

# IRFB4321PbF

## Applications

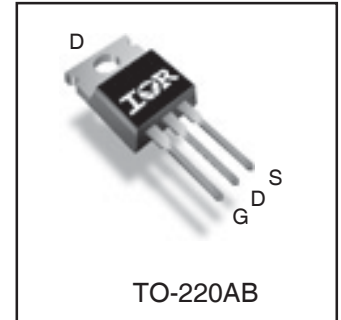
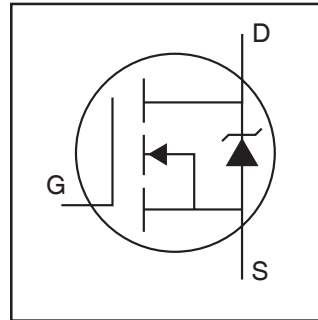
- Motion Control Applications
- High Efficiency Synchronous Rectification in SMPS
- Uninterruptible Power Supply
- Hard Switched and High Frequency Circuits

## Benefits

- Low  $R_{DS(on)}$  Reduces Losses
- Low Gate Charge Improves the Switching Performance
- Improved Diode Recovery Improves Switching & EMI Performance
- 30V Gate Voltage Rating Improves Robustness
- Fully Characterized Avalanche SOA

HEXFET® Power MOSFET

|                                         |             |
|-----------------------------------------|-------------|
| $V_{DSS}$                               | <b>150V</b> |
| $R_{DS(on)}$ <b>typ.</b><br><b>max.</b> | <b>12mΩ</b> |
|                                         | <b>15mΩ</b> |
| $I_D$                                   | <b>85A</b>  |



|          |          |          |
|----------|----------|----------|
| <b>G</b> | <b>D</b> | <b>S</b> |
| Gate     | Drain    | Source   |

## Absolute Maximum Ratings

| Symbol                                  | Parameter                                                  | Max.             | Units    |
|-----------------------------------------|------------------------------------------------------------|------------------|----------|
| I <sub>D</sub> @ T <sub>C</sub> = 25°C  | Continuous Drain Current, V <sub>GS</sub> @ 10V            | 85 ①             | A        |
| I <sub>D</sub> @ T <sub>C</sub> = 100°C | Continuous Drain Current, V <sub>GS</sub> @ 10V            | 60               |          |
| I <sub>DM</sub>                         | Pulsed Drain Current ②                                     | 330              |          |
| P <sub>D</sub> @T <sub>C</sub> = 25°C   | Maximum Power Dissipation                                  | 350              | W        |
|                                         | Linear Derating Factor                                     | 2.3              | W/°C     |
| V <sub>GS</sub>                         | Gate-to-Source Voltage                                     | ±30              | V        |
| E <sub>AS</sub> (Thermally limited)     | Single Pulse Avalanche Energy ③                            | 120              | mJ<br>°C |
| T <sub>J</sub>                          | Operating Junction and                                     | -55 to + 175     |          |
| T <sub>STG</sub>                        | Storage Temperature Range                                  |                  |          |
|                                         | Soldering Temperature, for 10 seconds<br>(1.6mm from case) | 300              |          |
|                                         | Mounting torque, 6-32 or M3 screw                          | 10lb·in (1.1N·m) |          |

## Thermal Resistance

|                 | Parameter                           | Typ. | Max. | Units |
|-----------------|-------------------------------------|------|------|-------|
| $R_{\theta JC}$ | Junction-to-Case ⑤                  | —    | 0.43 | °C/W  |
| $R_{\theta CS}$ | Case-to-Sink, Flat, Greased Surface | 0.50 | —    |       |
| $R_{\theta JA}$ | Junction-to-Ambient ⑤               | —    | 62   |       |

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

| Symbol                          | Parameter                            | Min. | Typ. | Max. | Units      | Conditions                                             |
|---------------------------------|--------------------------------------|------|------|------|------------|--------------------------------------------------------|
| $V_{(BR)DSS}$                   | Drain-to-Source Breakdown Voltage    | 150  | —    | —    | V          | $V_{GS} = 0V, I_D = 250\mu A$                          |
| $\Delta V_{(BR)DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient  | —    | 150  | —    | mV/°C      | Reference to $25^\circ\text{C}$ , $I_D = 1\text{mA}$ ② |
| $R_{DS(on)}$                    | Static Drain-to-Source On-Resistance | —    | 12   | 15   | m $\Omega$ | $V_{GS} = 10V, I_D = 33A$ ④                            |
| $V_{GS(th)}$                    | Gate Threshold Voltage               | 3.0  | —    | 5.0  | V          | $V_{DS} = V_{GS}, I_D = 250\mu A$                      |
| $I_{DSS}$                       | Drain-to-Source Leakage Current      | —    | —    | 20   | $\mu A$    | $V_{DS} = 150V, V_{GS} = 0V$                           |
|                                 |                                      | —    | —    | 1.0  | mA         | $V_{DS} = 150V, V_{GS} = 0V, T_J = 125^\circ\text{C}$  |
| $I_{GSS}$                       | Gate-to-Source Forward Leakage       | —    | —    | 100  | nA         | $V_{GS} = 20V$                                         |
|                                 | Gate-to-Source Reverse Leakage       | —    | —    | -100 | nA         | $V_{GS} = -20V$                                        |
| $R_{G(int)}$                    | Internal Gate Resistance             | —    | 0.8  | —    | $\Omega$   |                                                        |

