

# IRF1607PbF

## Typical Applications

- Industrial Motor Drive

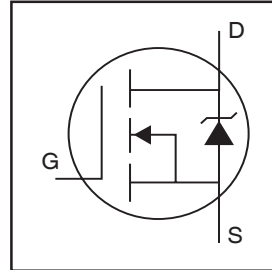
## Benefits

- Ultra Low On-Resistance
- Dynamic dv/dt Rating
- 175°C Operating Temperature
- Fast Switching
- Repetitive Avalanche Allowed up to Tjmax
- Lead-Free

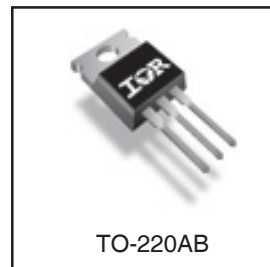
## Description

This Stripe Planar design of HEXFET® Power MOSFETs utilizes the latest processing techniques to achieve extremely low on-resistance per silicon area. Additional features of this HEXFET power MOSFET are a 175°C junction operating temperature, fast switching speed and improved repetitive avalanche rating. These benefits combine to make this design an extremely efficient and reliable device for use in a wide variety of applications.

## HEXFET® Power MOSFET



|                             |
|-----------------------------|
| $V_{DSS} = 75V$             |
| $R_{DS(on)} = 0.0075\Omega$ |
| $I_D = 142A^{⑥}$            |



## Absolute Maximum Ratings

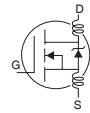
|                           | Parameter                                  | Max.                     | Units |
|---------------------------|--------------------------------------------|--------------------------|-------|
| $I_D @ T_C = 25^\circ C$  | Continuous Drain Current, $V_{GS} @ 10V$   | 142 <sup>⑥</sup>         | A     |
| $I_D @ T_C = 100^\circ C$ | Continuous Drain Current, $V_{GS} @ 10V$   | 100 <sup>⑥</sup>         |       |
| $I_{DM}$                  | Pulsed Drain Current <sup>①</sup>          | 570                      |       |
| $P_D @ T_C = 25^\circ C$  | Power Dissipation                          | 380                      | W     |
|                           | Linear Derating Factor                     | 2.5                      | W/°C  |
| $V_{GS}$                  | Gate-to-Source Voltage                     | $\pm 20$                 | V     |
| $E_{AS}$                  | Single Pulse Avalanche Energy <sup>②</sup> | 1250                     | mJ    |
| $I_{AR}$                  | Avalanche Current <sup>①</sup>             | See Fig.12a, 12b, 15, 16 | A     |
| $E_{AR}$                  | Repetitive Avalanche Energy <sup>②</sup>   |                          | mJ    |
| dv/dt                     | Peak Diode Recovery dv/dt <sup>③</sup>     | 5.2                      | 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 )   |       |
|                           | Mounting Torque, 6-32 or M3 screw          | 10 lbf•in (1.1N•m)       |       |

