

# IRF1503PbF

## Typical Applications

- Industrial Motor Drive

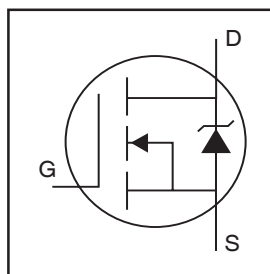
## Features

- Advanced Process Technology
- Ultra Low On-Resistance
- 175°C Operating Temperature
- Fast Switching
- Repetitive Avalanche Allowed up to  $T_{jmax}$

## Description

This 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 combine to make this design an extremely efficient and reliable device for use in a wide variety of applications.

## HEXFET® Power MOSFET



$V_{DS} = 30V$   
 $R_{DS(on)} = 3.3m\Omega$   
 $I_D = 75A$



## Absolute Maximum Ratings

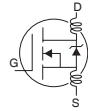
|                           | Parameter                                                  | Max.                     | Units |
|---------------------------|------------------------------------------------------------|--------------------------|-------|
| $I_D @ T_C = 25^\circ C$  | Continuous Drain Current, $V_{GS} @ 10V$ (Silicon limited) | 240                      | A     |
| $I_D @ T_C = 100^\circ C$ | Continuous Drain Current, $V_{GS} @ 10V$ (See Fig.9)       | 170                      |       |
| $I_D @ T_C = 25^\circ C$  | Continuous Drain Current, $V_{GS} @ 10V$ (Package limited) | 75                       |       |
| $I_{DM}$                  | Pulsed Drain Current ①                                     | 960                      |       |
| $P_D @ T_C = 25^\circ C$  | Power Dissipation                                          | 330                      | W     |
|                           | Linear Derating Factor                                     | 2.2                      | W/°C  |
| $V_{GS}$                  | Gate-to-Source Voltage                                     | $\pm 20$                 | V     |
| $E_{AS}$                  | Single Pulse Avalanche Energy②                             | 510                      | mJ    |
| $E_{AS} (tested)$         | Single Pulse Avalanche Energy Tested Value⑥                | 980                      |       |
| $I_{AR}$                  | Avalanche Current①                                         | See Fig.12a, 12b, 15, 16 | A     |
| $E_{AR}$                  | Repetitive Avalanche Energy⑤                               |                          | mJ    |
| $T_J$                     | Operating Junction and                                     | -55 to + 175             | °C    |
| $T_{STG}$                 | Storage Temperature Range                                  |                          |       |
|                           | Soldering Temperature, for 10 seconds                      | 300 (1.6mm from case )   |       |

