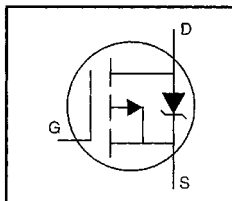


## HEXFET® Power MOSFET

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



$$V_{DS} = -60V$$

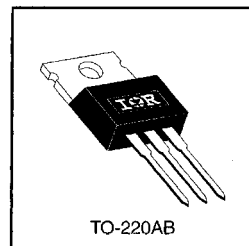
$$R_{DS(on)} = 0.28\Omega$$

$$I_D = -11A$$

## 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.



DATA  
SHEETS

## Absolute Maximum Ratings

|                           | Parameter                                        | Max.                  | Units |
|---------------------------|--------------------------------------------------|-----------------------|-------|
| $I_D @ T_C = 25^\circ C$  | Continuous Drain Current, $V_{GS} @ -10 V$       | -11                   | A     |
| $I_D @ T_C = 100^\circ C$ | Continuous Drain Current, $V_{GS} @ -10 V$       | -7.7                  |       |
| $I_{DM}$                  | Pulsed Drain Current ①                           | -44                   |       |
| $P_D @ T_C = 25^\circ C$  | Power Dissipation                                | 60                    | W     |
|                           | Linear Derating Factor                           | 0.40                  | W/°C  |
| $V_{GS}$                  | Gate-to-Source Voltage                           | $\pm 20$              | V     |
| $E_{AS}$                  | Single Pulse Avalanche Energy ②                  | 240                   | mJ    |
| $I_{AR}$                  | Avalanche Current ①                              | -11                   | A     |
| $E_{AR}$                  | Repetitive Avalanche Energy ①                    | 6.0                   | mJ    |
| dv/dt                     | Peak Diode Recovery dv/dt ③                      | -4.5                  | V/ns  |
| $T_J$                     | Operating Junction and Storage Temperature Range | -55 to +175           | °C    |
| $T_{STG}$                 | 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 |
|----------|-------------------------------------|------|------|------|-------|
| $R_{JC}$ | Junction-to-Case                    | —    | —    | 2.5  | °C/W  |
| $R_{CS}$ | Case-to-Sink, Flat, Greased Surface | —    | 0.50 | —    |       |
| $R_{JA}$ | 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    | -60  | —      | —    | V                   | $V_{GS}=0V$ , $I_D=-250\mu A$                                       |
| $\Delta V_{(BR)DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient  | —    | -0.056 | —    | V/ $^\circ\text{C}$ | Reference to $25^\circ\text{C}$ , $I_D=-1mA$                        |
| $R_{DS(on)}$                    | Static Drain-to-Source On-Resistance | —    | —      | 0.28 | $\Omega$            | $V_{GS}=-10V$ , $I_D=-6.6A$ ③                                       |
| $V_{GS(th)}$                    | Gate Threshold Voltage               | -2.0 | —      | -4.0 | V                   | $V_{DS}=V_{GS}$ , $I_D=-250\mu A$                                   |
| $g_{fs}$                        | Forward Transconductance             | 1.4  | —      | —    | S                   | $V_{DS}=-25V$ , $I_D=-6.6A$ ④                                       |
| $I_{DSS}$                       | Drain-to-Source Leakage Current      | —    | —      | -100 | $\mu A$             | $V_{DS}=-60V$ , $V_{GS}=0V$                                         |
|                                 |                                      | —    | —      | -500 |                     | $V_{DS}=-48V$ , $V_{GS}=0V$ , $T_J=150^\circ\text{C}$               |
| $I_{GSS}$                       | Gate-to-Source Forward Leakage       | —    | —      | -100 | nA                  | $V_{GS}=-20V$                                                       |
|                                 | Gate-to-Source Reverse Leakage       | —    | —      | 100  |                     | $V_{GS}=20V$                                                        |
| $Q_{gi}$                        | Total Gate Charge                    | —    | —      | 19   | nC                  | $I_D=-11A$                                                          |
| $Q_{gs}$                        | Gate-to-Source Charge                | —    | —      | 5.4  |                     | $V_{DS}=-48V$                                                       |
| $Q_{gd}$                        | Gate-to-Drain ("Miller") Charge      | —    | —      | 11   |                     | $V_{GS}=-10V$ See Fig. 6 and 13 ④                                   |
| $t_{d(on)}$                     | Turn-On Delay Time                   | —    | 13     | —    | ns                  | $V_{DD}=-30V$                                                       |
| $t_r$                           | Rise Time                            | —    | 68     | —    |                     | $I_D=-11A$                                                          |
| $t_{d(off)}$                    | Turn-Off Delay Time                  | —    | 15     | —    |                     | $R_G=18\Omega$                                                      |
| $t_f$                           | Fall Time                            | —    | 29     | —    |                     | $R_D=2.5\Omega$ 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                    | —    | 570    | —    | pF                  | $V_{GS}=0V$                                                         |
| $C_{oss}$                       | Output Capacitance                   | —    | 360    | —    |                     | $V_{DS}=-25V$                                                       |
| $C_{rss}$                       | Reverse Transfer Capacitance         | —    | 65     | —    |                     | $f=1.0MHz$ See Figure 5                                             |

