

# IRF9540NS/L

HEXFET® Power MOSFET

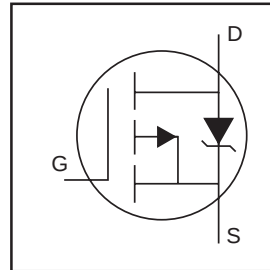
- Advanced Process Technology
- Surface Mount (IRF9540NS)
- Low-profile through-hole (IRF9540NL)
- 175°C Operating Temperature
- Fast Switching
- P-Channel
- Fully Avalanche Rated

## 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<sup>2</sup>Pak 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<sup>2</sup>Pak 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.

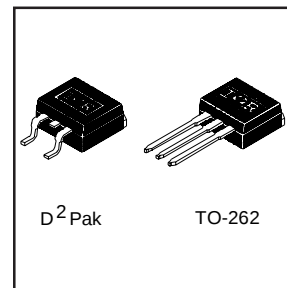
The through-hole version (IRF9540L) is available for low-profile applications.



$$V_{DS} = -100V$$

$$R_{DS(on)} = 0.117\Omega$$

$$I_D = -23A$$



## Absolute Maximum Ratings

|                           | Parameter                                   | Max.                   | Units |
|---------------------------|---------------------------------------------|------------------------|-------|
| $I_D @ T_C = 25^\circ C$  | Continuous Drain Current, $V_{GS} @ -10V$ ⑤ | -23                    | A     |
| $I_D @ T_C = 100^\circ C$ | Continuous Drain Current, $V_{GS} @ -10V$ ⑤ | -16                    |       |
| $I_{DM}$                  | Pulsed Drain Current ① ⑤                    | -76                    |       |
| $P_D @ T_A = 25^\circ C$  | Power Dissipation                           | 3.8                    | W     |
| $P_D @ T_C = 25^\circ C$  | Power Dissipation                           | 140                    | W     |
|                           | Linear Derating Factor                      | 0.91                   | W/°C  |
| $V_{GS}$                  | Gate-to-Source Voltage                      | $\pm 20$               | V     |
| $E_{AS}$                  | Single Pulse Avalanche Energy② ⑤            | 430                    | mJ    |
| $I_{AR}$                  | Avalanche Current①                          | -11                    | A     |
| $E_{AR}$                  | Repetitive Avalanche Energy①                | 14                     | mJ    |
| $dv/dt$                   | Peak Diode Recovery $dv/dt$ ③ ⑤             | -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                                   | —    | 1.1  | °C/W  |
| $R_{\theta JA}$ | Junction-to-Ambient ( PCB Mounted, steady-state)** | —    | 40   |       |

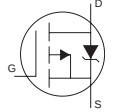
# IRF9540NS/L

International  
IR Rectifier

## 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    | -100 | —     | —     | V                   | $V_{GS} = 0V, I_D = -250\mu A$                        |
| $\Delta V_{(BR)DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient  | —    | -0.11 | —     | V/ $^\circ\text{C}$ | Reference to $25^\circ\text{C}$ , $I_D = -1mA$ ⑤      |
| $R_{DS(on)}$                    | Static Drain-to-Source On-Resistance | —    | —     | 0.117 | $\Omega$            | $V_{GS} = -10V, I_D = -11A$ 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             | 5.3  | —     | —     | S                   | $V_{DS} = -50V, I_D = -11A$ ⑤                         |
| $I_{DSS}$                       | Drain-to-Source Leakage Current      | —    | —     | -25   | $\mu A$             | $V_{DS} = -100V, V_{GS} = 0V$                         |
|                                 |                                      | —    | —     | -250  |                     | $V_{DS} = -80V, V_{GS} = 0V, T_J = 150^\circ\text{C}$ |
| $I_{GSS}$                       | Gate-to-Source Forward Leakage       | —    | —     | 100   | nA                  | $V_{GS} = 20V$                                        |
|                                 | Gate-to-Source Reverse Leakage       | —    | —     | -100  |                     | $V_{GS} = -20V$                                       |
| $Q_g$                           | Total Gate Charge                    | —    | —     | 97    | nC                  | $I_D = -11A$                                          |
| $Q_{gs}$                        | Gate-to-Source Charge                | —    | —     | 15    |                     | $V_{DS} = -80V$                                       |
| $Q_{gd}$                        | Gate-to-Drain ("Miller") Charge      | —    | —     | 51    |                     | $V_{GS} = -10V$ , See Fig. 6 and 13 ④⑤                |
| $t_{d(on)}$                     | Turn-On Delay Time                   | —    | 15    | —     | ns                  | $V_{DD} = -50V$                                       |
| $t_r$                           | Rise Time                            | —    | 67    | —     |                     | $I_D = -11A$                                          |
| $t_{d(off)}$                    | Turn-Off Delay Time                  | —    | 51    | —     |                     | $R_G = 5.1\Omega$                                     |
| $t_f$                           | Fall Time                            | —    | 51    | —     |                     | $R_D = 4.2\Omega$ , See Fig. 10 ④                     |
| $L_S$                           | Internal Source Inductance           | —    | 7.5   | —     | nH                  | Between lead,<br>and center of die contact            |
| $C_{iss}$                       | Input Capacitance                    | —    | 1300  | —     | pF                  | $V_{GS} = 0V$                                         |
| $C_{oss}$                       | Output Capacitance                   | —    | 400   | —     |                     | $V_{DS} = -25V$                                       |
| $C_{rss}$                       | Reverse Transfer Capacitance         | —    | 240   | —     |                     | $f = 1.0MHz$ , See Fig. 5⑤                            |