## Thermal Resistance

|                 | Parameter                           | Typ. | Max. | Units |
|-----------------|-------------------------------------|------|------|-------|
| $R_{\theta JC}$ | Junction-to-Case                    | —    | 0.45 | °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    | 30   | —     | —    | V                   | $V_{GS} = 0V, I_D = 250\mu A$                                               |
| $\Delta V_{(BR)DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient  | —    | 0.028 | —    | V/ $^\circ\text{C}$ | Reference to $25^\circ\text{C}$ , $I_D = 1\text{mA}$                        |
| $R_{DS(on)}$                    | Static Drain-to-Source On-Resistance | —    | 2.6   | 3.3  | m $\Omega$          | $V_{GS} = 10V, I_D = 140A$ ③                                                |
| $V_{GS(th)}$                    | Gate Threshold Voltage               | 2.0  | —     | 4.0  | V                   | $V_{DS} = 10V, I_D = 250\mu A$                                              |
| $g_{fs}$                        | Forward Transconductance             | 75   | —     | —    | S                   | $V_{DS} = 25V, I_D = 140A$                                                  |
| $I_{DSS}$                       | Drain-to-Source Leakage Current      | —    | —     | 20   | $\mu A$             | $V_{DS} = 30V, V_{GS} = 0V$                                                 |
|                                 |                                      | —    | —     | 250  |                     | $V_{DS} = 30V, V_{GS} = 0V, T_J = 125^\circ\text{C}$                        |
| $I_{GSS}$                       | Gate-to-Source Forward Leakage       | —    | —     | 200  | nA                  | $V_{GS} = 20V$                                                              |
|                                 | Gate-to-Source Reverse Leakage       | —    | —     | -200 |                     | $V_{GS} = -20V$                                                             |
| $Q_g$                           | Total Gate Charge                    | —    | 130   | 200  | nC                  | $I_D = 140A$                                                                |
| $Q_{gs}$                        | Gate-to-Source Charge                | —    | 36    | 54   |                     | $V_{DS} = 24V$                                                              |
| $Q_{gd}$                        | Gate-to-Drain ("Miller") Charge      | —    | 41    | 62   |                     | $V_{GS} = 10V$                                                              |
| $t_{d(on)}$                     | Turn-On Delay Time                   | —    | 17    | —    | ns                  | $V_{DD} = 15V$                                                              |
| $t_r$                           | Rise Time                            | —    | 130   | —    |                     | $I_D = 140A$                                                                |
| $t_{d(off)}$                    | Turn-Off Delay Time                  | —    | 59    | —    |                     | $R_G = 2.5\Omega$                                                           |
| $t_f$                           | Fall Time                            | —    | 48    | —    |                     | $V_{GS} = 10V$ ③                                                            |
| $L_D$                           | Internal Drain Inductance            | —    | 5.0   | —    | nH                  | Between lead,<br>6mm (0.25in.)<br>from package<br>and center of die contact |
| $L_S$                           | Internal Source Inductance           | —    | 13    | —    |                     |                                                                             |
| $C_{iss}$                       | Input Capacitance                    | —    | 5730  | —    | pF                  | $V_{GS} = 0V$                                                               |
| $C_{oss}$                       | Output Capacitance                   | —    | 2250  | —    |                     | $V_{DS} = 25V$                                                              |
| $C_{rss}$                       | Reverse Transfer Capacitance         | —    | 290   | —    |                     | $f = 1.0\text{MHz}$ , See Fig. 5                                            |
| $C_{oss}$                       | Output Capacitance                   | —    | 7580  | —    |                     | $V_{GS} = 0V, V_{DS} = 1.0V, f = 1.0\text{MHz}$                             |
| $C_{oss}$                       | Output Capacitance                   | —    | 2290  | —    |                     | $V_{GS} = 0V, V_{DS} = 24V, f = 1.0\text{MHz}$                              |
| $C_{oss \text{ eff.}}$          | Effective Output Capacitance ④       | —    | 3420  | —    |                     | $V_{GS} = 0V, V_{DS} = 0V \text{ to } 24V$                                  |



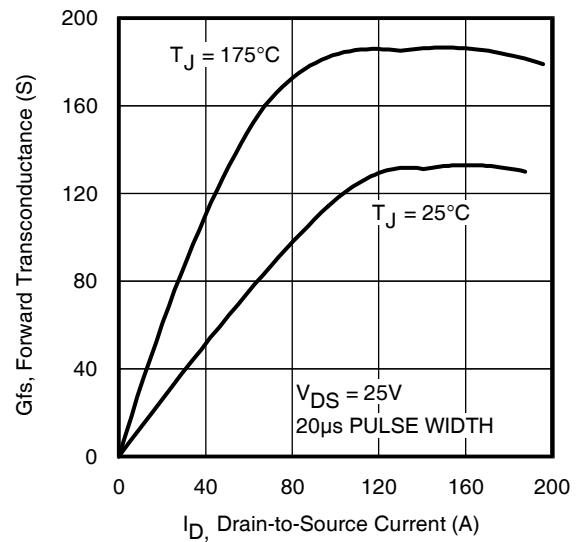
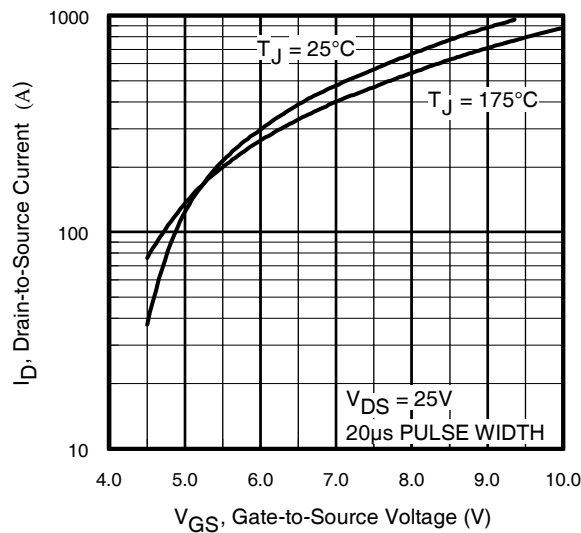
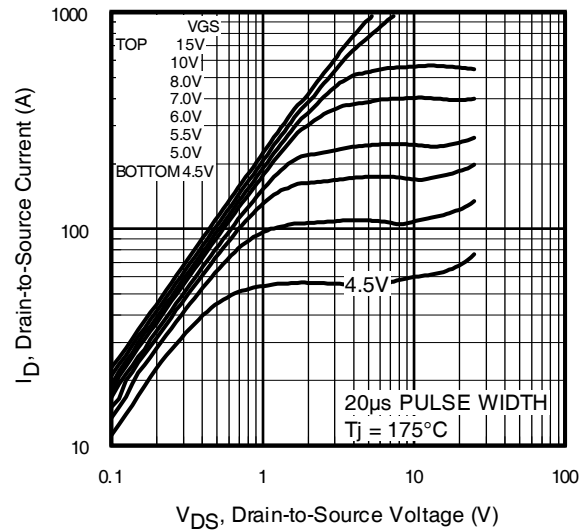
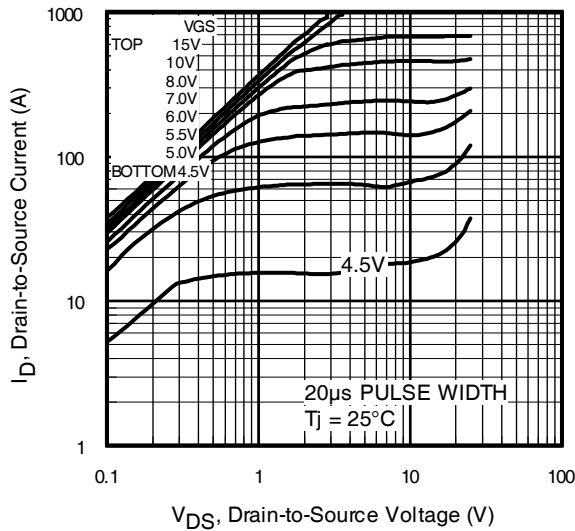
## Source-Drain Ratings and Characteristics

