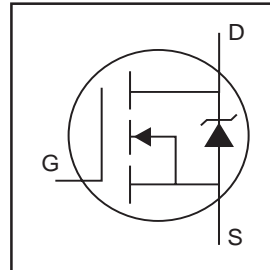


IRL1404PbF

HEXFET® Power MOSFET

- Advanced Process Technology
- Ultra Low On-Resistance
- Dynamic dv/dt Rating
- 175°C Operating Temperature
- Fast Switching
- Fully Avalanche Rated
- Lead-Free

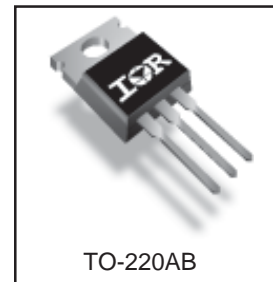


| |
|-----------------------------|
| $V_{DSS} = 40V$ |
| $R_{DS(on)} = 4.0m\Omega$ |
| $I_D = 160A\textcircled{C}$ |

Description

Seventh Generation HEXFET® power MOSFETs from International Rectifier utilize advanced processing techniques to achieve extremely low on-resistance per silicon area. This benefit, combined with the fast switching speed and ruggedized device design that HEXFET power MOSFETs are well known for, provides the designer with an extremely efficient and reliable device for use in a wide variety of applications.

The TO-220 package is universally preferred for all commercial-industrial applications at power dissipation levels to approximately 50 watts. The low thermal resistance and low package cost of the TO-220 contribute to its wide acceptance throughout the industry.



Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---------------------------|--|-----------------------|-------|
| $I_D @ T_C = 25^\circ C$ | Continuous Drain Current, $V_{GS} @ 10V$ | 160 \textcircled{C} | A |
| $I_D @ T_C = 100^\circ C$ | Continuous Drain Current, $V_{GS} @ 10V$ | 110 \textcircled{C} | |
| I_{DM} | Pulsed Drain Current $\textcircled{1}$ | 640 | |
| $P_D @ T_C = 25^\circ C$ | Power Dissipation | 200 | W |
| | Linear Derating Factor | 1.3 | W/°C |
| V_{GS} | Gate-to-Source Voltage | ± 20 | V |
| E_{AS} | Single Pulse Avalanche Energy $\textcircled{2}$ | 620 | mJ |
| I_{AR} | Avalanche Current $\textcircled{1}$ | 95 | A |
| E_{AR} | Repetitive Avalanche Energy $\textcircled{1}$ | 20 | mJ |
| dv/dt | Peak Diode Recovery dv/dt $\textcircled{3}$ | 5.0 | V/ns |
| T_J | Operating Junction and Storage Temperature Range | -55 to + 175 | °C |
| T_{STG} | | | |
| | | | |
| | Mounting torque, 6-32 or M3 screw | 10 lbf•in (1.1N•m) | |

Thermal Resistance

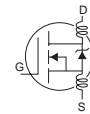
| | Parameter | Typ. | Max. | Units |
|-----------------|---|------|------|-------|
| $R_{\theta JC}$ | Junction-to-Case | — | 0.75 | °C/W |
| $R_{\theta CS}$ | Case-to-Sink, Flat, Greased Surface | 0.50 | — | |
| $R_{\theta JA}$ | Junction-to-Ambient (PCB Mounted) $\textcircled{4}$ | — | 62 | |