## Source-Drain Ratings and Characteristics

|          | Parameter                                 | Min.                                                                        | Typ. | Max. | Units | Conditions                                                                                                                                                       |
|----------|-------------------------------------------|-----------------------------------------------------------------------------|------|------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $I_S$    | Continuous Source Current<br>(Body Diode) | —                                                                           | —    | -23  | A     | MOSFET symbol<br>showing the<br>integral reverse<br>p-n junction diode.<br> |
| $I_{SM}$ | Pulsed Source Current<br>(Body Diode) ①   | —                                                                           | —    | -76  |       |                                                                                                                                                                  |
| $V_{SD}$ | Diode Forward Voltage                     | —                                                                           | —    | -1.6 | V     | $T_J = 25^\circ\text{C}, I_S = -11A, V_{GS} = 0V$ ④                                                                                                              |
| $t_{rr}$ | Reverse Recovery Time                     | —                                                                           | 150  | 220  | ns    | $T_J = 25^\circ\text{C}, I_F = -11A$                                                                                                                             |
| $Q_{rr}$ | Reverse Recovery Charge                   | —                                                                           | 830  | 1200 | nC    | $di/dt = -100A/\mu s$ ④⑤                                                                                                                                         |
| $t_{on}$ | 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  $T_J = 25^\circ\text{C}$ ,  $L = 7.1mH$   
 $R_G = 25\Omega$ ,  $I_{AS} = -11A$ . (See Figure 12)

