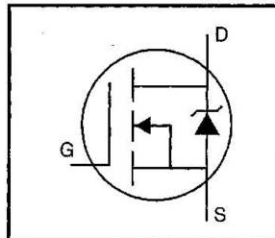


# IRF540PbF

## HEXFET® Power MOSFET

- Dynamic dv/dt Rating
- Repetitive Avalanche Rated
- 175°C Operating Temperature
- Fast Switching
- Ease of Paralleling
- Simple Drive Requirements
- Lead-Free



$$V_{DSS} = 100V$$

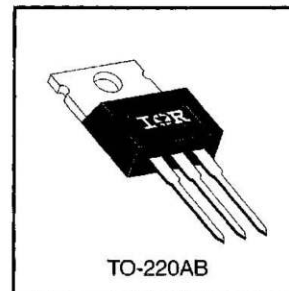
$$R_{DS(on)} = 0.077\Omega$$

$$I_D = 28A$$

### Description

Third Generation HEXFETs from International Rectifier provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.

The TO-220 package is universally preferred for all commercial-industrial applications at power dissipation levels to approximately 50 watts. The low thermal resistance and low package cost of the TO-220 contribute to its wide acceptance throughout the industry.



### Absolute Maximum Ratings

|                             | Parameter                                           | Max.                  | Units |
|-----------------------------|-----------------------------------------------------|-----------------------|-------|
| $I_D$ @ $T_C = 25^\circ C$  | Continuous Drain Current, $V_{GS}$ @ 10 V           | 28                    | A     |
| $I_D$ @ $T_C = 100^\circ C$ | Continuous Drain Current, $V_{GS}$ @ 10 V           | 20                    |       |
| $I_{DM}$                    | Pulsed Drain Current ①                              | 110                   |       |
| $P_D$ @ $T_C = 25^\circ C$  | Power Dissipation                                   | 150                   | W     |
|                             | Linear Derating Factor                              | 1.0                   | W/°C  |
| $V_{GS}$                    | Gate-to-Source Voltage                              | $\pm 20$              | V     |
| $E_{AS}$                    | Single Pulse Avalanche Energy ②                     | 230                   | mJ    |
| $I_{AR}$                    | Avalanche Current ①                                 | 28                    | A     |
| $E_{AR}$                    | Repetitive Avalanche Energy ①                       | 15                    | mJ    |
| dv/dt                       | Peak Diode Recovery dv/dt ③                         | 5.5                   | V/ns  |
| $T_J$<br>$T_{STG}$          | Operating Junction and<br>Storage Temperature Range | -55 to +175           | °C    |
|                             | Soldering Temperature, for 10 seconds               | 300 (1.6mm from case) |       |
|                             | Mounting Torque, 6-32 or M3 screw                   | 10 lbf•in (1.1 N•m)   |       |

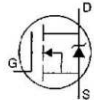
### Thermal Resistance

|                 | Parameter                           | Min. | Typ. | Max. | Units |
|-----------------|-------------------------------------|------|------|------|-------|
| $R_{\theta JC}$ | Junction-to-Case                    | —    | —    | 1.0  | °C/W  |
| $R_{\theta CS}$ | Case-to-Sink, Flat, Greased Surface | —    | 0.50 | —    |       |
| $R_{\theta JA}$ | Junction-to-Ambient                 | —    | —    | 62   |       |

