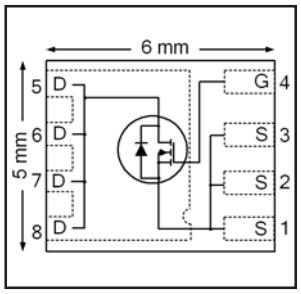
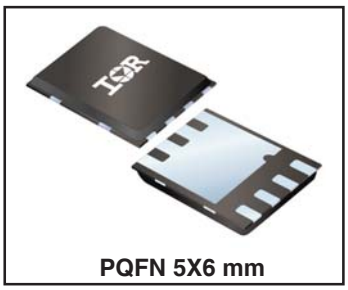
# IRFH5004PbF

HEXFET® Power MOSFET

| | | |
|---|---|---|
| $V_{DS}$ | 40 | V |
| $R_{DS(on)\ max}$ ($@V_{GS}$ = 10V) | 2.6 | mΩ |
| $Q_{g\ (typical)}$ | 73 | nC |
| $R_{G\ (typical)}$ | 1.2 | Ω |
| $I_D$ ($@T_{mb}$ = 25°C) | 100⑥ | A |




PQFN 5X6 mm

## Applications

- Secondary Side Synchronous Rectification
- Inverters for DC Motors
- DC-DC Brick Applications
- Boost Converters

## Features and Benefits

| Features | | Benefits |
|---|---|---|
| Low $R_{DSon}$ (≤ 2.6mΩ) | | Lower Conduction Losses |
| Low Thermal Resistance to PCB (≤ 0.8°C/W) | | Enables better thermal dissipation |
| 100% Rg tested | | Increased Reliability |
| Low Profile (≤ 0.9 mm) | results in | Increased Power Density |
| Industry-Standard Pinout | ⇒ | Multi-Vendor Compatibility |
| Compatible with Existing Surface Mount Techniques | | Easier Manufacturing |
| RoHS Compliant Containing no Lead, no Bromide and no Halogen | | Environmentally Friendlier |
| MSL1, Industrial Qualification | | Increased Reliability |

| Base Part Number | Package Type | Standard Pack | | Orderable part number | Note |
|---|---|---|---|---|---|
| | | Form | Quantity | | |
| IRFH5004PBF | PQFN 5mm x 6mm | Tape and Reel | 4000 | IRFH5004TRPBF | |
| | ~~PQFN 5mm x 6mm~~ | ~~Tape and Reel~~ | ~~1000~~ | ~~IRFH5004TR2PBF~~ | EOL notice #259 |

## Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---|---|---|---|
| $V_{DS}$ | Drain-to-Source Voltage | 40 | V |
| $V_{GS}$ | Gate-to-Source Voltage | ±20 | |
| $I_D$ @ $T_A$ = 25°C | Continuous Drain Current, $V_{GS}$ @ 10V | 28 | A |
| $I_D$ @ $T_A$ = 70°C | Continuous Drain Current, $V_{GS}$ @ 10V | 23 | |
| $I_D$ @ $T_{mb}$ = 25°C | Continuous Drain Current, $V_{GS}$ @ 10V | 100⑥ | |
| $I_D$ @ $T_{mb}$ = 100°C | Continuous Drain Current, $V_{GS}$ @ 10V | 100⑥ | |
| $I_{DM}$ | Pulsed Drain Current ① | 400 | |
| $P_D$ @$T_A$ = 25°C | Power Dissipation ⑤ | 3.6 | W |
| $P_D$ @ $T_{mb}$ = 25°C | Power Dissipation ⑤ | 156 | |
| | Linear Derating Factor ⑤ | 0.029 | W/°C |
| $T_J$<br>$T_{STG}$ | Operating Junction and<br>Storage Temperature Range | -55 to + 150 | °C |

Notes ① through ⑥ are on page 8

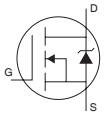
## Static @ $T_J$ = 25°C (unless otherwise specified)