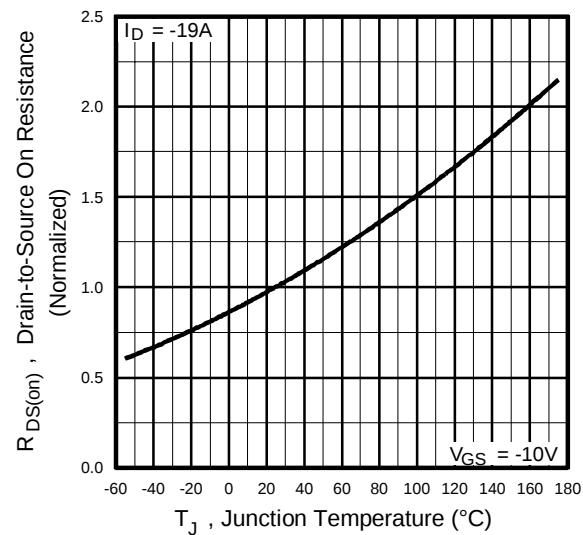
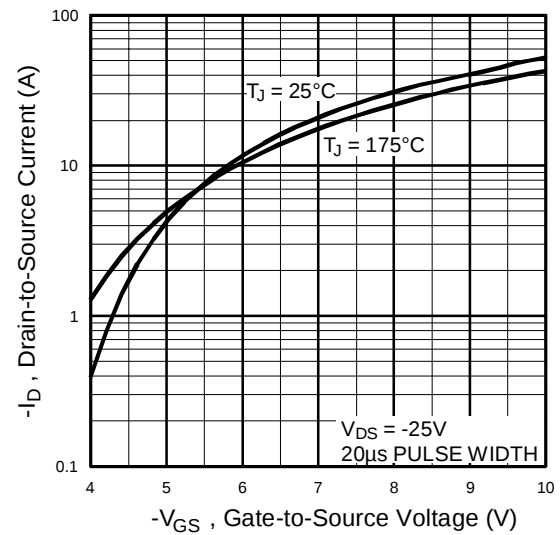
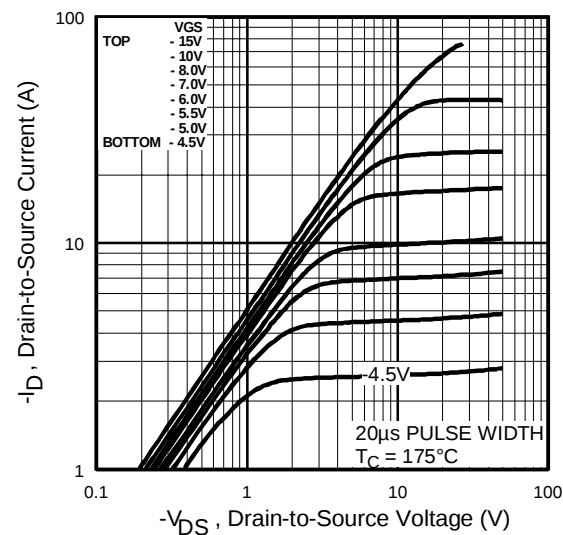
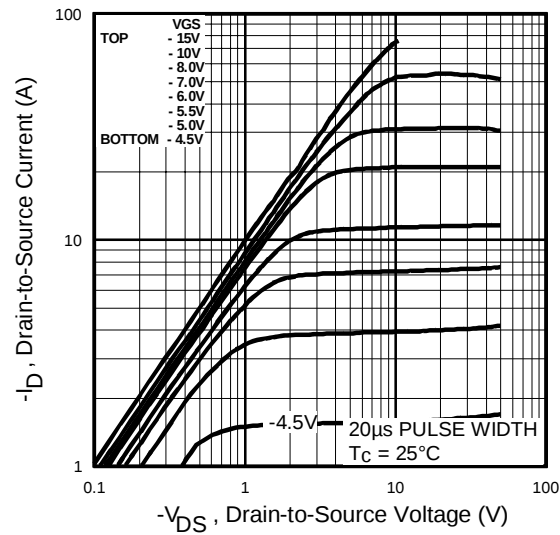
③  $I_{SD} \leq -11A$ ,  $di/dt \leq -470A/\mu s$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  
 $T_J \leq 175^\circ\text{C}$

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

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

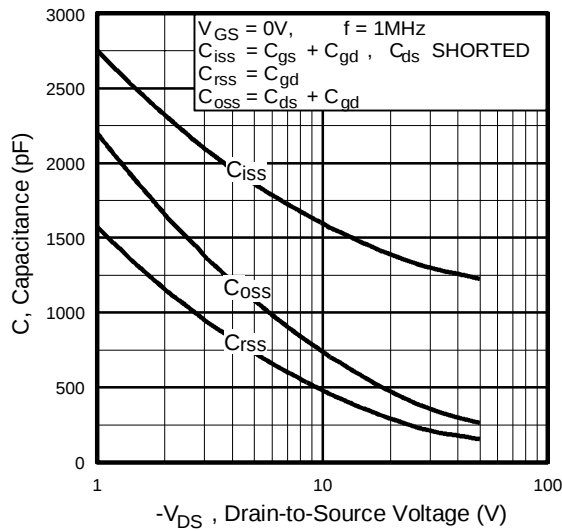
④ Pulse width  $\leq 300\mu s$ ; duty cycle  $\leq 2\%$ .