|          | Parameter                                 | Min.                                                                        | Typ. | Max. | Units | Conditions                                                              |
|----------|-------------------------------------------|-----------------------------------------------------------------------------|------|------|-------|-------------------------------------------------------------------------|
| $I_S$    | Continuous Source Current<br>(Body Diode) | —                                                                           | —    | 240  | A     | MOSFET symbol<br>showing the<br>integral reverse<br>p-n junction diode. |
| $I_{SM}$ | Pulsed Source Current<br>(Body Diode) ①   | —                                                                           | —    | 960  |       |                                                                         |
| $V_{SD}$ | Diode Forward Voltage                     | —                                                                           | —    | 1.3  | V     | $T_J = 25^\circ\text{C}, I_S = 140A, V_{GS} = 0V$ ③                     |
| $t_{rr}$ | Reverse Recovery Time                     | —                                                                           | 71   | 110  | ns    | $T_J = 25^\circ\text{C}, I_F = 140A, V_{DD} = 15V$                      |
| $Q_{rr}$ | Reverse Recovery Charge                   | —                                                                           | 110  | 170  | nC    | $di/dt = 100A/\mu s$ ③                                                  |
| $t_{on}$ | Forward Turn-On Time                      | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S + L_D$ ) |      |      |       |                                                                         |

