

AUTOMOTIVE MOSFET

IRF2204

Typical Applications

- Electric Power Steering
- 14 Volts Automotive Electrical Systems

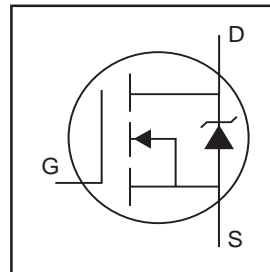
Features

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

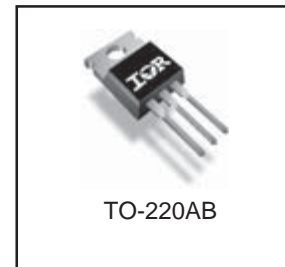
Description

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

HEXFET® Power MOSFET



| |
|---------------------------|
| $V_{DSS} = 40V$ |
| $R_{DS(on)} = 3.6m\Omega$ |
| $I_D = 210A\text{⑥}$ |



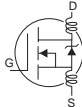
Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---------------------------|--|--------------------------|-------|
| $I_D @ T_C = 25^\circ C$ | Continuous Drain Current, $V_{GS} @ 10V$ | 210⑥ | A |
| $I_D @ T_C = 100^\circ C$ | Continuous Drain Current, $V_{GS} @ 10V$ | 150⑥ | |
| I_{DM} | Pulsed Drain Current ① | 850 | |
| $P_D @ T_C = 25^\circ C$ | Power Dissipation | 330 | W |
| | Linear Derating Factor | 2.2 | W/°C |
| V_{GS} | Gate-to-Source Voltage | ± 20 | V |
| E_{AS} | Single Pulse Avalanche Energy② | 460 | mJ |
| I_{AR} | Avalanche Current① | See Fig.12a, 12b, 15, 16 | A |
| E_{AR} | Repetitive Avalanche Energy② | | 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) | |
| | 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 | — | 0.45 | °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°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 |
| ΔV _{(BR)DSS} /ΔT _J | Breakdown Voltage Temp. Coefficient | — | 0.041 | — | V/°C | Reference to 25°C, I _D = 1mA |
| R _{DS(on)} | Static Drain-to-Source On-Resistance | — | 3.0 | 3.6 | mΩ | V _{GS} = 10V, I _D = 130A ④ |
| V _{GS(th)} | Gate Threshold Voltage | 2.0 | — | 4.0 | V | V _{DS} = 10V, I _D = 250μA |
| g _{fs} | Forward Transconductance | 120 | — | — | S | V _{DS} = 10V, I _D = 130A |
| I _{DSS} | Drain-to-Source Leakage Current | — | — | 20 | μA | V _{DS} = 40V, V _{GS} = 0V |
| | | — | — | 250 | | V _{DS} = 32V, 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 | — | 130 | 200 | nC | I _D = 130A |
| Q _{gs} | Gate-to-Source Charge | — | 35 | 52 | | V _{DS} = 32V |
| Q _{gd} | Gate-to-Drain ("Miller") Charge | — | 39 | 59 | | V _{GS} = 10V ④ |
| t _{d(on)} | Turn-On Delay Time | — | 15 | — | ns | V _{DD} = 20V |
| t _r | Rise Time | — | 140 | — | | I _D = 130A |
| t _{d(off)} | Turn-Off Delay Time | — | 62 | — | | R _G = 2.5Ω |
| t _f | Fall Time | — | 110 | — | | V _{GS} = 10V 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 | — | 5890 | — | pF | V _{GS} = 0V |
| C _{oss} | Output Capacitance | — | 1570 | — | | V _{DS} = 25V |
| C _{rss} | Reverse Transfer Capacitance | — | 130 | — | | f = 1.0MHz, See Fig. 5 |
| C _{oss} | Output Capacitance | — | 8000 | — | | V _{GS} = 0V, V _{DS} = 1.0V, f = 1.0MHz |
| C _{oss} | Output Capacitance | — | 1370 | — | | V _{GS} = 0V, V _{DS} = 32V, f = 1.0MHz |
| C _{oss eff.} | Effective Output Capacitance ④ | — | 2380 | — | | 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) | — | — | 210⑥ | A | MOSFET symbol showing the integral reverse p-n junction diode. |
| I _{SM} | Pulsed Source Current (Body Diode) ① | — | — | 850 | | |
| V _{SD} | Diode Forward Voltage | — | — | 1.3 | V | T _J = 25°C, I _S = 130A, V _{GS} = 0V ④ |
| t _{rr} | Reverse Recovery Time | — | 68 | 100 | ns | T _J = 25°C, I _F = 130A |
| Q _{rr} | Reverse Recovery Charge | — | 120 | 180 | 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) | | | | |

