_{DS}$ = 25V, $I_D$ = 78A⑥ |
| $I_{DSS}$ | Drain-to-Source Leakage Current | — | — | 25 | µA | $V_{DS}$ = 40V, $V_{GS}$ = 0V |
| | | — | — | 250 | | $V_{DS}$ = 32V, $V_{GS}$ = 0V, $T_J$ = 150°C |
| $I_{GSS}$ | Gate-to-Source Forward Leakage | — | — | 100 | nA | $V_{GS}$ = 16V |
| | Gate-to-Source Reverse Leakage | — | — | -100 | | $V_{GS}$ = -16V |
| $Q_g$ | Total Gate Charge | — | — | 100 | nC | $I_D$ = 78A |
| $Q_{gs}$ | Gate-to-Source Charge | — | — | 32 | | $V_{DS}$ = 32V |
| $Q_{gd}$ | Gate-to-Drain ("Miller") Charge | — | — | 43 | | $V_{GS}$ = 4.5V, See Fig. 6 and 13 ④⑥ |
| $t_{d(on)}$ | Turn-On Delay Time | — | 16 | — | ns | $V_{DD}$ = 20V, |
| $t_r$ | Rise Time | — | 210 | — | | $I_D$ = 78A, |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 25 | — | | $R_G$ = 2.5Ω, |
| $t_f$ | Fall Time | — | 14 | — | | $R_D$ = 0.18Ω, See Fig. 10 ④⑥ |
| $L_S$ | Internal Source Inductance | — | 7.5 | — | nH | Between lead, and center of die contact |
| $C_{iss}$ | Input Capacitance | — | 5330 | — | pF | $V_{GS}$ = 0V |
| $C_{oss}$ | Output Capacitance | — | 1480 | — | | $V_{DS}$ = 25V |
| $C_{rss}$ | Reverse Transfer Capacitance | — | 320 | — | | $f$ = 1.0MHz, See Fig. 5⑤⑥ |

## Source-Drain Ratings and Characteristics

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| $I_S$ | Continuous Source Current (Body Diode)⑦ | — | — | 130⑤ | A | MOSFET symbol showing the integral reverse p-n junction diode. |
| $I_{SM}$ | Pulsed Source Current (Body Diode) ①⑦ | — | — | 520 | | |
| $V_{SD}$ | Diode Forward Voltage | — | — | 1.3 | V | $T_J$ = 25°C, $I_S$ = 78A, $V_{GS}$ = 0V④ |
| $t_{rr}$ | Reverse Recovery Time | — | 78 | 120 | ns | $T_J$ = 25°C, $I_F$ = 78A |
| $Q_{rr}$ | Reverse RecoveryCharge | — | 180 | 270 | nC | di/dt = 100A/µs④⑥ |
| $t_{on}$ | 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°C, L = 0.23mH $R_G$ = 25Ω, $I_{AS}$ = 78A. (See Figure 12)

③ $I_{SD}$ ≤ 78A, di/dt ≤ 370A/µs, $V_{DD}$ ≤ $V_{(BR)DSS}$, $T_J$ ≤ 175°C

④ Pulse width ≤ 300µs; duty cycle ≤ 2%.

⑤ Calculated continuous current based on maximum allowable junction temperature; for recommended current-handing of the package refer to Design Tip # 93-4

⑥ Uses IRL1004 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.