### Notes:

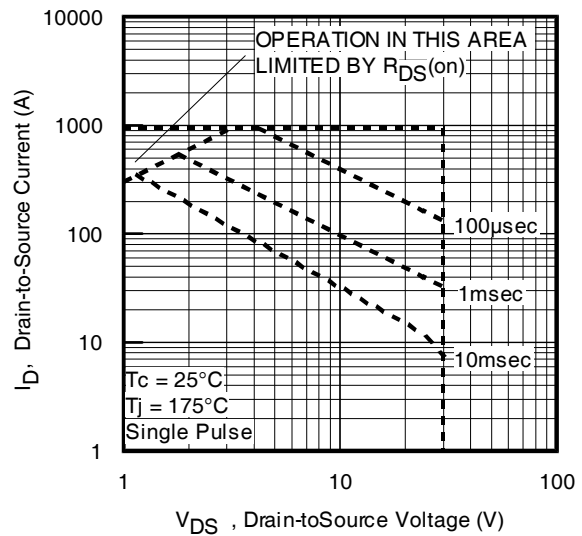
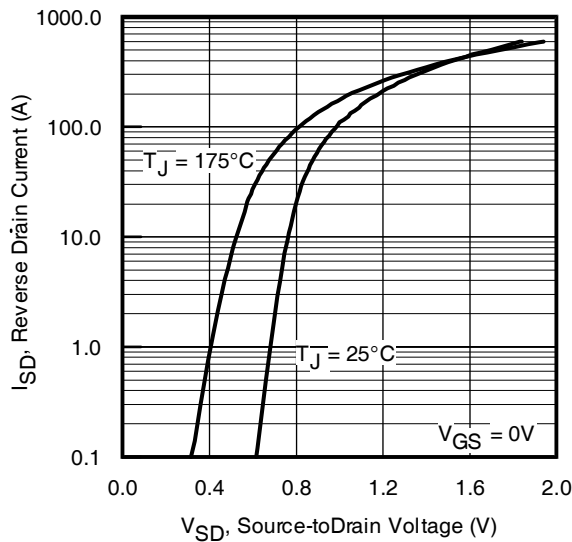
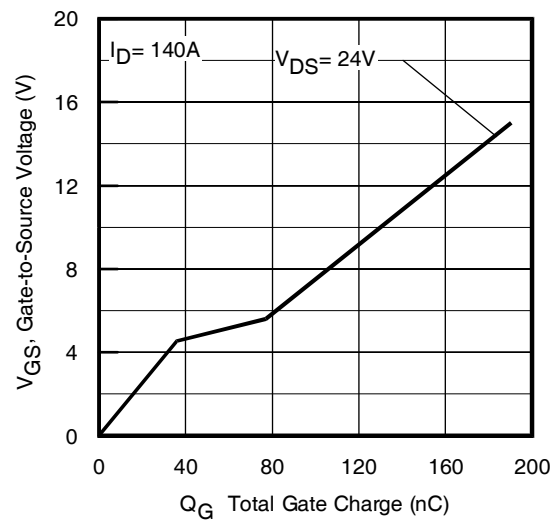
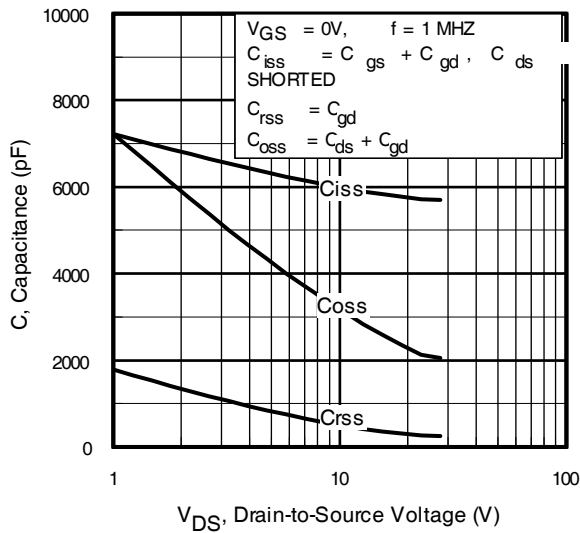
- ① Repetitive rating; pulse width limited by max. junction temperature. (See fig. 11).
- ② Starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.049\text{mH}$   
 $R_G = 25\Omega$ ,  $I_{AS} = 140A$ . (See Figure 12).
- ③ Pulse width  $\leq 400\mu s$ ; duty cycle  $\leq 2\%$ .

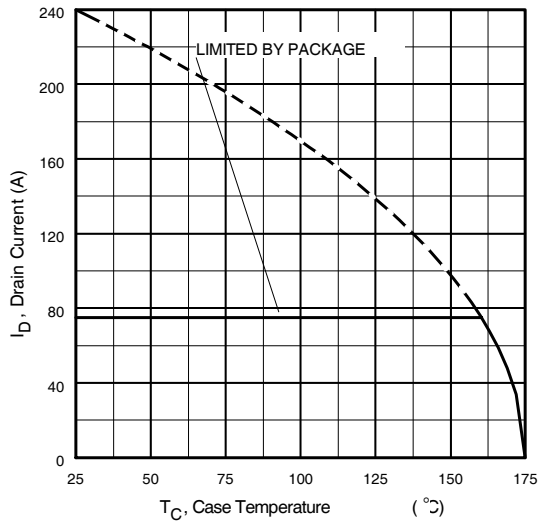
- ④  $C_{oss \text{ eff.}}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .
- ⑤ Limited by  $T_{Jmax}$ , see Fig.12a, 12b, 15, 16 for typical repetitive avalanche performance.
- ⑥ This value determined from sample failure population. 100% tested to this value in production.



