International
IOR Rectifier

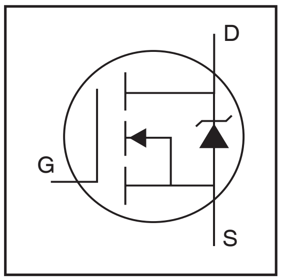


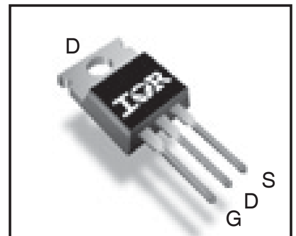
# IRFB4228PbF

**PDP SWITCH**

### Features
- Advanced Process Technology
- Key Parameters Optimized for PDP Sustain, Energy Recovery and Pass Switch Applications
- Low $E_{PULSE}$ Rating to Reduce Power Dissipation in PDP Sustain, Energy Recovery and Pass Switch Applications
- Low $Q_G$ for Fast Response
- High Repetitive Peak Current Capability for Reliable Operation
- Short Fall & Rise Times for Fast Switching
- 175°C Operating Junction Temperature for Improved Ruggedness
- Repetitive Avalanche Capability for Robustness and Reliability

| Key Parameters | | |
|---|---|---|
| $V_{DS}$ min | 150 | V |
| $V_{DS\ (Avalanche)}$ typ. | 180 | V |
| $R_{DS(ON)}$ typ. @ 10V | 12 | mΩ |
| $I_{RP}$ max @ $T_C$= 100°C | 170 | A |
| $T_J$ max | 175 | °C |




TO-220AB

| G | D | S |
|---|---|---|
| Gate | Drain | Source |

### Description
This HEXFET® Power MOSFET is specifically designed for Sustain; Energy Recovery & Pass switch applications in Plasma Display Panels. This MOSFET utilizes the latest processing techniques to achieve low on-resistance per silicon area and low $E_{PULSE}$ rating. Additional features of this MOSFET are 175°C operating junction temperature and high repetitive peak current capability. These features combine to make this MOSFET a highly efficient, robust and reliable device for PDP driving applications.

### Absolute Maximum Ratings

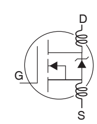
| | Parameter | Max. | Units |
|---|---|---|---|
| $V_{GS}$ | Gate-to-Source Voltage | ±30 | V |
| $I_D$ @ $T_C$ = 25°C | Continuous Drain Current, $V_{GS}$ @ 10V | 83 | A |
| $I_D$ @ $T_C$ = 100°C | Continuous Drain Current, $V_{GS}$ @ 10V | 59 | |
| $I_{DM}$ | Pulsed Drain Current ① | 330 | |
| $I_{RP}$ @ $T_C$ = 100°C | Repetitive Peak Current ⑤ | 170 | |
| $P_D$ @$T_C$ = 25°C | Power Dissipation | 330 | W |
| $P_D$ @$T_C$ = 100°C | Power Dissipation | 170 | |
| | Linear Derating Factor | 2.2 | W/°C |
| $T_J$<br>$T_{STG}$ | Operating Junction and<br>Storage Temperature Range | -40 to + 175 | °C |
| | Soldering Temperature for 10 seconds | 300 | |
| | Mounting Torque, 6-32 or M3 Screw | 10lb·in (1.1N·m) | N |

### Thermal Resistance

| | Parameter | Typ. | Max. | Units |
|---|---|---|---|---|
| $R_{\theta JC}$ | Junction-to-Case ④ | — | 0.45 | °C/W |
| $R_{\theta CS}$ | Case-to-Sink, Flat, Greased Surface | 0.50 | — | |
| $R_{\theta JA}$ | Junction-to-Ambient ④ | — | 62 | |

Notes ① through ⑤ are on page 8

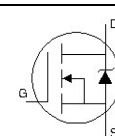
## Electrical Characteristics @ $T_J = 25°C$ (unless otherwise specified)