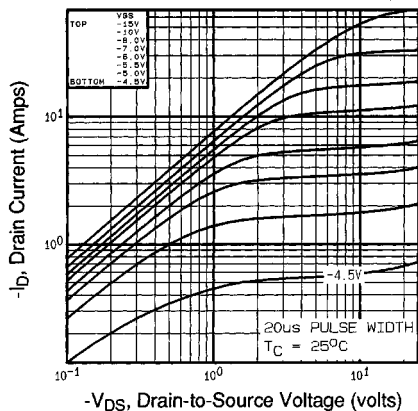


## Source-Drain Ratings and Characteristics

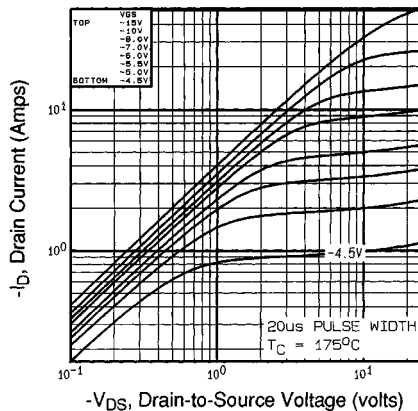
|          | Parameter                              | Min.                                                                      | Typ. | Max. | Units   | Test Conditions                                                |
|----------|----------------------------------------|---------------------------------------------------------------------------|------|------|---------|----------------------------------------------------------------|
| $I_S$    | Continuous Source Current (Body Diode) | —                                                                         | —    | -11  | A       | MOSFET symbol showing the integral reverse p-n junction diode. |
| $I_{SM}$ | Pulsed Source Current (Body Diode) ①   | —                                                                         | —    | -44  |         |                                                                |
| $V_{SD}$ | Diode Forward Voltage                  | —                                                                         | —    | -6.3 | V       | $T_J=25^\circ\text{C}$ , $I_S=-11A$ , $V_{GS}=0V$ ④            |
| $t_{rr}$ | Reverse Recovery Time                  | —                                                                         | 100  | 200  | ns      | $T_J=25^\circ\text{C}$ , $I_F=-11A$                            |
| $Q_{rr}$ | Reverse Recovery Charge                | —                                                                         | 0.32 | 0.64 | $\mu C$ | $di/dt=100A/\mu s$ ④                                           |
| $t_{on}$ | Forward Turn-On Time                   | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S+L_D$ ) |      |      |         |                                                                |

### Notes:

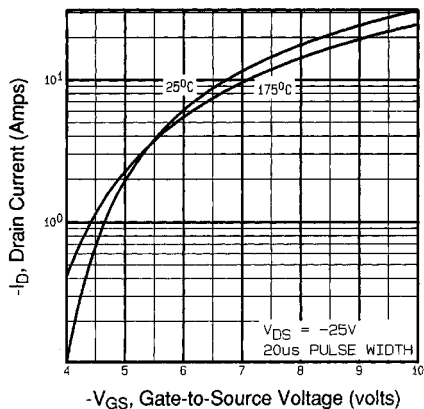
- ① Repetitive rating; pulse width limited by max. junction temperature (See Figure 11)
- ②  $V_{DD}=-25V$ , starting  $T_J=25^\circ\text{C}$ ,  $L=2.3mH$ ,  $R_G=25\Omega$ ,  $I_{AS}=-11A$  (See Figure 12)
- ③  $I_{SD}\leq -11A$ ,  $di/dt\leq 140A/\mu s$ ,  $V_{DD}\leq V_{(BR)DSS}$ ,  $T_J\leq 175^\circ\text{C}$
- ④ Pulse width  $\leq 300\mu s$ ; duty cycle  $\leq 2\%$ .