## Thermal Resistance

|                 | Parameter                           | Typ. | Max. | Units |
|-----------------|-------------------------------------|------|------|-------|
| $R_{\theta JC}$ | Junction-to-Case                    | —    | 0.40 | °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    | Conditions                                                                  |
|---------------------------------|--------------------------------------|------|--------|--------|----------|-----------------------------------------------------------------------------|
| $V_{(BR)DSS}$                   | Drain-to-Source Breakdown Voltage    | 75   | —      | —      | V        | $V_{GS} = 0V, I_D = 250\mu A$                                               |
| $\Delta V_{(BR)DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient  | —    | 0.086  | —      | V/°C     | Reference to $25^\circ\text{C}$ , $I_D = 1mA$                               |
| $R_{DS(on)}$                    | Static Drain-to-Source On-Resistance | —    | 0.0058 | 0.0075 | $\Omega$ | $V_{GS} = 10V, I_D = 85A$ ④                                                 |
| $V_{GS(th)}$                    | Gate Threshold Voltage               | 2.0  | —      | 4.0    | V        | $V_{DS} = 10V, I_D = 250\mu A$                                              |
| $g_{fs}$                        | Forward Transconductance             | 79   | —      | —      | S        | $V_{DS} = 25V, I_D = 85A$                                                   |
| $I_{DSS}$                       | Drain-to-Source Leakage Current      | —    | —      | 20     | $\mu A$  | $V_{DS} = 75V, V_{GS} = 0V$                                                 |
|                                 |                                      | —    | —      | 250    |          | $V_{DS} = 60V, V_{GS} = 0V, T_J = 150^\circ\text{C}$                        |
| $I_{GSS}$                       | Gate-to-Source Forward Leakage       | —    | —      | 200    | nA       | $V_{GS} = 20V$                                                              |
|                                 | Gate-to-Source Reverse Leakage       | —    | —      | -200   |          | $V_{GS} = -20V$                                                             |
| $Q_g$                           | Total Gate Charge                    | —    | 210    | 320    | nC       | $I_D = 85A$                                                                 |
| $Q_{gs}$                        | Gate-to-Source Charge                | —    | 45     | 68     |          | $V_{DS} = 60V$                                                              |
| $Q_{gd}$                        | Gate-to-Drain ("Miller") Charge      | —    | 73     | 110    |          | $V_{GS} = 10V$                                                              |
| $t_{d(on)}$                     | Turn-On Delay Time                   | —    | 22     | —      | ns       | $V_{DD} = 38V$                                                              |
| $t_r$                           | Rise Time                            | —    | 130    | —      |          | $I_D = 85A$                                                                 |
| $t_{d(off)}$                    | Turn-Off Delay Time                  | —    | 84     | —      |          | $R_G = 1.8\Omega$                                                           |
| $t_f$                           | Fall Time                            | —    | 86     | —      |          | $V_{GS} = 10V$ ④                                                            |
| $L_D$                           | Internal Drain Inductance            | —    | 4.5    | —      | nH       | Between lead,<br>6mm (0.25in.)<br>from package<br>and center of die contact |
| $L_S$                           | Internal Source Inductance           | —    | 7.5    | —      |          |                                                                             |
| $C_{iss}$                       | Input Capacitance                    | —    | 7750   | —      | pF       | $V_{GS} = 0V$                                                               |
| $C_{oss}$                       | Output Capacitance                   | —    | 1230   | —      |          | $V_{DS} = 25V$                                                              |
| $C_{rss}$                       | Reverse Transfer Capacitance         | —    | 310    | —      |          | $f = 1.0MHz$ , See Fig. 5                                                   |
| $C_{oss}$                       | Output Capacitance                   | —    | 5770   | —      |          | $V_{GS} = 0V, V_{DS} = 1.0V, f = 1.0MHz$                                    |
| $C_{oss}$                       | Output Capacitance                   | —    | 790    | —      |          | $V_{GS} = 0V, V_{DS} = 60V, f = 1.0MHz$                                     |
| $C_{oss \text{ eff.}}$          | Effective Output Capacitance ⑤       | —    | 1420   | —      |          | $V_{GS} = 0V, V_{DS} = 0V \text{ to } 60V$                                  |



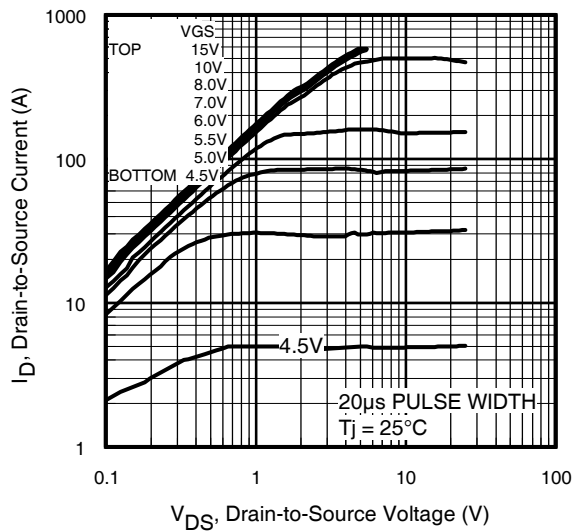
## Source-Drain Ratings and Characteristics

|          | Parameter                                 | Min.                                                                        | Typ. | Max. | Units | Conditions                                                              |
|----------|-------------------------------------------|-----------------------------------------------------------------------------|------|------|-------|-------------------------------------------------------------------------|
| $I_S$    | Continuous Source Current<br>(Body Diode) | —                                                                           | —    | 142⑥ | A     | MOSFET symbol<br>showing the<br>integral reverse<br>p-n junction diode. |
| $I_{SM}$ | Pulsed Source Current<br>(Body Diode) ①   | —                                                                           | —    | 570  |       |                                                                         |
| $V_{SD}$ | Diode Forward Voltage                     | —                                                                           | —    | 1.3  | V     | $T_J = 25^\circ\text{C}, I_S = 85A, V_{GS} = 0V$ ④                      |
| $t_{rr}$ | Reverse Recovery Time                     | —                                                                           | 130  | 200  | ns    | $T_J = 25^\circ\text{C}, I_F = 85A$                                     |
| $Q_{rr}$ | Reverse Recovery Charge                   | —                                                                           | 690  | 1040 | nC    | $di/dt = 100A/\mu s$ ④                                                  |
| $t_{on}$ | Forward Turn-On Time                      | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S + L_D$ ) |      |      |       |                                                                         |