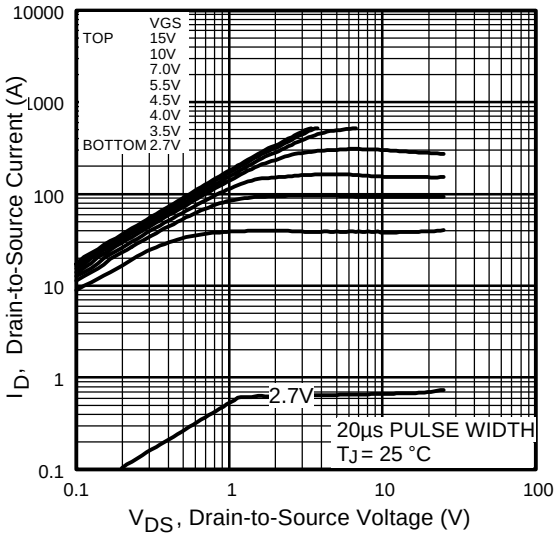



**Fig 1.** Typical Output Characteristics

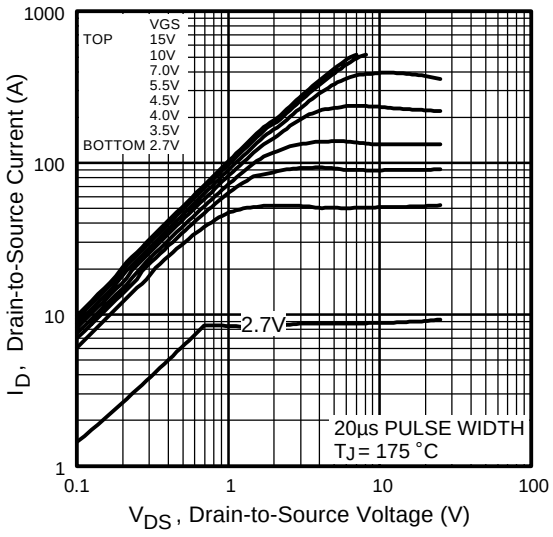



**Fig 2.** Typical Output Characteristics

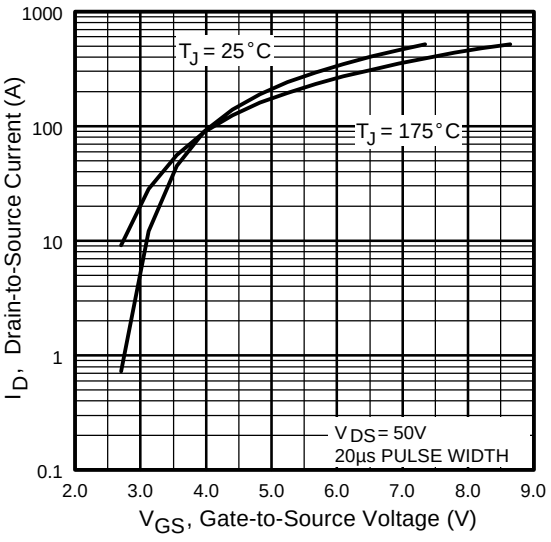



**Fig 3.** Typical Transfer Characteristics

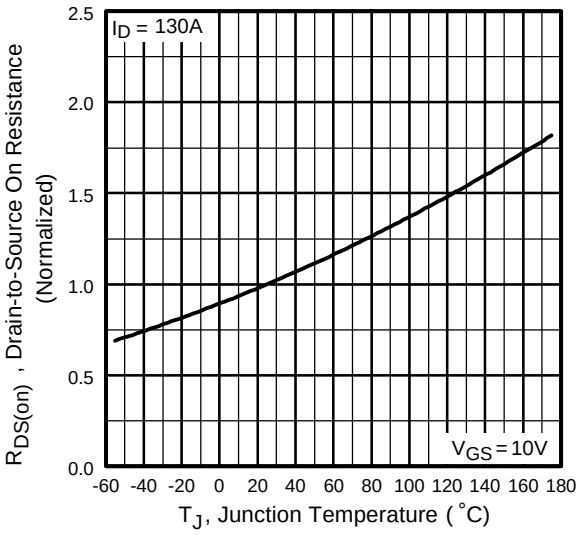