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

| Symbol       | Parameter                       | Min. | Typ. | Max. | Units | Conditions                                                             |
|--------------|---------------------------------|------|------|------|-------|------------------------------------------------------------------------|
| $g_{fs}$     | Forward Transconductance        | 130  | —    | —    | S     | $V_{DS} = 25V, I_D = 50A$                                              |
| $Q_g$        | Total Gate Charge               | —    | 71   | 110  | nC    | $I_D = 50A$<br>$V_{DS} = 75V$<br>$V_{GS} = 10V$ ④                      |
| $Q_{gs}$     | Gate-to-Source Charge           | —    | 24   | —    | nC    |                                                                        |
| $Q_{gd}$     | Gate-to-Drain ("Miller") Charge | —    | 21   | —    | nC    |                                                                        |
| $t_{d(on)}$  | Turn-On Delay Time              | —    | 18   | —    | ns    | $V_{DD} = 98V$<br>$I_D = 50A$<br>$R_G = 2.5\Omega$<br>$V_{GS} = 10V$ ④ |
| $t_r$        | Rise Time                       | —    | 60   | —    | ns    |                                                                        |
| $t_{d(off)}$ | Turn-Off Delay Time             | —    | 25   | —    | ns    |                                                                        |
| $t_f$        | Fall Time                       | —    | 35   | —    | ns    |                                                                        |
| $C_{iss}$    | Input Capacitance               | —    | 4460 | —    | pF    | $V_{GS} = 0V$<br>$V_{DS} = 50V$<br>$f = 1.0\text{MHz}$                 |
| $C_{oss}$    | Output Capacitance              | —    | 390  | —    | pF    |                                                                        |
| $C_{rss}$    | Reverse Transfer Capacitance    | —    | 82   | —    | pF    |                                                                        |

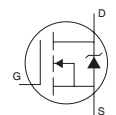
## Diode Characteristics

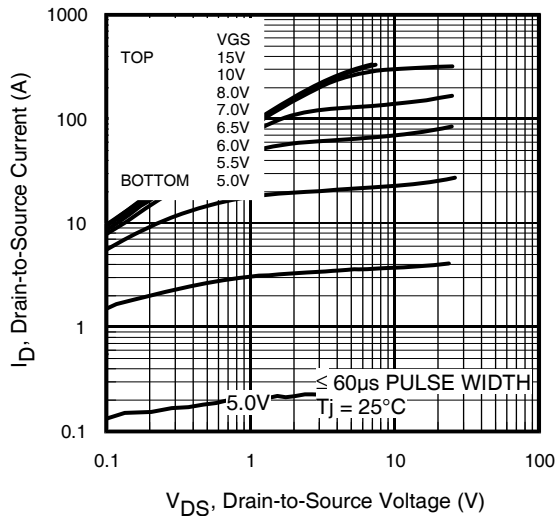
| Symbol           | Parameter                                 | Min.                                                                 | Typ. | Max.            | Units | Conditions                                                                                                                                                    |
|------------------|-------------------------------------------|----------------------------------------------------------------------|------|-----------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| I <sub>S</sub>   | Continuous Source Current<br>(Body Diode) | —                                                                    | —    | 85 <sup>①</sup> | A     | MOSFET symbol<br>showing the<br>integral reverse<br>p-n junction diode.  |
| I <sub>SM</sub>  | Pulsed Source Current<br>(Body Diode) ②   | —                                                                    | —    | 330             | A     |                                                                                                                                                               |
| V <sub>SD</sub>  | Diode Forward Voltage                     | —                                                                    | —    | 1.3             | V     | T <sub>J</sub> = 25°C, I <sub>S</sub> = 50A, V <sub>GS</sub> = 0V ④                                                                                           |
| t <sub>rr</sub>  | Reverse Recovery Time                     | —                                                                    | 89   | 130             | ns    | I <sub>D</sub> = 50A<br>V <sub>R</sub> = 128V,<br>di/dt = 100A/μs ④                                                                                           |
| Q <sub>rr</sub>  | Reverse Recovery Charge                   | —                                                                    | 300  | 450             | nC    |                                                                                                                                                               |
| I <sub>RRM</sub> | Reverse Recovery Current                  | —                                                                    | 6.5  | —               | A     |                                                                                                                                                               |
| t <sub>on</sub>  | Forward Turn-On Time                      | Intrinsic turn-on time is negligible (turn-on is dominated by LS+LD) |      |                 |       |                                                                                                                                                               |

## Notes:

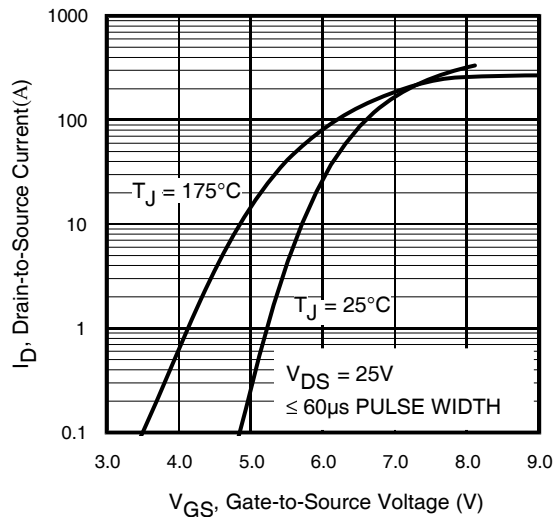
- ① Calculated continuous current based on maximum allowable junction temperature. Package limitation current is 75A
- ② Repetitive rating; pulse width limited by max. junction temperature.
- ③ Limited by  $T_{Jmax}$ , starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.095\text{mH}$   
 $R_G = 25\Omega$ ,  $I_{AS} = 50A$ ,  $V_{GS} = 10V$ . Part not recommended for use above this value.

