International
IOR Rectifier

PD -94012C

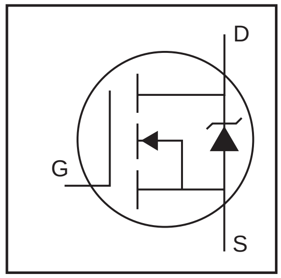
**AUTOMOTIVE MOSFET**

# IRF1704

HEXFET® Power MOSFET

### Benefits

- 200°C Operaing Temperature
- Advanced Process Technology
- Ultra Low On-Resistance
- Dynamic dv/dt Rating
- Fast Switching
- Repetitive Avalanche Allowed up to Tj Max
- Automotive Qualified (Q101)




$V_{DSS}$ = 40V

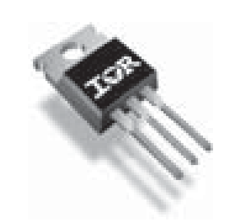
$R_{DS(on)}$ = 0.004Ω

$I_D$ = 170A⑥

### Description

Specifically designed for Automotive applications, this HEXFET® power MOSFET has a 200°C max operating temperature with a Stripe Planar design that utilizes the latest processing techniques to achieve extremely low on-resistance per silicon area. Additional features of this HEXFET® power MOSFET are fast switching speed and improved repetitive avalanche rating.

The continuing technology leadership of Internationl Rectifier provides 200°C operating temperature in a plastic package. At high ambient temperatures, the IRF1704 can carry up to 20% more current than similar 175 °C Tj max devices in the same package outline. This makes this part ideal for existing and emerging under-the-hood automotive applications such as Electric Power Steering (EPS), Fuel / Water Pump Control and 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 | 170⑥ | |
| $I_D$ @ $T_C$ = 100°C | Continuous Drain Current, $V_{GS}$ @ 10V | 120 | A |
| $I_{DM}$ | Pulsed Drain Current ① | 680 | |
| $P_D$ @$T_C$ = 25°C | Power Dissipation | 230 | W |
| | Linear Derating Factor | 1.3 | W/°C |
| $V_{GS}$ | Gate-to-Source Voltage | ± 20 | V |
| $E_{AS}$ | Single Pulse Avalanche Energy② | 670 | mJ |
| $I_{AR}$ | Avalanche Current① | 100 | A |
| $E_{AR}$ | Repetitive Avalanche Energy① | 23 | mJ |
| dv/dt | Peak Diode Recovery dv/dt ③ | 1.9 | V/ns |
| $T_J$<br>$T_{STG}$ | Operating Junction and<br>Storage Temperature Range | -55 to + 200 | °C |
| $T_{LEAD}$ | Lead Temperature⑦ | 175 | |
| | Soldering Temperature, for 10 seconds | 300 (1.6mm from case ) | °C |
| | Mounting torque, 6-32 or M3 srew | 10 lbf•in (1.1N•m) | |

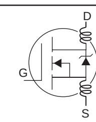
### Thermal Resistance

| | Parameter | Typ. | Max. | Units |
|---|---|---|---|---|
| $R_{\theta JC}$ | Junction-to-Case | —— | 0.75 | |
| $R_{\theta CS}$ | Case-to-Sink, Flat, Greased Surface | 0.50 | —— | °C/W |
| $R_{\theta JA}$ | Junction-to-Ambient | —— | 62 | |