**Fig 4.** Normalized On-Resistance Vs. Temperature

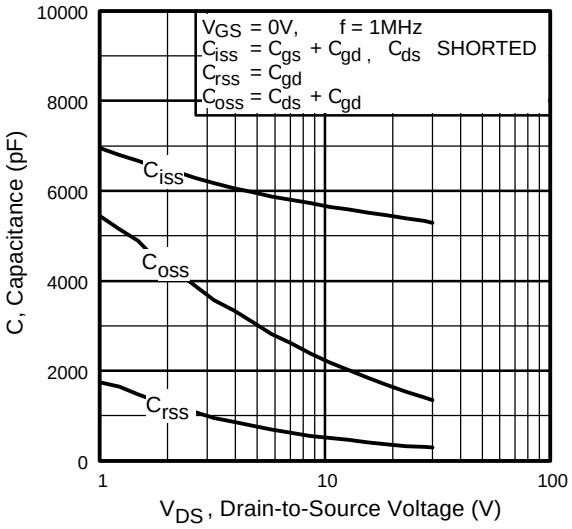



**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage

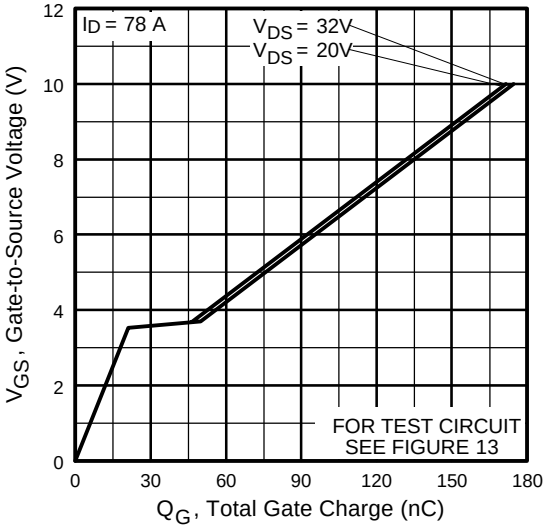



**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage

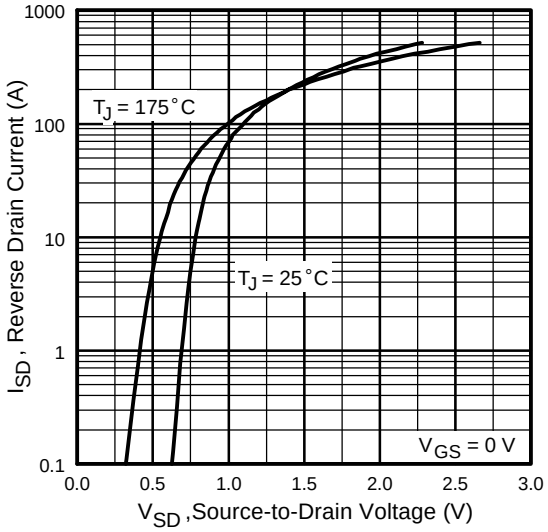