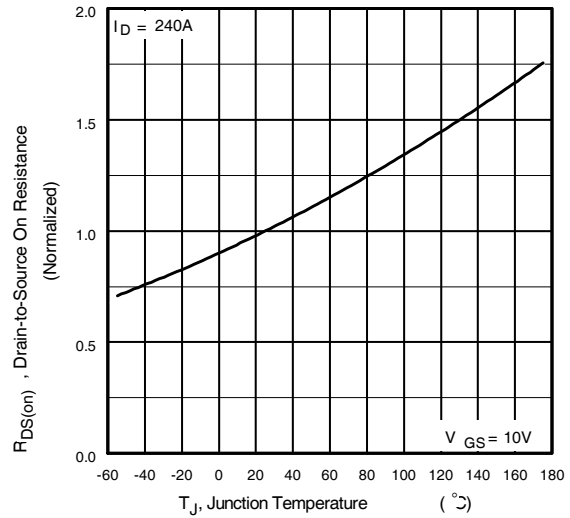
# IRF1503PbF

International  
**IR** Rectifier

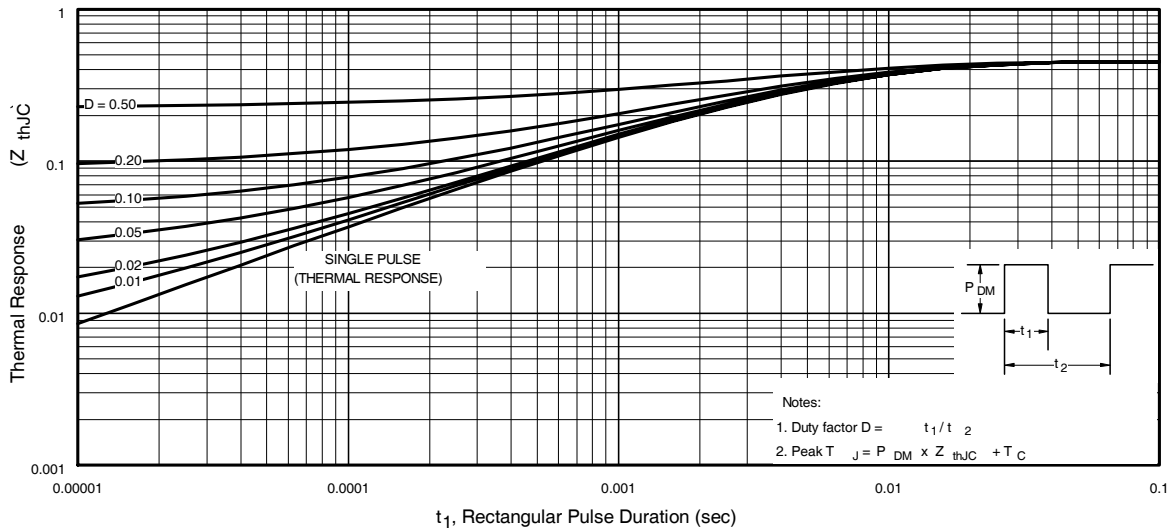




**Fig 9.** Maximum Drain Current Vs. Case Temperature



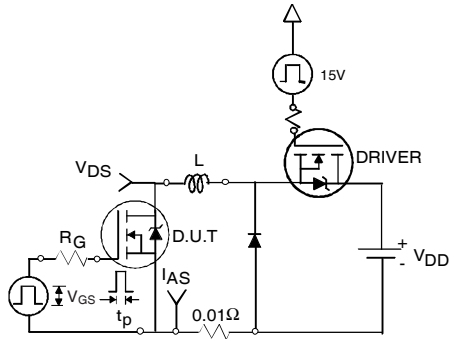
**Fig 10.** Normalized On-Resistance Vs. Temperature



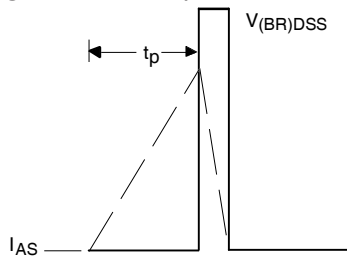
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