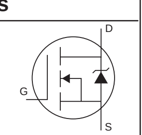



05/08/02

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

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-to-Source Breakdown Voltage | 40 | — | — | V | $V_{GS}$ = 0V, $I_D$ = 250µA |
| $\Delta V_{(BR)DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient | — | 0.036 | — | V/°C | Reference to 25°C, $I_D$ = 1mA |
| $R_{DS(on)}$ | Static Drain-to-Source On-Resistance | — | — | 0.004 | Ω | $V_{GS}$ = 10V, $I_D$ = 100A ④ |
| $V_{GS(th)}$ | Gate Threshold Voltage | 2.0 | — | 4.0 | V | $V_{DS} = V_{GS}$, $I_D$ = 250µA |
| | | 1.0 | — | — | | $V_{DS} = V_{GS}$, $I_D$ = 5.0mA, $T_J$ = 200°C |
| $g_{fs}$ | Forward Transconductance | 110 | — | — | S | $V_{DS}$ = 25V, $I_D$ = 100A |
| $I_{DSS}$ | Drain-to-Source Leakage Current | — | — | 20 | µA | $V_{DS}$ = 40V, $V_{GS}$ = 0V |
| | | — | — | 250 | | $V_{DS}$ = 32V, $V_{GS}$ = 0V, $T_J$ = 175°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 | — | 170 | 260 | nC | $I_D$ = 100A |
| $Q_{gs}$ | Gate-to-Source Charge | — | 42 | 63 | | $V_{DS}$ = 32V |
| $Q_{gd}$ | Gate-to-Drain ("Miller") Charge | — | 39 | 59 | | $V_{GS}$ = 10V, See Fig. 6 and 13 ④ |
| $t_{d(on)}$ | Turn-On Delay Time | — | 16 | — | ns | $V_{DD}$ = 20V |
| $t_r$ | Rise Time | — | 120 | — | | $I_D$ = 100A |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 73 | — | | $R_G$ = 2.5Ω |
| $t_f$ | Fall Time | — | 37 | — | | $V_{GS}$ = 10V,See Fig. 10 ④ |
| $L_D$ | Internal Drain Inductance | — | 4.5 | — | nH | Between lead, 6mm (0.25in.) from package and center of die contact  |
| $L_S$ | Internal Source Inductance | — | 7.5 | — | | |
| $C_{iss}$ | Input Capacitance | — | 6950 | — | pF | $V_{GS}$ = 0V |
| $C_{oss}$ | Output Capacitance | — | 1660 | — | | $V_{DS}$ = 25V |
| $C_{rss}$ | Reverse Transfer Capacitance | — | 200 | — | | $f$ = 1.0MHz, See Fig. 5 |
| $C_{oss}$ | Output Capacitance | — | 6250 | — | | $V_{GS}$ = 0V, $V_{DS}$ = 1.0V, $f$ = 1.0MHz |
| $C_{oss}$ | Output Capacitance | — | 1470 | — | | $V_{GS}$ = 0V, $V_{DS}$ = 32V, $f$ = 1.0MHz |
| $C_{oss}$ eff. | Effective Output Capacitance ⑤ | — | 2320 | — | | $V_{GS}$ = 0V, $V_{DS}$ = 0V to 32V |

## Source-Drain Ratings and Characteristics

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| $I_S$ | Continuous Source Current (Body Diode) | — | — | 170⑥ | A | MOSFET symbol showing the integral reverse p-n junction diode.  |
| $I_{SM}$ | Pulsed Source Current (Body Diode) ① | — | — | 680 | | |
| $V_{SD}$ | Diode Forward Voltage | — | — | 1.3 | V | $T_J$ = 25°C, $I_S$ = 100A, $V_{GS}$ = 0V ④ |
| $t_{rr}$ | Reverse Recovery Time | — | 73 | 110 | ns | $T_J$ = 25°C, $I_F$ = 100A |
| $Q_{rr}$ | Reverse RecoveryCharge | — | 200 | 300 | 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 = 0.13mH, $V_{GS}$ = 10V $R_G$ = 25Ω, $I_{AS}$ = 100A. (See Figure 12)

③ $I_{SD} \le$ 100A, di/dt ≤ 150A/µs, $V_{DD} \le V_{(BR)DSS}$, $T_J \le$ 200°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 At the point of termination of the leads at the PCB, the temp. should be limited to 175°C. The device case temperature is allowed to be higher