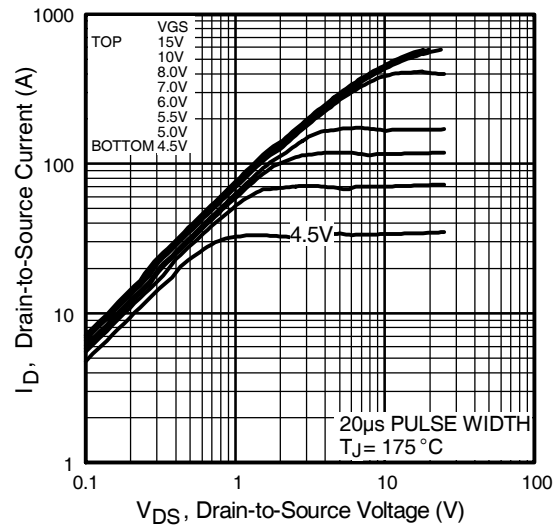
### Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature. (See fig. 11).
- ② Starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.21mH$   
 $R_G = 25\Omega$ ,  $I_{AS} = 85A$ ,  $V_{GS} = 10V$  (See Figure 12).
- ③  $I_{SD} \leq 85A$ ,  $di/dt \leq 310A/\mu s$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  
 $T_J \leq 175^\circ\text{C}$
- ④ Pulse width  $\leq 400\mu s$ ; duty cycle  $\leq 2\%$ .

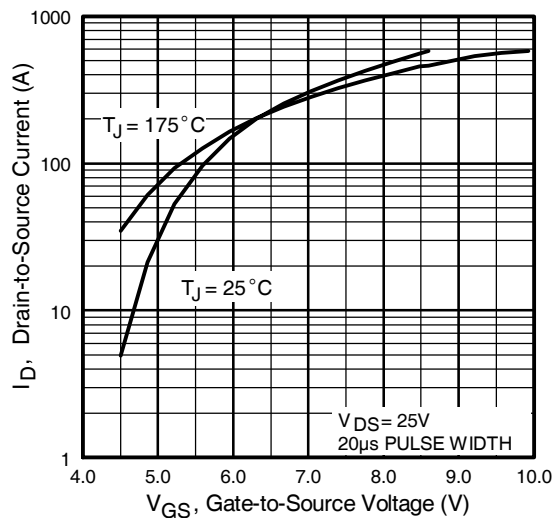
- ⑤  $C_{oss \text{ eff.}}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .
- ⑥ Calculated continuous current based on maximum allowable junction temperature. Package limitation current is 75A.
- ⑦ Limited by  $T_{Jmax}$ , see Fig.12a, 12b, 15, 16 for typical repetitive avalanche performance.



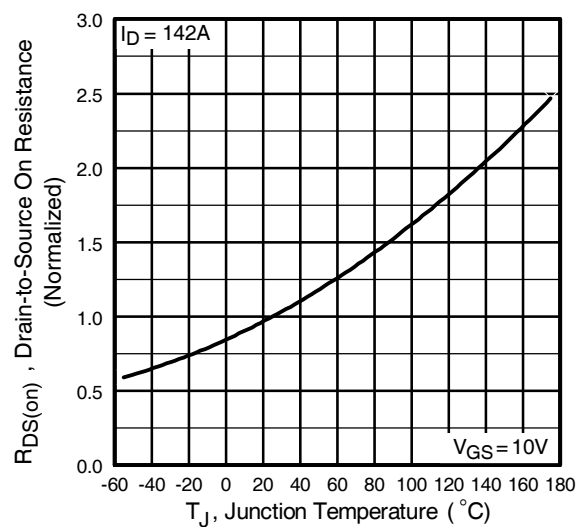
**Fig 1.** Typical Output Characteristics



**Fig 2.** Typical Output Characteristics



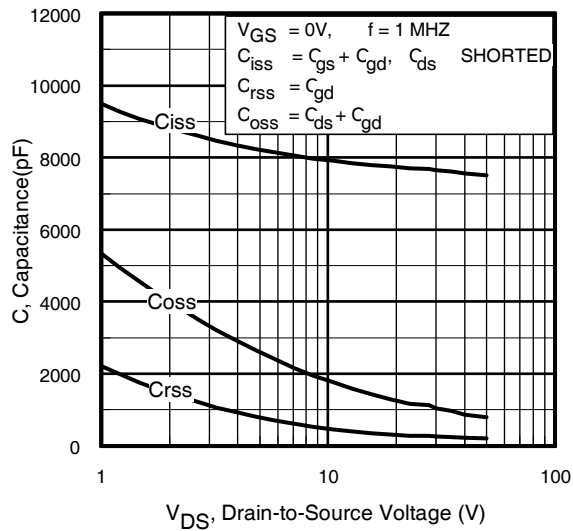
**Fig 3.** Typical Transfer Characteristics