# IRF1503PbF

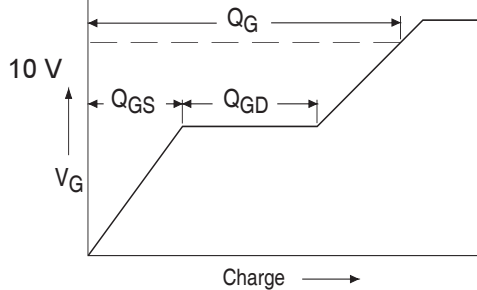
International  
**IR** Rectifier



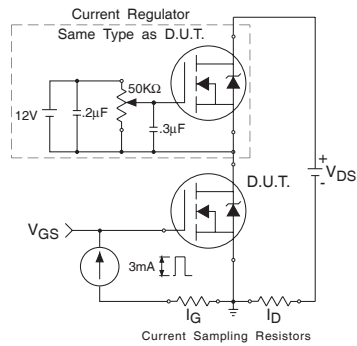
**Fig 12a.** Unclamped Inductive Test Circuit



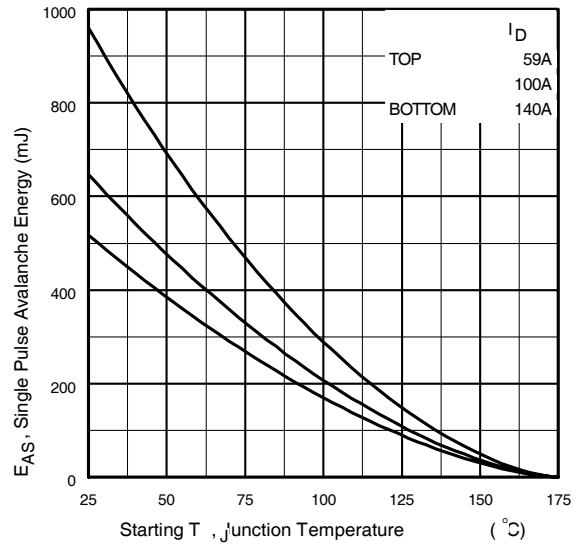
**Fig 12b.** Unclamped Inductive Waveforms



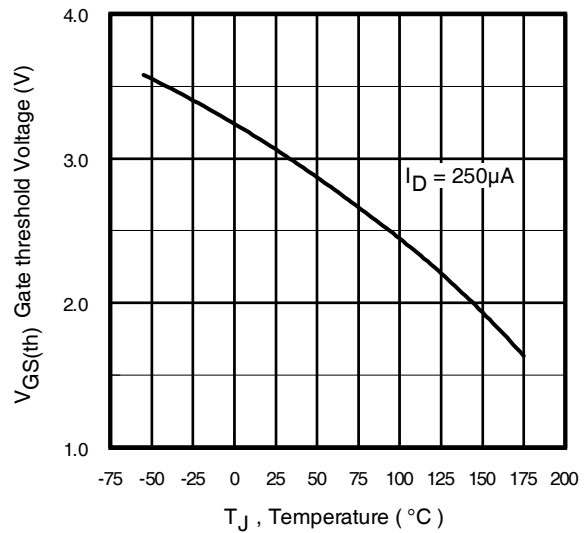
**Fig 13a.** Basic Gate Charge Waveform



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



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



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

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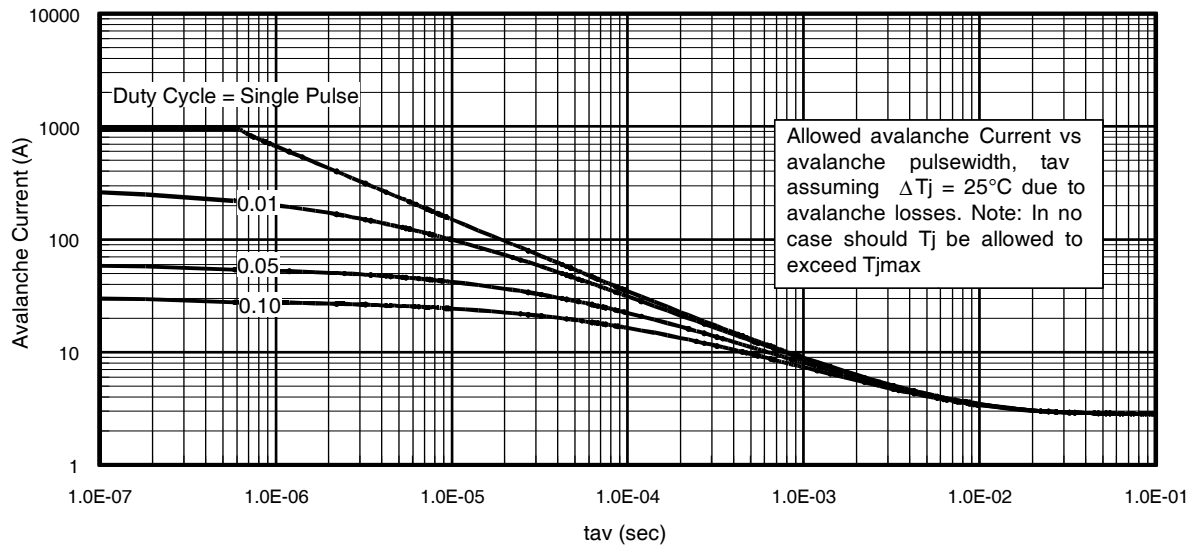