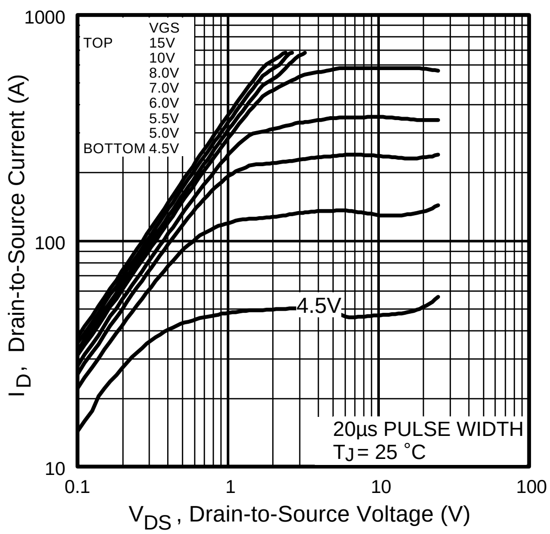



**Fig 1.** Typical Output Characteristics

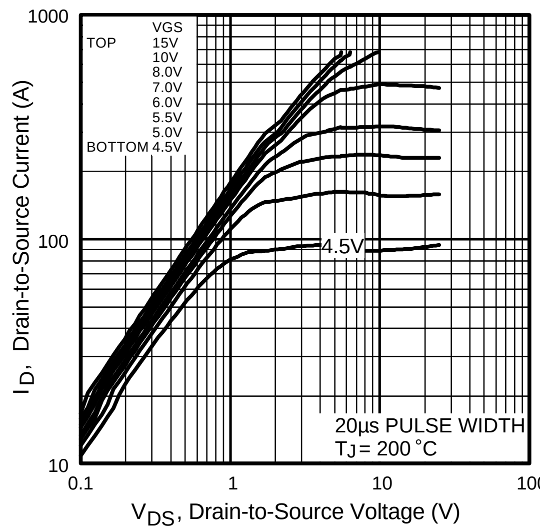



**Fig 2.** Typical Output Characteristics

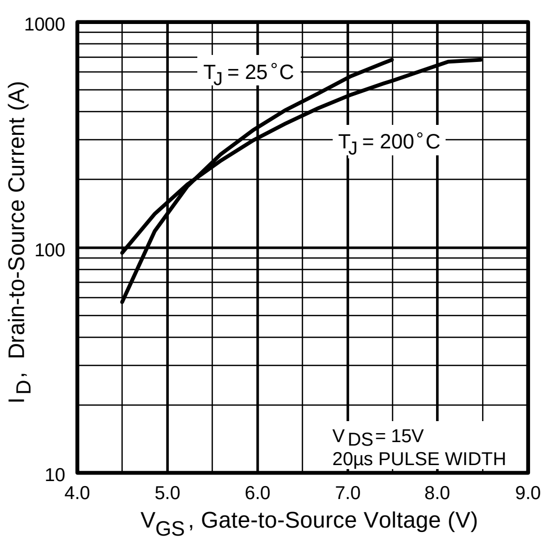



**Fig 3.** Typical Transfer Characteristics

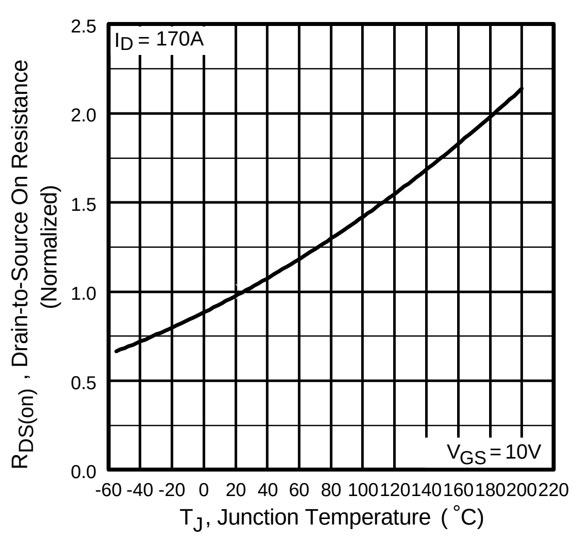



**Fig 4.** Normalized On-Resistance
Vs. Temperature

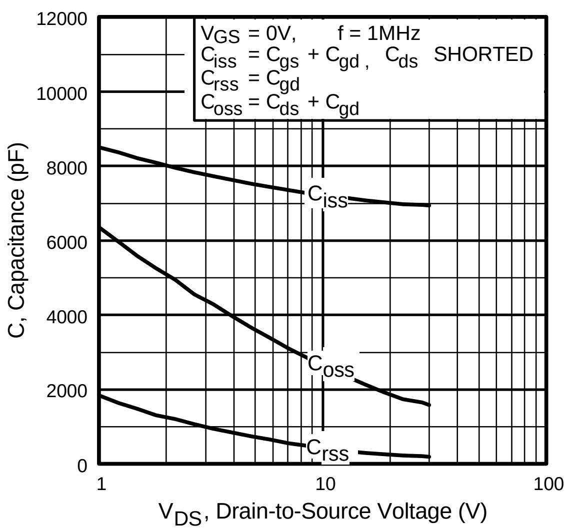