## Electrical Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

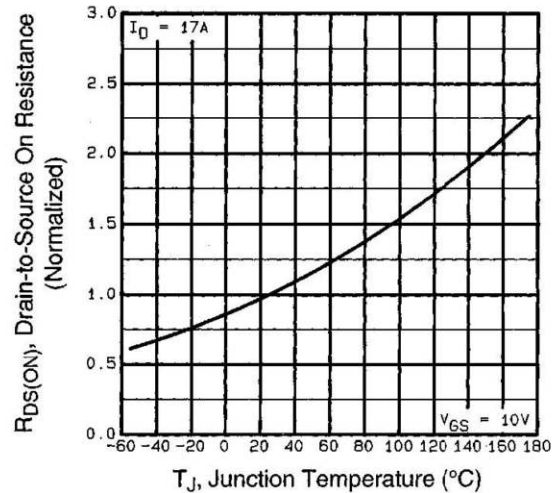
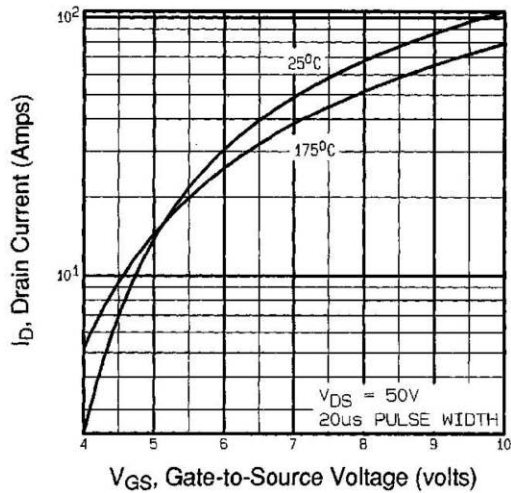
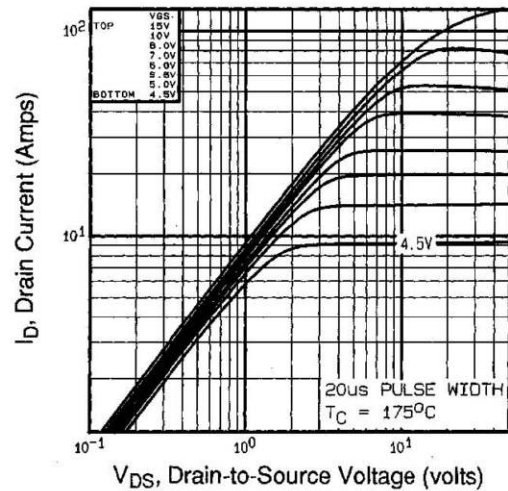
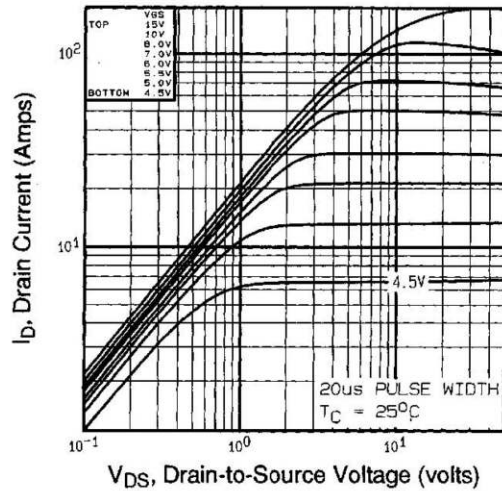
|                                 | Parameter                            | Min. | Typ. | Max.  | Units               | Test Conditions                                                     |
|---------------------------------|--------------------------------------|------|------|-------|---------------------|---------------------------------------------------------------------|
| $V_{(BR)DSS}$                   | 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  | —    | 0.13 | —     | V/ $^\circ\text{C}$ | Reference to $25^\circ\text{C}$ , $I_D=1mA$                         |
| $R_{DS(on)}$                    | Static Drain-to-Source On-Resistance | —    | —    | 0.077 | $\Omega$            | $V_{GS}=10V$ , $I_D=17A$ 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             | 8.7  | —    | —     | S                   | $V_{DS}=50V$ , $I_D=17A$ ④                                          |
| $I_{DSS}$                       | 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                    | —    | —    | 72    | nC                  | $I_D=17A$                                                           |
| $Q_{gs}$                        | Gate-to-Source Charge                | —    | —    | 11    |                     | $V_{DS}=80V$                                                        |
| $Q_{gd}$                        | Gate-to-Drain ("Miller") Charge      | —    | —    | 32    |                     | $V_{GS}=10V$ See Fig. 6 and 13 ④                                    |
| $t_{d(on)}$                     | Turn-On Delay Time                   | —    | 11   | —     | ns                  | $V_{DD}=50V$                                                        |
| $t_r$                           | Rise Time                            | —    | 44   | —     |                     | $I_D=17A$                                                           |
| $t_{d(off)}$                    | Turn-Off Delay Time                  | —    | 53   | —     |                     | $R_G=9.1\Omega$                                                     |
| $t_f$                           | Fall Time                            | —    | 43   | —     |                     | $R_D=2.9\Omega$ See Figure 10 ④                                     |
| $L_D$                           | Internal Drain Inductance            | —    | 4.5  | —     | nH                  | Between lead, 6 mm (0.25in.) from package and center of die contact |
| $L_S$                           | Internal Source Inductance           | —    | 7.5  | —     |                     |                                                                     |
| $C_{iss}$                       | Input Capacitance                    | —    | 1700 | —     | pF                  | $V_{GS}=0V$                                                         |
| $C_{oss}$                       | Output Capacitance                   | —    | 560  | —     |                     | $V_{DS}=25V$                                                        |
| $C_{rss}$                       | Reverse Transfer Capacitance         | —    | 120  | —     |                     | $f=1.0MHz$ See Figure 5                                             |