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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 | 40 | — | — | V | $V_{GS} = 0V, I_D = 250\mu A$ |
| $\Delta V_{(BR)DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient | — | 0.038 | — | V/°C | Reference to $25^\circ\text{C}, I_D = 1mA$ |
| $R_{DS(on)}$ | Static Drain-to-Source On-Resistance | — | — | 4.0 5.9 | mΩ | $V_{GS} = 10V, I_D = 95A$ ④ $V_{GS} = 4.3V, I_D = 40A$ ④ |
| $V_{GS(th)}$ | Gate Threshold Voltage | 1.0 | — | 3.0 | V | $V_{DS} = V_{GS}, I_D = 250\mu A$ |
| g_{fs} | Forward Transconductance | 93 | — | — | S | $V_{DS} = 25V, I_D = 95A$ |
| I_{DSS} | Drain-to-Source Leakage Current | — | — | 20 250 | μA | $V_{DS} = 40V, V_{GS} = 0V$ $V_{DS} = 32V, V_{GS} = 0V, T_J = 150^\circ\text{C}$ |
| I_{GSS} | Gate-to-Source Forward Leakage Gate-to-Source Reverse Leakage | — | — | 200 -200 | nA | $V_{GS} = 20V$ $V_{GS} = -20V$ |
| Q_g | Total Gate Charge | — | — | 140 | nC | $I_D = 95A$ |
| Q_{gs} | Gate-to-Source Charge | — | — | 48 | nC | $V_{DS} = 32V$ |
| Q_{gd} | Gate-to-Drain ("Miller") Charge | — | — | 60 | | $V_{GS} = 5.0V$, See Fig. 6 ④ |
| $t_{d(on)}$ | Turn-On Delay Time | — | 18 | — | ns | $V_{DD} = 20V$ |
| t_r | Rise Time | — | 270 | — | | $I_D = 95A$ |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 38 | — | | $R_G = 2.5\Omega, V_{GS} = 4.5V$ |
| t_f | Fall Time | — | 37 | — | | $R_D = 0.25\Omega$ 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 | — | 6590 | — | pF | $V_{GS} = 0V$ |
| C_{oss} | Output Capacitance | — | 1710 | — | | $V_{DS} = 25V$ |
| C_{rss} | Reverse Transfer Capacitance | — | 350 | — | | $f = 1.0MHz$, See Fig. 5 |
| C_{oss} | Output Capacitance | — | 6650 | — | | $V_{GS} = 0V, V_{DS} = 1.0V, f = 1.0MHz$ |
| C_{oss} | Output Capacitance | — | 1510 | — | | $V_{GS} = 0V, V_{DS} = 32V, f = 1.0MHz$ |
| $C_{oss\ eff.}$ | Effective Output Capacitance ⑤ | — | 1480 | — | | $V_{GS} = 0V, V_{DS} = 0V$ to $32V$ |



Source-Drain Ratings and Characteristics

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|----------|---|---|------|------|-------|---|
| I_S | Continuous Source Current (Body Diode) | — | — | 160 | A | MOSFET symbol showing the integral reverse p-n junction diode. |
| I_{SM} | Pulsed Source Current (Body Diode) ① | — | — | 640 | | |
| V_{SD} | Diode Forward Voltage | — | — | 1.3 | V | $T_J = 25^\circ\text{C}, I_S = 95A, V_{GS} = 0V$ ④ |
| t_{rr} | Reverse Recovery Time | — | 63 | 94 | ns | $T_J = 25^\circ\text{C}, I_F = 95A$ |
| Q_{rr} | Reverse Recovery Charge | — | 170 | 250 | 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 $T_J = 25^\circ\text{C}, L = 0.35mH$
 $R_G = 25\Omega, I_{AS} = 95A$. (See Figure 12).
- ③ $I_{SD} \leq 95A, di/dt \leq 160A/\mu s, V_{DD} \leq V_{(BR)DSS}, T_J \leq 175^\circ\text{C}$.
- ④ Pulse width $\leq 300\mu s$; duty cycle $\leq 2\%$.

- 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; for recommended current-handing of the package refer to Design Tip # 93-4.
- ⑦ Calculated continuous current based on maximum allowable junction temperature. Package limitation current is 75A.