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| $BV_{DSS}$ | Drain-to-Source Breakdown Voltage | 40 | — | — | V | $V_{GS}$ = 0V, $I_D$ = 250µA |
| $\Delta BV_{DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient | — | 0.04 | — | V/°C | Reference to 25°C, $I_D$ = 1mA |
| $R_{DS(on)}$ | Static Drain-to-Source On-Resistance | — | 2.1 | 2.6 | mΩ | $V_{GS}$ = 10V, $I_D$ = 50A ③ |
| $V_{GS(th)}$ | Gate Threshold Voltage | 2.0 | — | 4.0 | V | $V_{DS}$ = $V_{GS}$, $I_D$ = 150µA |
| $\Delta V_{GS(th)}$ | Gate Threshold Voltage Coefficient | — | -5.6 | — | mV/°C | |
| $I_{DSS}$ | Drain-to-Source Leakage Current | — | — | 20 | µA | $V_{DS}$ = 40V, $V_{GS}$ = 0V |
| | | — | — | 250 | | $V_{DS}$ = 40V, $V_{GS}$ = 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 |
| gfs | Forward Transconductance | 91 | — | — | S | $V_{DS}$ = 15V, $I_D$ = 50A |
| $Q_g$ | Total Gate Charge | — | 73 | 110 | nC | $V_{DS}$ = 20V<br>$V_{GS}$ = 10V<br>$I_D$ = 50A<br>See Fig.17 & 18 |
| $Q_{gs1}$ | Pre-Vth Gate-to-Source Charge | — | 15 | — | | |
| $Q_{gs2}$ | Post-Vth Gate-to-Source Charge | — | 6.1 | — | | |
| $Q_{gd}$ | Gate-to-Drain Charge | — | 27 | — | | |
| $Q_{godr}$ | Gate Charge Overdrive | — | 25 | — | | |
| $Q_{sw}$ | Switch Charge ($Q_{gs2}$ + $Q_{gd}$) | — | 33.1 | — | | |
| $Q_{oss}$ | Output Charge | — | 27 | — | nC | $V_{DS}$ = 16V, $V_{GS}$ = 0V |
| $R_G$ | Gate Resistance | — | 1.2 | — | Ω | |
| $t_{d(on)}$ | Turn-On Delay Time | — | 13 | — | ns | $V_{DD}$ = 20V, $V_{GS}$ = 10V<br>$I_D$ = 50A<br>$R_G$=1.8Ω<br>See Fig.15 |
| $t_r$ | Rise Time | — | 39 | — | | |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 28 | — | | |
| $t_f$ | Fall Time | — | 16 | — | | |
| $C_{iss}$ | Input Capacitance | — | 4490 | — | pF | $V_{GS}$ = 0V<br>$V_{DS}$ = 20V<br>$f$ = 1.0MHz |
| $C_{oss}$ | Output Capacitance | — | 970 | — | | |
| $C_{rss}$ | Reverse Transfer Capacitance | — | 460 | — | | |

## Avalanche Characteristics

| | Parameter | Typ. | Max. | Units |
|---|---|---|---|---|
| $E_{AS}$ | Single Pulse Avalanche Energy ② | — | 340 | mJ |
| $I_{AR}$ | Avalanche Current ① | — | 50 | A |

## Diode Characteristics

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| $I_S$ | Continuous Source Current (Body Diode) ⑥ | — | — | 100 | A | MOSFET symbol showing the integral reverse p-n junction diode.  |
| $I_{SM}$ | Pulsed Source Current (Body Diode) ① | — | — | 400 | | |
| $V_{SD}$ | Diode Forward Voltage | — | — | 1.0 | V | $T_J$ = 25°C, $I_S$ = 50A, $V_{GS}$ = 0V ③ |
| $t_{rr}$ | Reverse Recovery Time | — | 32 | 48 | ns | $T_J$ = 25°C, $I_F$ = 50A, $V_{DD}$ = 20V |
| $Q_{rr}$ | Reverse Recovery Charge | — | 100 | 150 | nC | di/dt = 300A/µs ③ |
| $t_{on}$ | Forward Turn-On Time | Time is dominated by parasitic Inductance | | | | |

## Thermal Resistance

| | Parameter | Typ. | Max. | Units |
|---|---|---|---|---|
| $R_{\theta JC\text{-}mb}$ | Junction-to-Mounting Base | 0.5 | 0.8 | °C/W |
| $R_{\theta JC}$ (Top) | Junction-to-Case ④ | — | 15 | |
| $R_{\theta JA}$ | Junction-to-Ambient ⑤ | — | 35 | |
| $R_{\theta JA}$ (<10s) | Junction-to-Ambient ⑤ | — | 33 | |