⑤ Uses IRF9540N data and test conditions

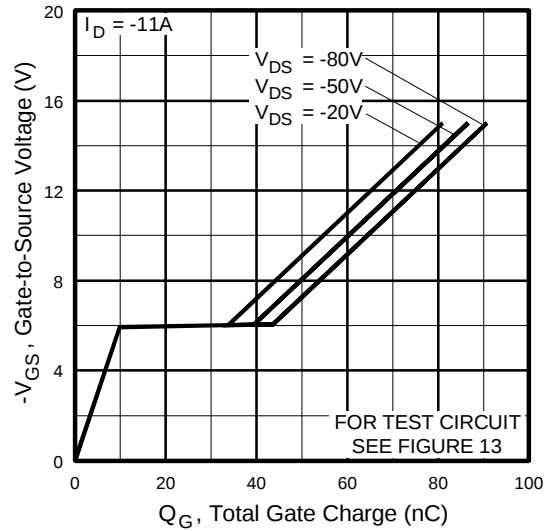


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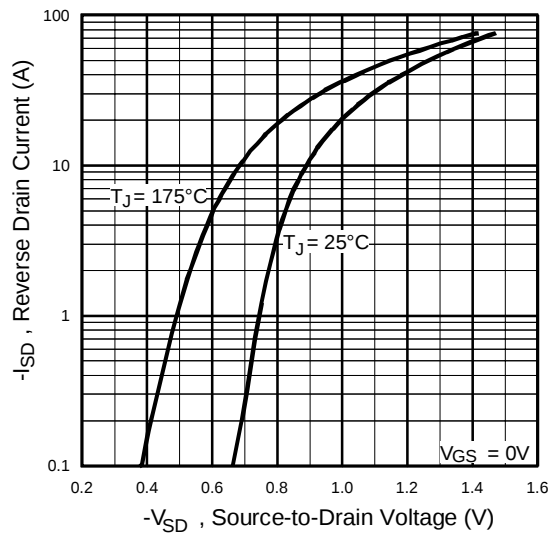
International  
**IR** Rectifier



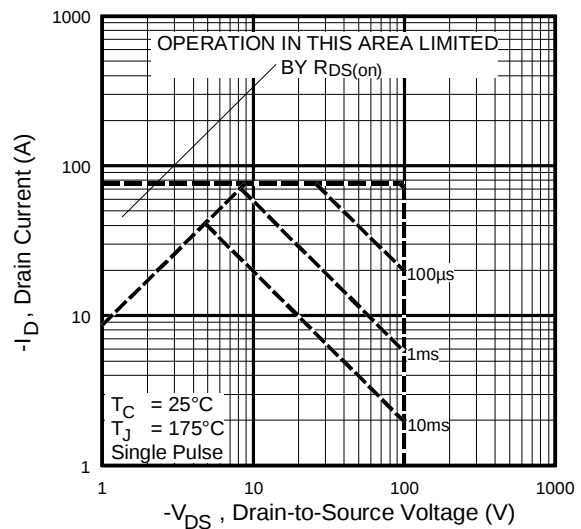
**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage



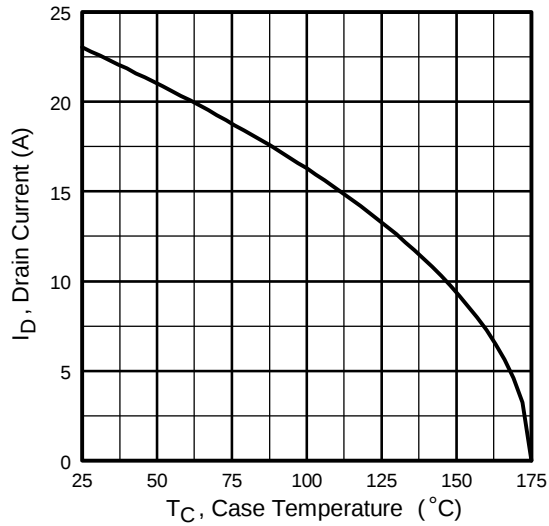
**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage



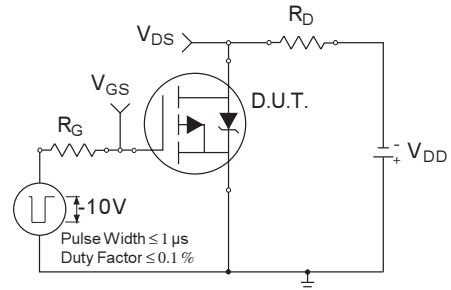
**Fig 7.** Typical Source-Drain Diode Forward Voltage