Fig 15. Typical Avalanche Current Vs. Pulsewidth

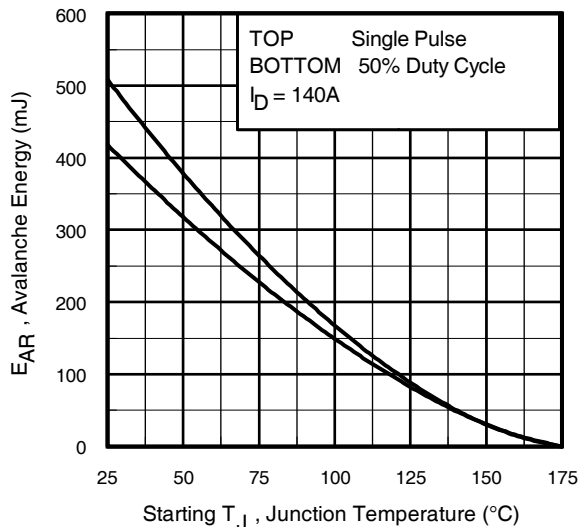


Fig 16. Maximum Avalanche Energy Vs. Temperature

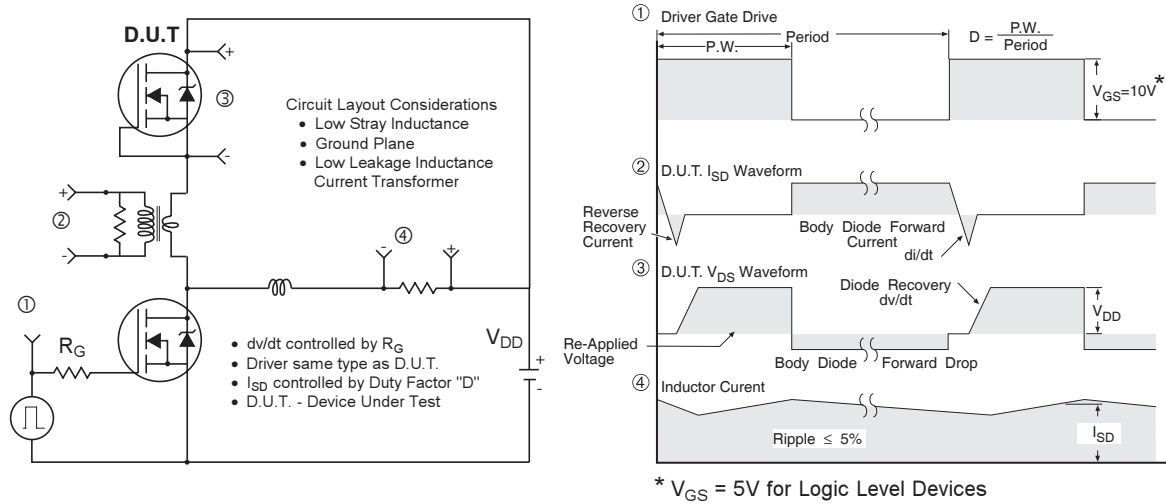
**Notes on Repetitive Avalanche Curves , Figures 15, 16:**  
(For further info, see AN-1005 at [www.irf.com](http://www.irf.com))

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)