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| $BV_{DSS}$ | Drain-to-Source Breakdown Voltage | 150 | — | — | V | $V_{GS} = 0V$, $I_D = 250\mu A$ |
| $\Delta BV_{DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient | — | 150 | — | mV/°C | Reference to 25°C, $I_D = 1mA$ |
| $R_{DS(on)}$ | Static Drain-to-Source On-Resistance | — | 12 | 15 | mΩ | $V_{GS} = 10V$, $I_D = 33A$ ③ |
| $V_{GS(th)}$ | Gate Threshold Voltage | 3.0 | — | 5.0 | V | $V_{DS} = V_{GS}$, $I_D = 250\mu A$ |
| $\Delta V_{GS(th)}/\Delta T_J$ | Gate Threshold Voltage Coefficient | — | -14 | — | mV/°C | |
| $I_{DSS}$ | Drain-to-Source Leakage Current | — | — | 20 | μA | $V_{DS} = 150V$, $V_{GS} = 0V$ |
| | | — | — | 1.0 | mA | $V_{DS} = 150V$, $V_{GS} = 0V$, $T_J = 125°C$ |
| $I_{GSS}$ | Gate-to-Source Forward Leakage | — | — | 100 | nA | $V_{GS} = 20V$ |
| | Gate-to-Source Reverse Leakage | — | — | -100 | | $V_{GS} = -20V$ |
| $g_{fs}$ | Forward Transconductance | 170 | — | — | S | $V_{DS} = 25V$, $I_D = 50A$ |
| $Q_g$ | Total Gate Charge | — | 71 | 107 | nC | $V_{DD} = 75V$, $I_D = 50A$, $V_{GS} = 10V$③ |
| $Q_{gd}$ | Gate-to-Drain Charge | — | 21 | — | | |
| $t_{d(on)}$ | Turn-On Delay Time | — | 18 | — | ns | $V_{DD} = 75V$, $V_{GS} = 10V$ ③ |
| $t_r$ | Rise Time | — | 59 | — | | $I_D = 50A$ |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 24 | — | | $R_G = 2.5\Omega$ |
| $t_f$ | Fall Time | — | 33 | — | | See Fig. 22 |
| $t_{st}$ | Shoot Through Blocking Time | 100 | — | — | ns | $V_{DD} = 120V$, $V_{GS} = 15V$, $R_G = 5.1\Omega$ |
| $E_{PULSE}$ | Energy per Pulse | — | 58 | — | μJ | L = 220nH, C= 0.3μF, $V_{GS} = 15V$<br>$V_{DS} = 120V$, $R_G = 5.1\Omega$, $T_J = 25°C$ |
| | | — | 110 | — | | L = 220nH, C= 0.3μF, $V_{GS} = 15V$<br>$V_{DS} = 120V$, $R_G = 5.1\Omega$, $T_J = 100°C$ |
| $C_{iss}$ | Input Capacitance | — | 4530 | — | pF | $V_{GS} = 0V$ |
| $C_{oss}$ | Output Capacitance | — | 550 | — | | $V_{DS} = 25V$ |
| $C_{rss}$ | Reverse Transfer Capacitance | — | 100 | — | | $f = 1.0MHz$ |
| $C_{oss}$ eff. | Effective Output Capacitance | — | 480 | — | | $V_{GS} = 0V$, $V_{DS} = 0V$ to 120V |
| $L_D$ | Internal Drain Inductance | — | 4.5 | — | nH | Between lead,<br>6mm (0.25in.)<br>from package<br>and center of die contact  |
| $L_S$ | Internal Source Inductance | — | 7.5 | — | | |

## Avalanche Characteristics

| | Parameter | Typ. | Max. | Units |
|---|---|---|---|---|
| $E_{AS}$ | Single Pulse Avalanche Energy② | — | 120 | mJ |
| $E_{AR}$ | Repetitive Avalanche Energy ① | — | 33 | mJ |
| $V_{DS(Avalanche)}$ | Repetitive Avalanche Voltage ① | 180 | — | V |
| $I_{AS}$ | Avalanche Current ② | — | 50 | A |

## Diode Characteristics

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| $I_S$ @ $T_C = 25°C$ | Continuous Source Current<br>(Body Diode) | — | — | 83 | A | MOSFET symbol<br>showing the<br>integral reverse<br>p-n junction diode.  |
| $I_{SM}$ | Pulsed Source Current<br>(Body Diode) ① | — | — | 330 | | |
| $V_{SD}$ | Diode Forward Voltage | — | — | 1.3 | V | $T_J = 25°C$, $I_S = 50A$, $V_{GS} = 0V$ ③ |
| $t_{rr}$ | Reverse Recovery Time | — | 76 | 110 | ns | $T_J = 25°C$, $I_F = 50A$, $V_{DD} = 50V$ |
| $Q_{rr}$ | Reverse Recovery Charge | — | 230 | 350 | nC | di/dt = 100A/μs ③ |

