

# IRF9540NS/LPbF

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                   | $V_{GS} = 0V$ , $I_D = -250\mu A$                                  |
| $\Delta BV_{DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient  | —    | -0.11 | —    | V/ $^\circ\text{C}$ | Reference to $25^\circ\text{C}$ , $I_D = -1mA$                     |
| $R_{DS(on)}$                 | Static Drain-to-Source On-Resistance | —    | —     | 117  | m $\Omega$          | $V_{GS} = -10V$ , $I_D = -14A$ 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             | 5.6  | —     | —    | S                   | $V_{DS} = -50V$ , $I_D = -14A$                                     |
| $I_{DSS}$                    | Drain-to-Source Leakage Current      | —    | —     | -50  | $\mu A$             | $V_{DS} = -100V$ , $V_{GS} = 0V$                                   |
|                              |                                      | —    | —     | -250 |                     | $V_{DS} = -80V$ , $V_{GS} = 0V$ , $T_J = 125^\circ\text{C}$        |
| $I_{GSS}$                    | Gate-to-Source Forward Leakage       | —    | —     | 100  | nA                  | $V_{GS} = -20V$                                                    |
|                              | Gate-to-Source Reverse Leakage       | —    | —     | -100 |                     | $V_{GS} = 20V$                                                     |
| $Q_g$                        | Total Gate Charge                    | —    | 73    | 110  | nC                  | $I_D = -14A$                                                       |
| $Q_{gs}$                     | Gate-to-Source Charge                | —    | 13    | 20   |                     | $V_{DS} = -80V$                                                    |
| $Q_{gd}$                     | Gate-to-Drain ("Miller") Charge      | —    | 38    | 57   |                     | $V_{GS} = -10V$ ④                                                  |
| $t_{d(on)}$                  | Turn-On Delay Time                   | —    | 13    | —    | ns                  | $V_{DD} = -50V$                                                    |
| $t_r$                        | Rise Time                            | —    | 64    | —    |                     | $I_D = -14A$                                                       |
| $t_{d(off)}$                 | Turn-Off Delay Time                  | —    | 40    | —    |                     | $R_G = 5.1\Omega$                                                  |
| $t_f$                        | Fall Time                            | —    | 45    | —    |                     | $V_{GS} = -10V$ 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                    | —    | 1450  | —    | pF                  | $V_{GS} = 0V$                                                      |
| $C_{oss}$                    | Output Capacitance                   | —    | 430   | —    |                     | $V_{DS} = -25V$                                                    |
| $C_{rss}$                    | Reverse Transfer Capacitance         | —    | 230   | —    |                     | $f = 1.0MHz$ , See Fig. 5                                          |

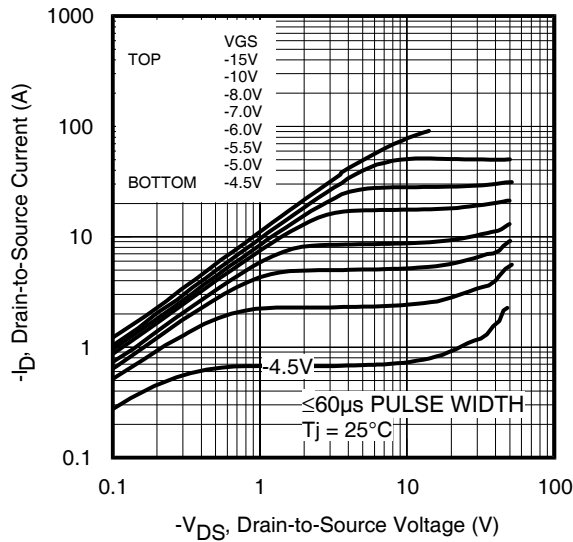
## Source-Drain Ratings and Characteristics

