PD -95487

International
IOR Rectifier

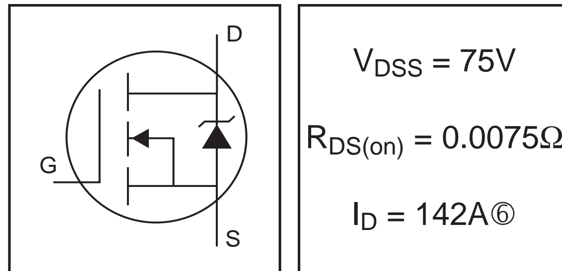
**AUTOMOTIVE MOSFET**

# IRF1607PbF

## Typical Applications

- 42 Volts Automotive Electrical Systems
- Electrical Power Steering (EPS)
- Integrated Starter Alternator
- Lead-Free

HEXFET® Power MOSFET

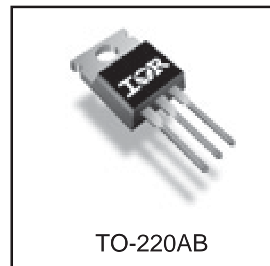



## Benefits

- Ultra Low On-Resistance
- Dynamic dv/dt Rating
- 175°C Operating Temperature
- Fast Switching
- Repetitive Avalanche Allowed up to Tjmax
- Automotive [Q101] Qualified

## Description

Specifically designed for Automotive applications, this Stripe Planar design of HEXFET® Power MOSFETs utilizes the lastest 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 Automotive applications and a wide variety of other applications.



TO-220AB

## Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---|---|---|---|
| $I_D$ @ $T_C$ = 25°C | Continuous Drain Current, $V_{GS}$ @ 10V | 142⑥ | A |
| $I_D$ @ $T_C$ = 100°C | Continuous Drain Current, $V_{GS}$ @ 10V | 100⑥ | |
| $I_{DM}$ | Pulsed Drain Current ① | 570 | |
| $P_D$ @$T_C$ = 25°C | Power Dissipation | 380 | W |
| | Linear Derating Factor | 2.5 | W/°C |
| $V_{GS}$ | Gate-to-Source Voltage | ± 20 | V |
| $E_{AS}$ | Single Pulse Avalanche Energy② | 1250 | mJ |
| $I_{AR}$ | Avalanche Current① | See Fig.12a, 12b, 15, 16 | A |
| $E_{AR}$ | Repetitive Avalanche Energy⑦ | | mJ |
| dv/dt | Peak Diode Recovery dv/dt ③ | 5.2 | 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 (1.1N•m) | |