- ④ Pulse width  $\leq 400\mu s$ ; duty cycle  $\leq 2\%$ .
- ⑤  $R_\theta$  is measured at  $T_J$  approximately  $90^\circ\text{C}$

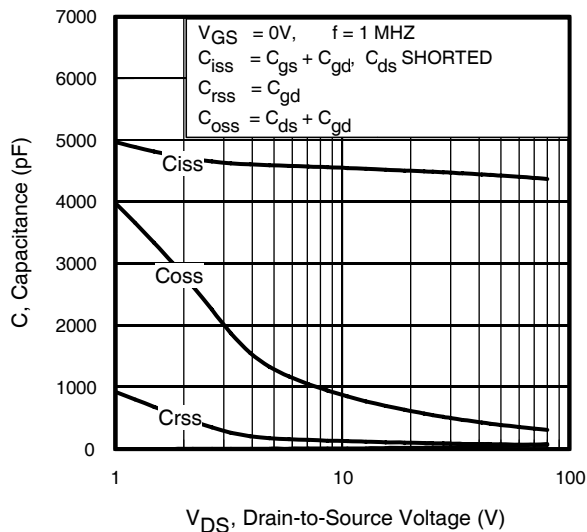




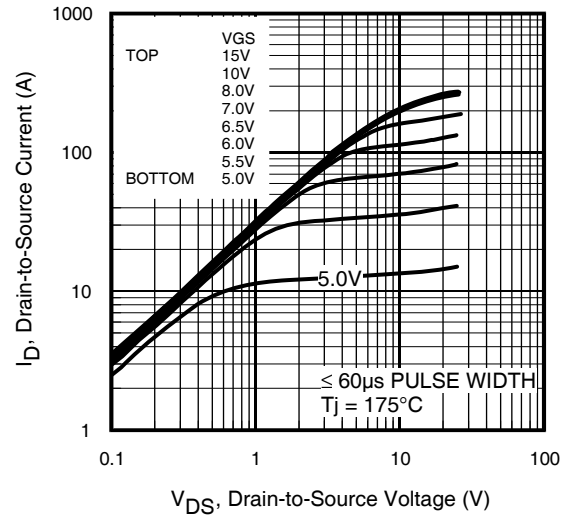
**Fig 1.** Typical Output Characteristics



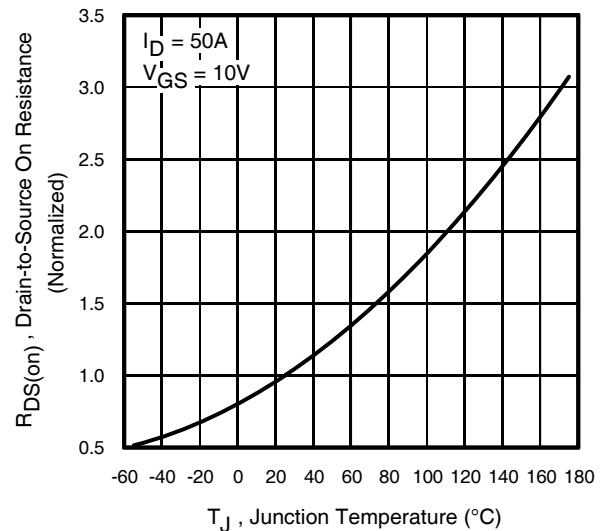
**Fig 3.** Typical Transfer Characteristics



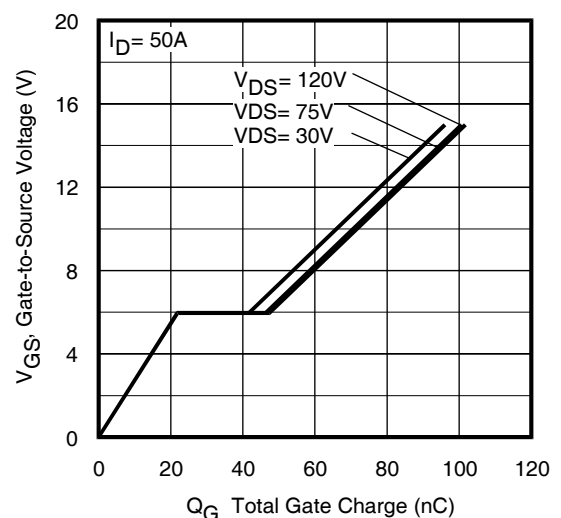
**Fig 5.** Typical Capacitance vs. Drain-to-Source Voltage



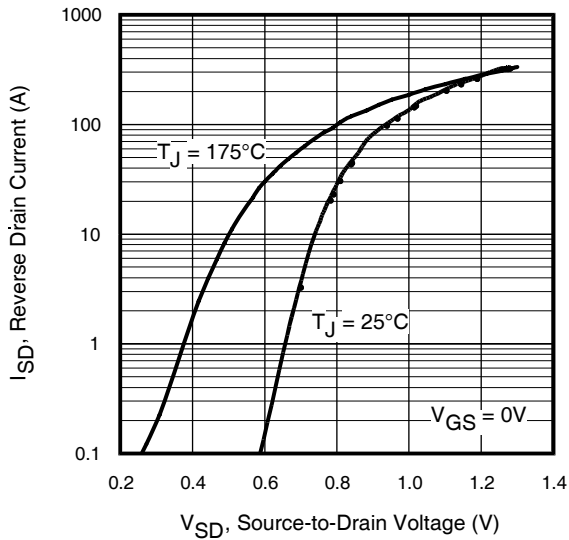
**Fig 2.** Typical Output Characteristics