|          | Parameter                              | Min.                                                                      | Typ. | Max. | Units | Conditions                                                     |
|----------|----------------------------------------|---------------------------------------------------------------------------|------|------|-------|----------------------------------------------------------------|
| $I_S$    | Continuous Source Current (Body Diode) | —                                                                         | —    | -23  | A     | MOSFET symbol showing the integral reverse p-n junction diode. |
| $I_{SM}$ | Pulsed Source Current (Body Diode) ①   | —                                                                         | —    | -92  |       |                                                                |
| $V_{SD}$ | Diode Forward Voltage                  | —                                                                         | —    | -1.6 | V     | $T_J = 25^\circ\text{C}$ , $I_S = -14A$ , $V_{GS} = 0V$ ④      |
| $t_{rr}$ | Reverse Recovery Time                  | —                                                                         | 140  | 210  | ns    | $T_J = 25^\circ\text{C}$ , $I_F = -14A$ , $V_{DD} = -25V$      |
| $Q_{rr}$ | Reverse Recovery Charge                | —                                                                         | 890  | 1340 | nC    | $di/dt = -100A/\mu s$ ④                                        |
| $t_{on}$ | Forward Turn-On Time                   | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S+L_D$ ) |      |      |       |                                                                |

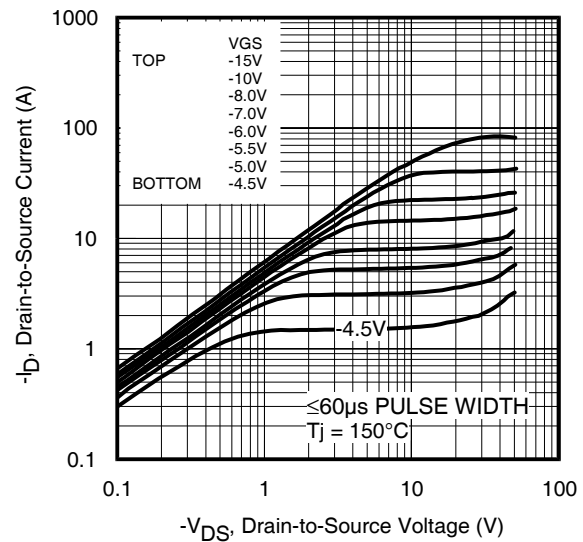
### Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature. ( See fig. 11)
- ② Starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.88mH$   
 $R_G = 25\Omega$ ,  $I_{AS} = -14A$ . (See Figure 12)
- ③  $I_{SD} \leq -14A$ ,  $di/dt \leq -620A/\mu s$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  
 $T_J \leq 150^\circ\text{C}$ .

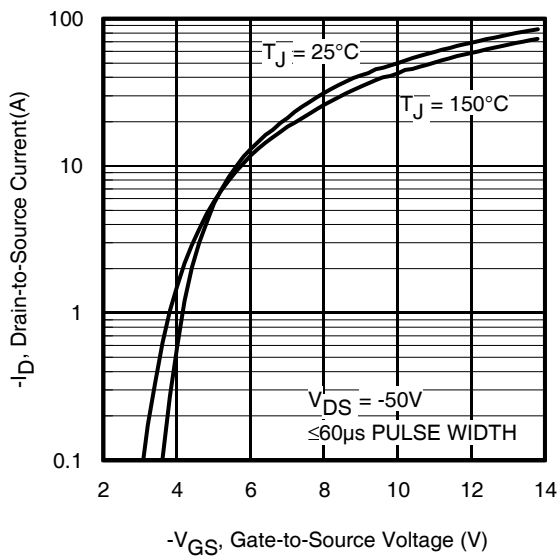
- ④ Pulse width  $\leq 300\mu s$ ; duty cycle  $\leq 2\%$ .
- ⑤ When mounted on 1" square PCB (FR-4or G-10 Material). For recommended footprint and soldering techniques refer to application note #AN-994.



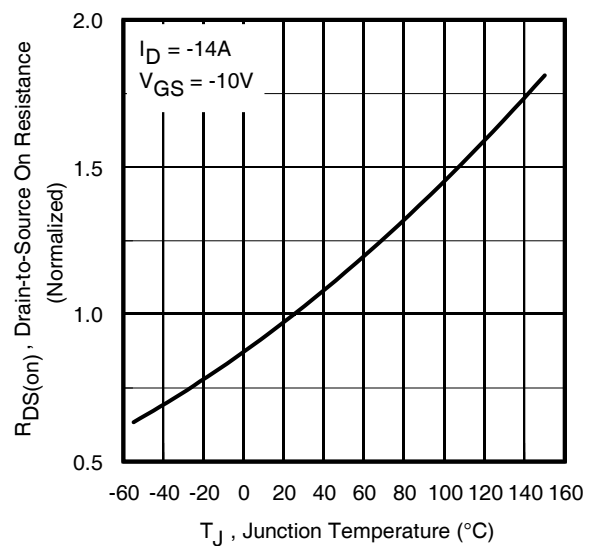
**Fig 1.** Typical Output Characteristics