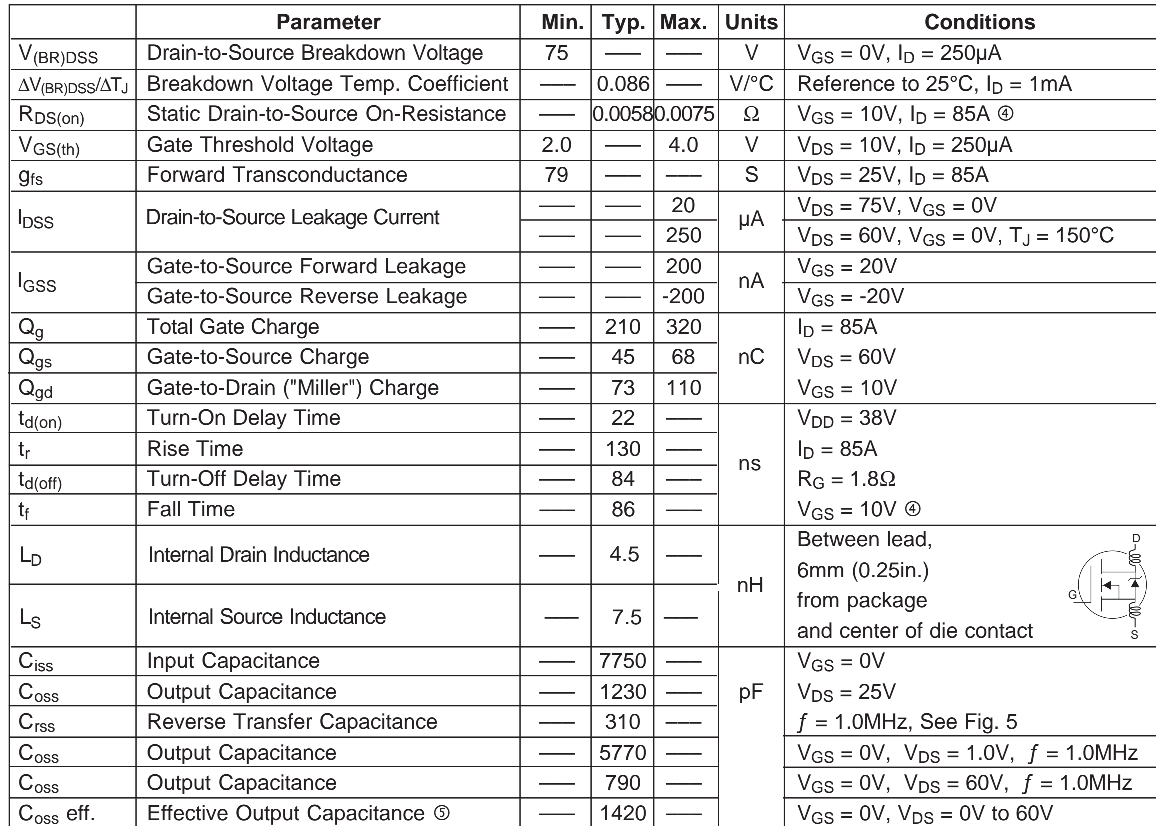
## Thermal Resistance

| | 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 | |



06/30/04

## Electrical Characteristics @ $T_J$ = 25°C (unless otherwise specified)



| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-to-Source Breakdown Voltage | 75 | —— | —— | V | $V_{GS}$ = 0V, $I_D$ = 250μA |
| $\Delta V_{(BR)DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient | —— | 0.086 | —— | V/°C | Reference to 25°C, $I_D$ = 1mA |
| $R_{DS(on)}$ | Static Drain-to-Source On-Resistance | —— | 0.0058 | 0.0075 | Ω | $V_{GS}$ = 10V, $I_D$ = 85A ④ |
| $V_{GS(th)}$ | Gate Threshold Voltage | 2.0 | —— | 4.0 | V | $V_{DS}$ = 10V, $I_D$ = 250μA |
| $g_{fs}$ | Forward Transconductance | 79 | —— | —— | S | $V_{DS}$ = 25V, $I_D$ = 85A |
| $I_{DSS}$ | Drain-to-Source Leakage Current | —— | —— | 20 | μA | $V_{DS}$ = 75V, $V_{GS}$ = 0V |
| | | —— | —— | 250 | | $V_{DS}$ = 60V, $V_{GS}$ = 0V, $T_J$ = 150°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 | —— | | $R_G$ = 1.8Ω |
| $t_f$ | Fall Time | —— | 86 | —— | | $V_{GS}$ = 10V ④ |
| $L_D$ | Internal Drain Inductance | —— | 4.5 | —— | nH | Between lead, 6mm (0.25in.) |
| $L_S$ | Internal Source Inductance | —— | 7.5 | —— | | from package and center of die contact |
| $C_{iss}$ | 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 |
| $C_{oss}$ eff. | Effective Output Capacitance ⑤ | —— | 1420 | —— | | $V_{GS}$ = 0V, $V_{DS}$ = 0V to 60V |

## Source-Drain Ratings and Characteristics

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| $I_S$ | Continuous Source Current (Body Diode) | —— | —— | 142⑥ | A | MOSFET symbol showing the |
| $I_{SM}$ | Pulsed Source Current (Body Diode) ① | —— | —— | 570 | | integral reverse p-n junction diode. |
| $V_{SD}$ | Diode Forward Voltage | —— | —— | 1.3 | V | $T_J$ = 25°C, $I_S$ = 85A, $V_{GS}$ = 0V ④ |
| $t_{rr}$ | Reverse Recovery Time | —— | 130 | 200 | ns | $T_J$ = 25°C, $I_F$ = 85A |
| $Q_{rr}$ | Reverse RecoveryCharge | —— | 690 | 1040 | nC | di/dt = 100A/μs 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°C, L = 0.21mH $R_G$ = 25Ω, $I_{AS}$ = 85A, $V_{GS}$=10V (See Figure 12).

③ $I_{SD} \le$ 85A, di/dt ≤ 310A/μs, $V_{DD} \le V_{(BR)DSS}$, $T_J \le$ 175°C

④ Pulse width ≤ 400μs; duty cycle ≤ 2%.