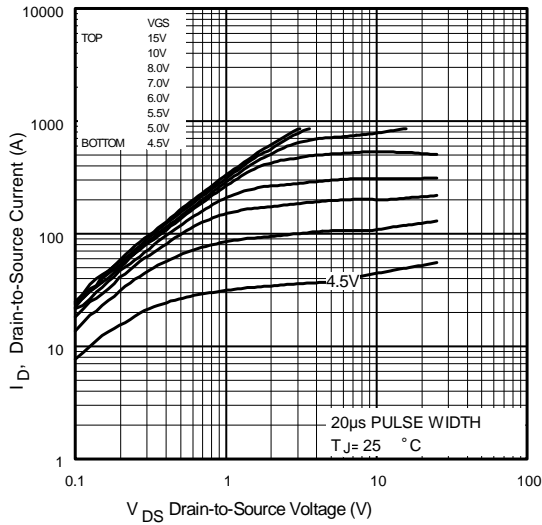


Fig 1. Typical Output Characteristics

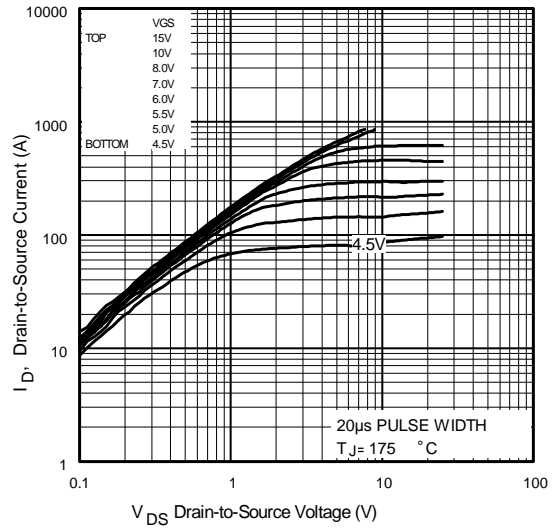


Fig 2. Typical Output Characteristics

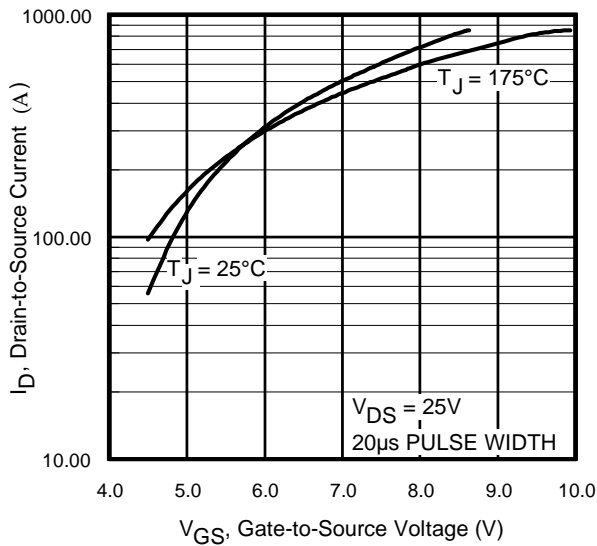


Fig 3. Typical Transfer Characteristics

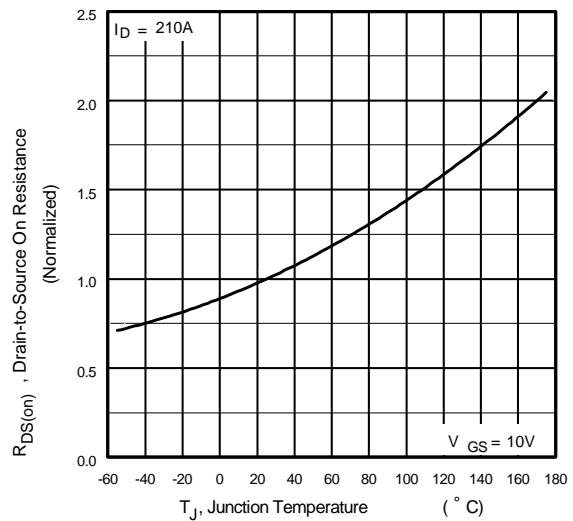


Fig 4. Normalized On-Resistance Vs. Temperature

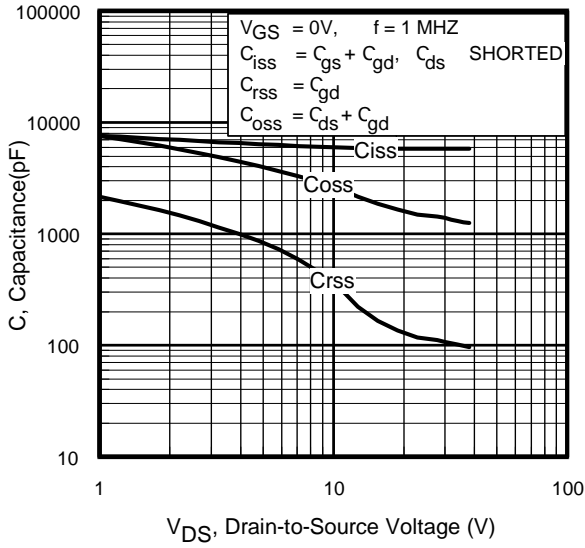


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