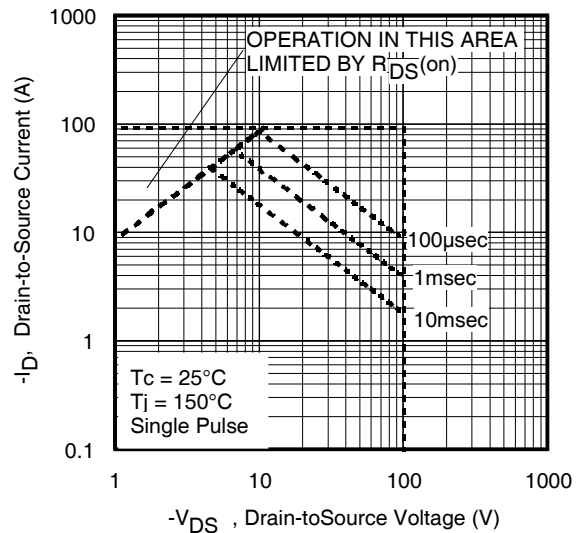
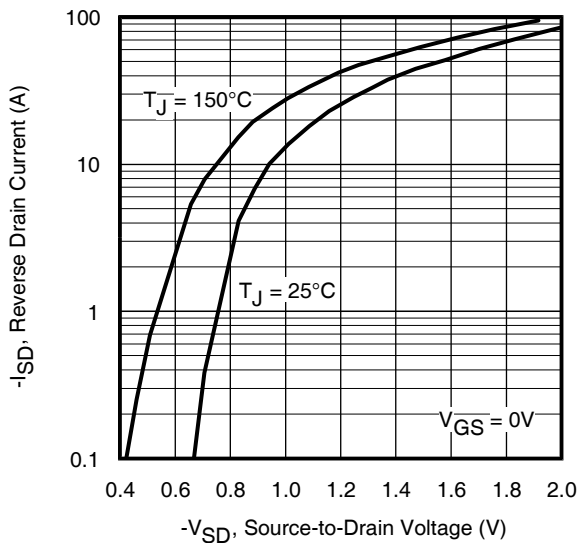
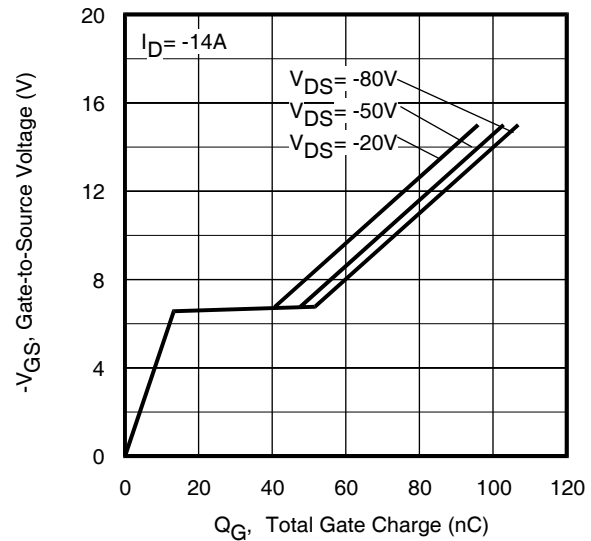
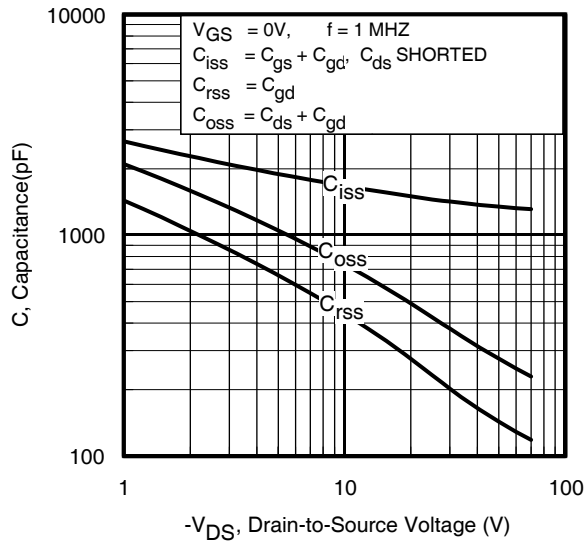
**Fig 2.** Typical Output Characteristics