⑤ $C_{oss}$ 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.

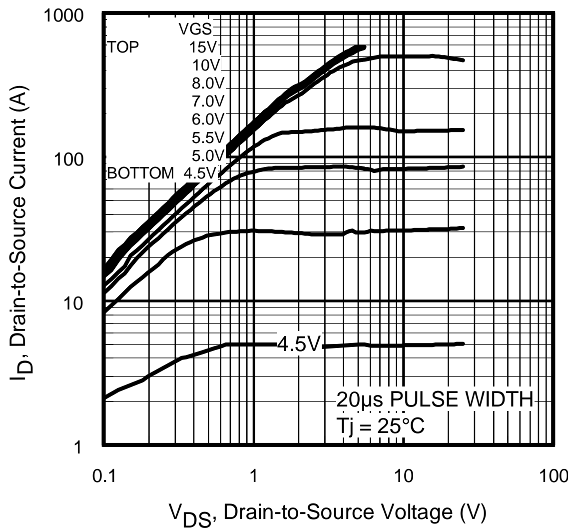



**Fig 1.** Typical Output Characteristics

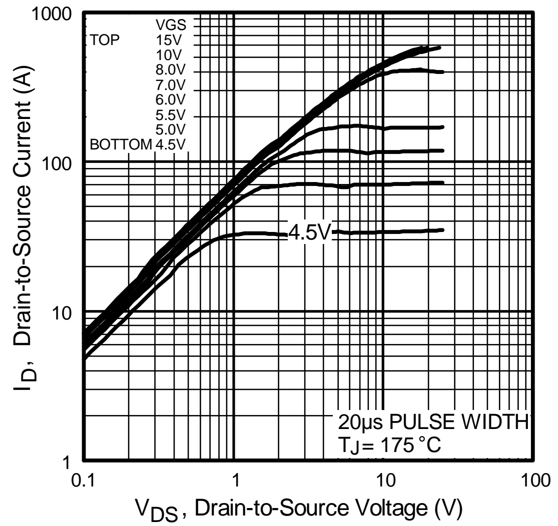



**Fig 2.** Typical Output Characteristics

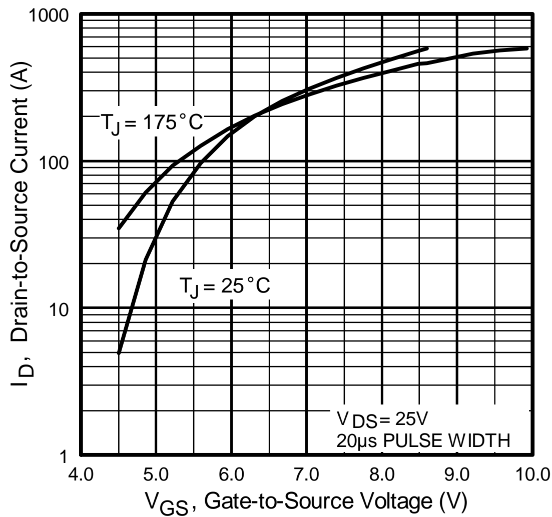



**Fig 3.** Typical Transfer Characteristics

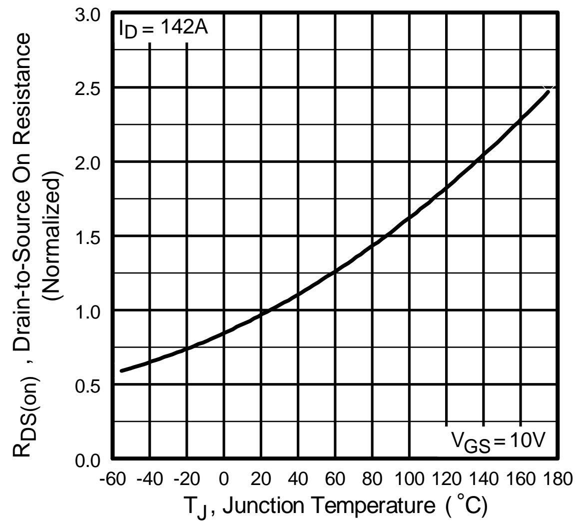



**Fig 4.** Normalized On-Resistance Vs. Temperature

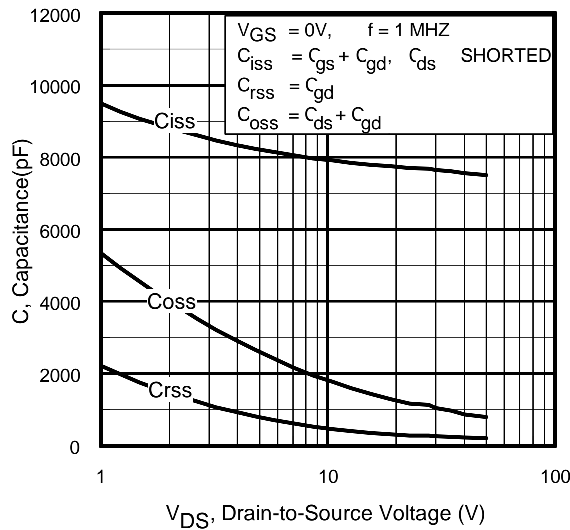



**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage

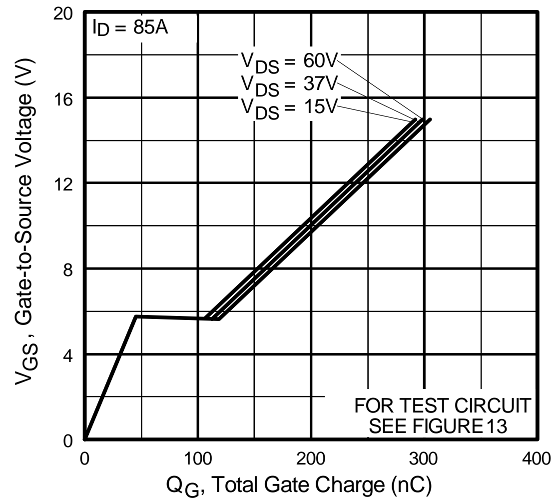