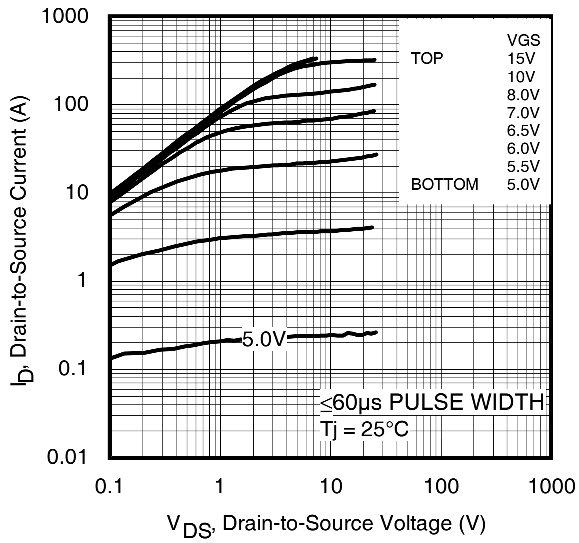



**Fig 1.** Typical Output Characteristics

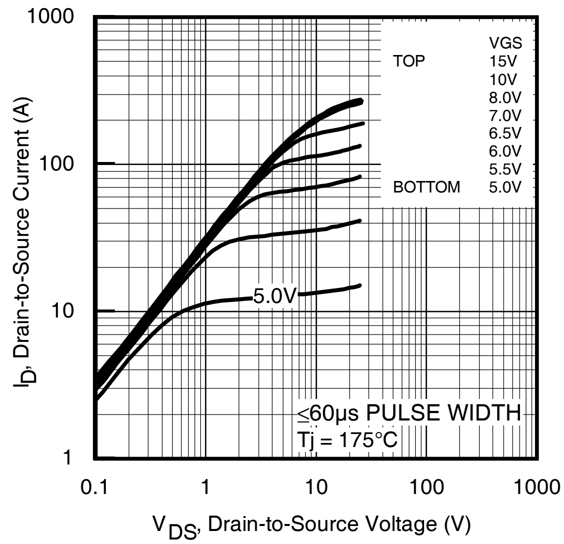



**Fig 2.** Typical Output Characteristics

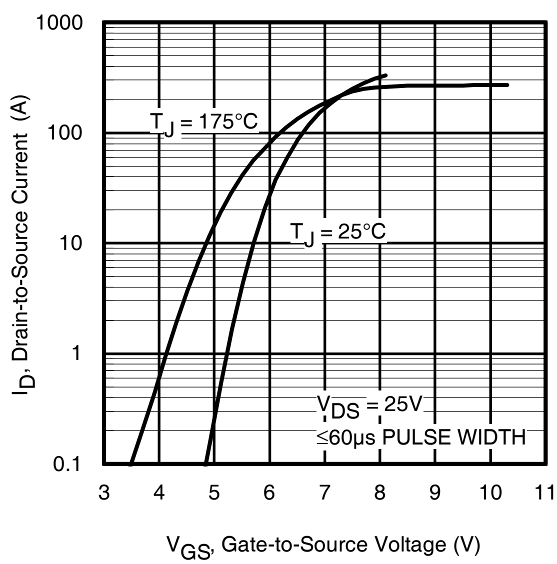



**Fig 3.** Typical Transfer Characteristics

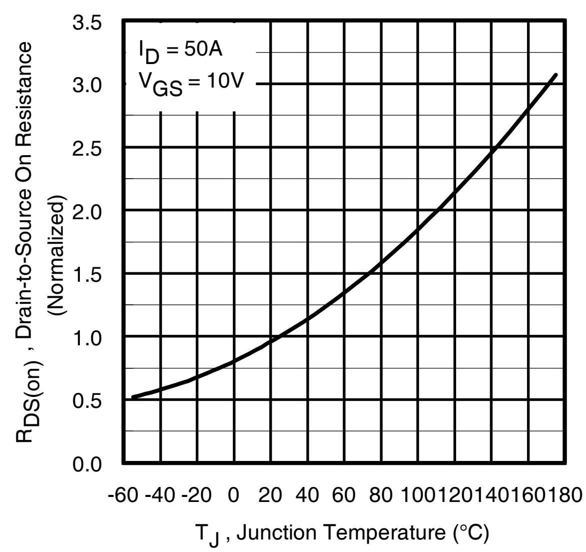



**Fig 4.** Normalized On-Resistance vs. Temperature

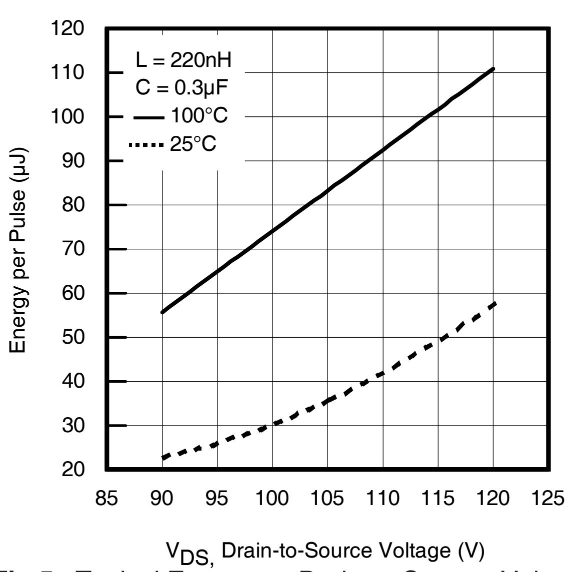



**Fig 5.** Typical $E_{PULSE}$ vs. Drain-to-Source Voltage

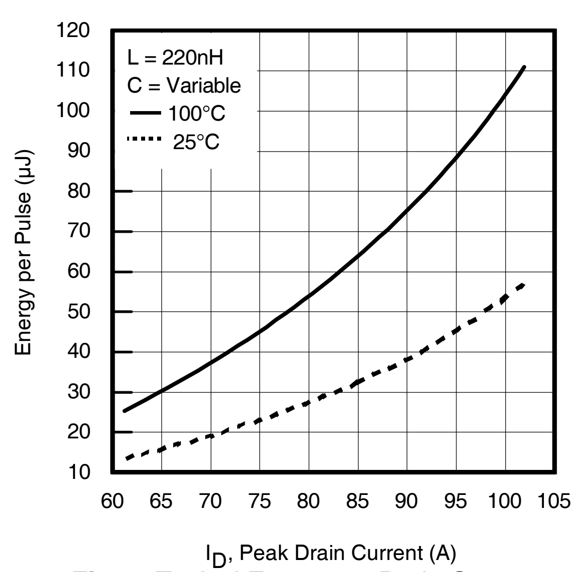



**Fig 6.** Typical $E_{PULSE}$ vs. Drain Current

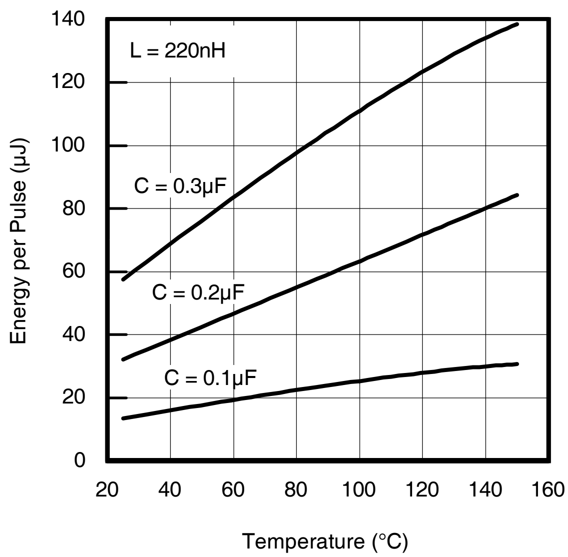



**Fig 7.** Typical $E_{PULSE}$ vs.Temperature

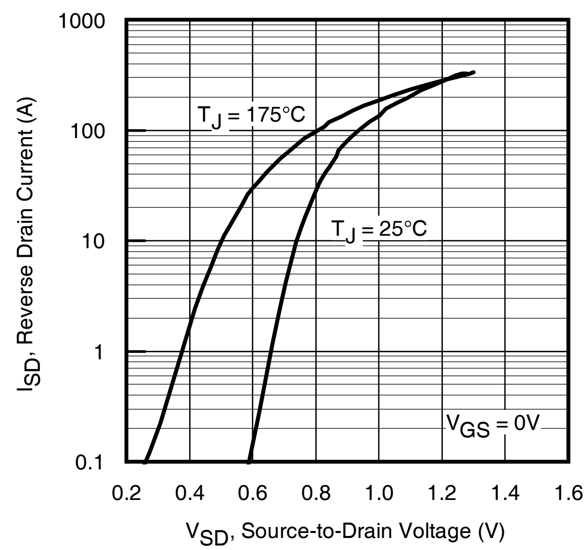



**Fig 8.** Typical Source-Drain Diode Forward Voltage

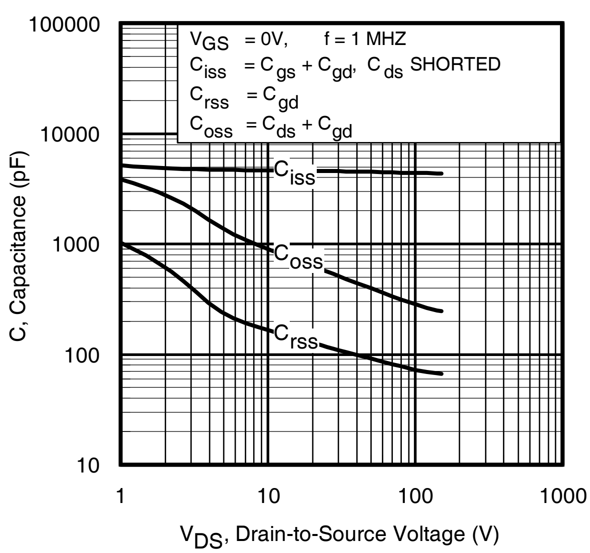