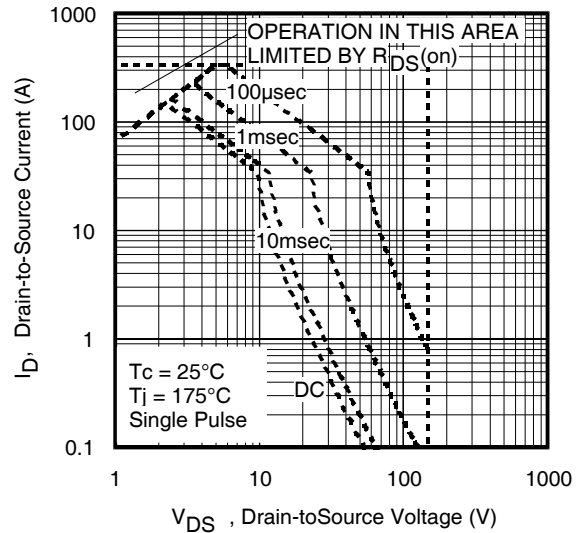
**Fig 4.** Normalized On-Resistance vs. Temperature



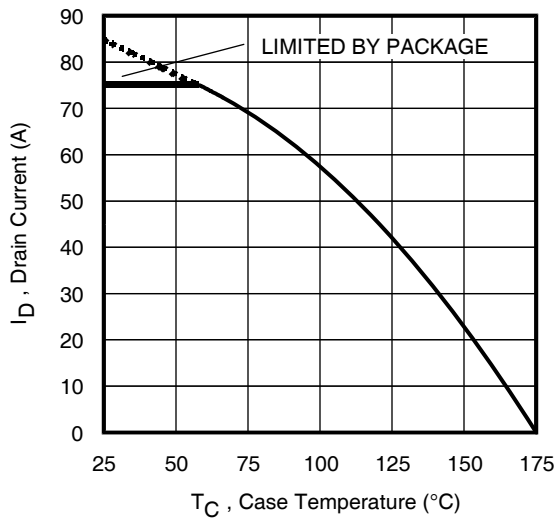
**Fig 6.** Typical Gate Charge vs. Gate-to-Source Voltage



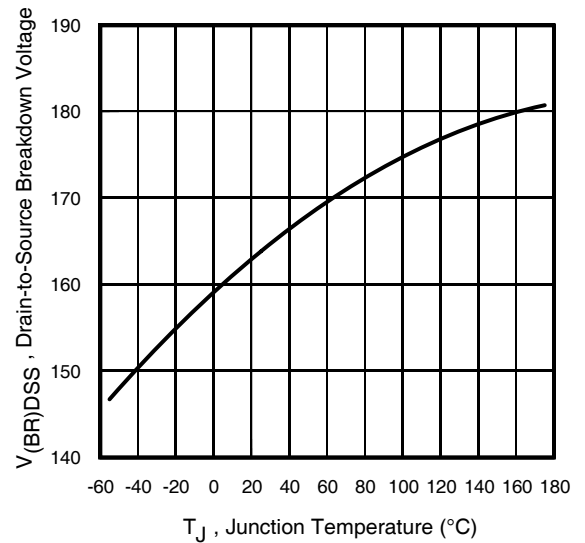
**Fig 7.** Typical Source-Drain Diode Forward Voltage



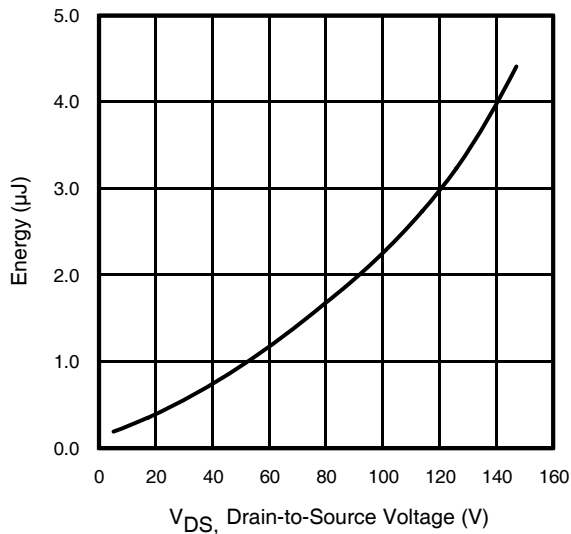
**Fig 8.** Maximum Safe Operating Area



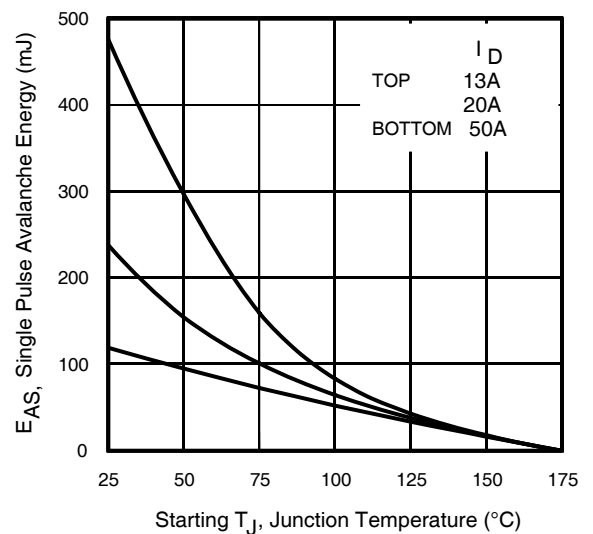
**Fig 9.** Maximum Drain Current vs. Case Temperature