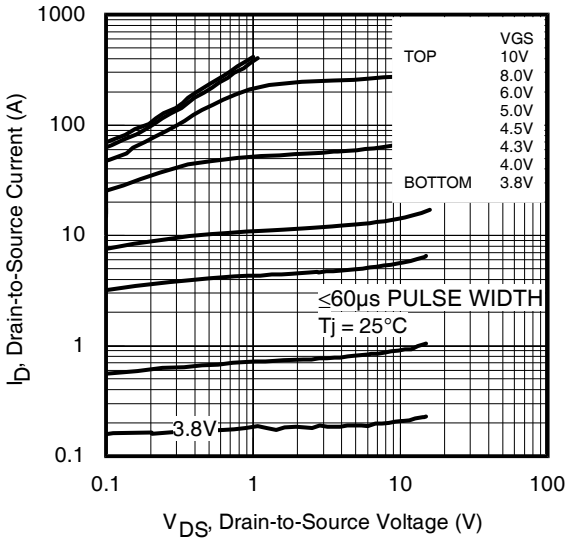



**Fig 1.** Typical Output Characteristics

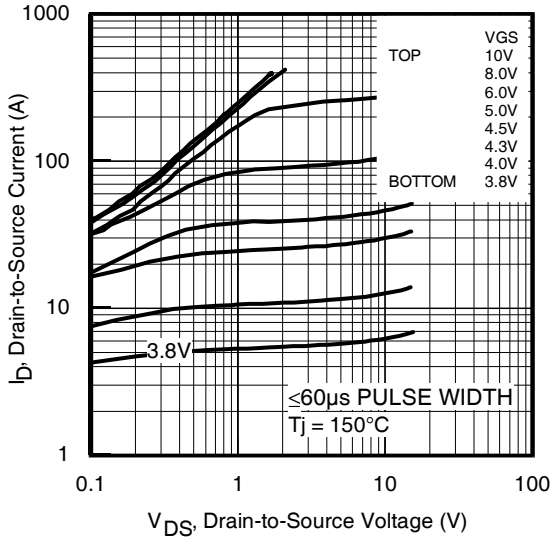



**Fig 2.** Typical Output Characteristics

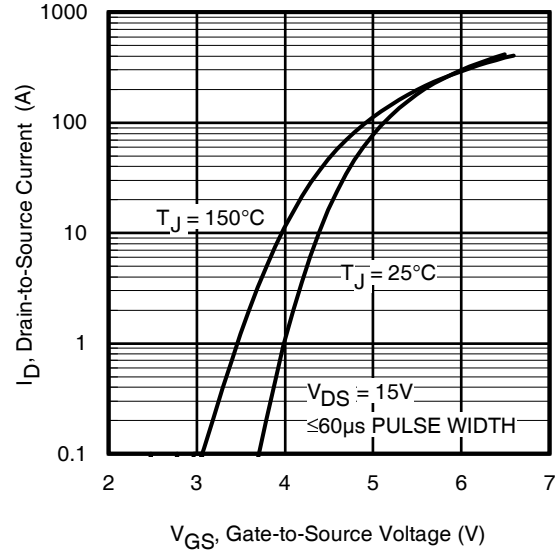



**Fig 3.** Typical Transfer Characteristics

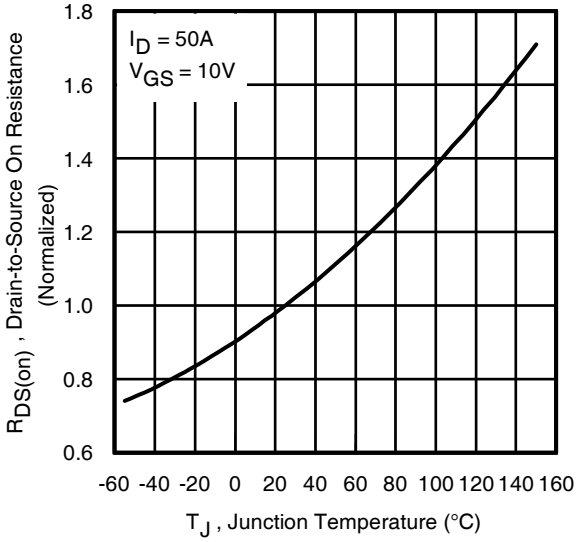