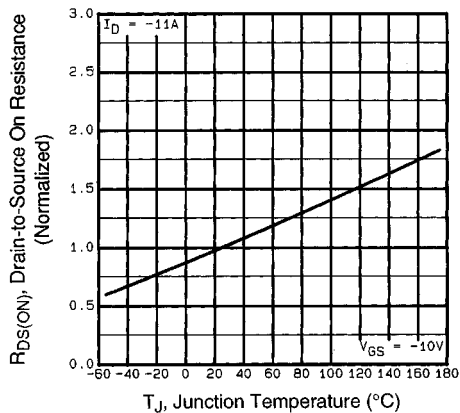
**Fig 1.** Typical Output Characteristics,  
 $T_C = 25^\circ\text{C}$



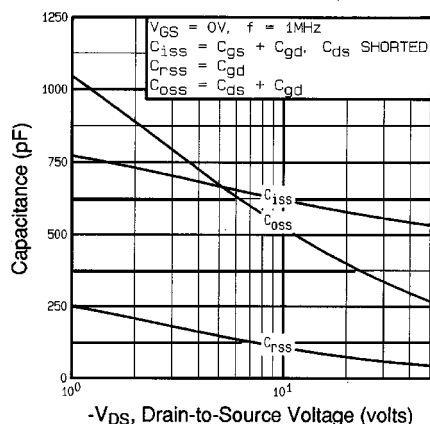
**Fig 2.** Typical Output Characteristics,  
 $T_C = 175^\circ\text{C}$



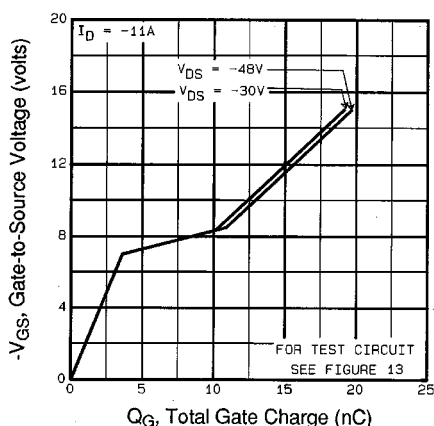
**Fig 3.** Typical Transfer Characteristics



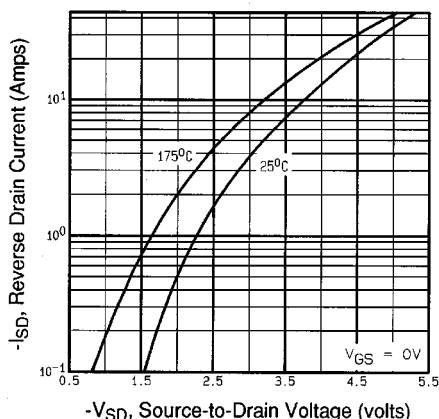
**Fig 4.** Normalized On-Resistance  
Vs. Temperature



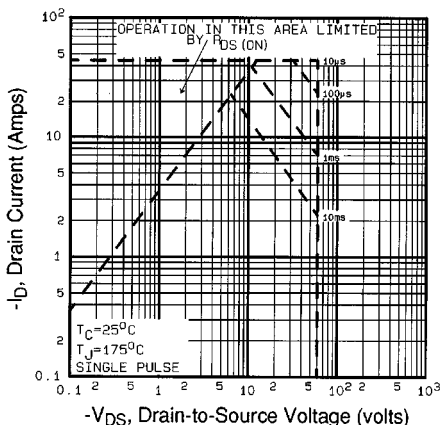
**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage



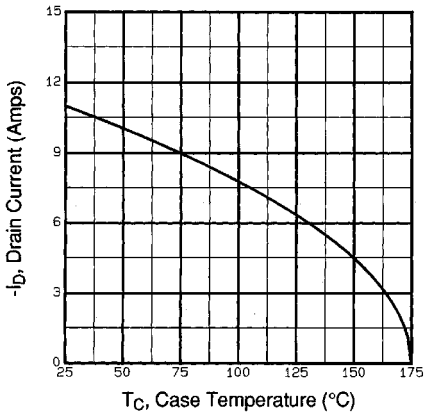
**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage



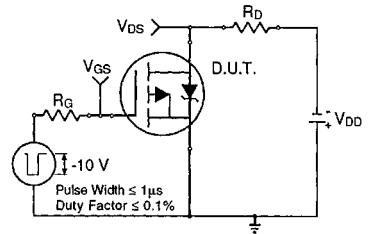
**Fig 7.** Typical Source-Drain Diode Forward Voltage



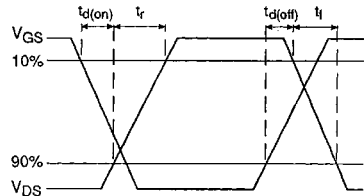
**Fig 8.** Maximum Safe Operating Area



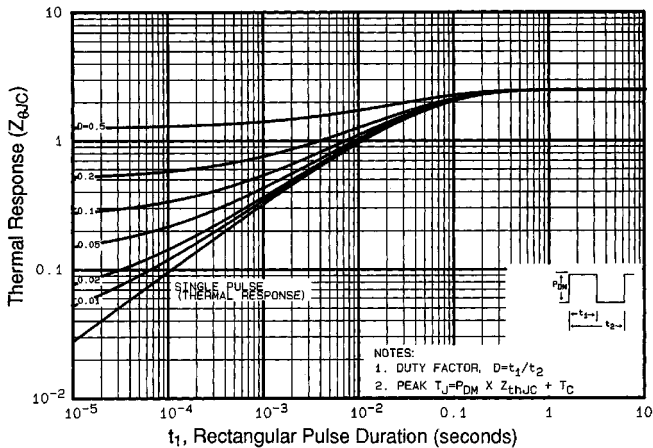
**Fig 9.** Maximum Drain Current Vs. Case Temperature



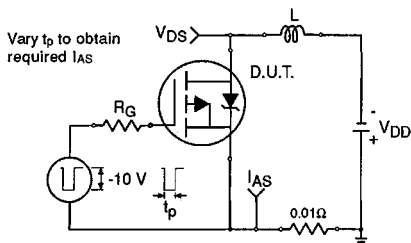
**Fig 10a.** Switching Time Test Circuit



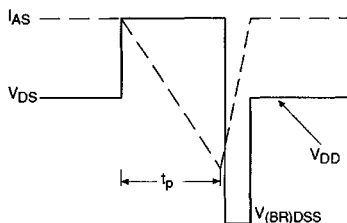
**Fig 10b.** Switching Time Waveforms



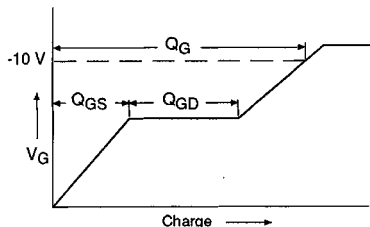
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case



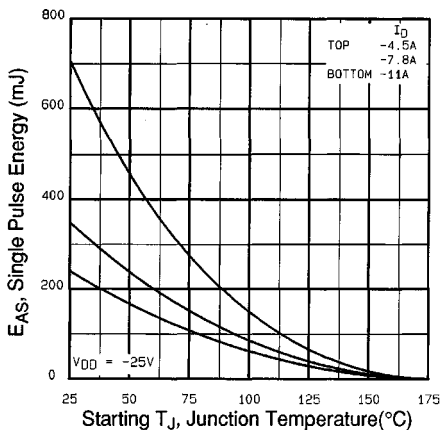
**Fig 12a.** Unclamped Inductive Test Circuit



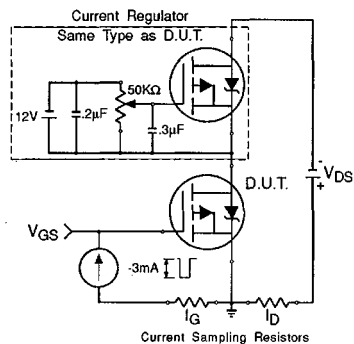
**Fig 12b.** Unclamped Inductive Waveforms



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



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



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

**Appendix A:** Figure 14, Peak Diode Recovery  $dv/dt$  Test Circuit – See page 1506

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

**Appendix C:** Part Marking Information – See page 1516

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

**International  
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