**Fig 10.** Drain-to-Source Breakdown Voltage



**Fig 11.** Typical  $C_{OSS}$  Stored Energy



**Fig 12.** Maximum Avalanche Energy Vs. Drain Current  
www.irf.com

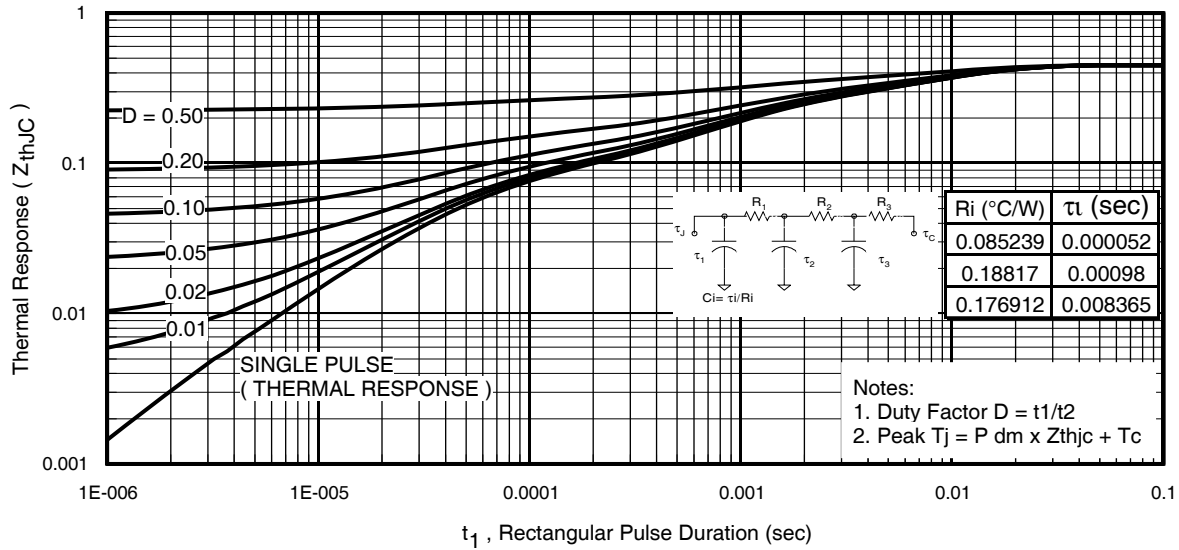


Fig 13. Maximum Effective Transient Thermal Impedance, Junction-to-Case

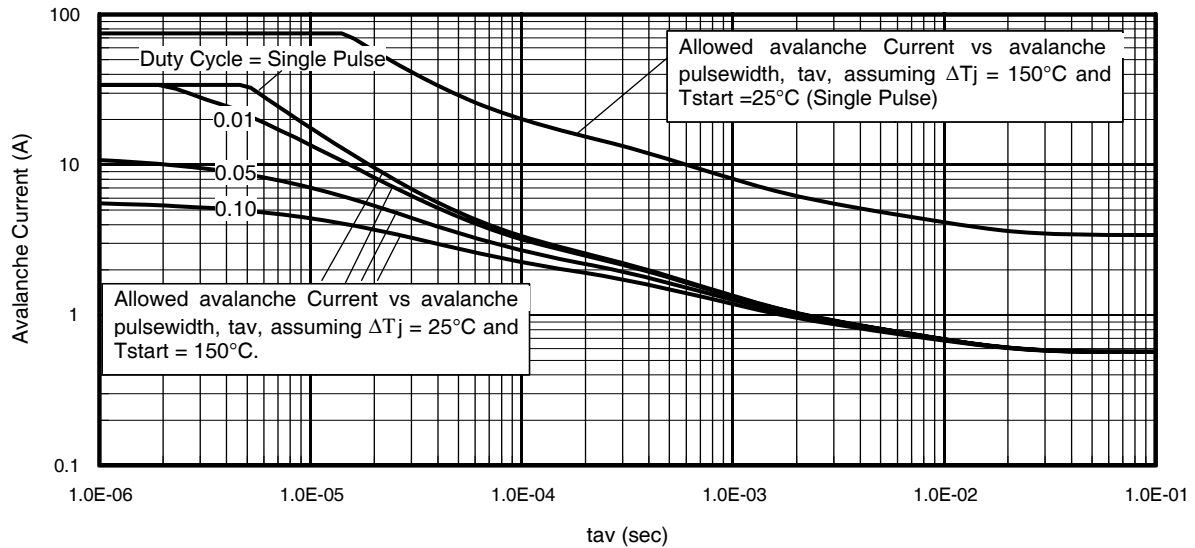


Fig 14. Typical Avalanche Current vs. Pulsewidth

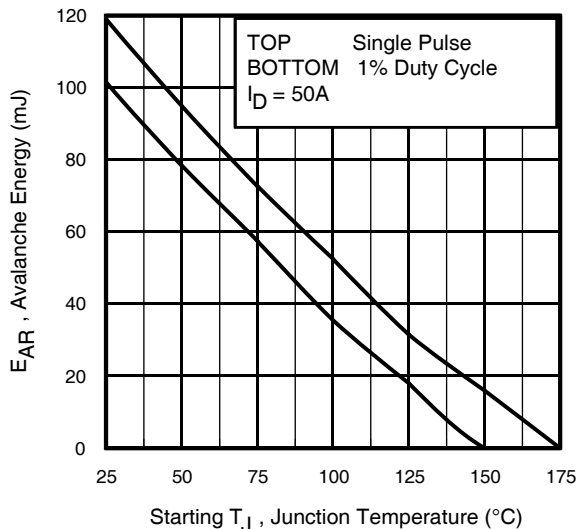


Fig 15. Maximum Avalanche Energy vs. Temperature

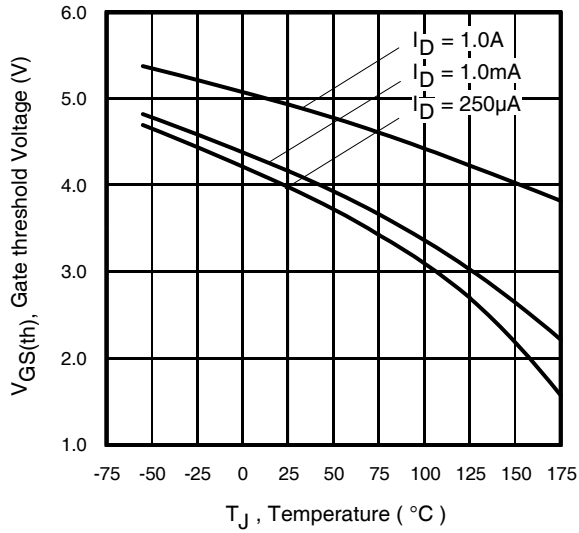
**Notes on Repetitive Avalanche Curves , Figures 14, 15:**  
(For further info, see AN-1005 at [www.irf.com](http://www.irf.com))

1. Avalanche failures assumption:  
Purely a thermal phenomenon and failure occurs at a temperature far in excess of  $T_{jmax}$ . This is validated for every part type.
2. Safe operation in Avalanche is allowed as long as  $T_{jmax}$  is not exceeded.