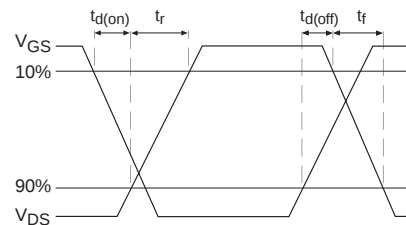
**Fig 8.** Maximum Safe Operating Area



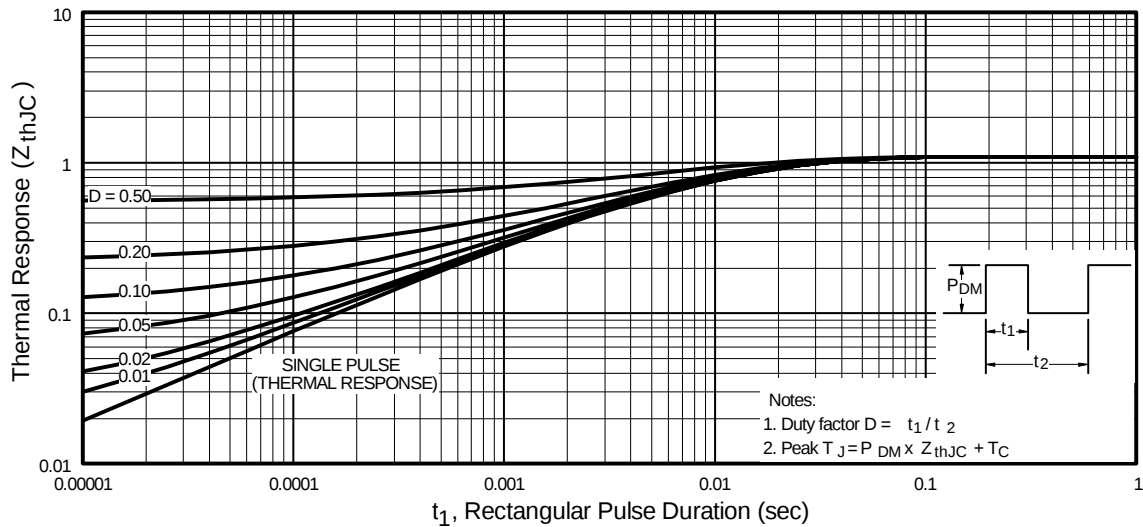
**Fig 9.** Maximum Drain Current Vs. Case Temperature



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



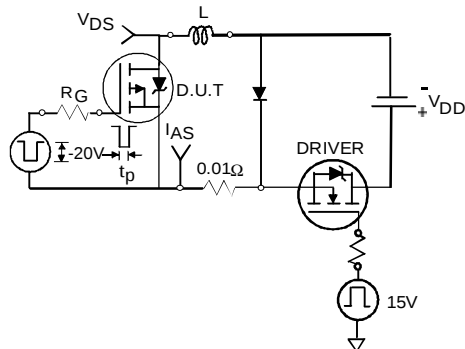
**Fig 10b.** Switching Time Waveforms



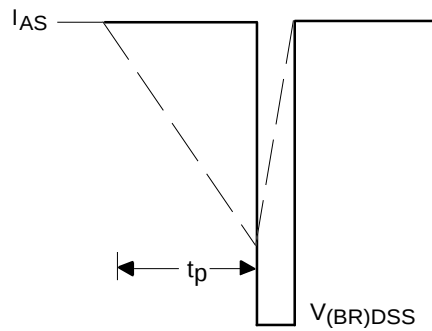
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