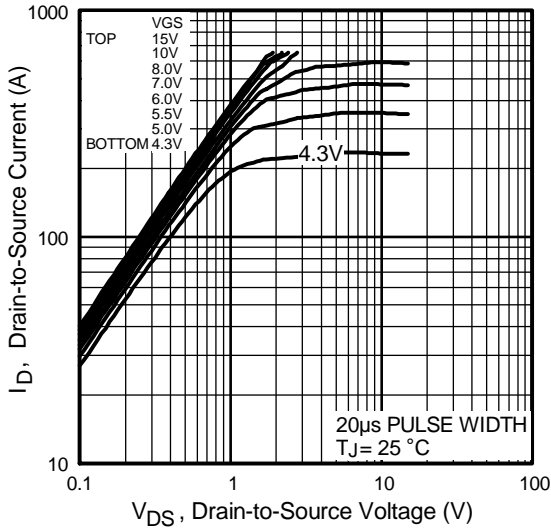


Fig 1. Typical Output Characteristics

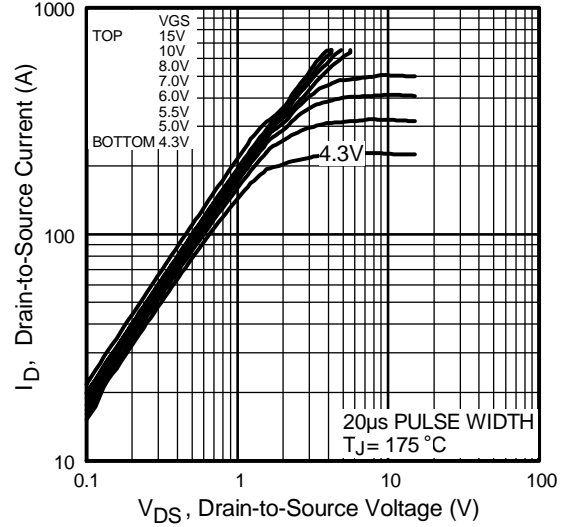


Fig 2. Typical Output Characteristics

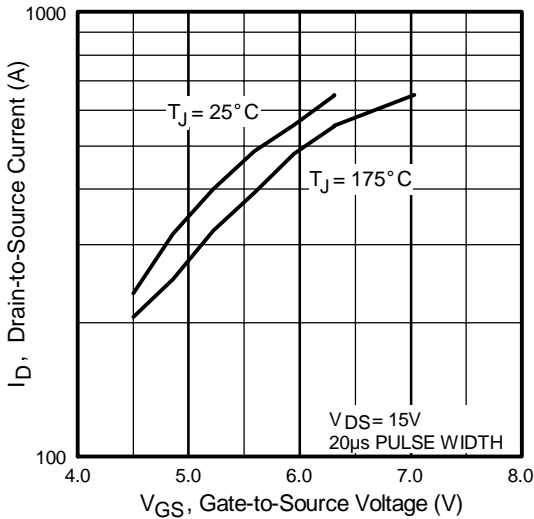


Fig 3. Typical Transfer Characteristics

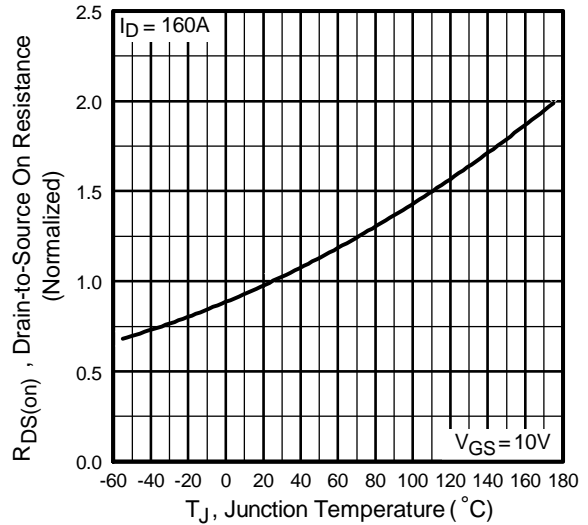


Fig 4. Normalized On-Resistance Vs. Temperature

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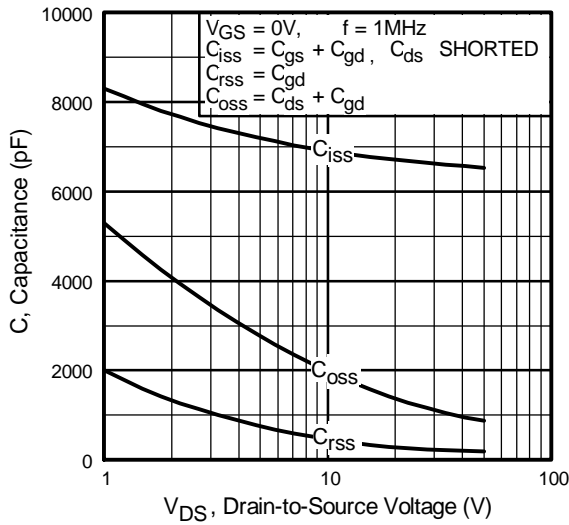