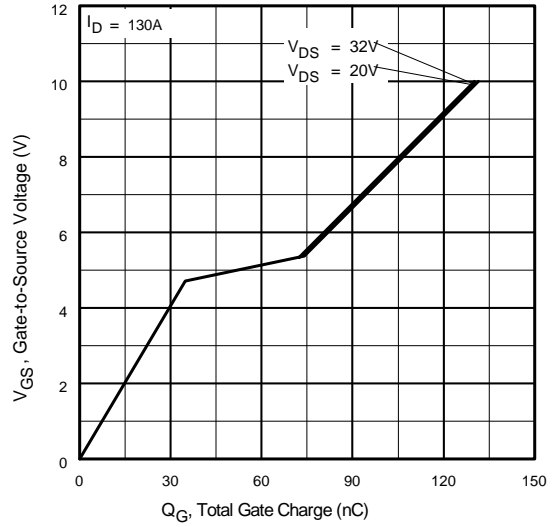


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

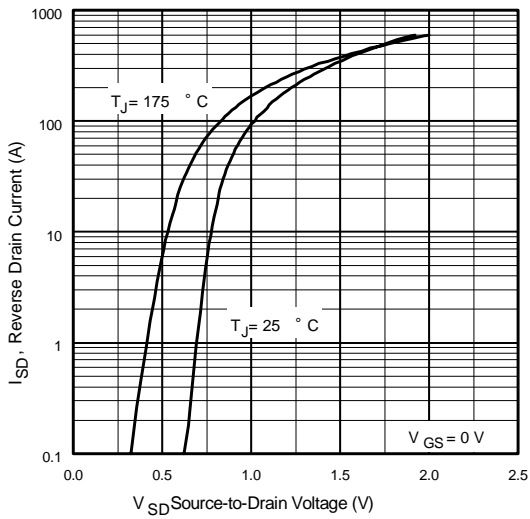


Fig 7. Typical Source-Drain Diode Forward Voltage

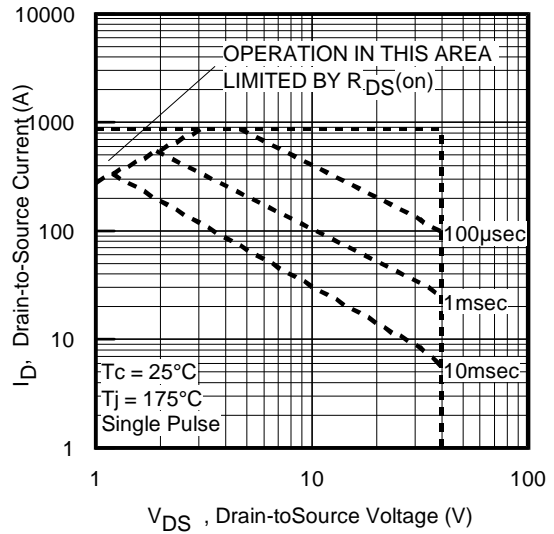


Fig 8. Maximum Safe Operating Area

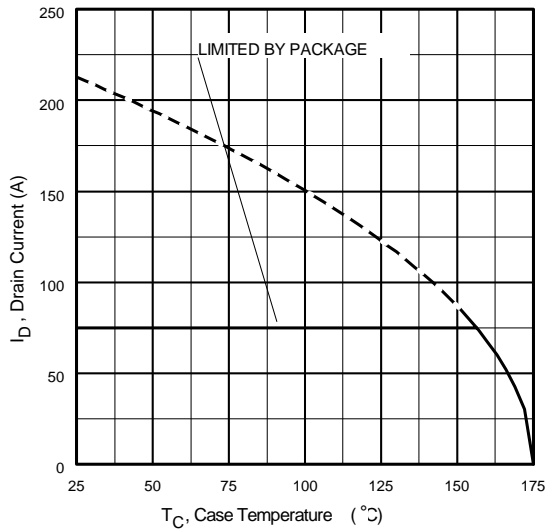


Fig 9. Maximum Drain Current Vs. Case Temperature

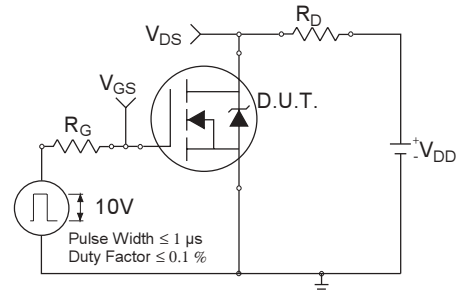


Fig 10a. Switching Time Test Circuit