**Fig 9.** Typical Capacitance vs.Drain-to-Source Voltage

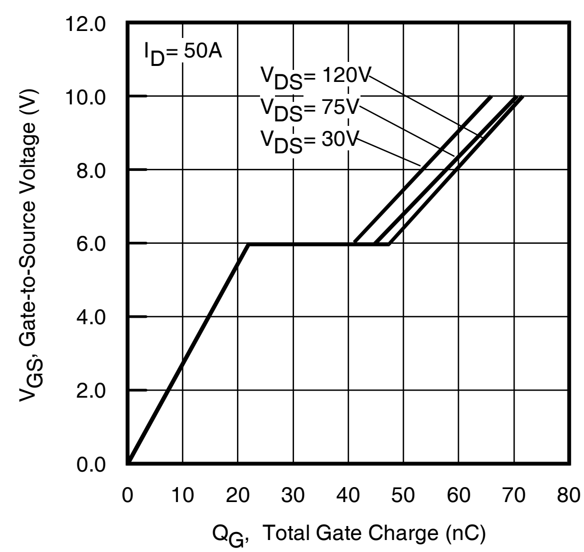



**Fig 10.** Typical Gate Charge vs.Gate-to-Source Voltage

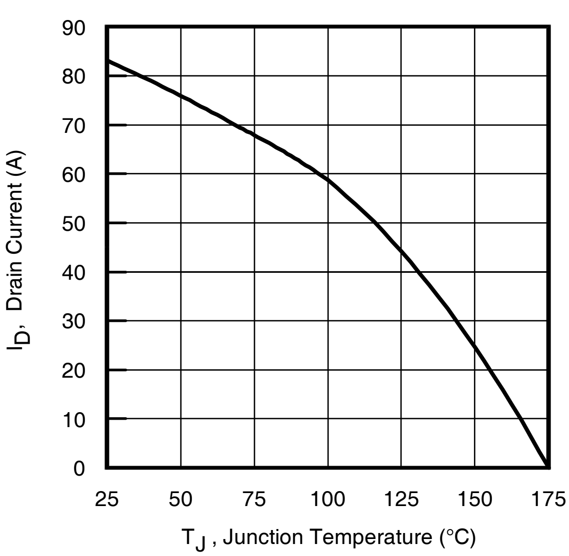



**Fig 11.** Maximum Drain Current vs. Case Temperature

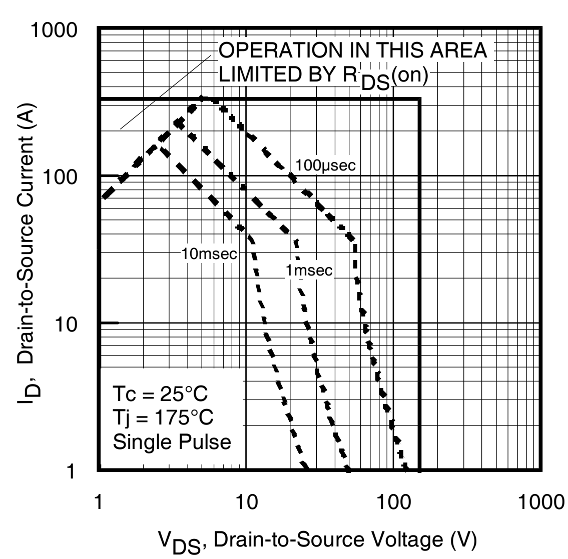



**Fig 12.** Maximum Safe Operating Area

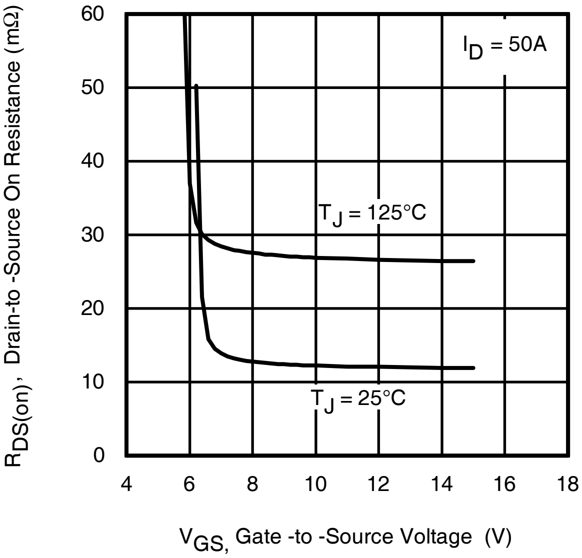



**Fig 13.** On-Resistance vs. Gate Voltage

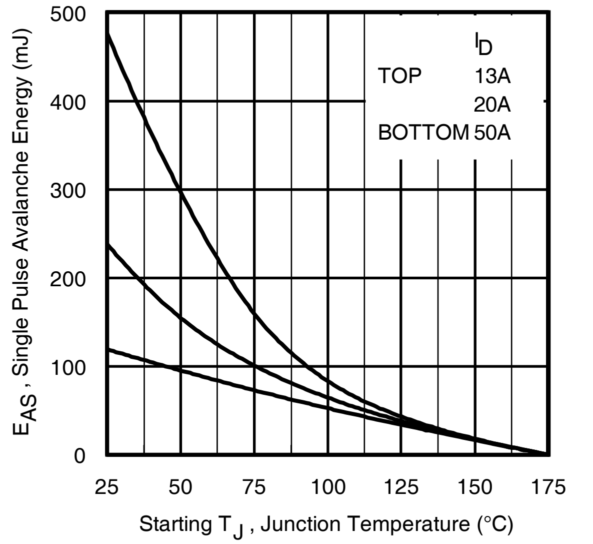



**Fig 14.** Maximum Avalanche Energy vs. Temperature

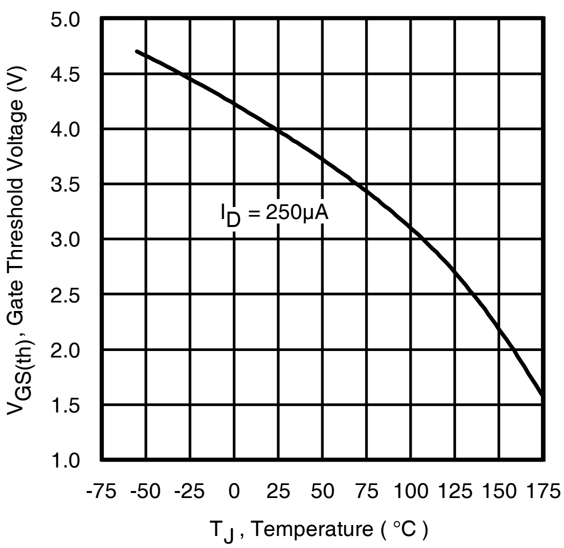



**Fig 15.** Threshold Voltage vs. Temperature

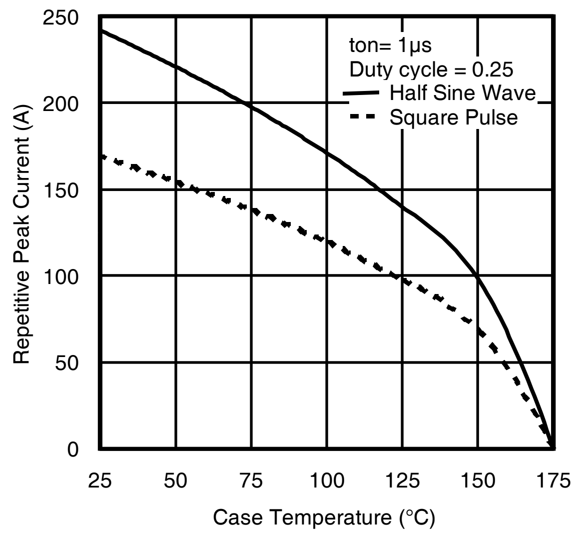



**Fig 16.** Typical Repetitive peak Current vs. Case temperature

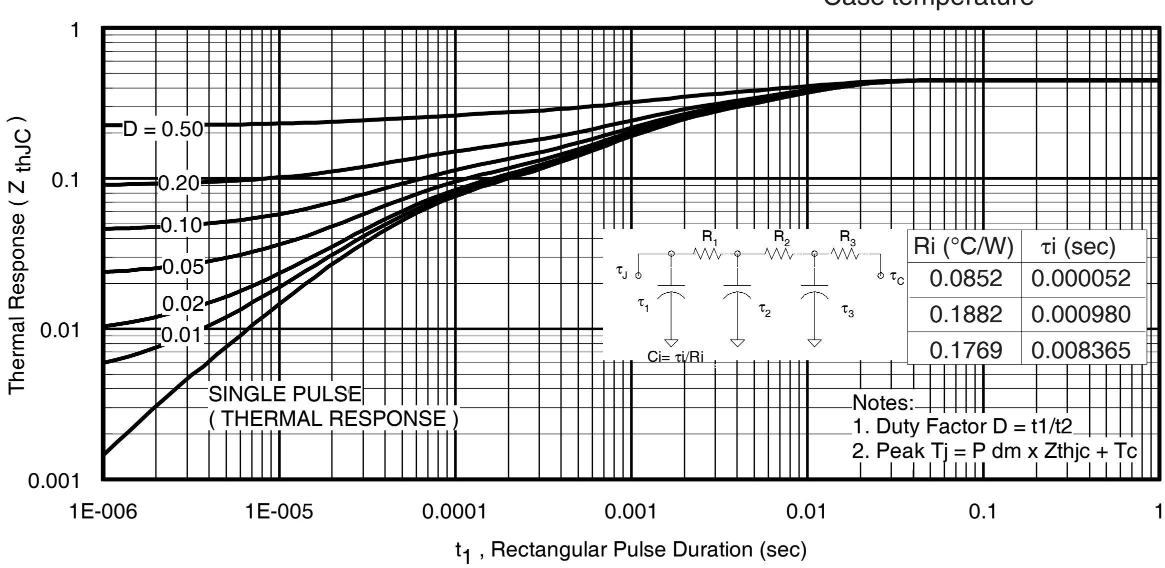



**Fig 17.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

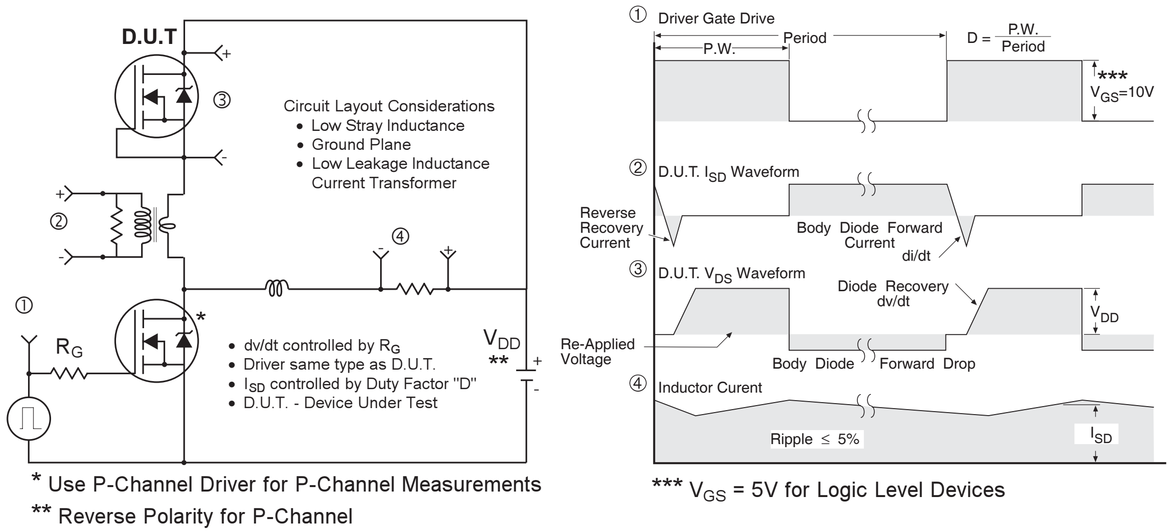