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

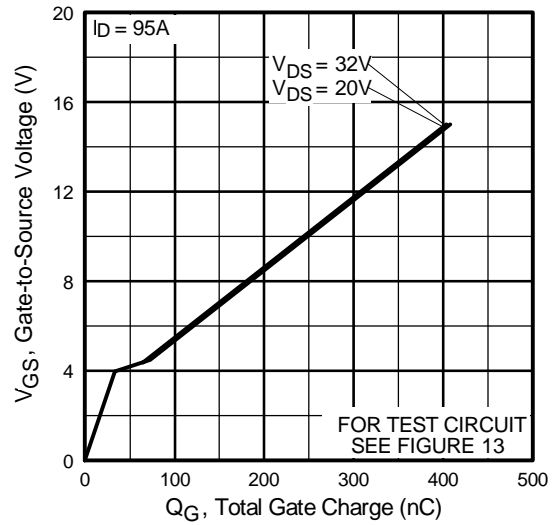


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

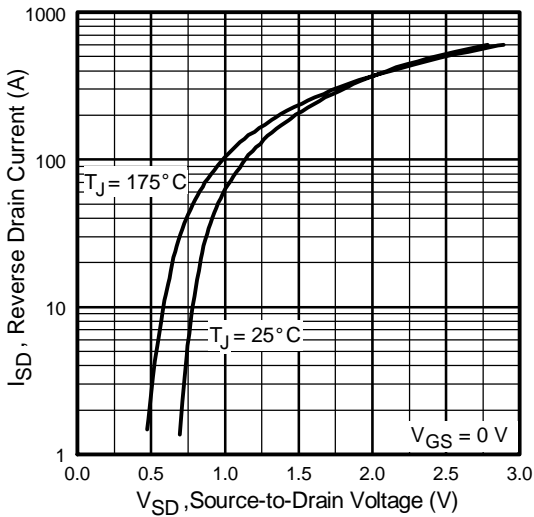


Fig 7. Typical Source-Drain Diode Forward Voltage

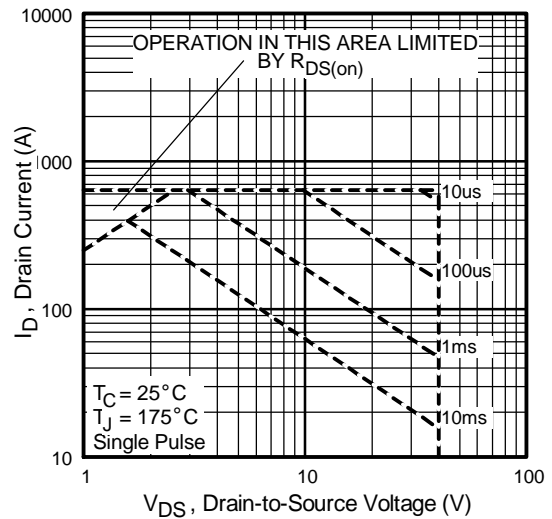


Fig 8. Maximum Safe Operating Area

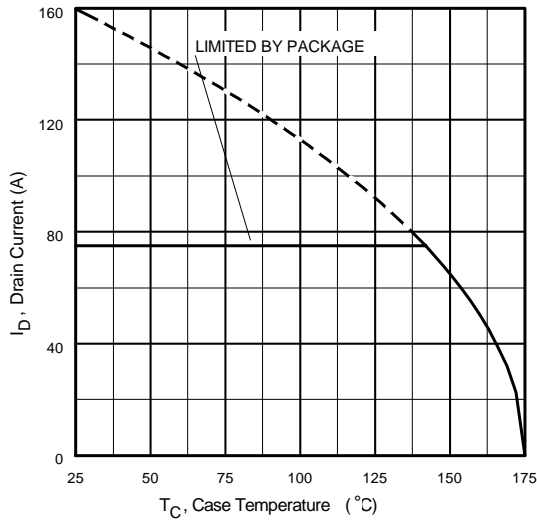