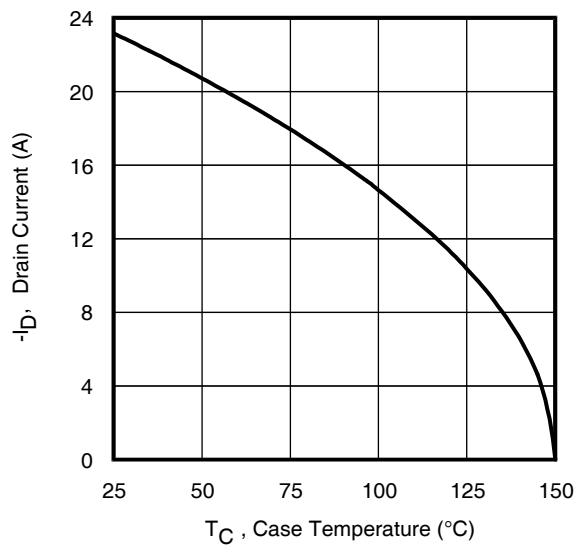
**Fig 3.** Typical Transfer Characteristics



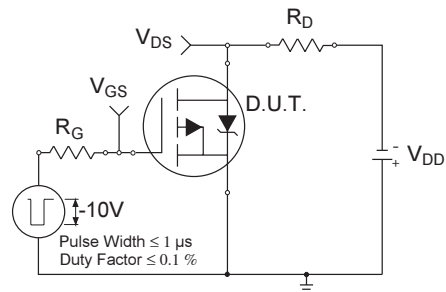
**Fig 4.** Normalized On-Resistance vs. Temperature



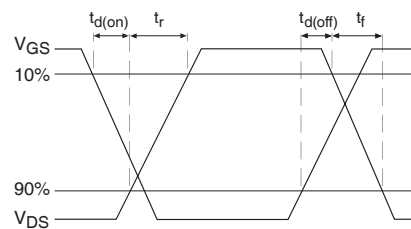
# IRF9540NS/LPbF



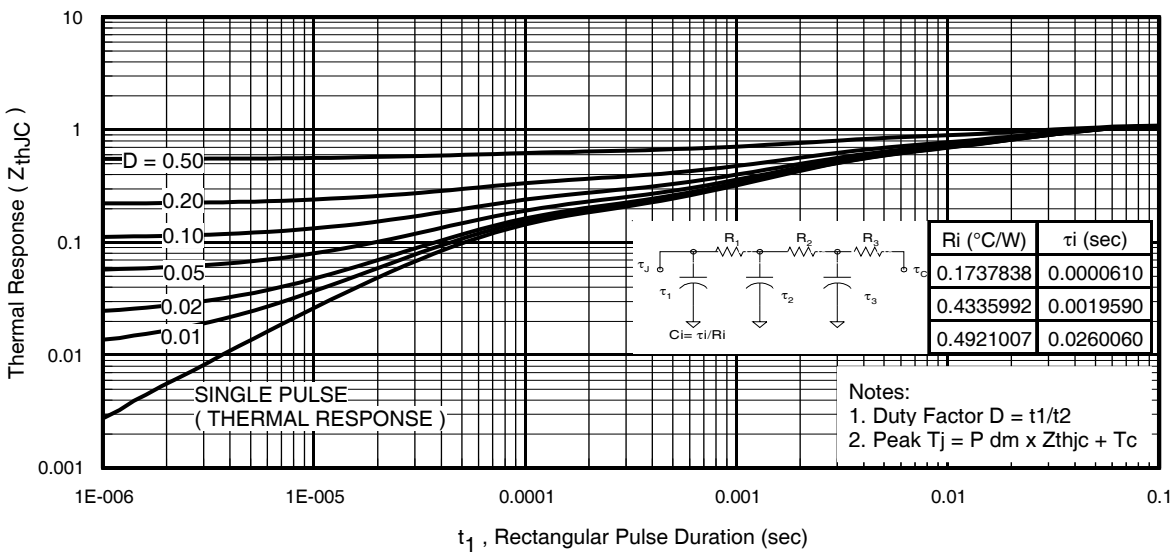
**Fig 9.** Maximum Drain Current vs. Case Temperature