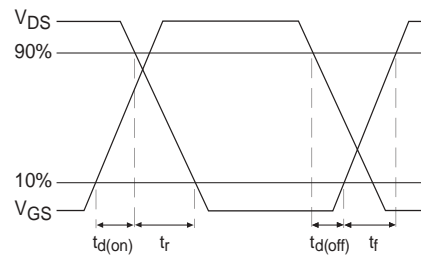


Fig 10b. Switching Time Waveforms

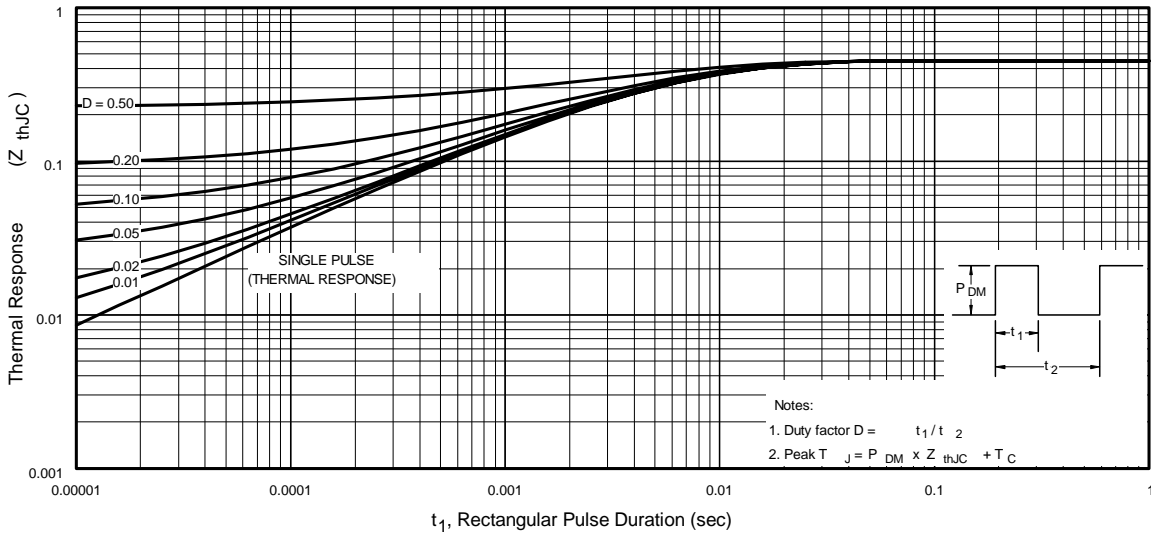


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

IRF2204

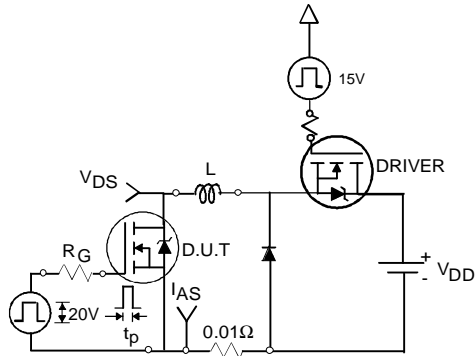


Fig 12a. Unclamped Inductive Test Circuit

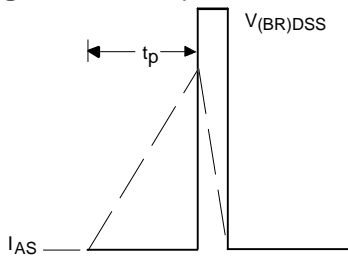


Fig 12b. Unclamped Inductive Waveforms

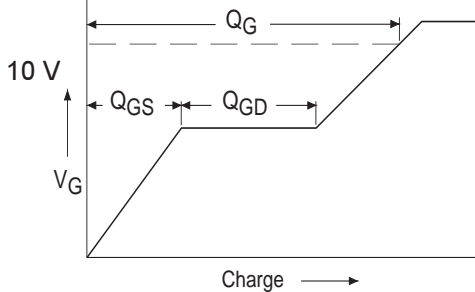


Fig 13a. Basic Gate Charge Waveform