**Fig 4.** Normalized On-Resistance vs. Temperature

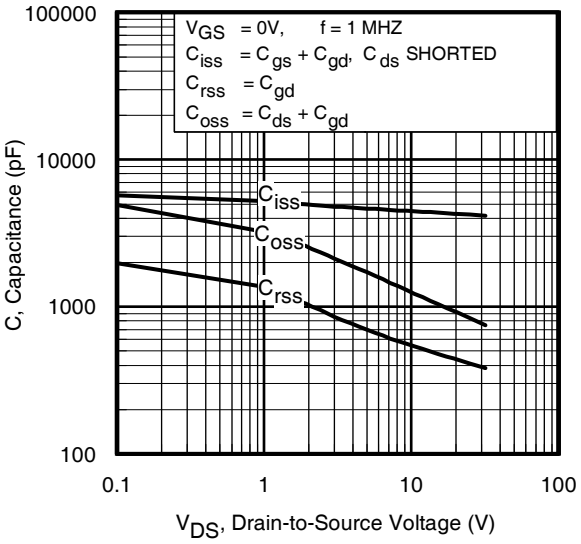



**Fig 5.** Typical Capacitance vs.Drain-to-Source Voltage

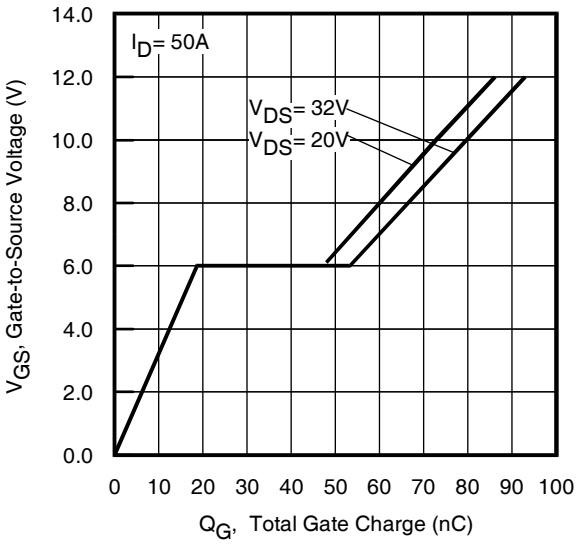



**Fig 6.** Typical Gate Charge vs.Gate-to-Source Voltage

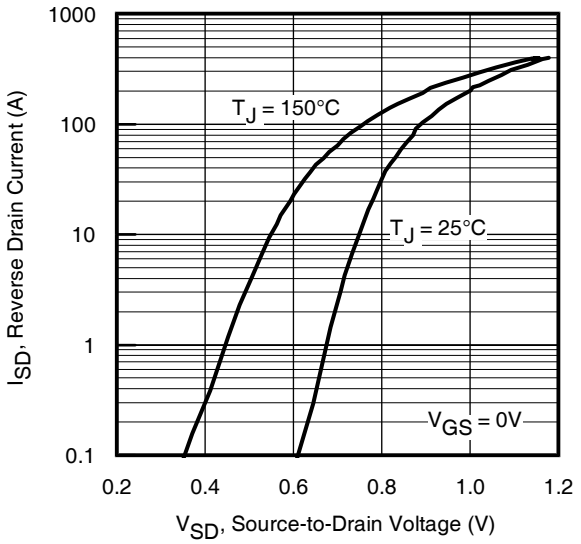



**Fig 7.** Typical Source-Drain Diode Forward Voltage

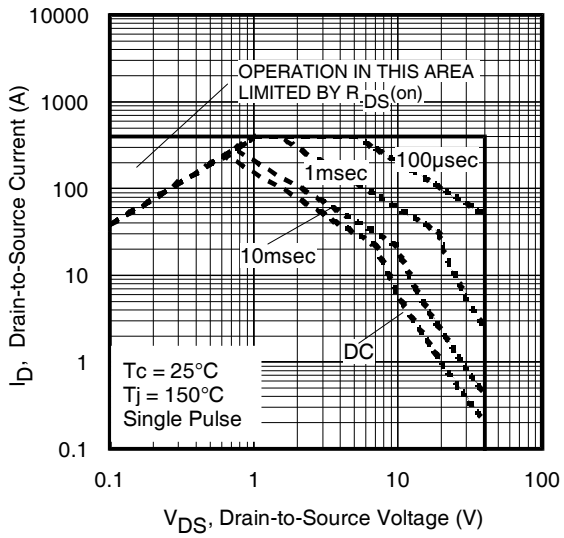