**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage

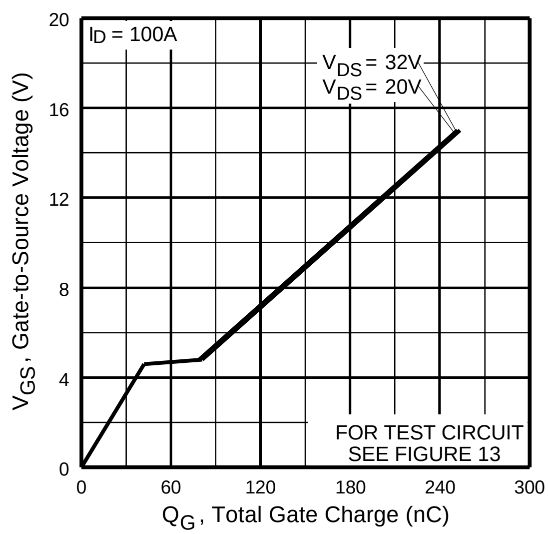



**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage

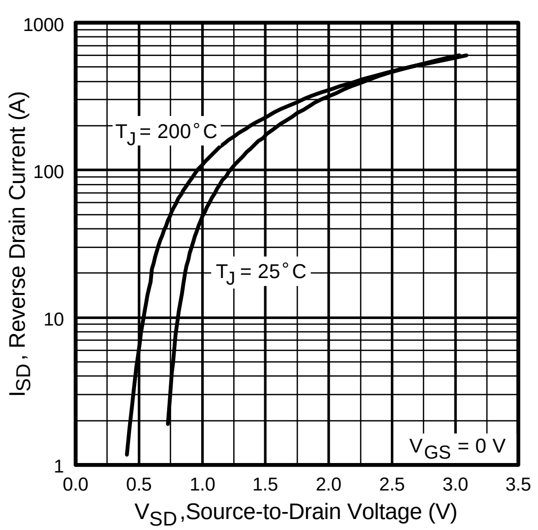



**Fig 7.** Typical Source-Drain Diode Forward Voltage

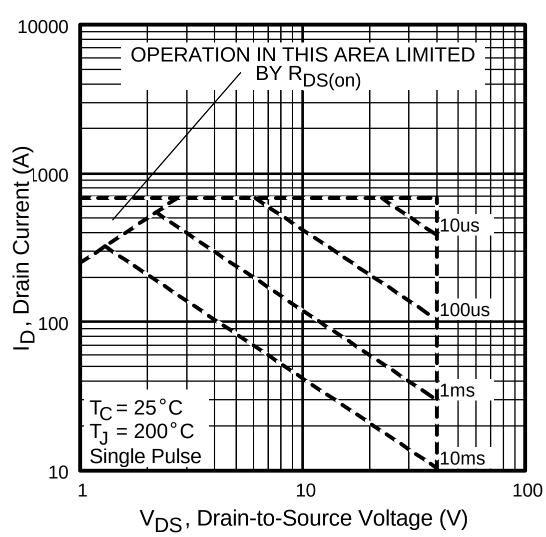



**Fig 8.** Maximum Safe Operating Area

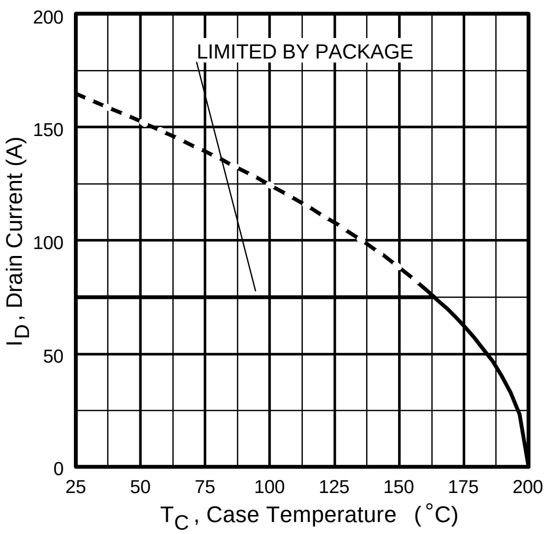
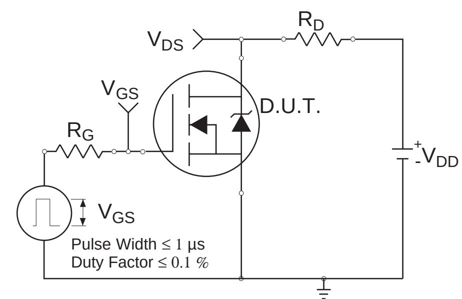
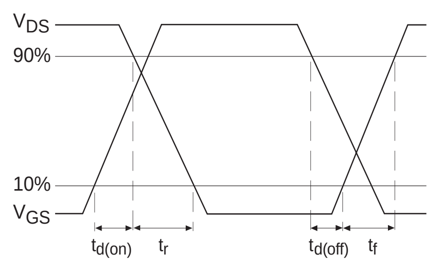