**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage

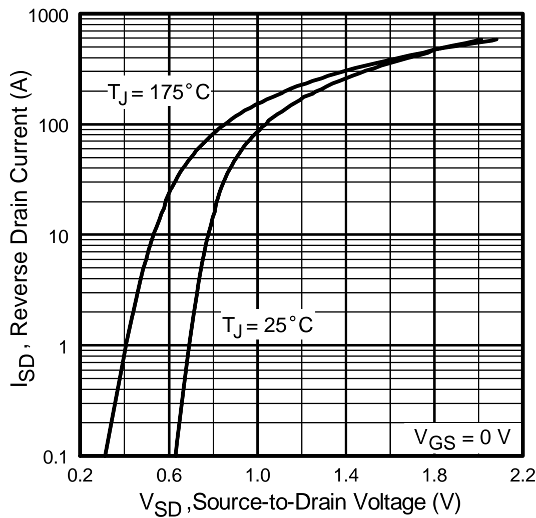



**Fig 7.** Typical Source-Drain Diode Forward Voltage

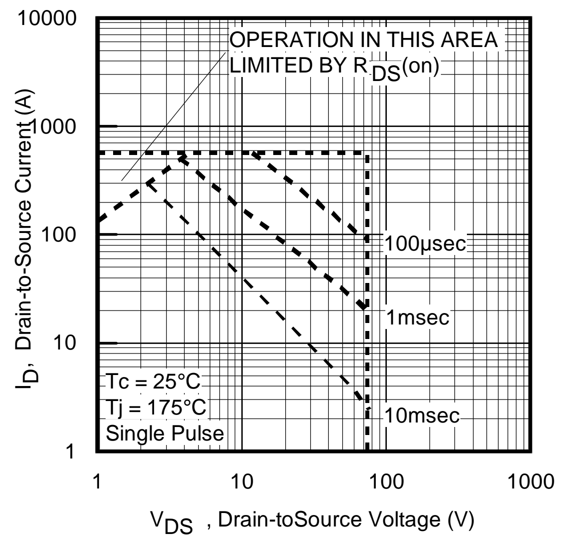



**Fig 8.** Maximum Safe Operating Area

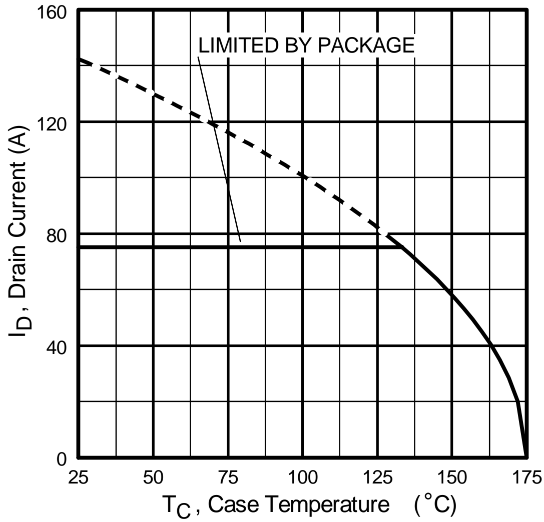



**Fig 9.** Maximum Drain Current Vs. Case Temperature

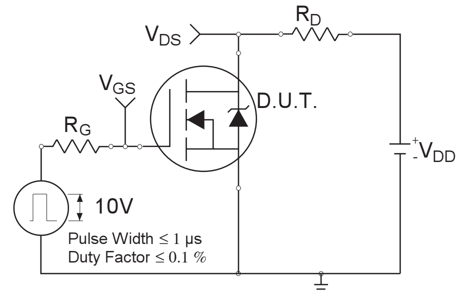



**Fig 10a.** Switching Time Test Circuit

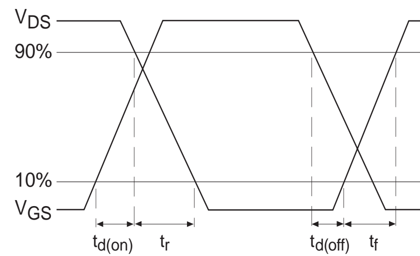



**Fig 10b.** Switching Time Waveforms

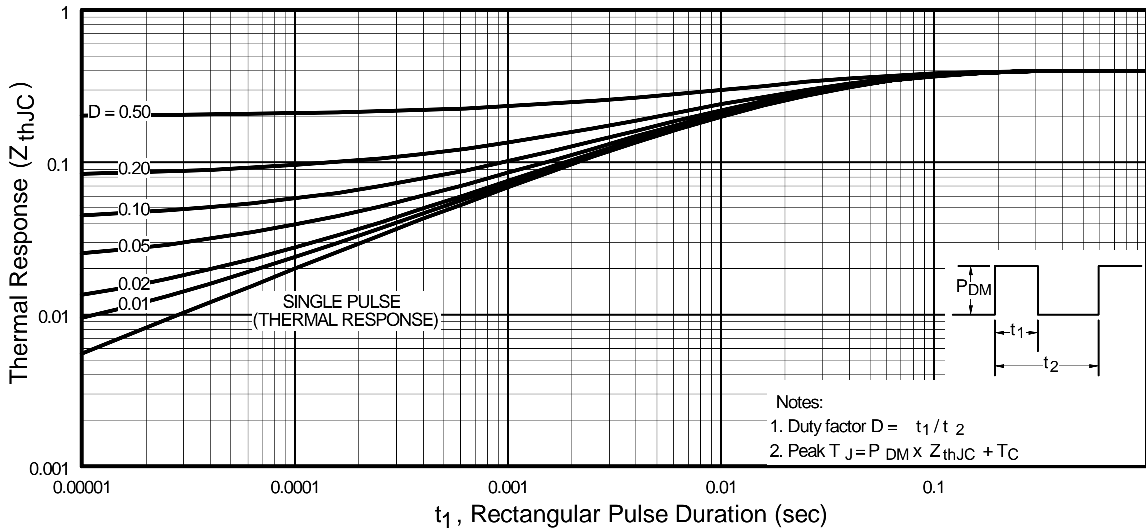



**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

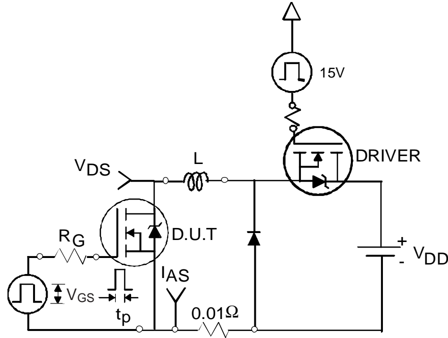