3. Equation below based on circuit and waveforms shown in Figures 16a, 16b.
4.  $P_{D(ave)}$  = Average power dissipation per single avalanche pulse.
5. BV = Rated breakdown voltage (1.3 factor accounts for voltage increase during avalanche).
6.  $I_{av}$  = Allowable avalanche current.
7.  $\Delta T$  = Allowable rise in junction temperature, not to exceed  $T_{jmax}$  (assumed as 25°C in Figure 14, 15).  
 $t_{av}$  = Average time in avalanche.  
 $D$  = Duty cycle in avalanche =  $t_{av} \cdot f$   
 $Z_{thJC}(D, t_{av})$  = Transient thermal resistance, see Figures 13)

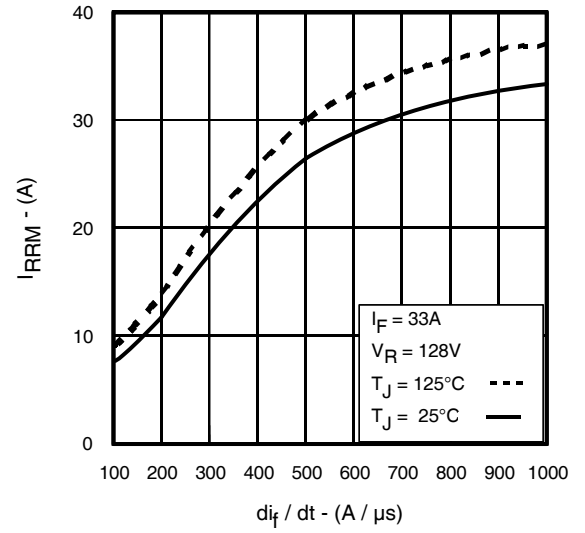
$$P_{D(ave)} = 1/2 (1.3 \cdot BV \cdot I_{av}) = \Delta T / Z_{thJC}$$

$$I_{av} = 2\Delta T / [1.3 \cdot BV \cdot Z_{th}]$$

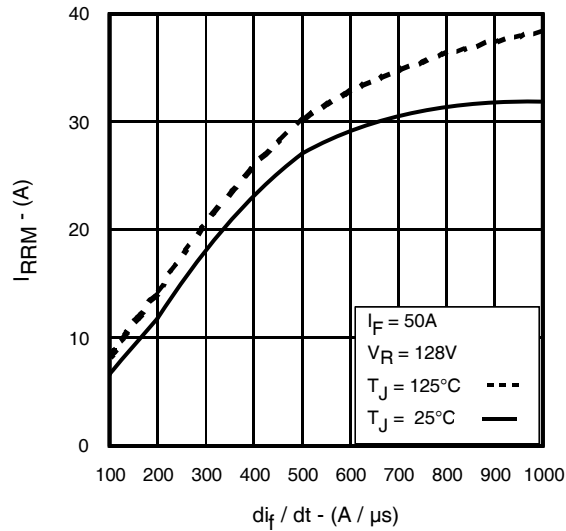
$$E_{AS(AR)} = P_{D(ave)} \cdot t_{av}$$



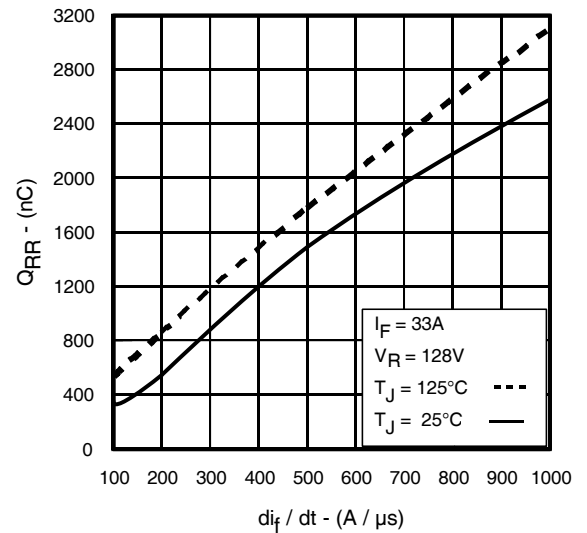
**Fig 16.** Threshold Voltage Vs. Temperature