**Fig 9.** Maximum Drain Current Vs. Case Temperature



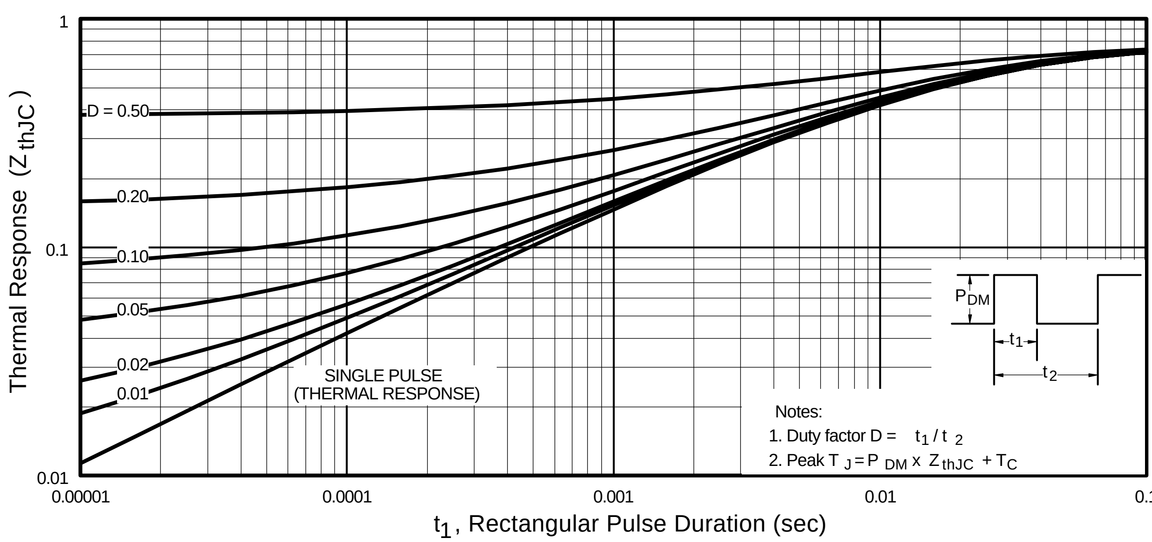




**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

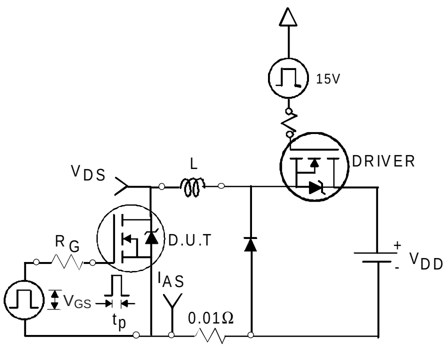



**Fig 12a.** Unclamped Inductive Test Circuit

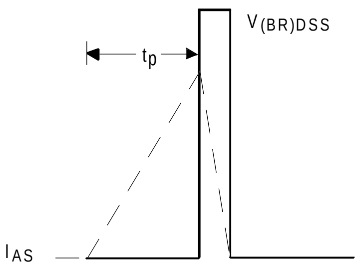



**Fig 12b.** Unclamped Inductive Waveforms

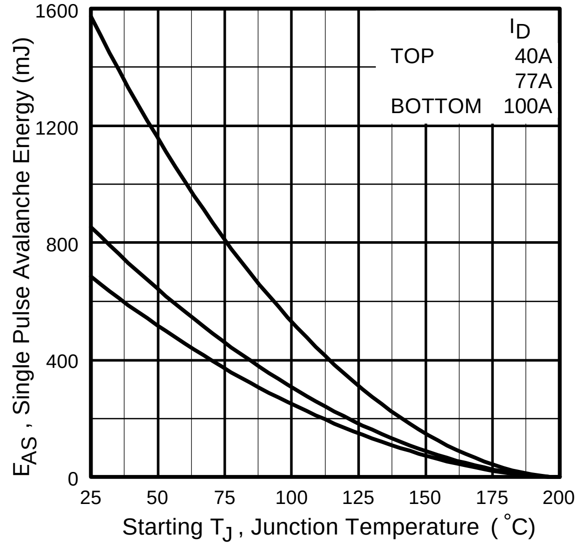