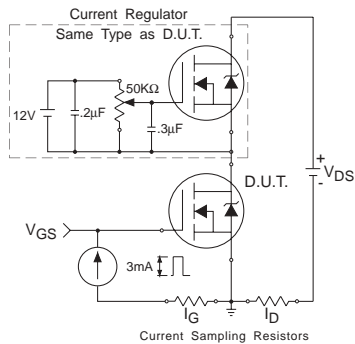


Fig 13b. Gate Charge Test Circuit

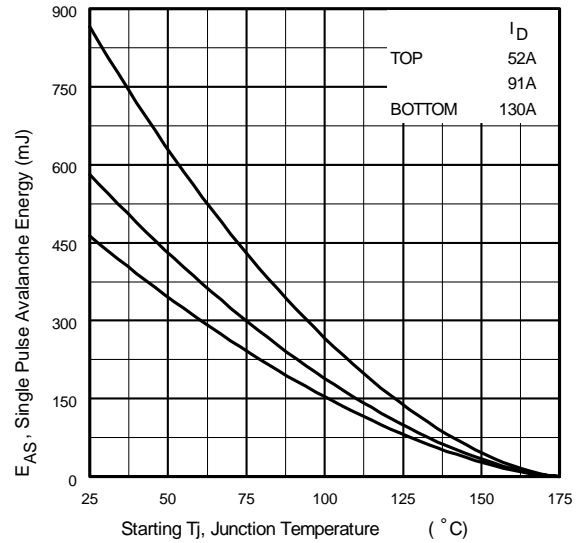


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

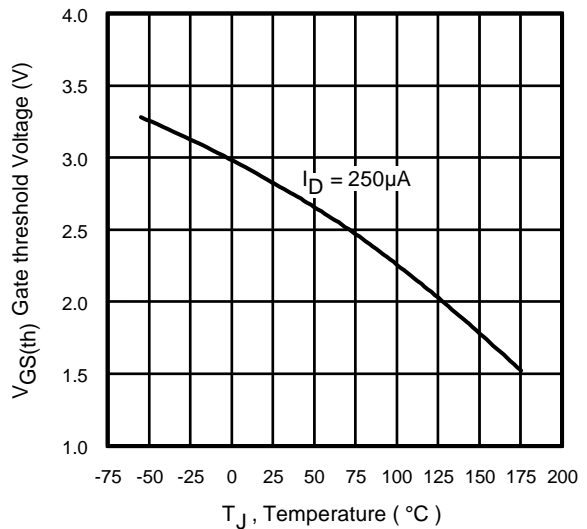


Fig 14. Threshold Voltage Vs. Temperature

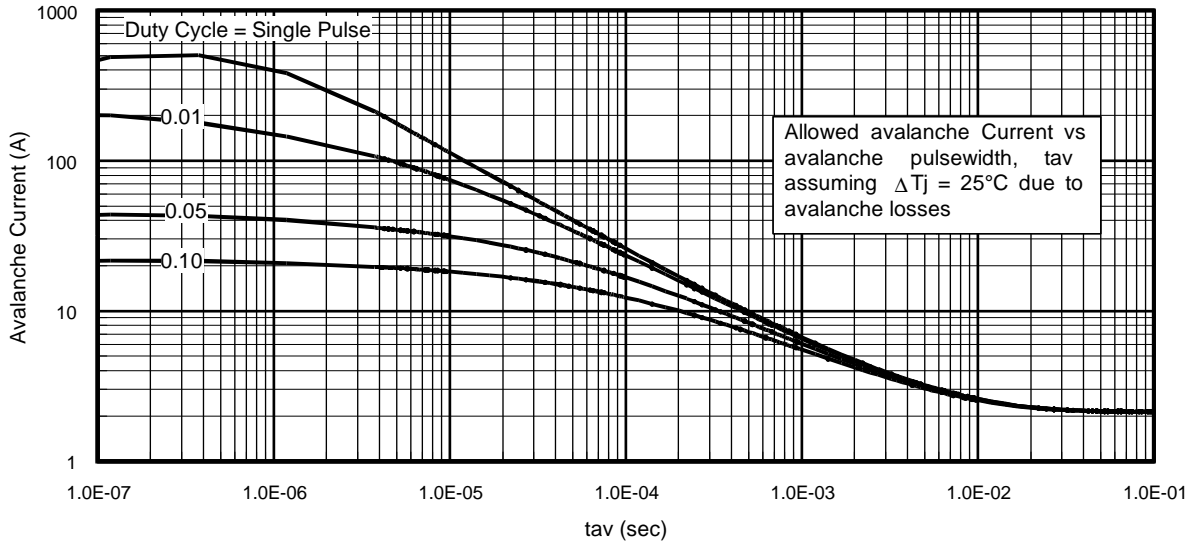


Fig 15. Typical Avalanche Current Vs.Pulsewidth

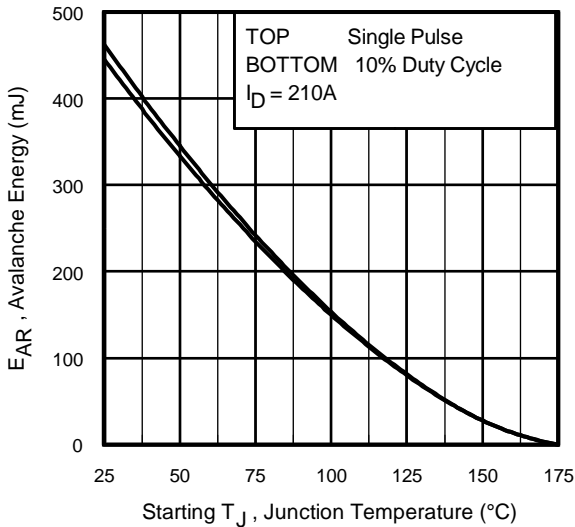


Fig 16. Maximum Avalanche Energy Vs. Temperature