## Source-Drain Ratings and Characteristics

|          | Parameter                              | Min.                                                                      | Typ. | Max. | Units   | Test Conditions                                                                                                                                      |
|----------|----------------------------------------|---------------------------------------------------------------------------|------|------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| $I_S$    | Continuous Source Current (Body Diode) | —                                                                         | —    | 28   | A       | MOSFET symbol showing the integral reverse p-n junction diode.  |
| $I_{SM}$ | Pulsed Source Current (Body Diode) ①   | —                                                                         | —    | 110  |         |                                                                                                                                                      |
| $V_{SD}$ | Diode Forward Voltage                  | —                                                                         | —    | 2.5  | V       | $T_J=25^\circ\text{C}$ , $I_S=28A$ , $V_{GS}=0V$ ④                                                                                                   |
| $t_{rr}$ | Reverse Recovery Time                  | —                                                                         | 180  | 360  | ns      | $T_J=25^\circ\text{C}$ , $I_F=17A$                                                                                                                   |
| $Q_{rr}$ | Reverse Recovery Charge                | —                                                                         | 1.3  | 2.8  | $\mu C$ | $di/dt=100A/\mu s$ ④                                                                                                                                 |
| $t_{on}$ | Forward Turn-On Time                   | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S+L_D$ ) |      |      |         |                                                                                                                                                      |

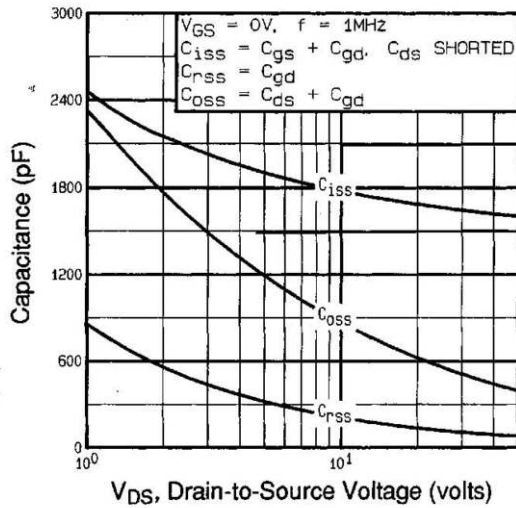
### Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature (See Figure 11)
- ②  $V_{DD}=25V$ , starting  $T_J=25^\circ\text{C}$ ,  $L=440\mu H$   
 $R_G=25\Omega$ ,  $I_{AS}=28A$  (See Figure 12)
- ③  $I_{SD}\leq 28A$ ,  $di/dt\leq 170A/\mu s$ ,  $V_{DD}\leq V_{(BR)DSS}$ ,  $T_J\leq 175^\circ\text{C}$
- ④ Pulse width  $\leq 300\mu s$ ; duty cycle  $\leq 2\%$ .