**Fig 18.** Diode Reverse Recovery Test Circuit for HEXFET® Power MOSFETs

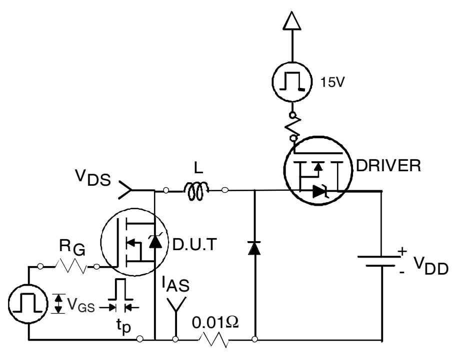



**Fig 19a.** Unclamped Inductive Test Circuit

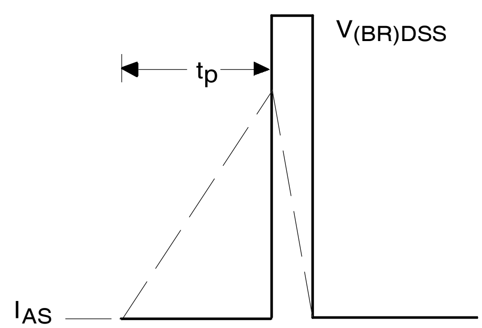



**Fig 19b.** Unclamped Inductive Waveforms

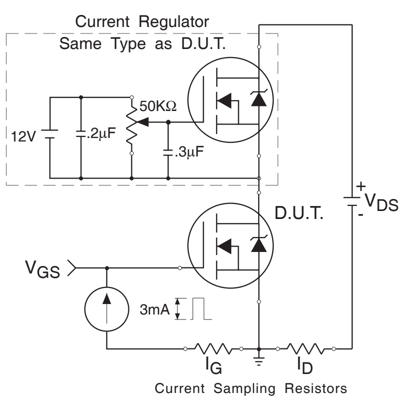



**Fig 20a.** Gate Charge Test Circuit

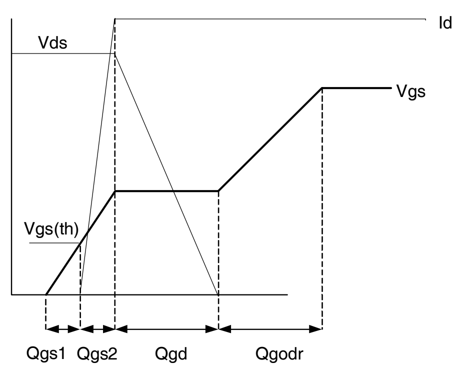



**Fig 20b.** Gate Charge Waveform

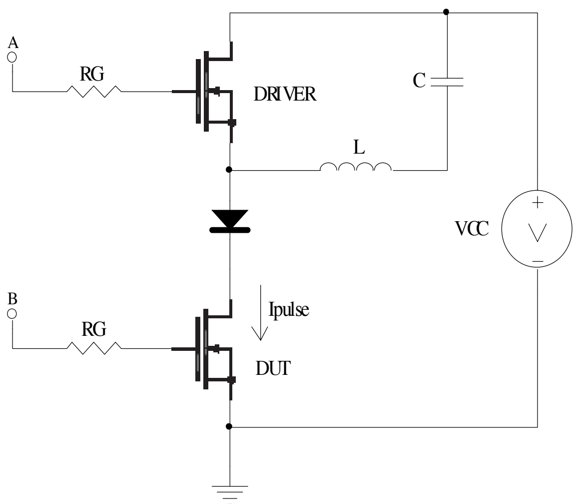



**Fig 21a.** $t_{st}$ and $E_{PULSE}$ Test Circuit

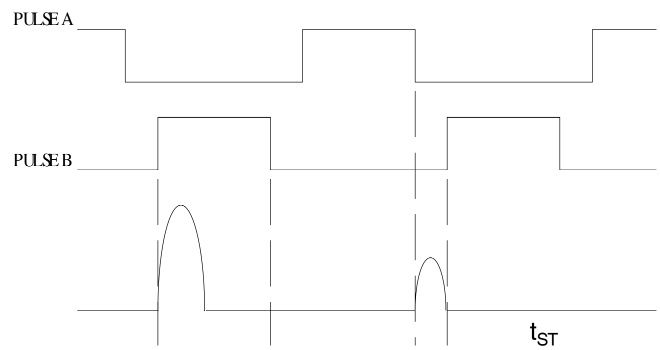



**Fig 21b.** $t_{st}$ Test Waveforms

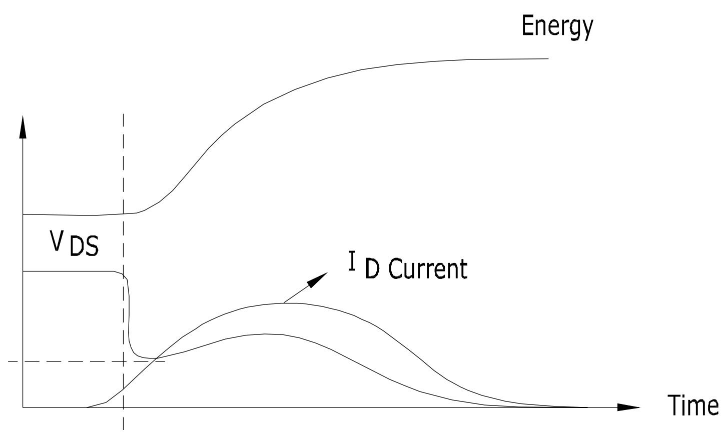



**Fig 21c.** $E_{PULSE}$ Test Waveforms

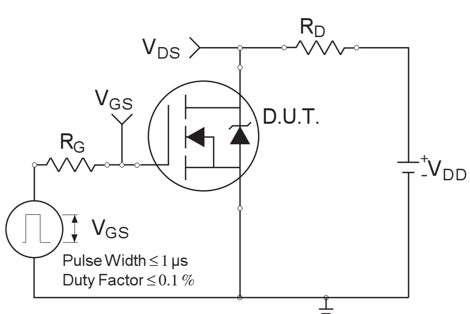



**Fig 22a.** Switching Time Test Circuit

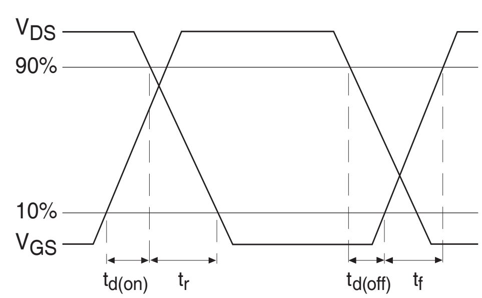