**Fig 7.** Typical Source-Drain Diode Forward Voltage

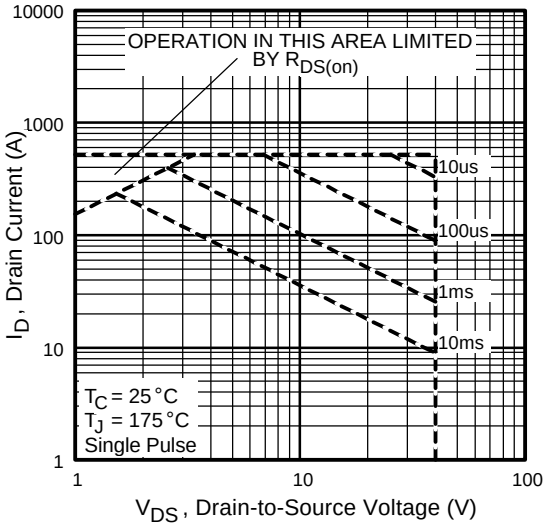



**Fig 8.** Maximum Safe Operating Area

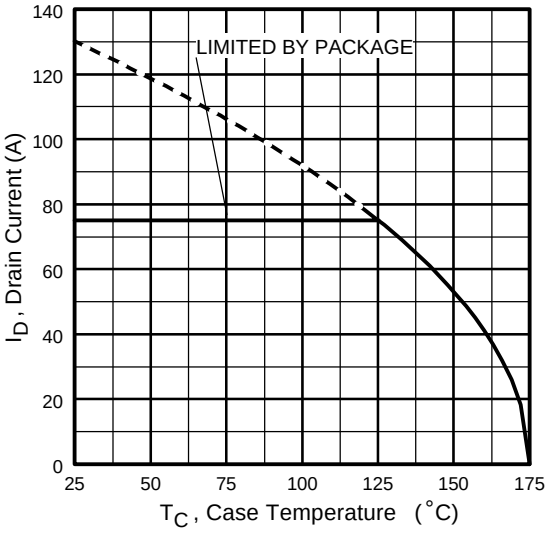



**Fig 9.** Maximum Drain Current Vs. Case Temperature

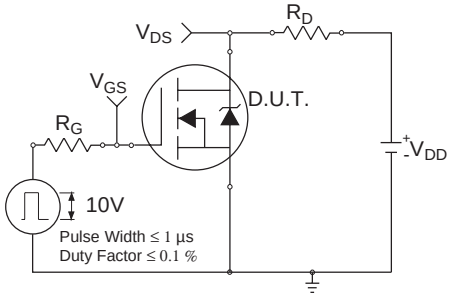



**Fig 10a.** Switching Time Test Circuit

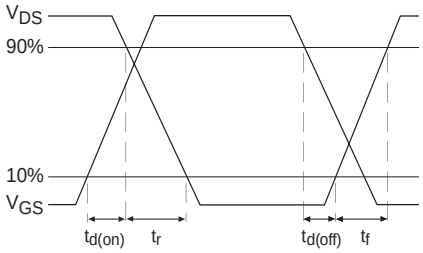