**Fig 12a.** Unclamped Inductive Test Circuit

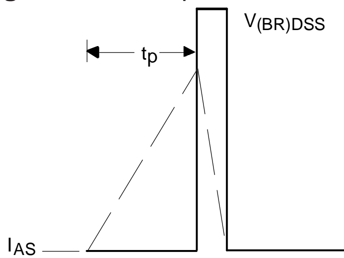



**Fig 12b.** Unclamped Inductive Waveforms

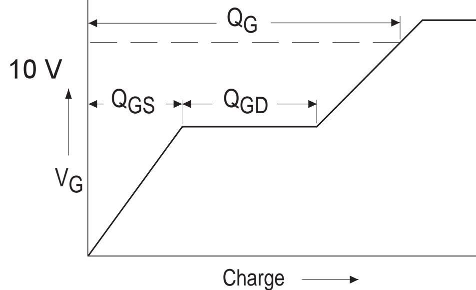



**Fig 13a.** Basic Gate Charge Waveform

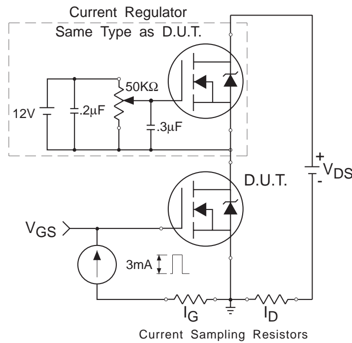



**Fig 13b.** Gate Charge Test Circuit

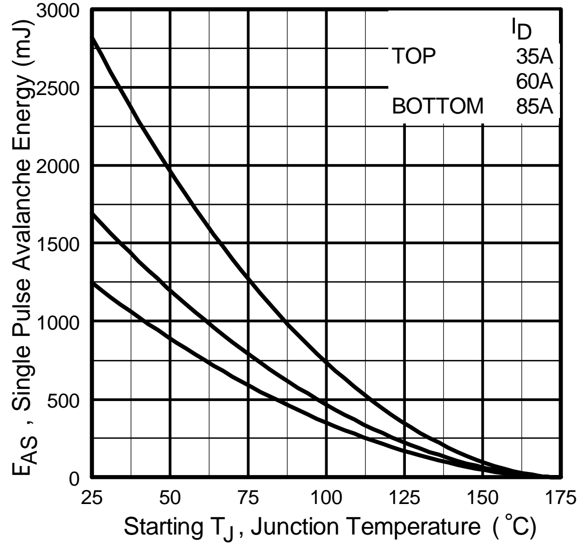



**Fig 12c.** Maximum Avalanche Energy Vs. Drain Current

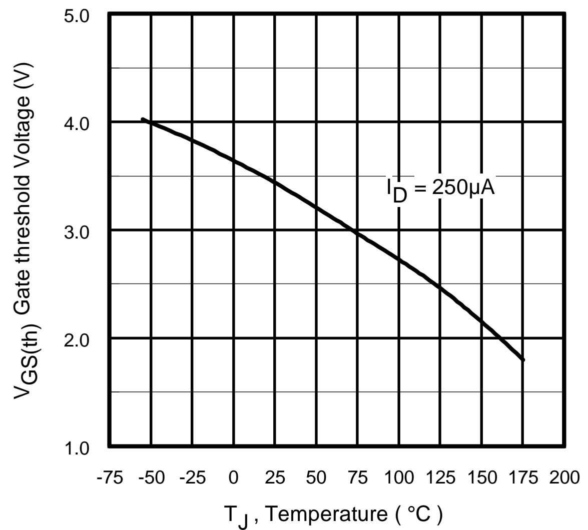



**Fig 14.** Threshold Voltage Vs. Temperature

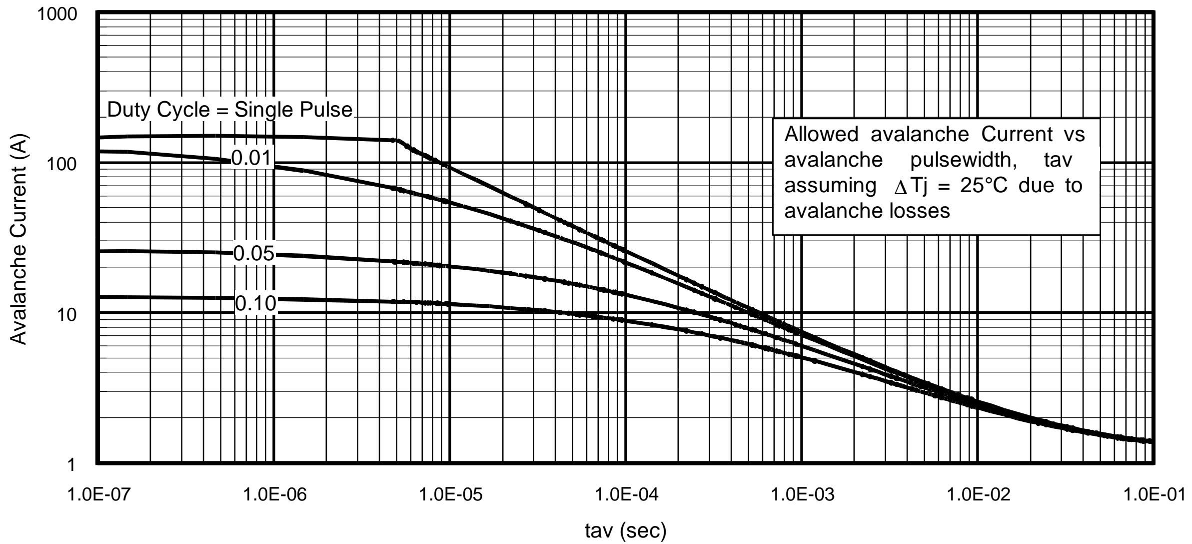



**Fig 15.** Typical Avalanche Current Vs.Pulsewidth

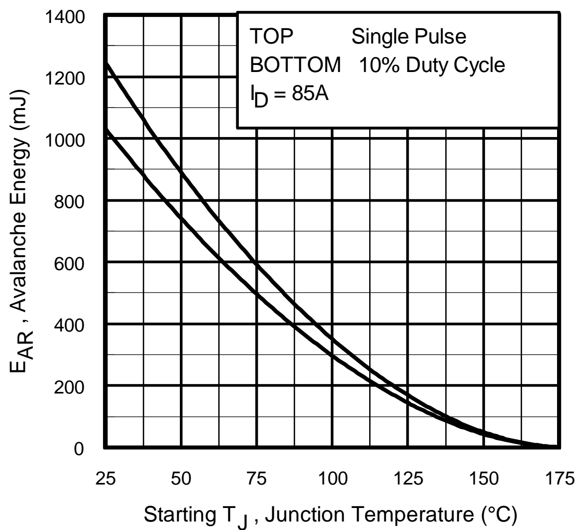