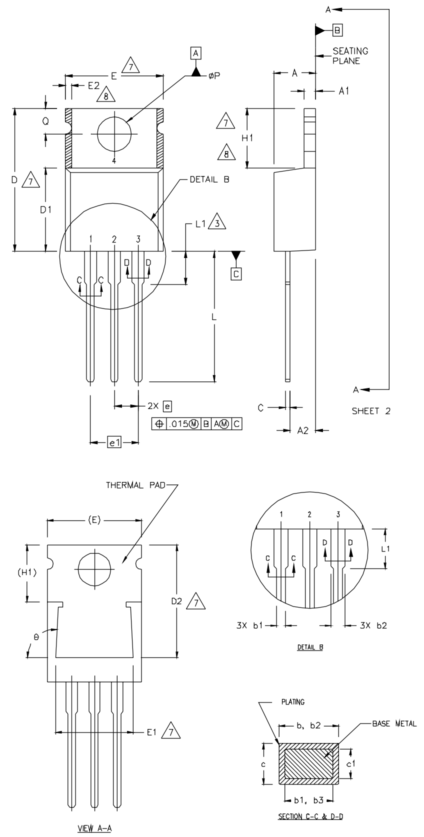



**Fig 22b.** Switching Time Waveforms

## TO-220AB Package Outline (Dimensions are shown in millimeters (inches))



NOTES:

1 DIMENSIONING AND TOLERANCING PER ASME Y14.5 M- 1994.
2 DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
3 LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
4 DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
5 DIMENSION b1 & c1 APPLY TO BASE METAL ONLY.
6 CONTROLLING DIMENSION : INCHES.
7 THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS E,H1,D2 & E1
8 DIMENSION E2 X H1 DEFINE A ZONE WHERE STAMPING AND SINGULATION IRREGULARITIES ARE ALLOWED.

| SYMBOL | DIMENSIONS | | | | NOTES |
|---|---|---|---|---|---|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 3.56 | 4.82 | .140 | .190 | |