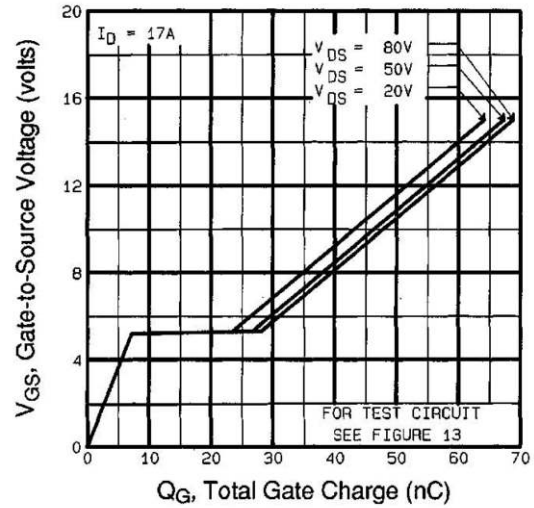


# IRF540PbF

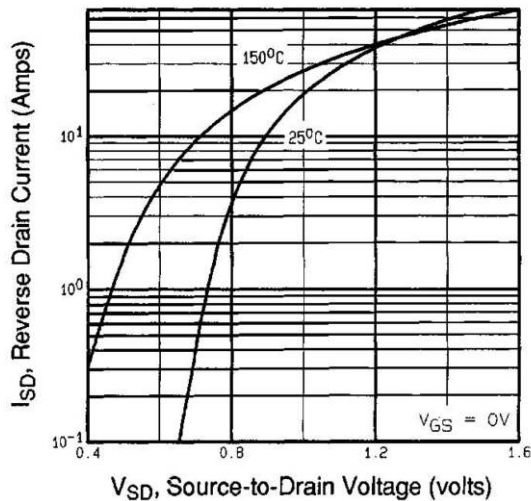
International  
**IR** Rectifier



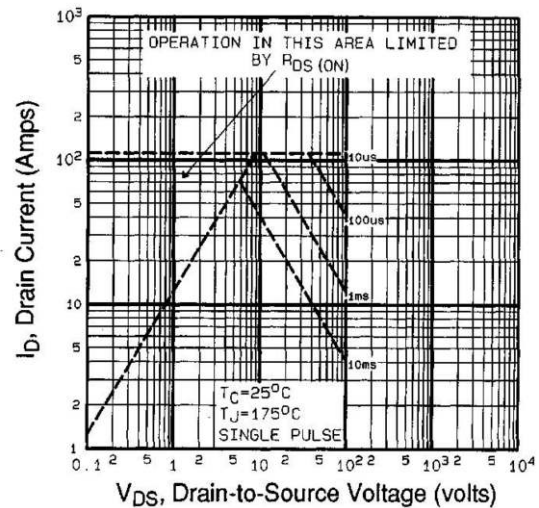
**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage



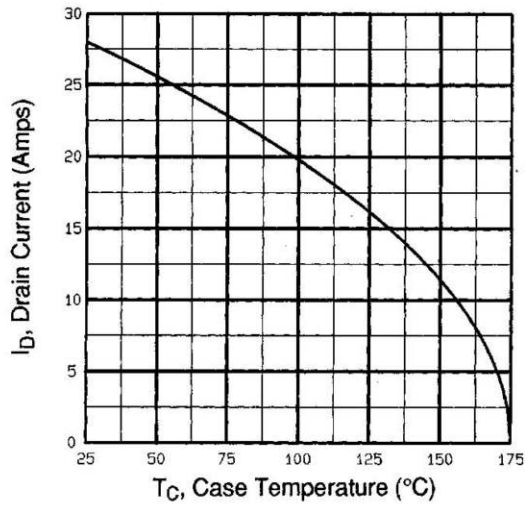
**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage



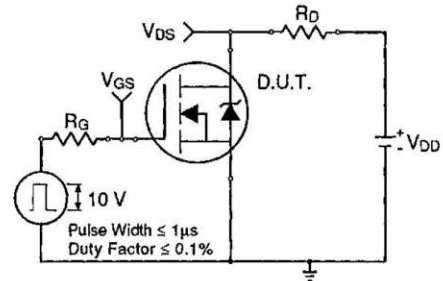
**Fig 7.** Typical Source-Drain Diode Forward Voltage