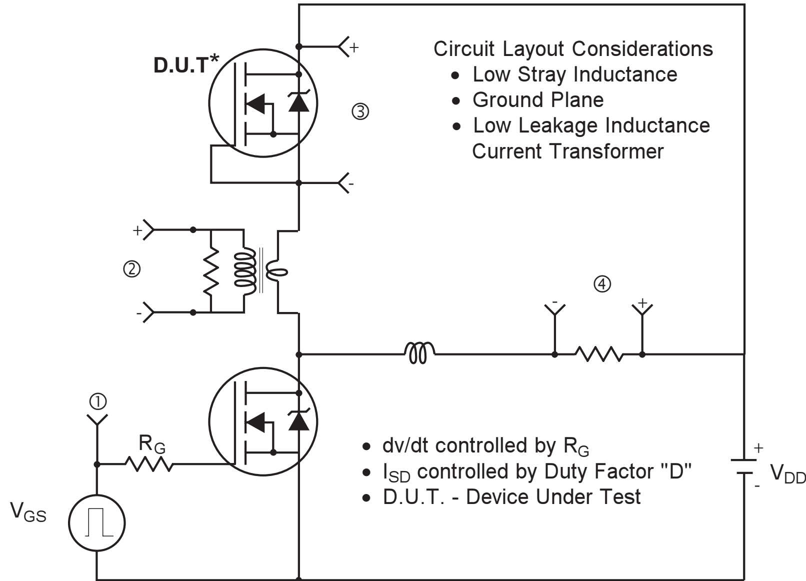

**Fig 16.** Maximum Avalanche Energy Vs. Temperature

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

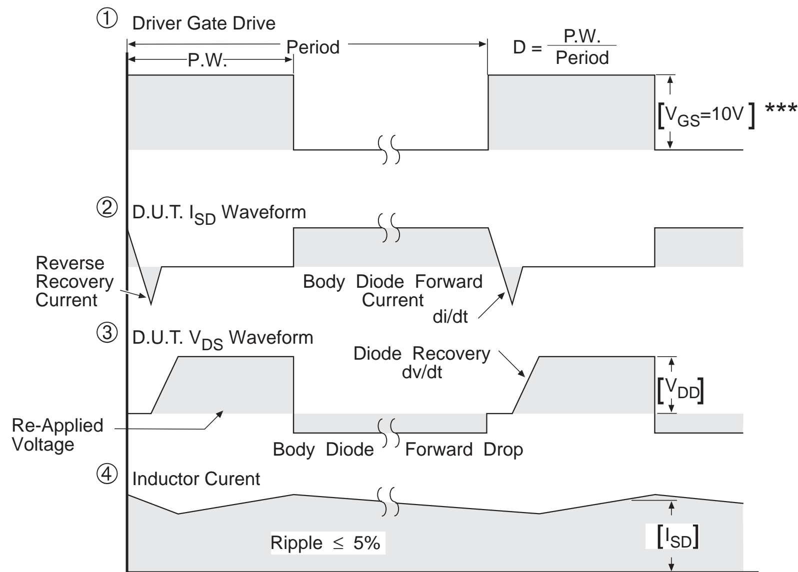
1. Avalanche failures assumption:
   Purely a thermal phenomenon and failure occurs at a temperature far in excess of $T_{jmax}$. This is validated for every part type.
2. Safe operation in Avalanche is allowed as long as$T_{jmax}$ is not exceeded.
3. Equation below based on circuit and waveforms shown 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)