Fig 9. Maximum Drain Current Vs. Case Temperature

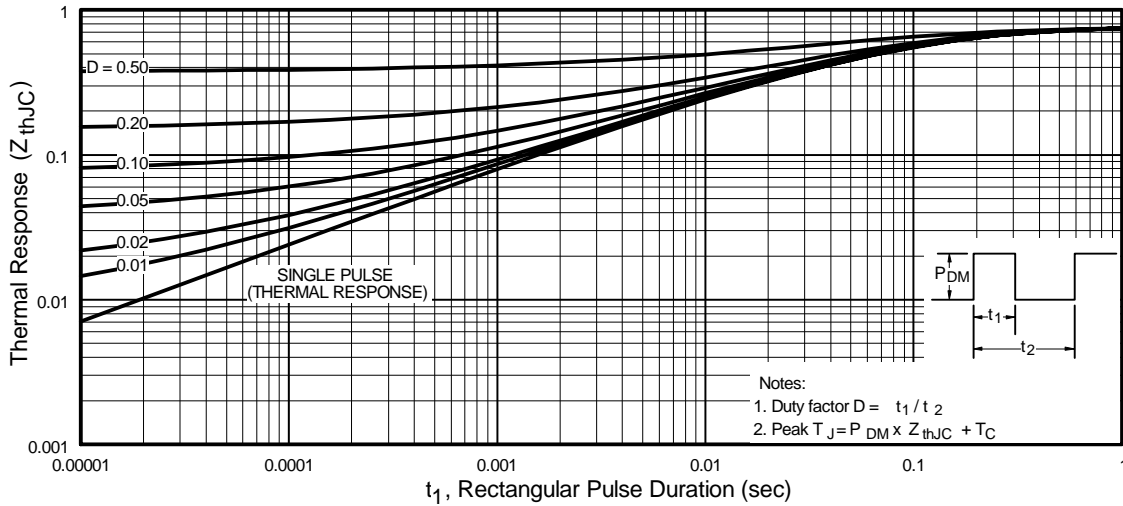
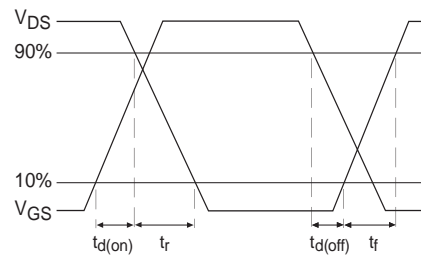
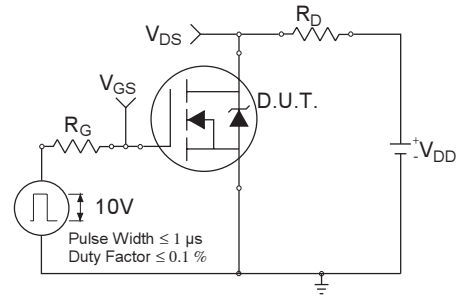


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

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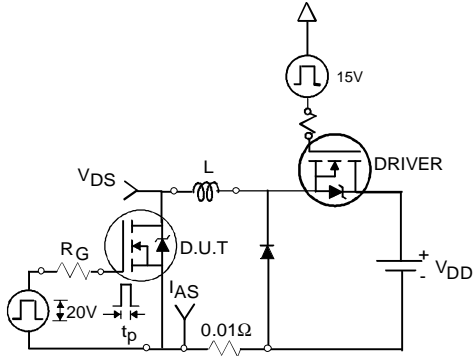