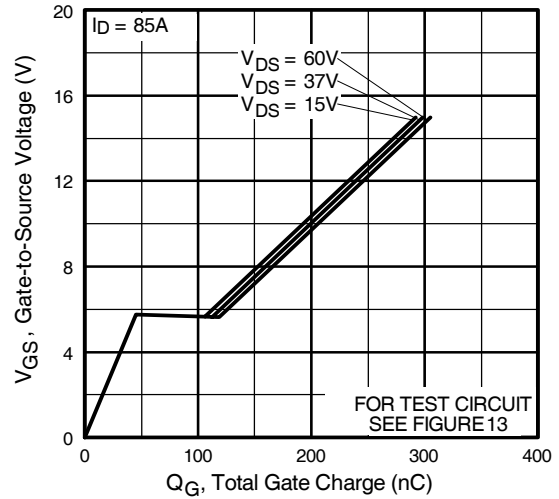
**Fig 4.** Normalized On-Resistance Vs. Temperature

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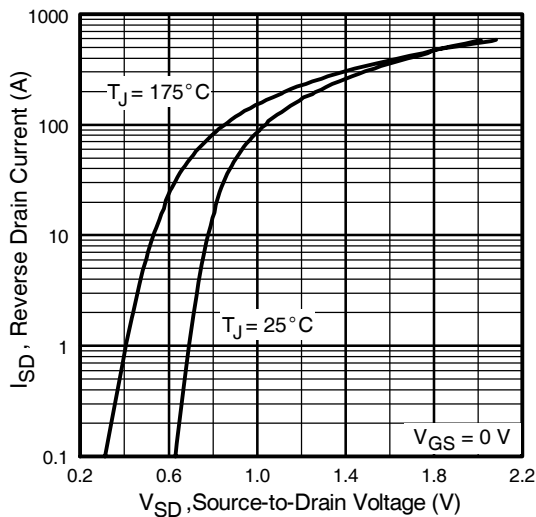
International  
**IR** Rectifier



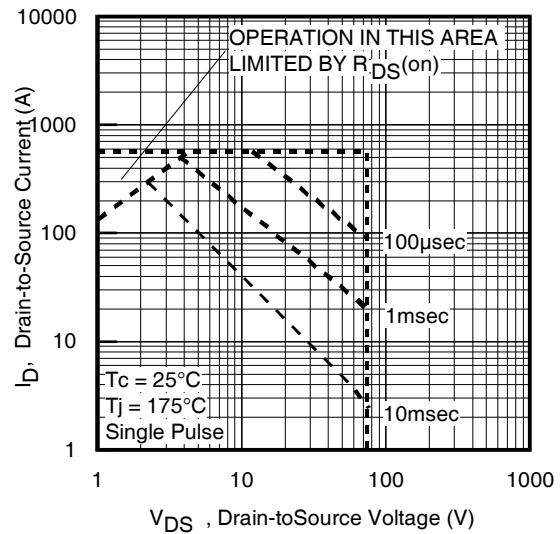
**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage



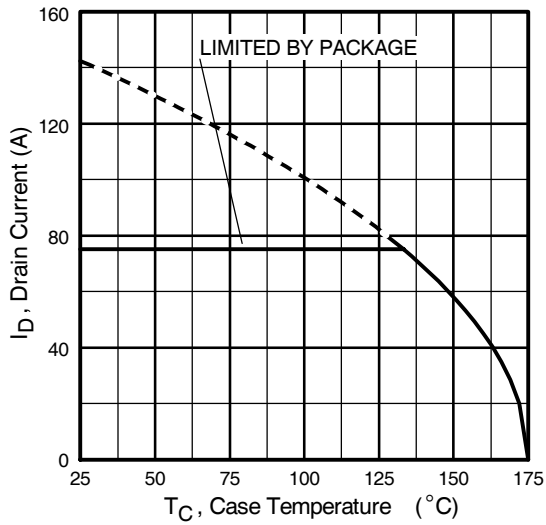
**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage



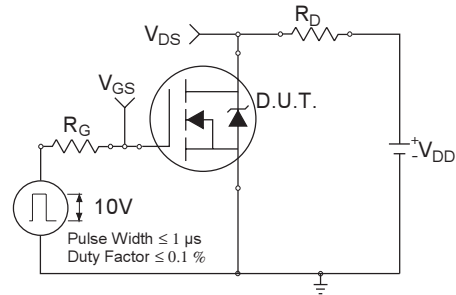
**Fig 7.** Typical Source-Drain Diode Forward Voltage