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



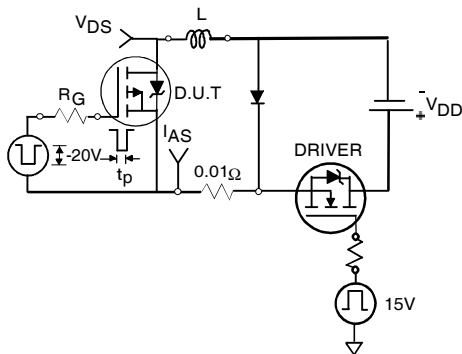
**Fig 10b.** Switching Time Waveforms



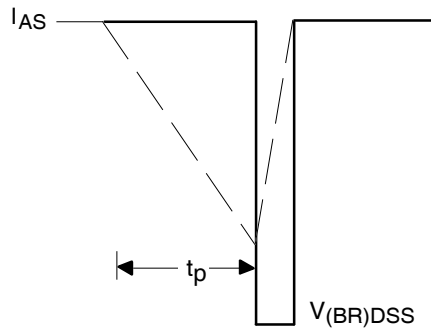
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

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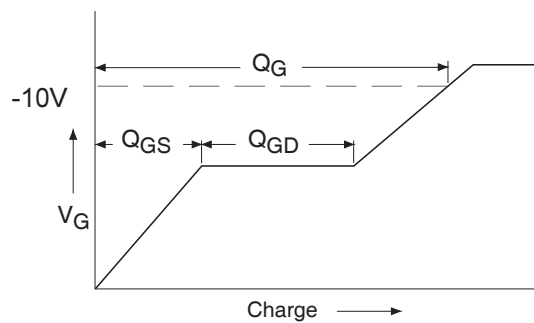
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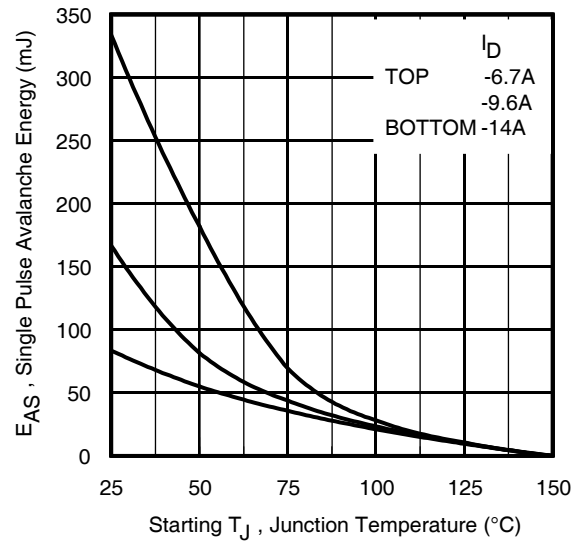
**Fig 12a.** Unclamped Inductive Test Circuit



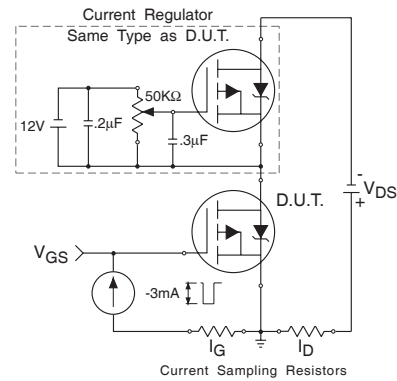
**Fig 12b.** Unclamped Inductive Waveforms