**Fig 10b.** Switching Time Waveforms

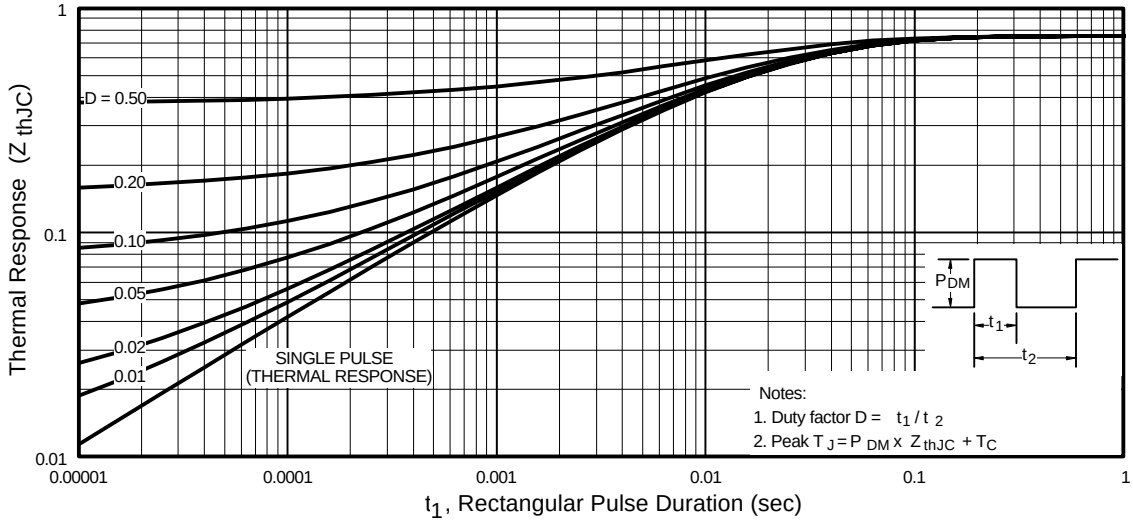



**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

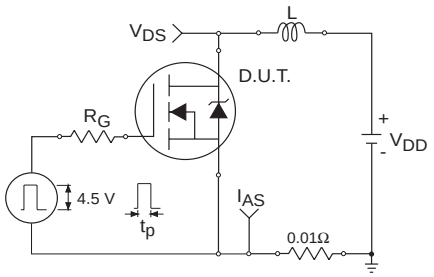



**Fig 12a.** Unclamped Inductive Test Circuit

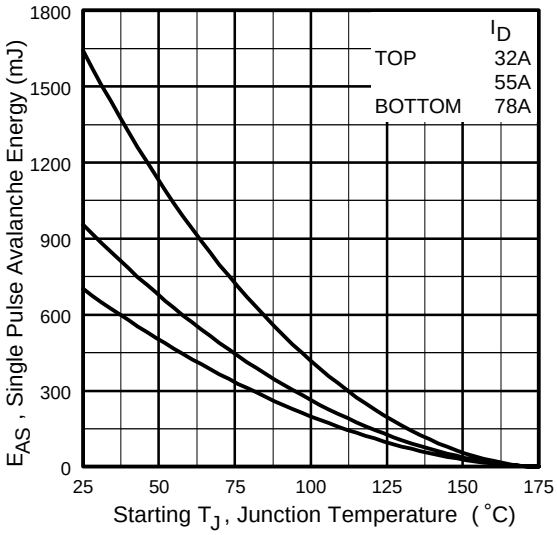