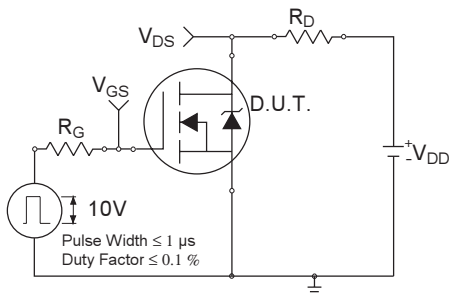
$$P_{D(ave)} = \frac{1}{2} (1.3 \cdot BV \cdot I_{av}) = \Delta T / Z_{thJC}$$

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

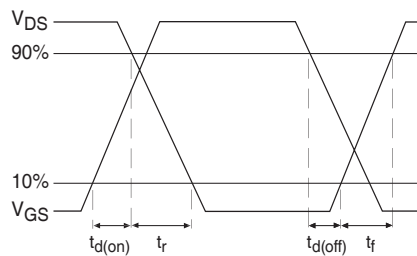
$$E_{AS(AR)} = P_{D(ave)} \cdot t_{av}$$



**Fig 17. Peak Diode Recovery  $dv/dt$  Test Circuit for N-Channel HEXFET® Power MOSFETs**



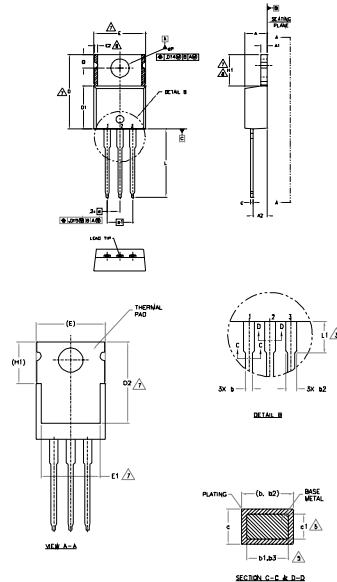
**Fig 18a. Switching Time Test Circuit**



**Fig 18b. Switching Time Waveforms**

## TO-220AB Package Outline

Dimensions are shown in millimeters (inches)



- NOTES
1. DIMENSIONS AND TOLERANCES AS PER ASSE Y14.5 M- 1994
  2. DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS)
  3. LEAD DIMENSION AND PITCH UNCONTROLLED IN LT
  4. DIMENSION D, D1 & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .007" (0.177) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
  5. DIMENSION D1, D2 & E1 APPLY TO BASE METAL ONLY
  6. CONTROLLING DIMENSION - INCHES
  7. THERMAL PAD CONTOUR OPTIONAL. WITHIN DIMENSIONS E, H1, D2 & E1
  8. DIMENSION E2 & H1 DEFINE A ZONE WHERE STAMPING AND SOLDERING 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     |
| H1     | 0.38        | 0.97  | .015        | .038 |       |
| H2     | 1.14        | 1.78  | .045        | .070 | 5     |
| H3     | 1.14        | 1.73  | .045        | .068 |       |
| C      | 0.36        | 0.61  | .014        | .024 |       |
| C1     | 0.36        | 0.56  | .014        | .022 |       |
| D      | 14.22       | 16.51 | .560        | .650 | 4     |
| D1     | 8.38        | 9.02  | .330        | .355 |       |
| D2     | 11.68       | 12.88 | .460        | .507 | 7     |
| E      | 9.85        | 10.67 | .380        | .420 | 4,7   |
| E1     | 6.86        | 6.89  | .270        | .250 | 7     |
| E2     | -           | 0.76  | -           | .030 | 8     |
| E      | 2.54 ± .02  |       | .100 ± .008 |      |       |
| E1     | 2.54 ± .02  |       | .100 ± .008 |      |       |
| 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 |       |

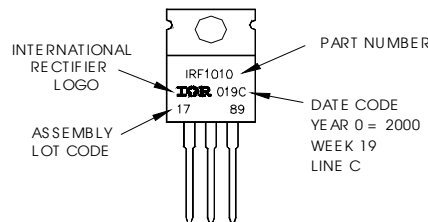
### LEAD ASSIGNMENTS

- IRF1503  
1- GATE  
2- DRAIN  
3- SOURCE
- IRF1503  
1- GATE  
2- DRAIN  
3- SOURCE

## 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 package is not recommended for Surface Mount Application.**

### Notes:

1. For an Automotive Qualified version of this part please see <http://www.irf.com/product-info/aufo/>
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 Industrial market.  
Qualification Standards can be found on IR's Web site.