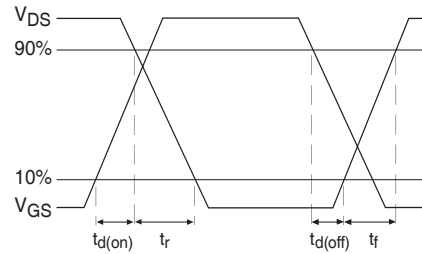
**Fig 8.** Maximum Safe Operating Area



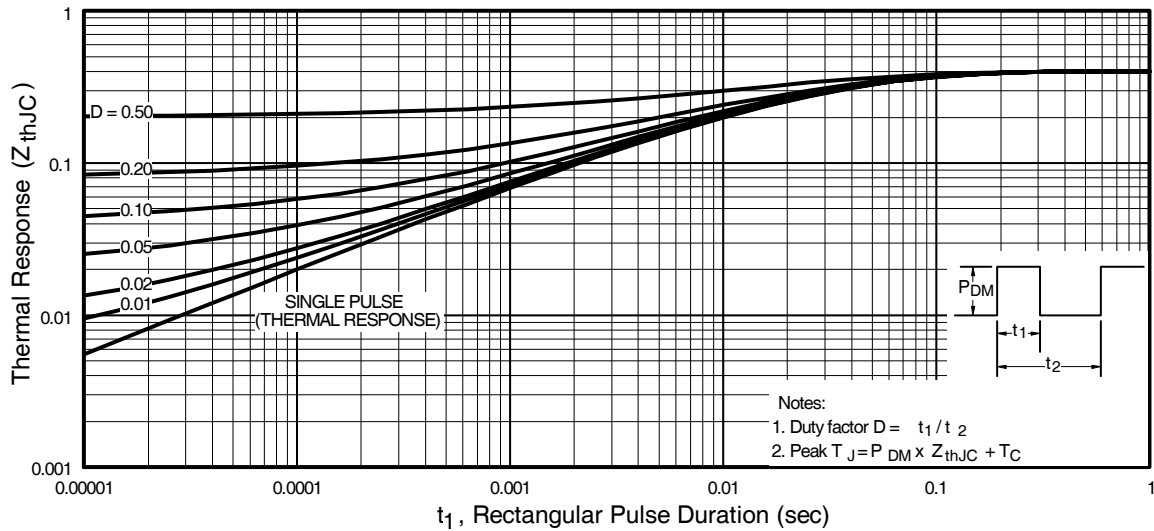
**Fig 9.** Maximum Drain Current Vs. Case Temperature



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



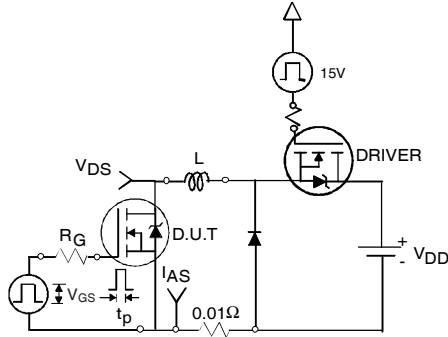
**Fig 10b.** Switching Time Waveforms



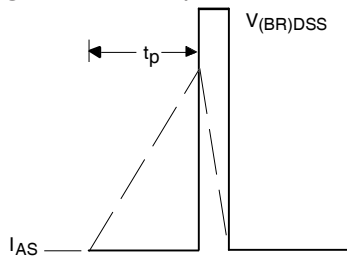
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

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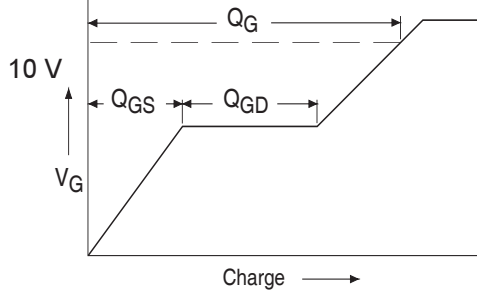
International  
**IR** Rectifier



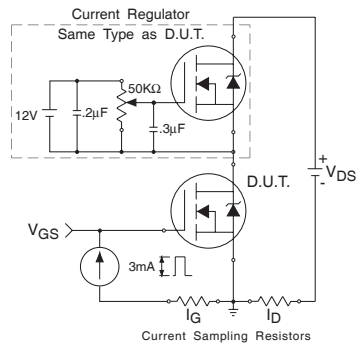
**Fig 12a.** Unclamped Inductive Test Circuit