Fig 12a. Unclamped Inductive Test Circuit

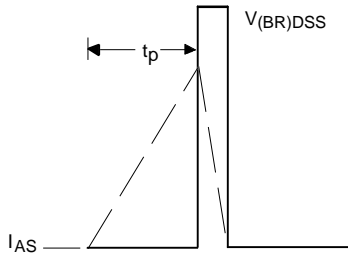


Fig 12b. Unclamped Inductive Waveforms

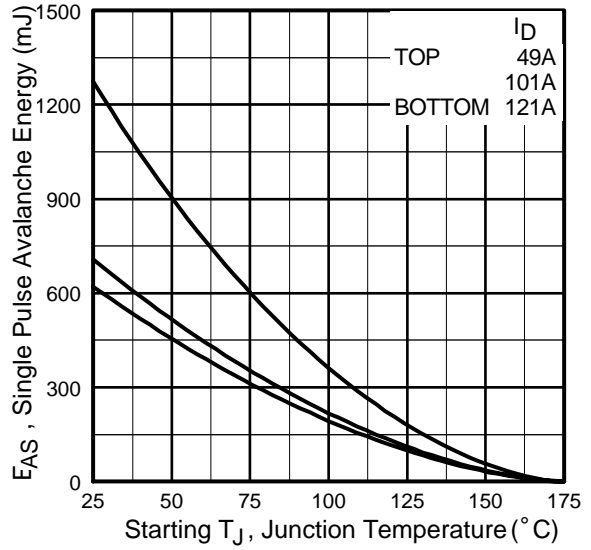


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

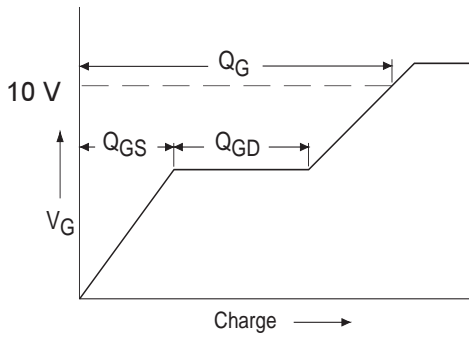


Fig 13a. Basic Gate Charge Waveform

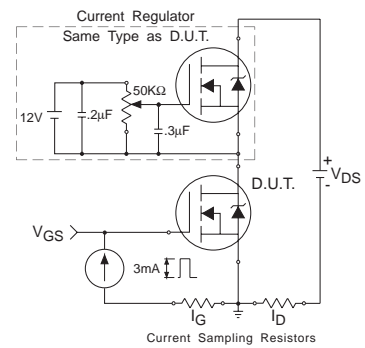
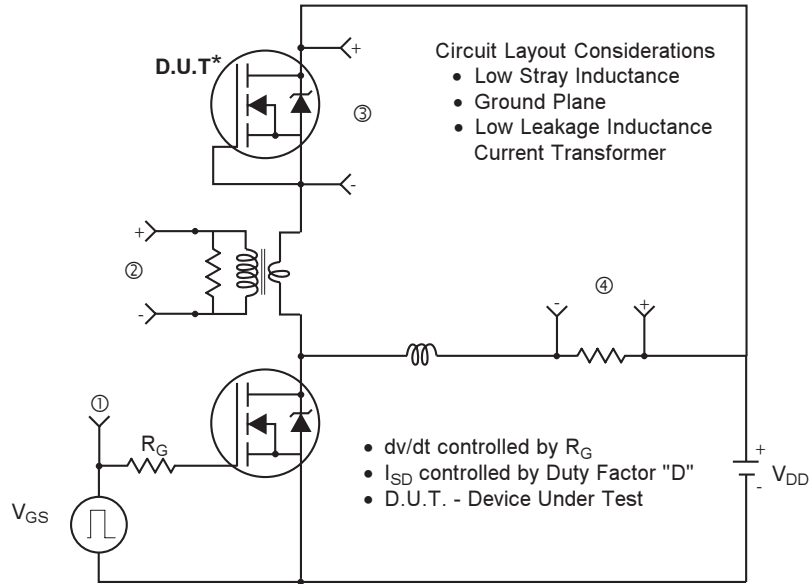
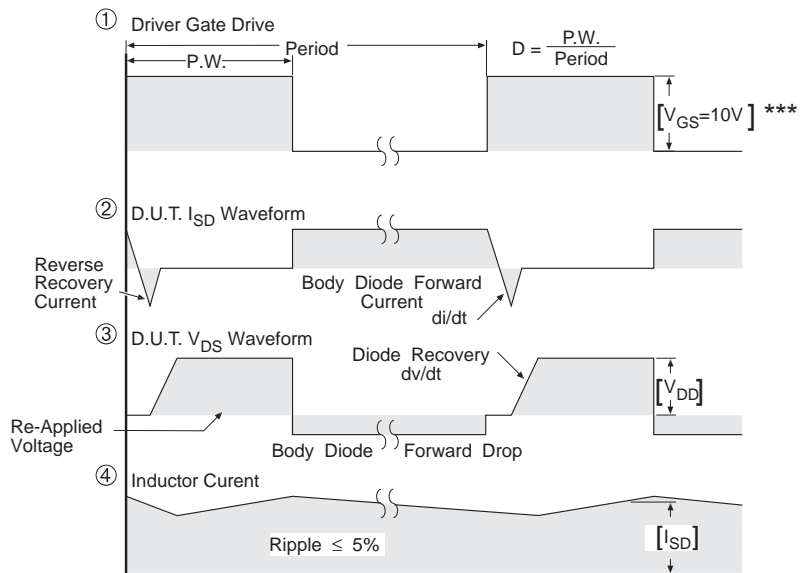