**Fig 14a.** Basic Gate Charge Waveform

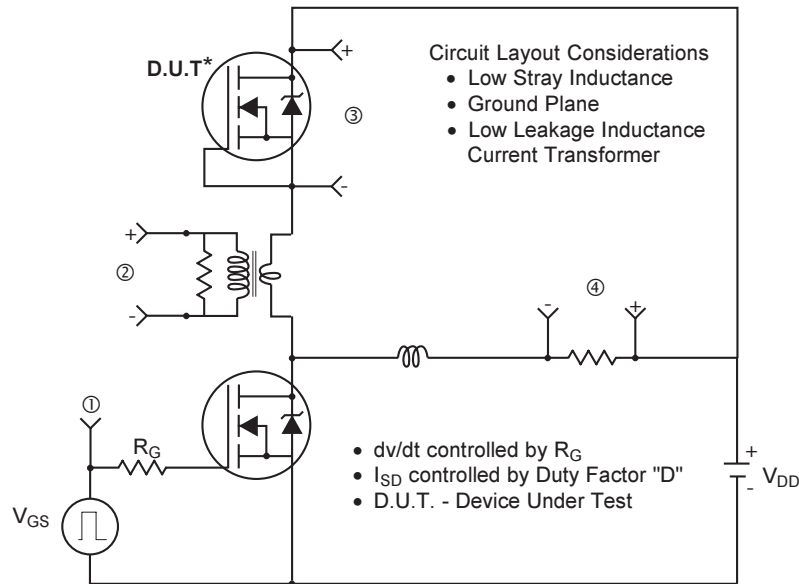


**Fig 13.** Maximum Avalanche Energy vs. Drain Current

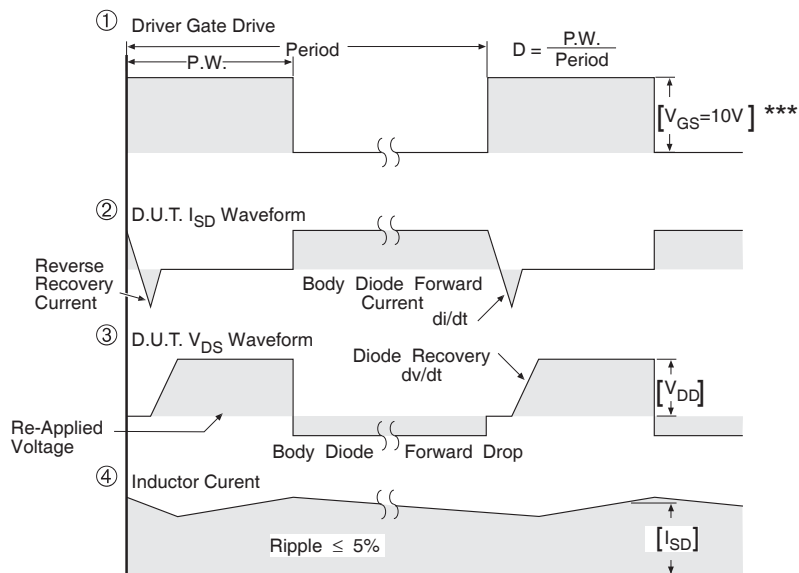


**Fig 14b.** Gate Charge Test Circuit

## 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

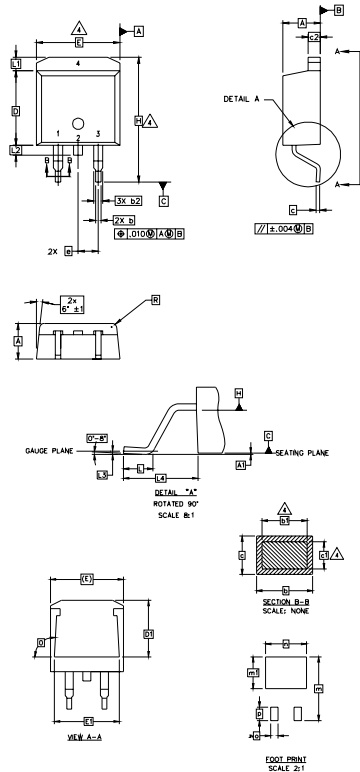
**Fig 15. For P-Channel HEXFETS**

# IRF9540NS/LPbF

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

Dimensions are shown in millimeters (inches)