**Fig 12c.** Maximum Avalanche Energy
Vs. Drain Current

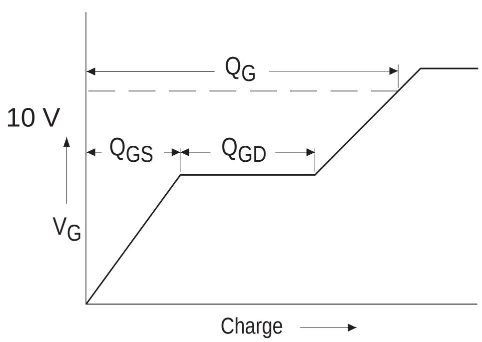



**Fig 13a.** Basic Gate Charge Waveform

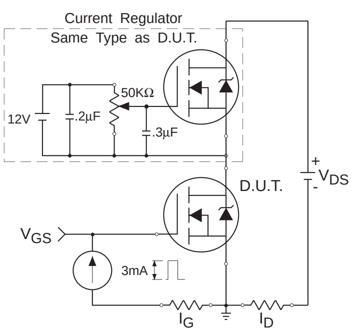



**Fig 13b.** Gate Charge Test Circuit

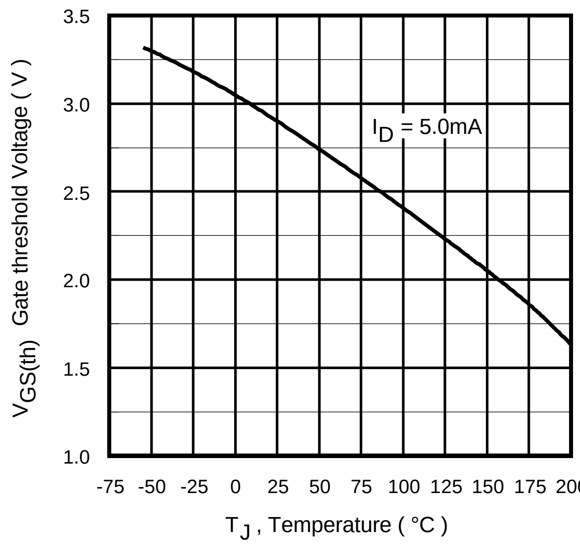
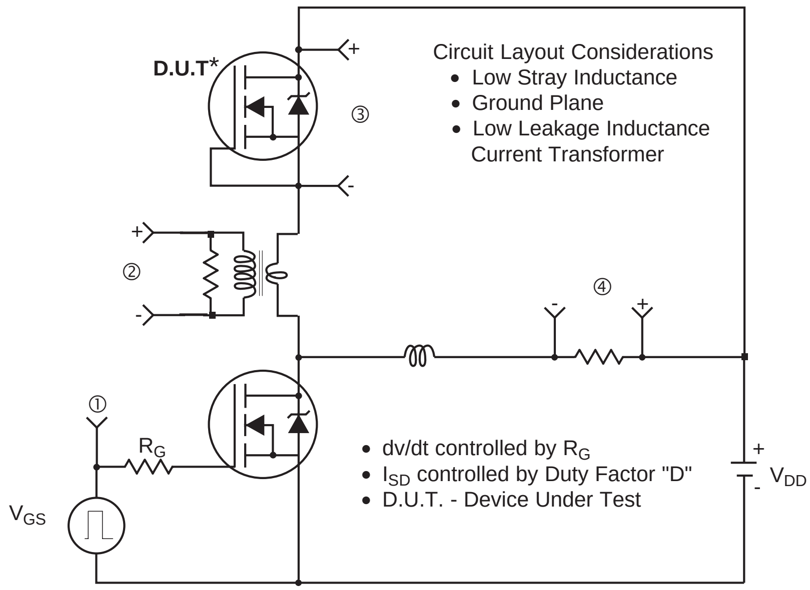
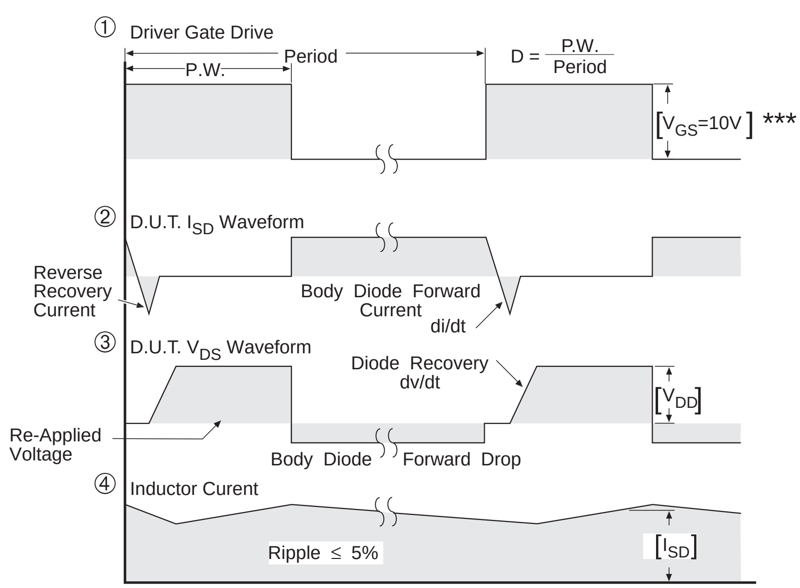