**Fig 12c.** Maximum Avalanche Energy Vs. Drain Current

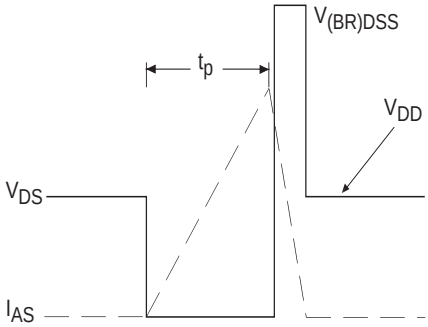



**Fig 12b.** Unclamped Inductive Waveforms

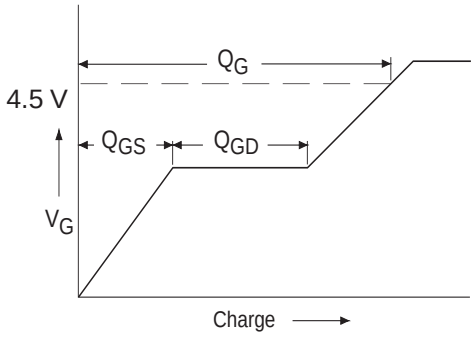



**Fig 13a.** Basic Gate Charge Waveform

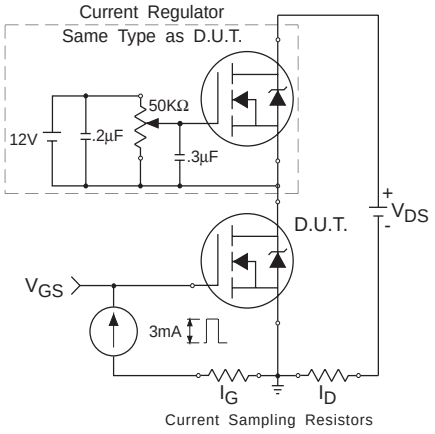
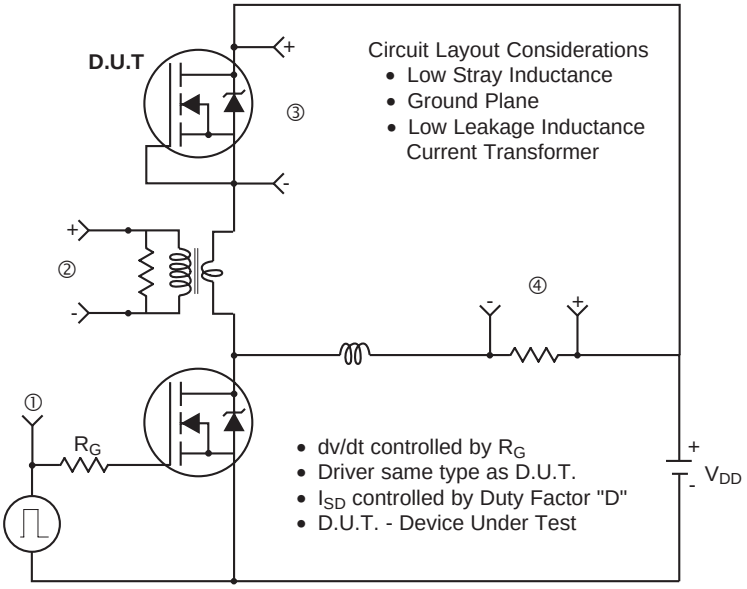
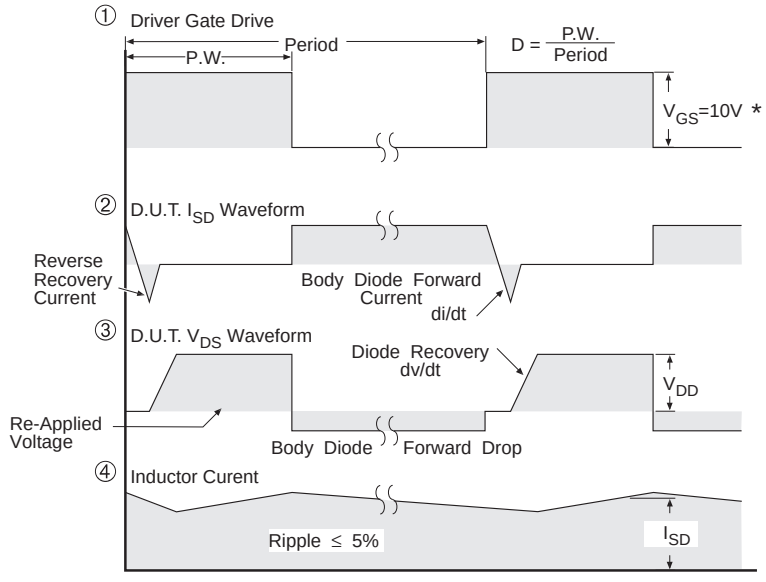