# IRF9540NS/L

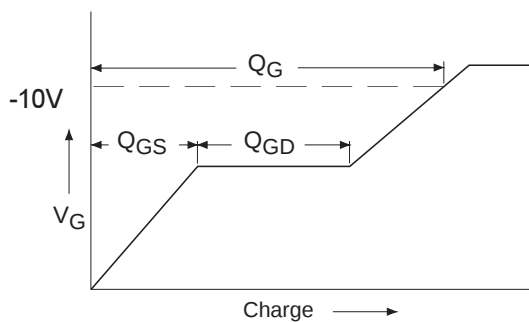
International  
**IOR** Rectifier



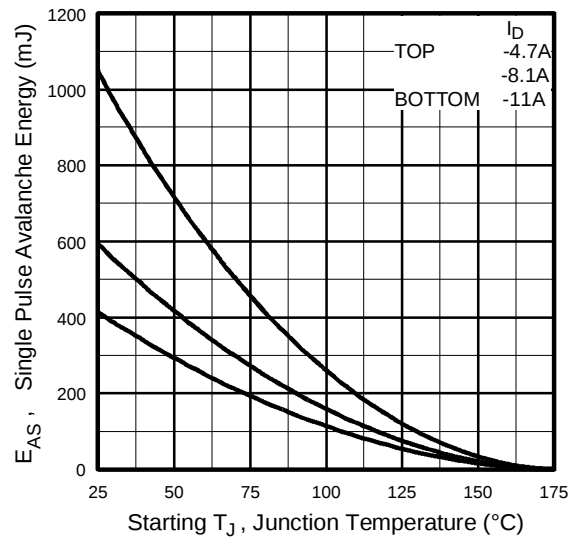
**Fig 12a.** Unclamped Inductive Test Circuit



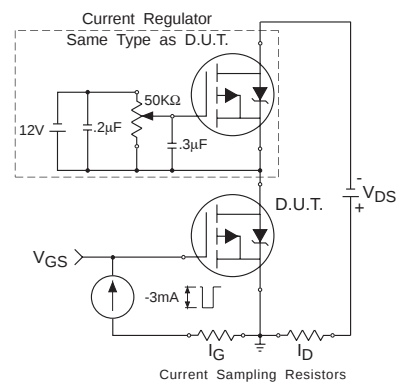
**Fig 12b.** Unclamped Inductive Waveforms