| A1 | 0.51 | 1.40 | .020 | .055 | |
| A2 | 2.04 | 2.92 | .080 | .115 | |
| b | 0.38 | 1.01 | .015 | .040 | |
| b1 | 0.38 | 0.96 | .015 | .038 | 5 |
| b2 | 1.15 | 1.77 | .045 | .070 | |
| b3 | 1.15 | 1.73 | .045 | .068 | |
| c | 0.36 | 0.61 | .014 | .024 | |
| c1 | 0.36 | 0.56 | .014 | .022 | 5 |
| D | 14.22 | 16.51 | .560 | .650 | 4 |
| D1 | 8.38 | 9.02 | .330 | .355 | |
| D2 | 12.19 | 12.88 | .480 | .507 | 7 |
| E | 9.66 | 10.66 | .380 | .420 | 4,7 |
| E1 | 8.38 | 8.89 | .330 | .350 | 7 |
| e | 2.54 BSC | | .100 BSC | | |
| e1 | 5.08 | | .200 BSC | | |
| H1 | 5.85 | 6.55 | .230 | .270 | 7,8 |
| L | 12.70 | 14.73 | .500 | .580 | |
| L1 | – | 6.35 | – | .250 | 3 |
| ØP | 3.54 | 4.08 | .139 | .161 | |
| Q | 2.54 | 3.42 | .100 | .135 | |
| Ø | 90°–93° | | 90°–93° | | |

LEAD ASSIGNMENTS