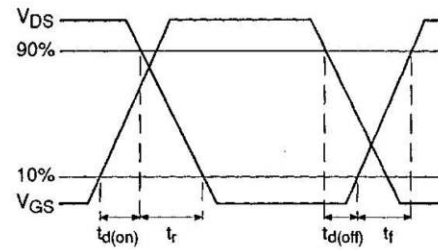
**Fig 8.** Maximum Safe Operating Area



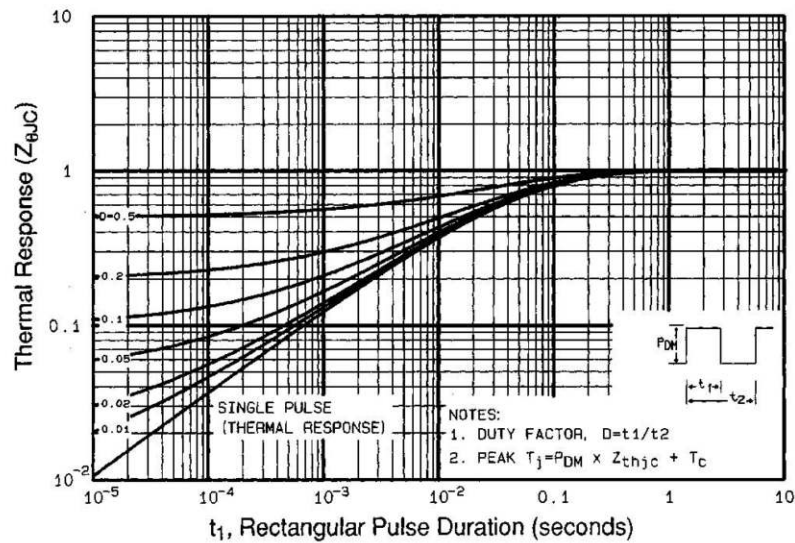
**Fig 9.** Maximum Drain Current Vs. Case Temperature



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



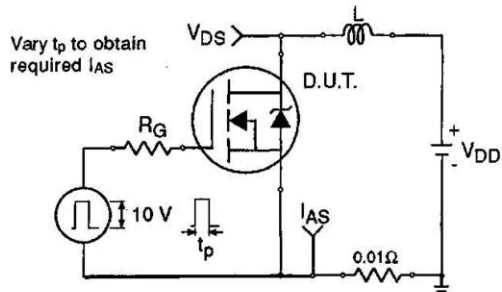
**Fig 10b.** Switching Time Waveforms



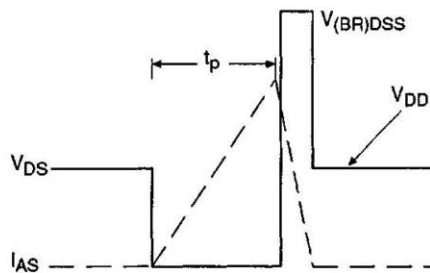
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

# IRF540PbF

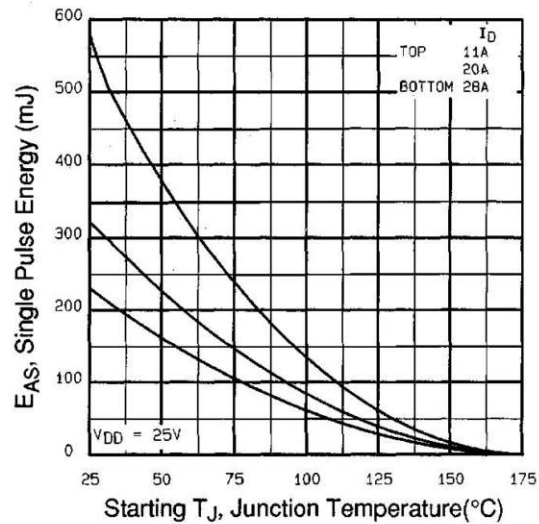
International  
IR Rectifier



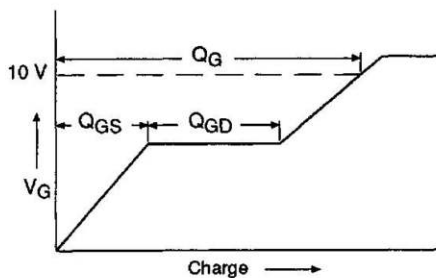
**Fig 12a.** Unclamped Inductive Test Circuit