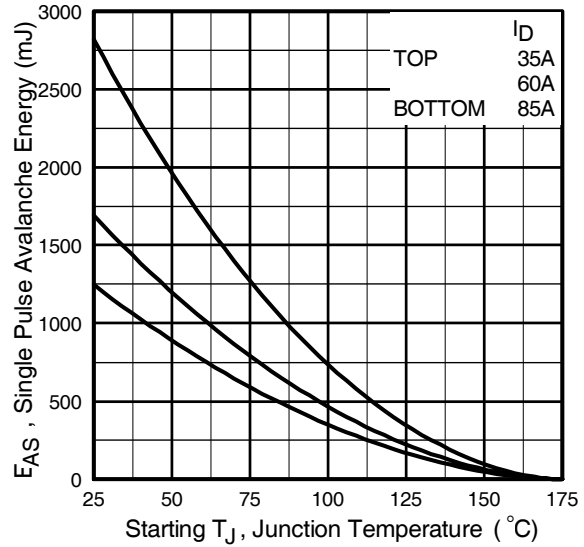
**Fig 12b.** Unclamped Inductive Waveforms



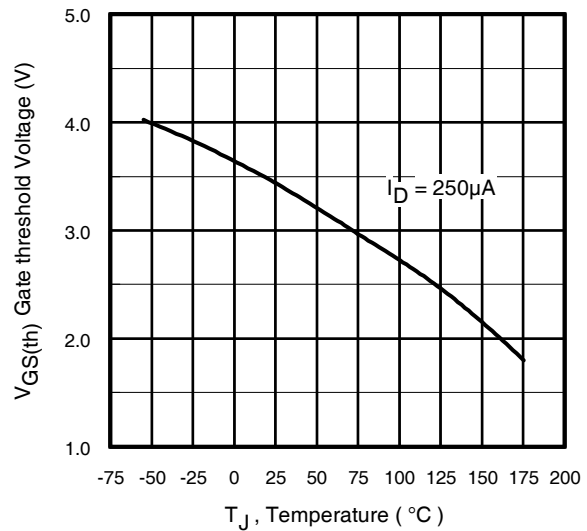
**Fig 13a.** Basic Gate Charge Waveform



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

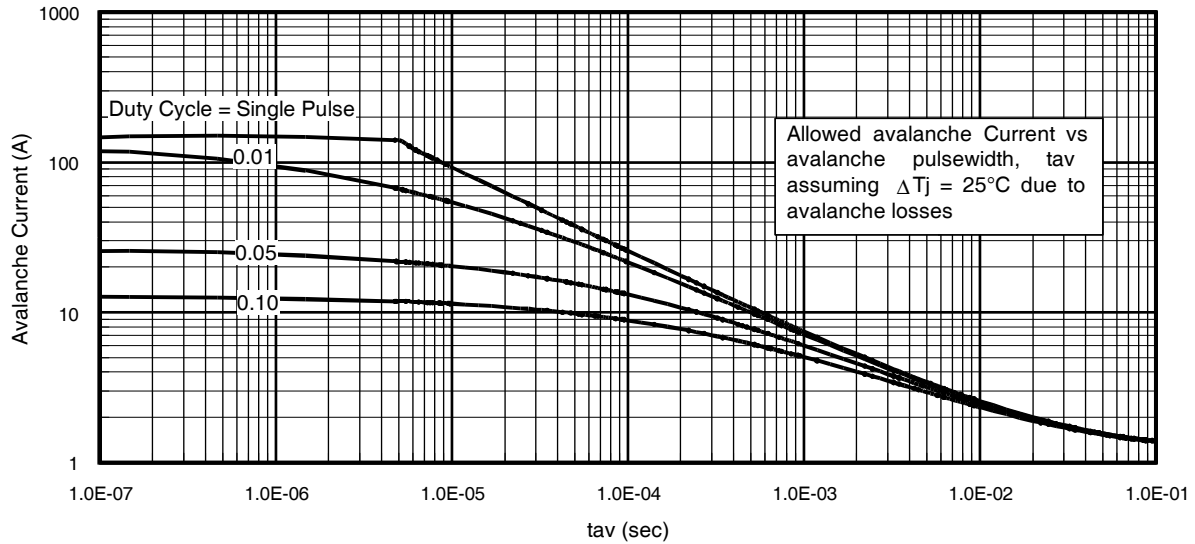


**Fig 12c.** Maximum Avalanche Energy Vs. Drain Current

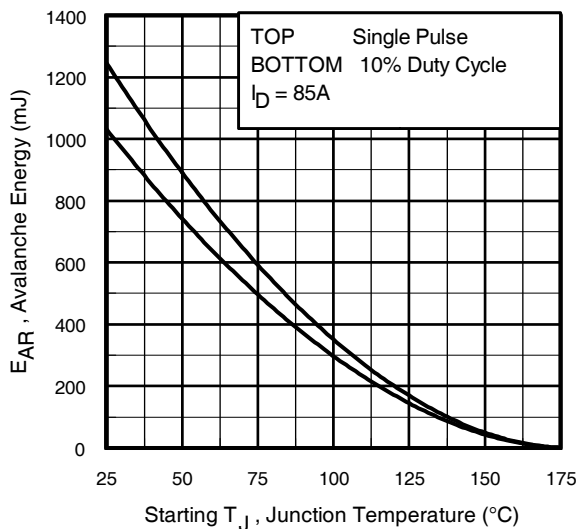


**Fig 14.** Threshold Voltage Vs. Temperature

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



**Fig 15.** Typical Avalanche Current Vs. Pulsewidth



**Fig 16.** Maximum Avalanche Energy Vs. Temperature

**Notes on Repetitive Avalanche Curves , Figures 15, 16:**  
(For further info, see AN-1005 at [www.irf.com](http://www.irf.com))

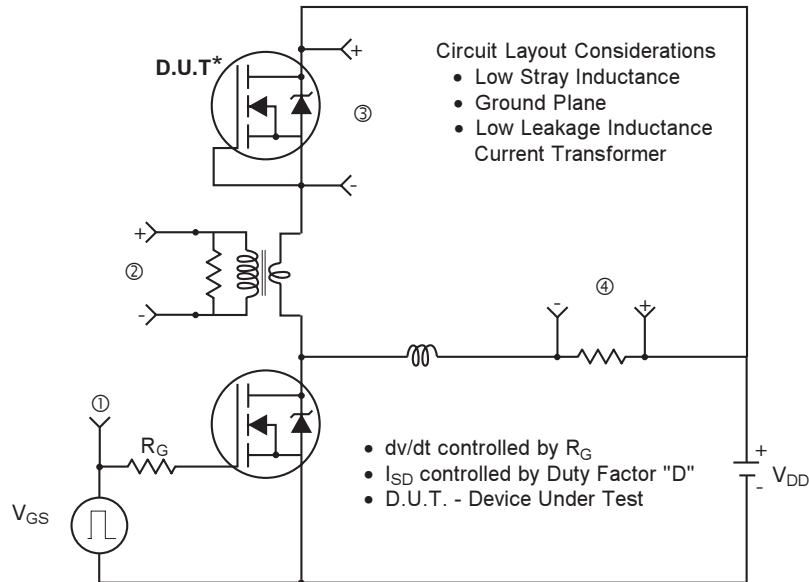