**Fig 14.** Threshold Voltage Vs Temperature

## Peak Diode Recovery dv/dt Test Circuit




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



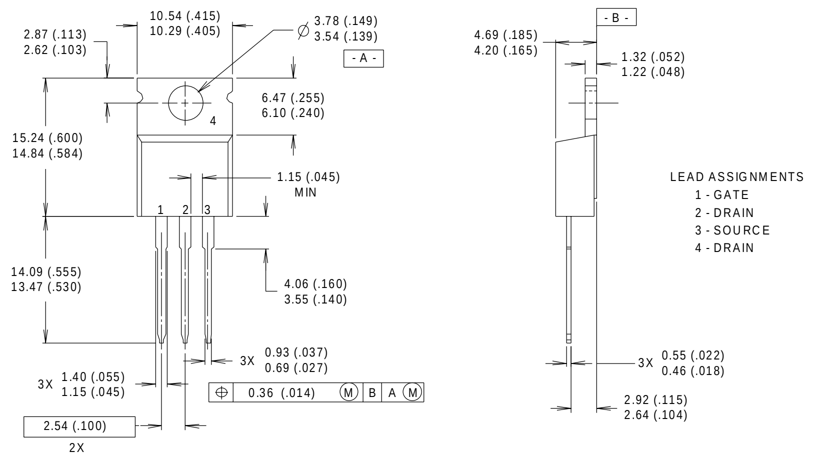

*** $V_{GS}$ = 5.0V for Logic Level and 3V Drive Devices

**Fig 14.** For N-channel HEXFET® power MOSFETs

## Package Outline

**TO-220AB**

Dimensions are shown in millimeters (inches)




NOTES:

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

2 CONTROLLING DIMENSION : INCH

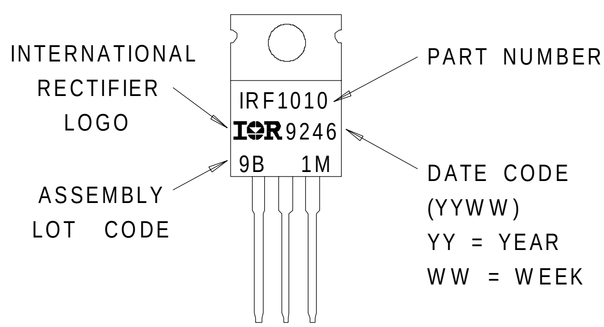
3 OUTLINE CONFORMS TO JEDEC OUTLINE TO-220AB.

4 HEATSINK & LEAD MEASUREMENTS DO NOT INCLUDE BURRS.

## Part Marking Information

**TO-220AB**

EXAMPLE : THIS IS AN IRF1010
WITH ASSEMBLY
LOT CODE 9B1M




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.

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**IR WORLD HEADQUARTERS:** 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105
TAC Fax: (310) 252-7903
Visit us at www.irf.com for sales contact information. 05/02

Note: For the most current drawings please refer to the IR website at:
http://www.irf.com/package/