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### 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 [0.005"] 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.

| SYM B O L | DIMENSIONS  |       |          |      | NOTES |
|-----------|-------------|-------|----------|------|-------|
|           | MILLIMETERS |       | INCHES   |      |       |
|           | MIN.        | MAX.  | MIN.     | MAX. |       |
| A         | 4.06        | 4.83  | .160     | .190 | 4     |
| A1        | 0.00        | 0.254 | .000     | .010 |       |
| b         | 0.51        | 0.99  | .020     | .039 |       |
| b1        | 0.51        | 0.89  | .020     | .035 |       |
| b2        | 1.14        | 1.78  | .045     | .070 | 4     |
| c         | 0.38        | 0.74  | .015     | .029 |       |
| c1        | 0.38        | 0.58  | .015     | .023 |       |
| c2        | 1.14        | 1.65  | .045     | .065 |       |
| D         | 8.51        | 9.65  | .335     | .380 | 3     |
| D1        | 6.86        |       | .270     |      |       |
| E         | 9.65        | 10.67 | .380     | .420 |       |
| E1        | 6.22        |       | .245     |      |       |
| e         | 2.54 BSC    |       | .100 BSC |      | 3     |
| H         | 14.61       | 15.88 | .575     | .625 |       |
| L         | 1.78        | 2.79  | .070     | .110 |       |
| L1        |             | 1.65  |          | .065 |       |
| L2        | 1.27        | 1.78  | .050     | .070 | 3     |
| L3        | 0.25 BSC    |       | .010 BSC |      |       |
| L4        | 4.78        | 5.28  | .188     | .208 |       |
| m         | 17.78       |       | .700     |      | 3     |
| m1        | 8.89        |       | .350     |      |       |
| n         | 11.43       |       | .450     |      |       |
| o         | 2.08        |       | .082     |      |       |
| p         | 3.81        |       | .150     |      | 3     |
| R         | 0.51        | 0.71  | .020     | .028 |       |
| θ         | 90°         | 93°   | 90°      | 93°  |       |

### LEAD ASSIGNMENTS

#### HEXFET

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

#### IGBTs, CoPACK

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

#### DIODES

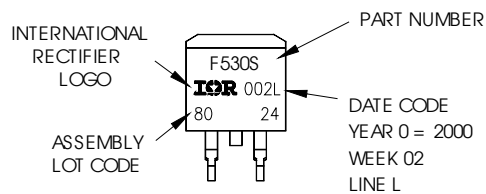
- 1.- ANODE \*
- 2, 4.- CATHODE
- 3.- ANODE

\* PART DEPENDENT.

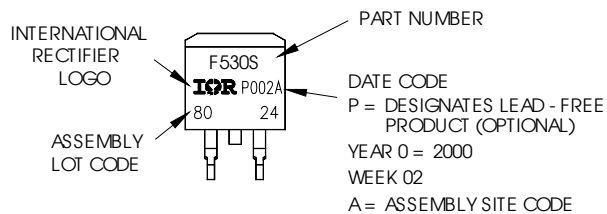
## D<sup>2</sup>Pak Part Marking Information

EXAMPLE: THIS IS AN IRF530S WITH  
LOT CODE 8024  
ASSEMBLED ON VV02, 2000  
IN THE ASSEMBLY LINE "L"

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

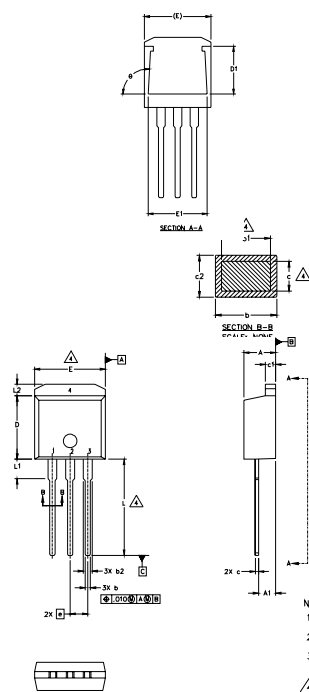


OR



## TO-262 Package Outline

Dimensions are shown in millimeters (inches)



| 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   |      |       |
| E      | 9.65        | 10.67 | .380   | .420 | 3     |
| 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