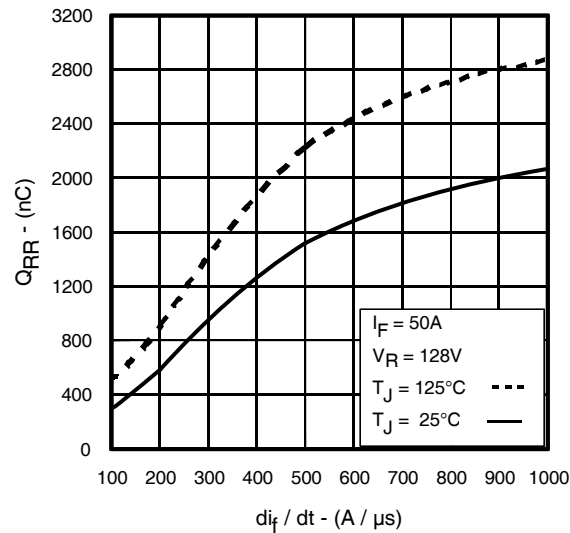
**Fig. 17 -** Typical Recovery Current vs.  $di_f/dt$



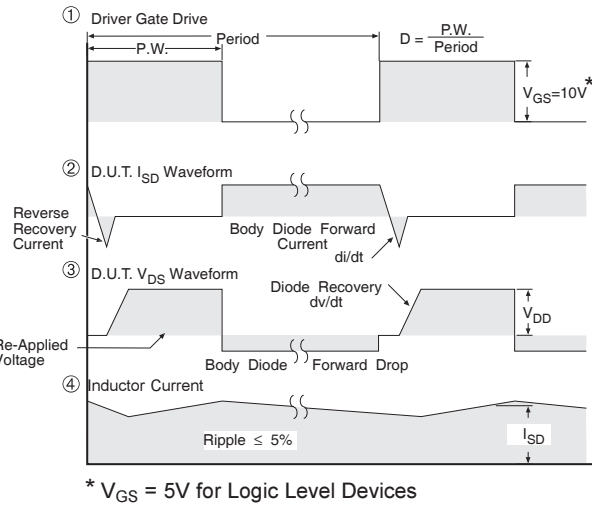
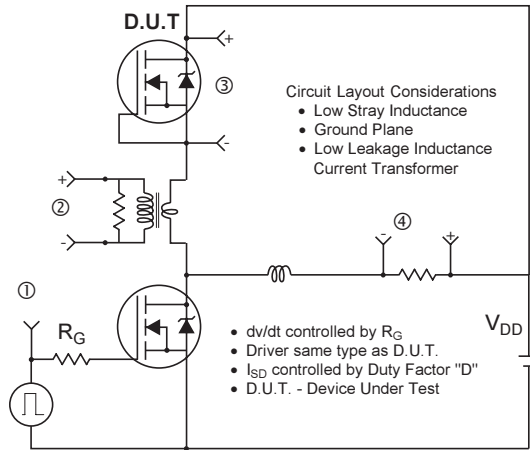
**Fig. 18 -** Typical Recovery Current vs.  $di_f/dt$



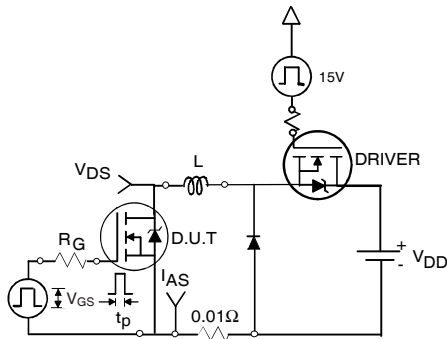
**Fig. 19 -** Typical Stored Charge vs.  $di_f/dt$



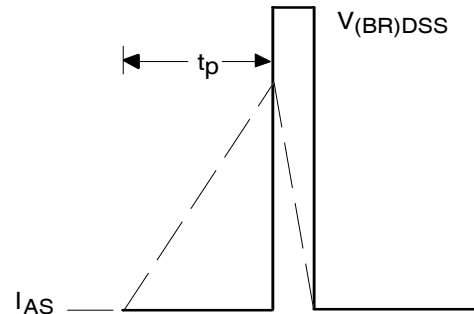
**Fig. 20 -** Typical Stored Charge vs.  $di_f/dt$



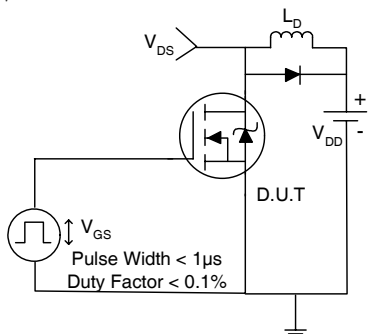
**Fig 21. Peak Diode Recovery  $dv/dt$  Test Circuit for N-Channel HEXFET® Power MOSFETs**



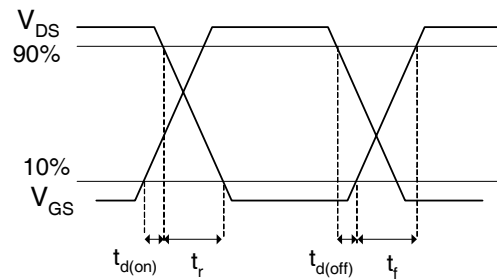
**Fig 22a. Unclamped Inductive Test Circuit**