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

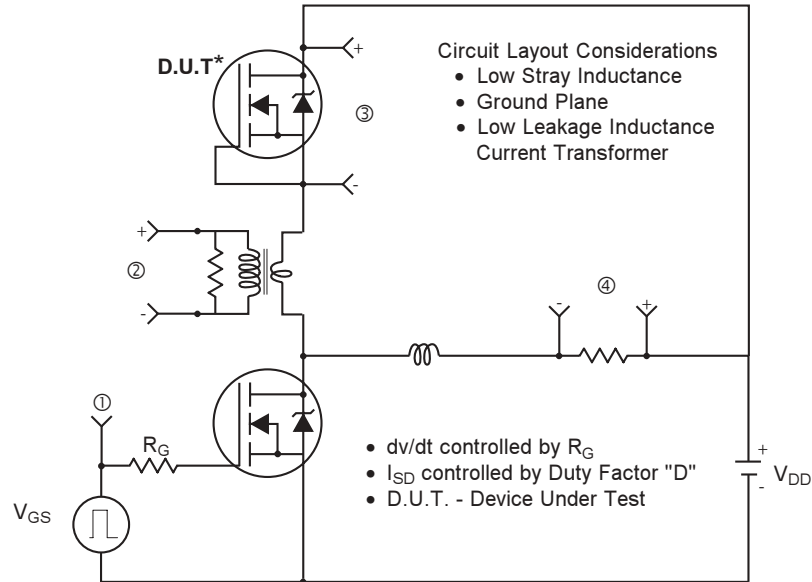
1. Avalanche failures assumption:
Purely a thermal phenomenon and failure occurs at a temperature far in excess of T_{jmax} . This is validated for every part type.
2. Safe operation in Avalanche is allowed as long as T_{jmax} is not exceeded.
3. Equation below based on circuit and waveforms shown in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