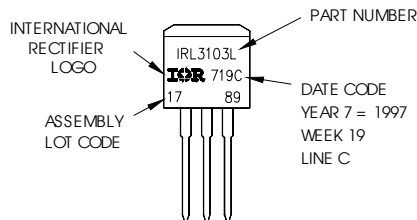
| HEXFET     | IGBT          |
|------------|---------------|
| 1.- GATE   | 1 - GATE      |
| 2.- DRAIN  | 2 - COLLECTOR |
| 3.- SOURCE | 3 - EMITTER   |
| 4.- DRAIN  |               |

- 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 [0.005"] 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.

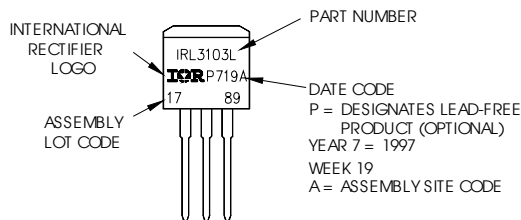
## TO-262 Part Marking Information

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

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



**OR**

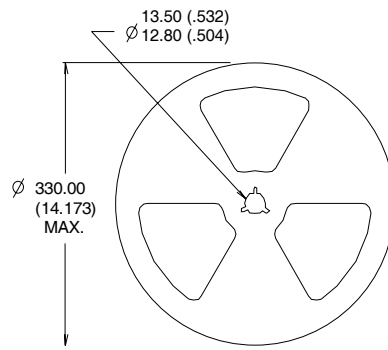
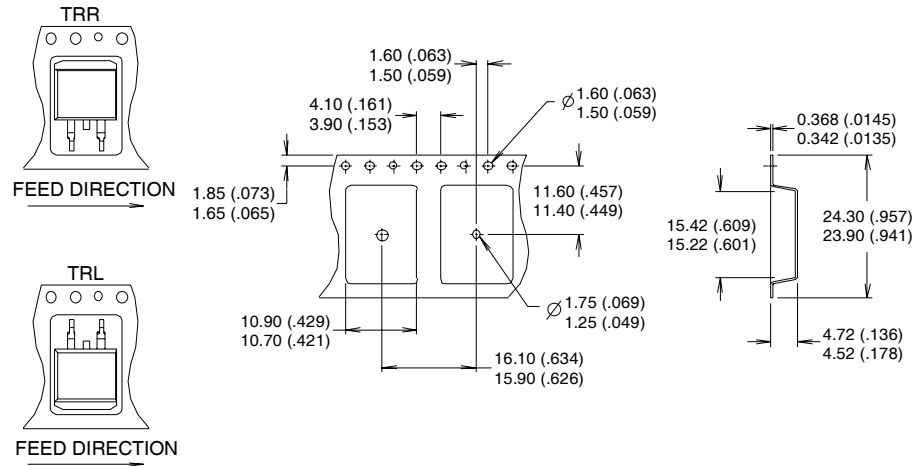


# IRF9540NS/LPbF

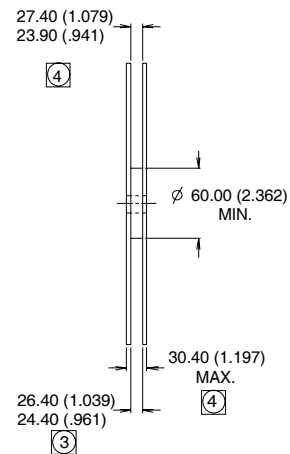
## D<sup>2</sup>Pak Tape & Reel Information

Dimensions are shown in millimeters (inches)

International  
**IR** Rectifier



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



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

International  
**IR** Rectifier

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TAC Fax: (310) 252-7903

Visit us at [www.irf.com](http://www.irf.com) for sales contact information. 09/05

[www.irf.com](http://www.irf.com)

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