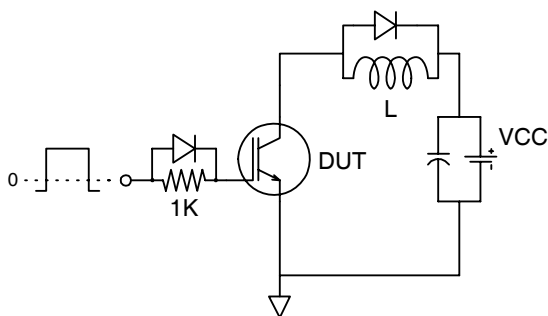
**Fig 22b. Unclamped Inductive Waveforms**



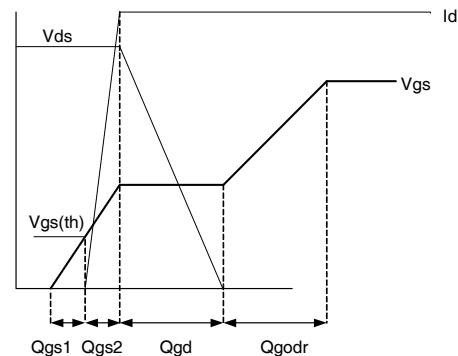
**Fig 23a. Switching Time Test Circuit**



**Fig 23b. Switching Time Waveforms**

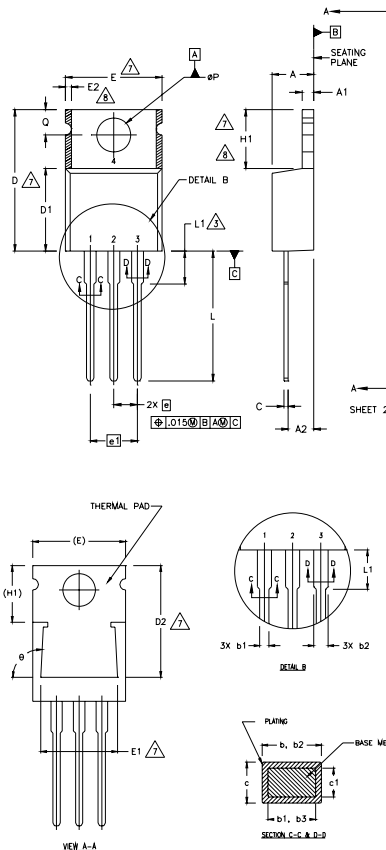


**Fig 24a. Gate Charge Test Circuit**



**Fig 24b. Gate Charge Waveform**

## TO-220AB Package Outline (Dimensions are shown in millimeters (inches))



### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5 M- 1994.
2. DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS).
3. LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
4. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
5. DIMENSION b1 & c1 APPLY TO BASE METAL ONLY.
6. CONTROLLING DIMENSION : INCHES.
7. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS E,H1,D2 & E1
8. DIMENSION E2 X H1 DEFINE A ZONE WHERE STAMPING AND SINGULATION IRREGULARITIES ARE ALLOWED.

### LEAD ASSIGNMENTS

#### HEXFET

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

#### IGBTs, CoPACK

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

#### DIODES

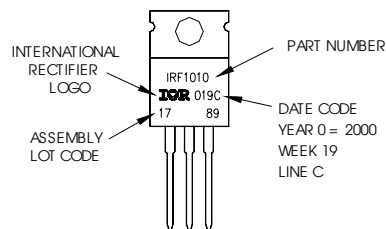
- 1.- ANODE/OPEN
- 2.- CATHODE
- 3.- ANODE

| SYMBOL | DIMENSIONS  |       |          |      | NOTES |
|--------|-------------|-------|----------|------|-------|
|        | MILLIMETERS |       | INCHES   |      |       |
|        | MIN.        | MAX.  | MIN.     | MAX. |       |
| A      | 3.56        | 4.82  | .140     | .190 | 5     |
| A1     | 0.51        | 1.40  | .020     | .055 |       |
| A2     | 2.04        | 2.92  | .080     | .115 |       |
| b      | 0.38        | 1.01  | .015     | .040 |       |
| b1     | 0.38        | 0.96  | .015     | .038 |       |
| b2     | 1.15        | 1.77  | .045     | .070 | 5     |
| b3     | 1.15        | 1.73  | .045     | .068 |       |
| c      | 0.36        | 0.61  | .014     | .024 |       |
| c1     | 0.36        | 0.56  | .014     | .022 | 4     |
| D      | 14.22       | 16.51 | .560     | .650 |       |
| D1     | 8.38        | 9.02  | .330     | .355 | 7     |
| D2     | 12.19       | 12.88 | .480     | .507 |       |
| E      | 9.66        | 10.66 | .380     | .420 | 4,7   |
| E1     | 8.38        | 8.89  | .330     | .350 | 7     |
| e      | 2.54 BSC    |       | .100 BSC |      | 7,8   |
| e1     | 5.08        |       | .200 BSC |      |       |
| H1     | 5.85        | 6.55  | .230     | .270 | 3     |
| L      | 12.70       | 14.73 | .500     | .580 |       |
| L1     | —           | 6.35  | —        | .250 | 3     |
| øP     | 3.54        | 4.08  | .139     | .161 |       |
| Q      | 2.54        | 3.42  | .100     | .135 | 3     |
| ø      | 90°-93°     |       | 90°-93°  |      |       |

## TO-220AB Part Marking Information

EXAMPLE: THIS IS AN IRF1010  
LOT CODE 1789  
ASSEMBLED ON WW 19, 2000  
IN THE ASSEMBLY LINE "C"

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



TO-220AB packages are not recommended for Surface Mount Application.

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.