Fig 13b. Gate Charge Test Circuit

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

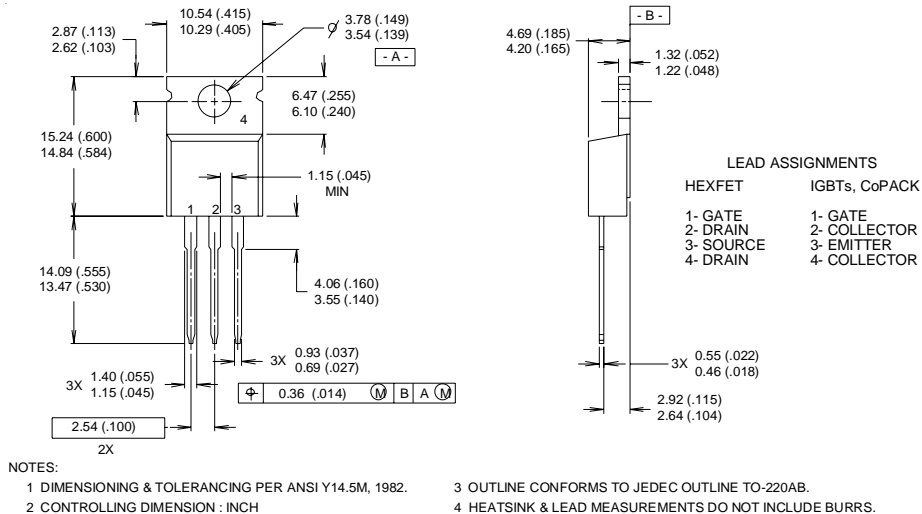
Fig 14. For N-channel HEXFET[®] power MOSFETs

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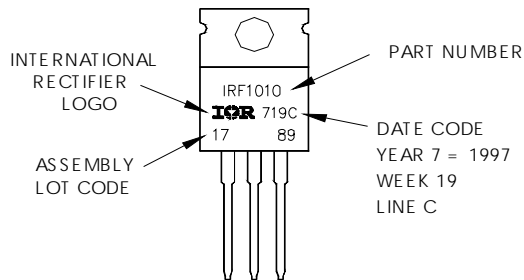
TO-220AB Package Outline

Dimensions are shown in millimeters (inches)



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.

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 TAC Fax: (310) 252-7903

Visit us at www.irf.com for sales contact information.07/04

www.irf.com

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