$$P_{D\ (ave)} = 1/2\ (1.3 \cdot BV \cdot I_{av}) = \Delta T / Z_{thJC}$$
$$I_{av} = 2\Delta T / [1.3 \cdot BV \cdot Z_{th}]$$
$$E_{AS\ (AR)} = P_{D\ (ave)} \cdot t_{av}$$

## Peak Diode Recovery dv/dt Test Circuit




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

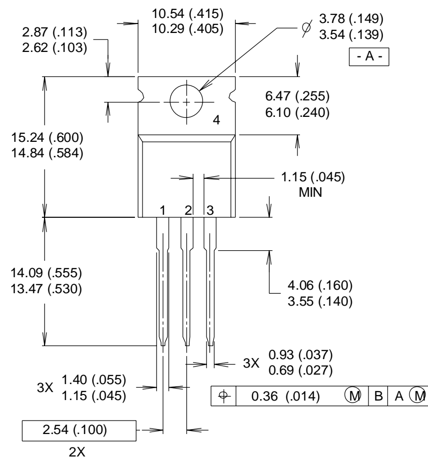


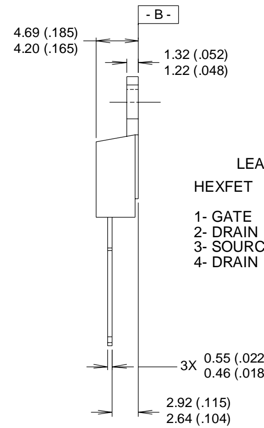

*** $V_{GS}$ = 5.0V for Logic Level and 3V Drive Devices

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

## TO-220AB Package Outline

Dimensions are shown in millimeters (inches)




LEAD ASSIGNMENTS

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

NOTES:

1 DIMENSIONING & TOLERANCING PER ANSI Y14.5M, 1982.

2 CONTROLLING DIMENSION : INCH

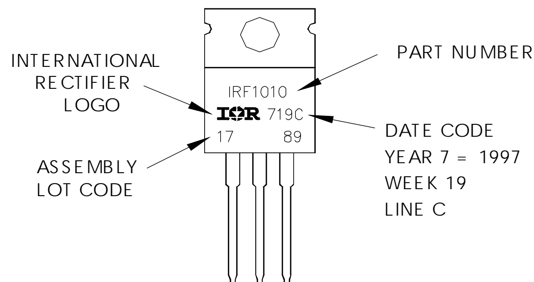
3 OUTLINE CONFORMS TO JEDEC OUTLINE TO-220AB.

4 HEATSINK & LEAD MEASUREMENTS DO NOT INCLUDE BURRS.

## 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.
This product has been designed and qualified for the Automotive [Q101] market.
Qualification Standards can be found on IR's Web site.

International
IOR Rectifier

**IR WORLD HEADQUARTERS:** 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105
TAC Fax: (310) 252-7903
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