1. Avalanche failures assumption:  
Purely a thermal phenomenon and failure occurs at a temperature far in excess of  $T_{jmax}$ . This is validated for every part type.
2. Safe operation in Avalanche is allowed as long as  $T_{jmax}$  is not exceeded.
3. Equation below based on circuit and waveforms shown in Figures 12a, 12b.
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 15, 16).  
 $t_{av}$  = Average time in avalanche.  
 $D$  = Duty cycle in avalanche =  $t_{av} \cdot f$   
 $Z_{thJC}(D, t_{av})$  = Transient thermal resistance, see figure 11)

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

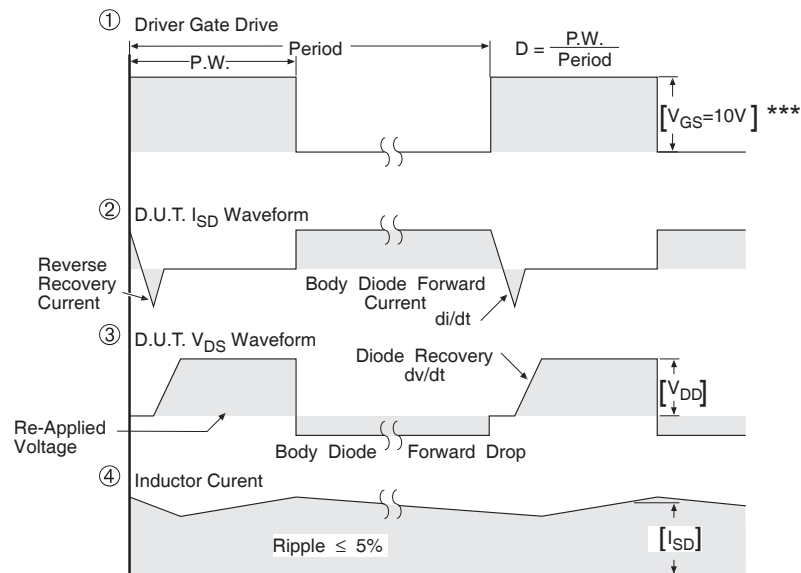
$$I_{av} = 2\Delta T / [1.3 \cdot BV \cdot Z_{thJC}]$$