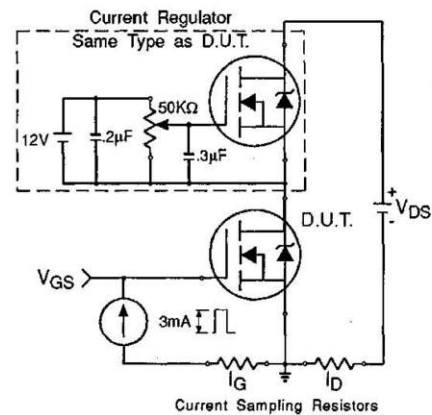
**Fig 12b.** Unclamped Inductive Waveforms



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



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



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

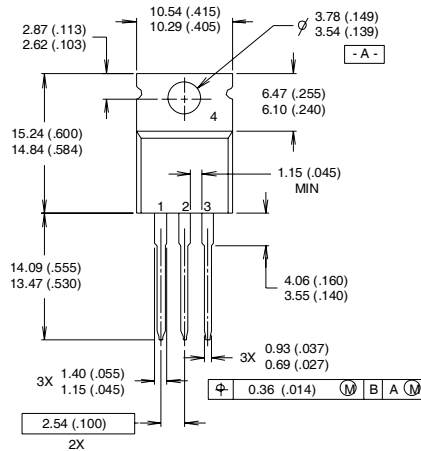
**Appendix A:** Figure 14, Peak Diode Recovery  $dv/dt$  Test Circuit – See page 1505

**Appendix B:** Package Outline Mechanical Drawing – See page 1509

**Appendix E:** Optional Leadforms – See page 1525

## TO-220AB Package Outline

Dimensions are shown in millimeters (inches)

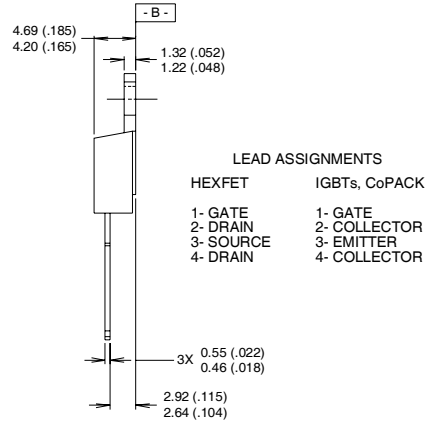


### NOTES:

- 1 DIMENSIONING & TOLERANCING PER ANSI Y14.5M, 1982.
- 2 CONTROLLING DIMENSION : INCH

3 OUTLINE CONFORMS TO JEDEC OUTLINE TO-220AB.

4 HEATSINK & LEAD MEASUREMENTS DO NOT INCLUDE BURRS.

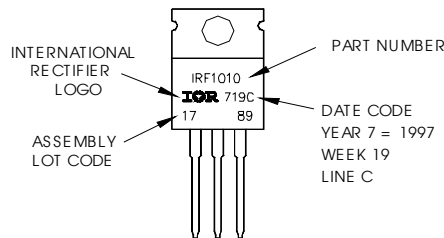


### LEAD ASSIGNMENTS

| HEXFET    | IGBTs, CoPACK |
|-----------|---------------|
| 1- GATE   | 1- GATE       |
| 2- DRAIN  | 2- COLLECTOR  |
| 3- SOURCE | 3- EMITTER    |
| 4- DRAIN  | 4- COLLECTOR  |

## TO-220AB Part Marking Information

EXAMPLE: THIS IS AN IRF1010  
LOT CODE 1789  
ASSEMBLED ON WW 19, 1997  
IN THE ASSEMBLY LINE "C"  
**Note:** "P" in assembly line  
position indicates "Lead-Free"



Data and specifications subject to change without notice.

International  
**IR** Rectifier

**IR WORLD HEADQUARTERS:** 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105

TAC Fax: (310) 252-7903

11/03



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