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

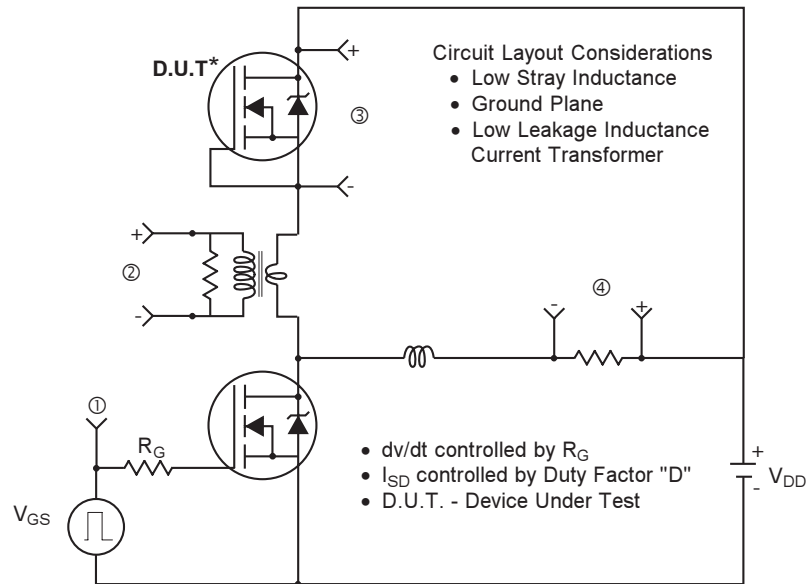


**Fig 12c.** Maximum Avalanche Energy  
Vs. Drain Current

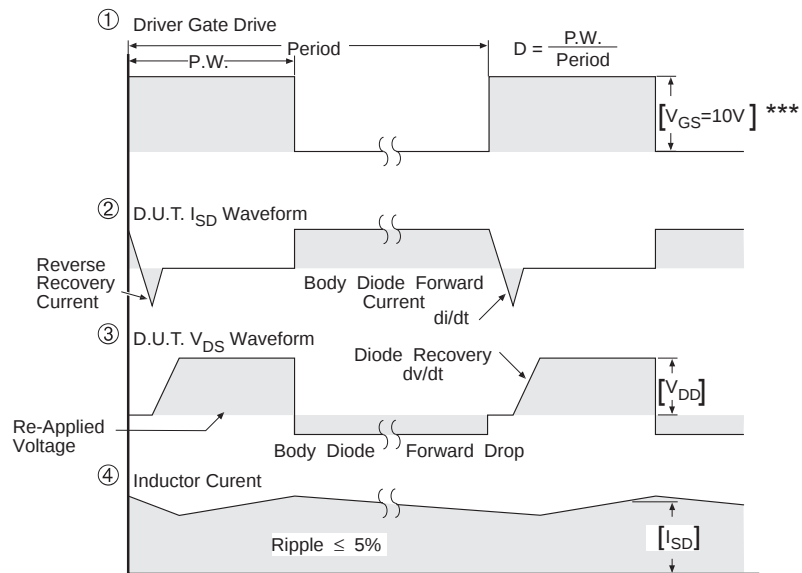


**Fig 13b.** Gate Charge Test Circuit

## Peak Diode Recovery dv/dt Test Circuit



\* Reverse Polarity of D.U.T. for P-Channel

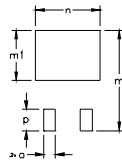
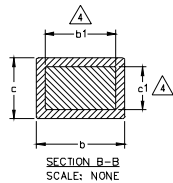
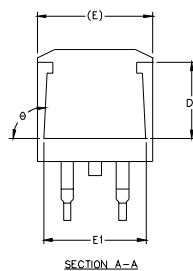


\*\*\*  $V_{GS} = 5.0V$  for Logic Level and 3V Drive Devices

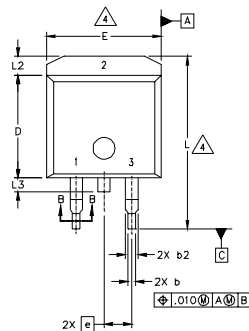
**Fig 14. For P-Channel HEXFETS**

## D<sup>2</sup>Pak Package Outline

# IOR Rectifier



Technical drawing of a mechanical part. The main view shows a vertical component with a horizontal section at the top. Dimension A is the total height, and  $c/2$  is the radius of the top section. A detail view is shown below, labeled "DETAIL A", which is a circular cross-section of the top part. The detail view shows a curved surface with a radius of  $2X c$ . A feature control symbol is present at the bottom left, indicating a positional tolerance of  $\pm 0.004$  at maximum material condition (M) for feature B.



### LEAD ASSIGNMENTS

• PART DEPENDENT.