**Fig 13b.** Gate Charge Test Circuit

## Peak Diode Recovery dv/dt Test Circuit

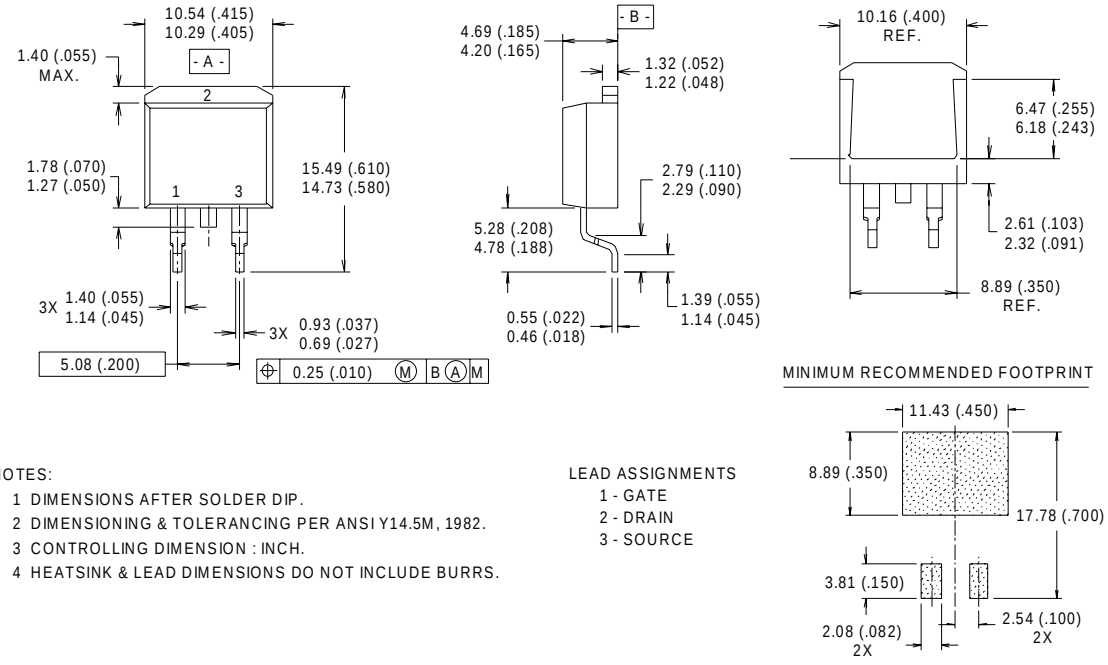



* $V_{GS}$ = 5V for Logic Level Devices

**Fig 14.** For N-channel HEXFET® Power MOSFETs

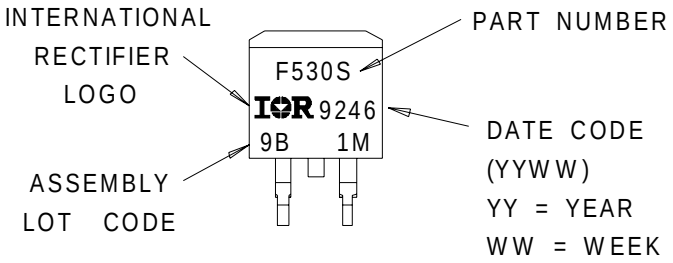
## D²Pak Package Outline



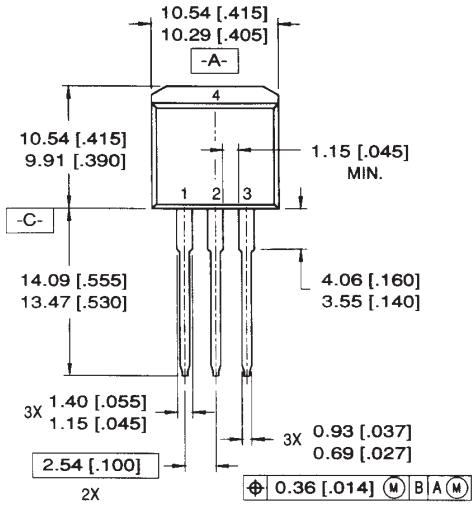

NOTES:
1 DIMENSIONS AFTER SOLDER DIP.
2 DIMENSIONING & TOLERANCING PER ANSI Y14.5M, 1982.
3 CONTROLLING DIMENSION : INCH.
4 HEATSINK & LEAD DIMENSIONS DO NOT INCLUDE BURRS.

LEAD ASSIGNMENTS
1 - GATE
2 - DRAIN
3 - SOURCE

## D²Pak Part Marking Information

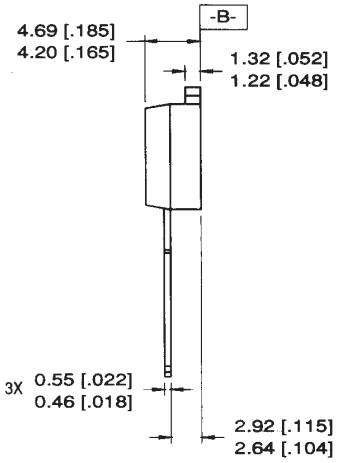


## TO-262 Package Outline




LEAD ASSIGNMENTS

1 = GATE 3 = SOURCE
2 = DRAIN 4 = DRAIN

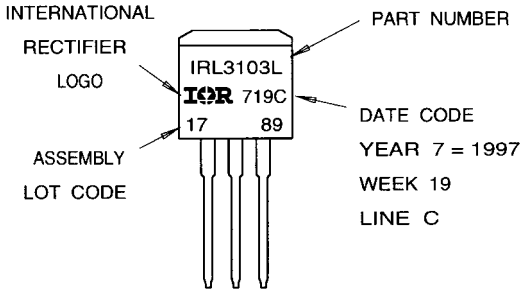



NOTES:

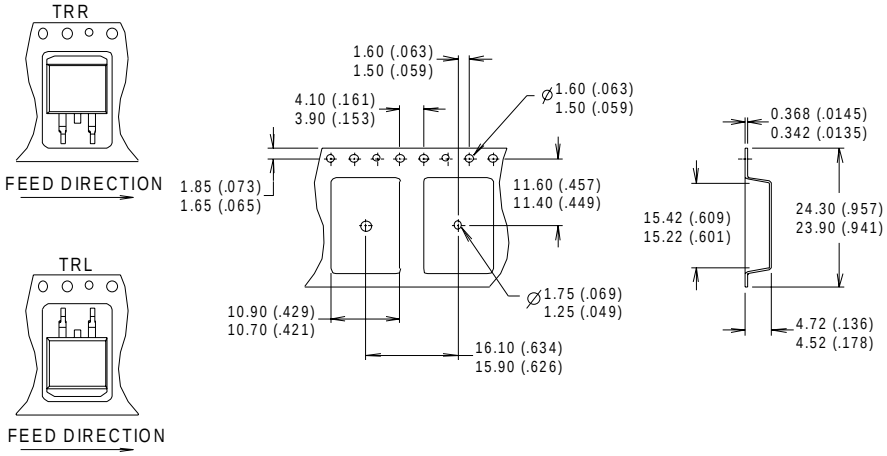
1. DIMENSIONING & TOLERANCING PER ANSI Y14.5M-1982
2. CONTROLLING DIMENSION: INCH.
3. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
4. HEATSINK & LEAD DIMENSIONS DO NOT INCLUDE BURRS.

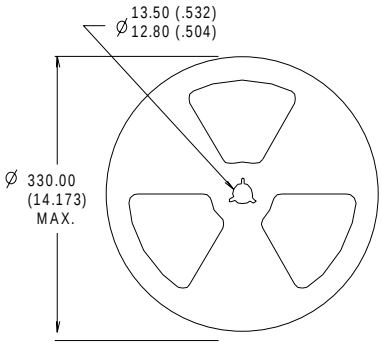
## TO-262 Part Marking Information

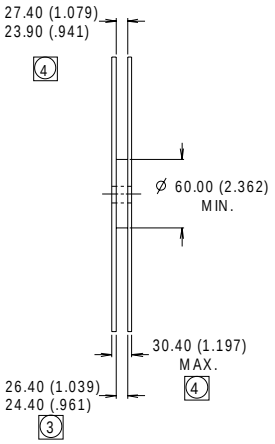
EXAMPLE: THIS IS AN IRL3103L
LOT CODE 1789
ASSEMBLED ON WW 19, 1997
IN THE ASSEMBLY LINE "C"



## D²Pak Tape & Reel Information




NOTES :
1. COMFORMS TO EIA-418.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION MEASURED @ HUB.
4. INCLUDES FLANGE DISTORTION @ OUTER EDGE.

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**IR ITALY:** Via Liguria 49, 10071 Borgaro, Torino Tel: ++ 39 11 451 0111
**IR JAPAN:** K&H Bldg., 2F, 30-4 Nishi-Ikebukuro 3-Chome, Toshima-Ku, Tokyo Japan 171 Tel: 81 3 3983 0086
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**IR TAIWAN:**16 Fl. Suite D. 207, Sec. 2, Tun Haw South Road, Taipei, 10673, Taiwan Tel: 886-2-2377-9936
*Data and specifications subject to change without notice. 12/99*