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

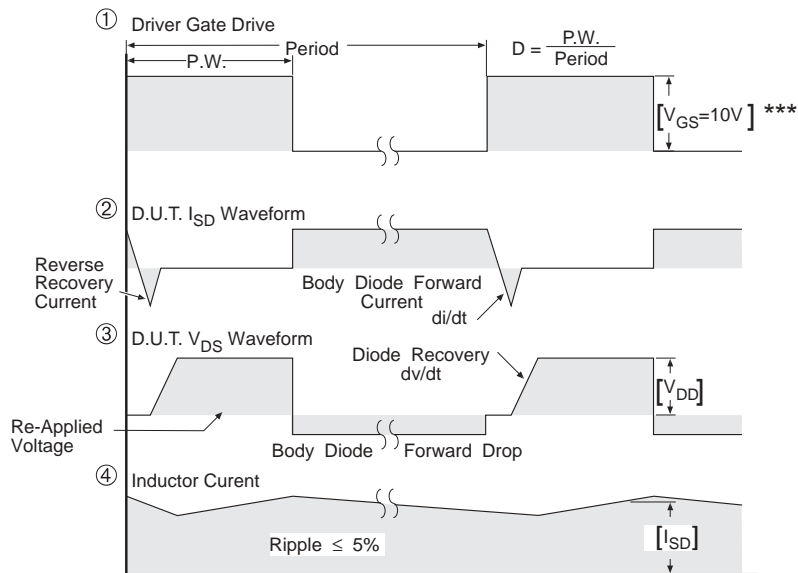
$$I_{av} = 2\Delta T / [1.3 \cdot BV \cdot Z_{th}]$$

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

Peak Diode Recovery dv/dt Test Circuit



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

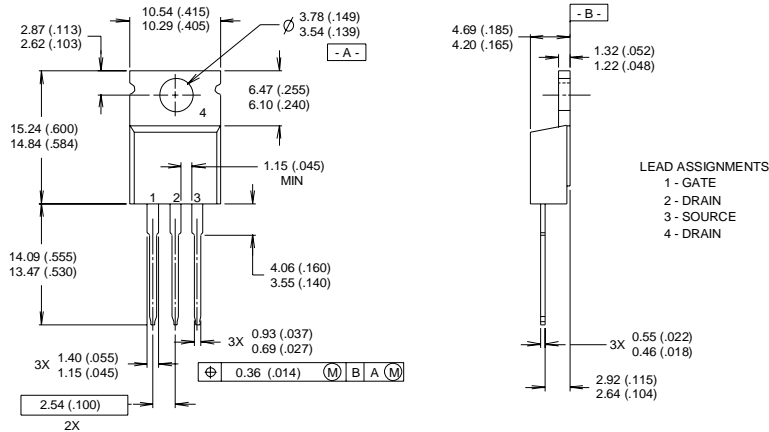


*** $V_{GS} = 5.0V$ for Logic Level and 3V Drive Devices

Fig 17. For N-channel HEXFET® power MOSFETs

TO-220AB Package Outline

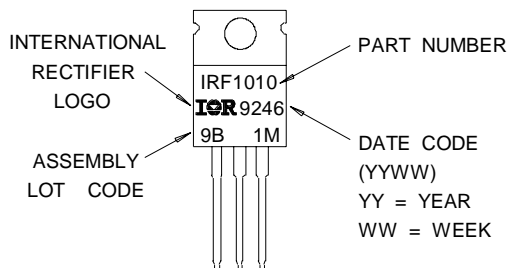
Dimensions are shown in millimeters (inches)



- 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
 WITH ASSEMBLY
 LOT CODE 9B1M



Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature. (See fig. 11).
- ② Starting $T_J = 25^\circ\text{C}$, $L = 0.06\text{mH}$
 $R_G = 25\Omega$, $I_{AS} = 130\text{A}$. (See Figure 12).
- ③ $I_{SD} \leq 130\text{A}$, $di/dt \leq 170\text{A}/\mu\text{s}$, $V_{DD} \leq V_{(BR)DSS}$,
 $T_J \leq 175^\circ\text{C}$.
- ④ Pulse width $\leq 400\mu\text{s}$; 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. Package limitation current is 75A.
- ⑦ Limited by T_{Jmax} , see Fig.12a, 12b, 15, 16 for typical repetitive avalanche performance.

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
IR Rectifier

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