- ## D<sup>2</sup>Pak Part Marking Information

INTERNATIONAL RECTIFIER LOGO

PART NUMBER

F530S

002L

80 24

DATE CODE

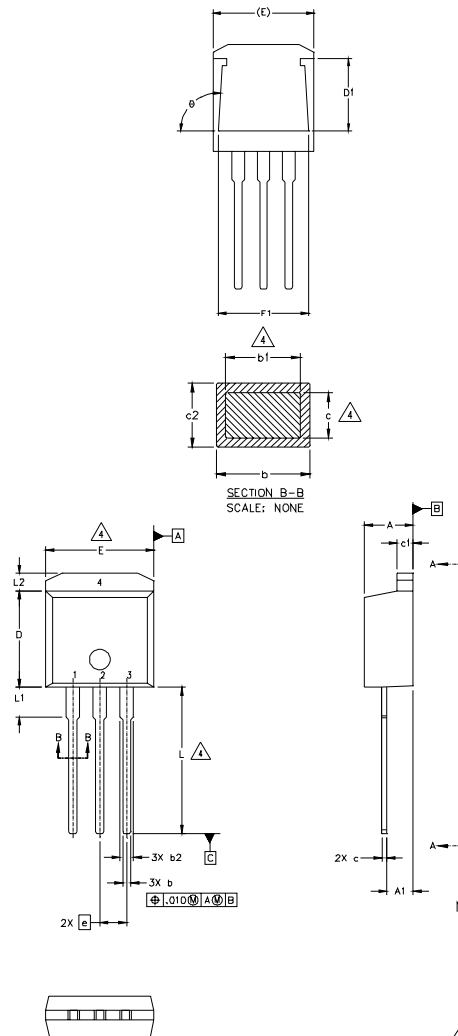
YEAR 0 = 2000

WEEK 02

LINE L

ASSEMBLY LOT CODE

## TO-262 Package Outline



## IRF9540NS/L

| SYMBOL | DIMENSIONS  |       |          |      | NOTES |
|--------|-------------|-------|----------|------|-------|
|        | MILLIMETERS |       | INCHES   |      |       |
|        | MIN.        | MAX.  | MIN.     | MAX. |       |
| A      | 4.06        | 4.83  | .160     | .190 | 4     |
| A1     | 2.03        | 2.92  | .080     | .115 |       |
| b      | 0.51        | 0.99  | .020     | .039 |       |
| b1     | 0.51        | 0.89  | .020     | .035 |       |
| b2     | 1.14        | 1.40  | .045     | .055 | 4     |
| c      | 0.38        | 0.63  | .015     | .025 |       |
| c1     | 1.14        | 1.40  | .045     | .055 |       |
| c2     | 0.43        | .063  | .017     | .029 |       |
| D      | 8.51        | 9.65  | .335     | .380 | 3     |
| D1     | 5.33        |       | .210     |      | 3     |
| E      | 9.65        | 10.67 | .380     | .420 |       |
| E1     | 6.22        |       | .245     |      |       |
| e      | 2.54 BSC    |       | .100 BSC |      |       |
| L      | 13.46       | 14.09 | .530     | .555 |       |
| L1     | 3.56        | 3.71  | .140     | .146 |       |
| L2     |             | 1.65  |          | .065 |       |

### LEAD ASSIGNMENTS

#### HEXFET

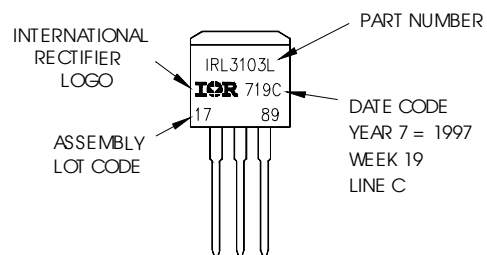
- 1. - GATE
- 2. - DRAIN
- 3. - SOURCE
- 4. - DRAIN

#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [".005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
4. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
5. CONTROLLING DIMENSION: INCH.

## TO-262 Part Marking Information

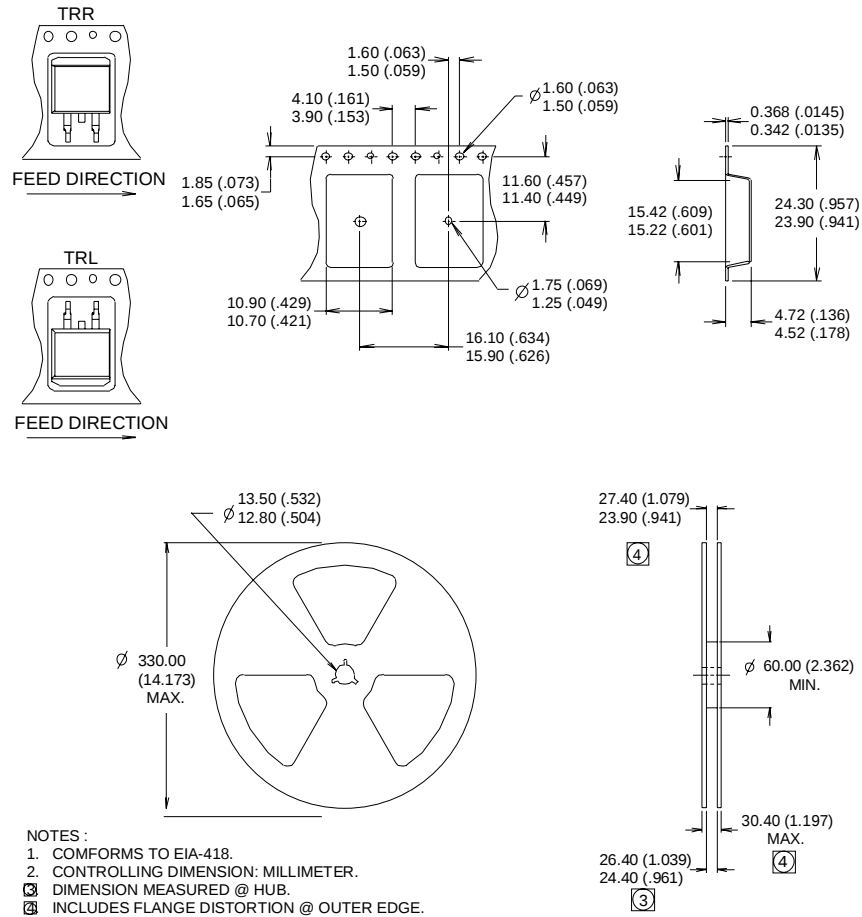
EXAMPLE: THIS IS AN IRL3103L  
LOT CODE 1789  
ASSEMBLED ON WW 19, 1997  
IN THE ASSEMBLY LINE "C"



# IRF9540NS/L

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## D<sup>2</sup>Pak Tape & Reel Information



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](http://www.irf.com) for sales contact information.03/03

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