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

## Peak Diode Recovery dv/dt Test Circuit



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

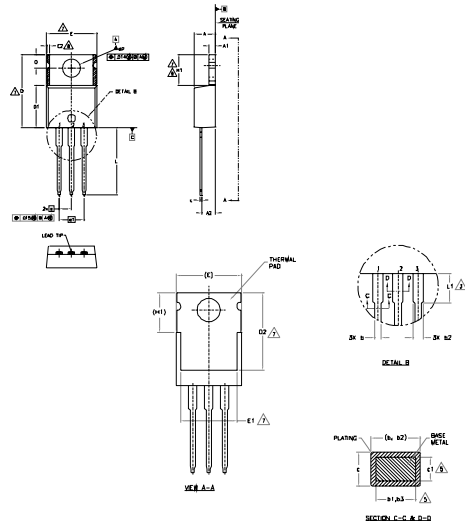


\*\*\*  $V_{GS} = 5.0V$  for Logic Level and 3V Drive Devices

**Fig 17.** For N-channel HEXFET® power MOSFETs

## TO-220AB Package Outline

Dimensions are shown in millimeters (inches)



- NOTES
- 1 - DIMENSIONING AND TOLERANCING AS PER ASME Y14.5 M-1994.
  - 2 - DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS).
  - 3 - LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
  - 4 - DIMENSION D, D1 & 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, b3 & c1 APPLY TO BASE METAL ONLY.
  - 6 - CONTROLLING DIMENSION - INCHES.
  - 7 - THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS E1, D2 & E1.
  - 8 - DIMENSION E2 X HT DEFINE A ZONE WHERE STAMPING AND SINGULATION IRREGULARITIES ARE ALLOWED.
  - 9 - OUTLINE CONFORMS TO JEDEC TO-220, EXCEPT A2 (max.) AND D2 (min.) WHERE DIMENSIONS ARE DERIVED FROM THE ACTUAL PACKAGE OUTLINE.

| SYMBOL | DIMENSIONS  |       |          |      | NOTES |
|--------|-------------|-------|----------|------|-------|
|        | MILLIMETERS |       | INCHES   |      |       |
|        | MIN.        | MAX.  | MIN.     | MAX. |       |
| A      | 3.56        | 4.83  | .140     | .190 |       |
| A1     | 0.51        | 1.40  | .020     | .055 |       |
| A2     | 2.03        | 2.92  | .080     | .115 |       |
| b      | 0.38        | 1.01  | .015     | .040 | 5     |
| b1     | 0.38        | 0.97  | .015     | .038 |       |
| b2     | 1.14        | 1.78  | .045     | .070 |       |
| b3     | 1.14        | 1.73  | .045     | .068 | 5     |
| c      | 0.36        | 0.61  | .014     | .024 |       |
| c1     | 0.36        | 0.56  | .014     | .022 | 5     |
| D      | 14.22       | 16.51 | .560     | .650 | 4     |
| D1     | 8.38        | 9.02  | .330     | .355 |       |
| D2     | 11.68       | 12.88 | .460     | .507 |       |
| E      | 9.65        | 10.67 | .380     | .420 | 4,7   |
| E1     | 6.86        | 8.89  | .270     | .350 | 7     |
| E2     | -           | 0.76  | -        | .030 | 8     |
| e      | 2.54 BSC    |       | .100 BSC |      |       |
| e1     | 5.08 BSC    |       | .200 BSC |      |       |
| H1     | 5.84        | 6.86  | .230     | .270 | 7,8   |
| L      | 12.70       | 14.73 | .500     | .580 |       |
| L1     | 3.56        | 4.06  | .140     | .160 | 3     |
| øP     | 3.54        | 4.08  | .139     | .161 |       |
| Q      | 2.54        | 3.42  | .100     | .135 |       |

### LEAD ASSIGNMENTS

#### HEXLETT

1 - GATE

2 - DRAIN

3 - SOURCE

#### CHIPS CAPAC

1 - GATE

2 - COLLECTOR

3 - EMITTER

#### DIODES

1 - ANODE

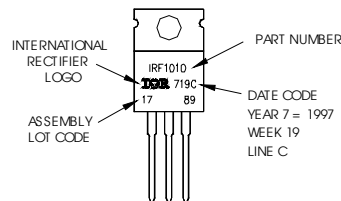
2 - CATHODE

3 - ANODE

## 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"



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

### Notes:

1. For an Automotive Qualified version of this part please see <http://www.irf.com/product-info/autof/>
2. For the most current drawing please refer to IR website at <http://www.irf.com/package/>

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.

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