HEXFET
1.- GATE
2.- DRAIN
3.- SOURCE

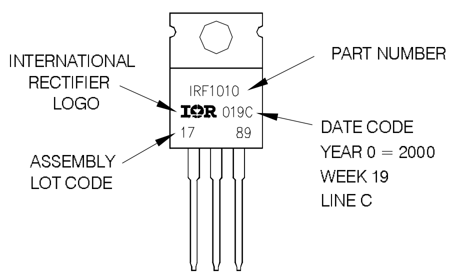
IGBTs, CoPACK
1.- GATE
2.- COLLECTOR
3.- EMITTER

DIODES
1.- ANODE/OPEN
2.- CATHODE
3.- ANODE

## 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 packages are not recommended for Surface Mount Application.**

**Notes:**

① Repetitive rating; pulse width limited by max. junction temperature.
② Starting $T_J$ = 25°C, L = 0.096mH, $R_G$ = 25Ω, $I_{AS}$ = 50A.
③ Pulse width ≤ 400µs; duty cycle ≤ 2%.
④ $R_\theta$ is measured at $T_J$ of approximately 90°C.
⑤ Half sine wave with duty cycle = 0.25, ton=1µsec.

**Note: 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 the Industrial market.
Qualification Standards can be found on IR's Web site.

International IOR Rectifier

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