**Fig 8.** Maximum Safe Operating Area

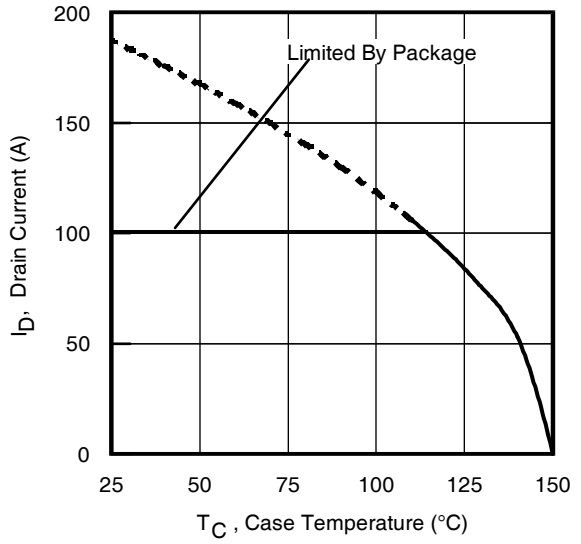



**Fig 9.** Maximum Drain Current vs. Case Temperature

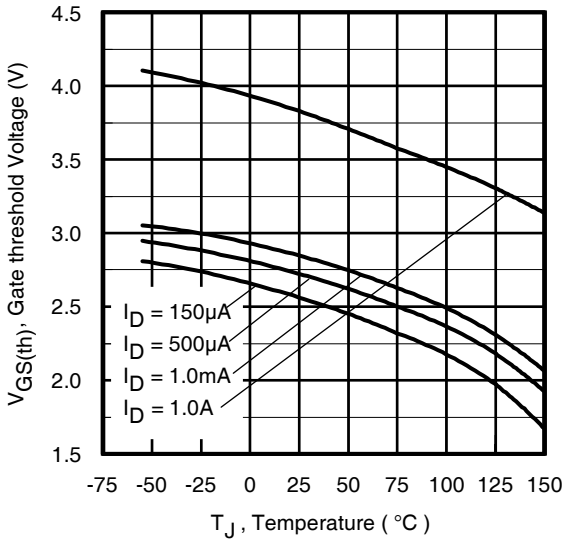



**Fig 10.** Threshold Voltage vs. Temperature

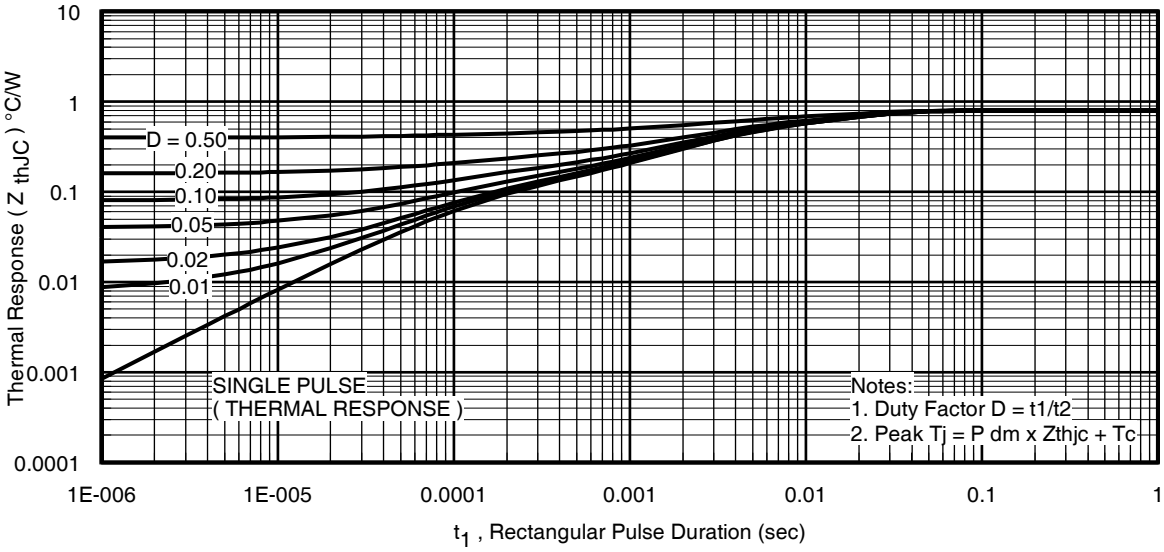



**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Mounting Base

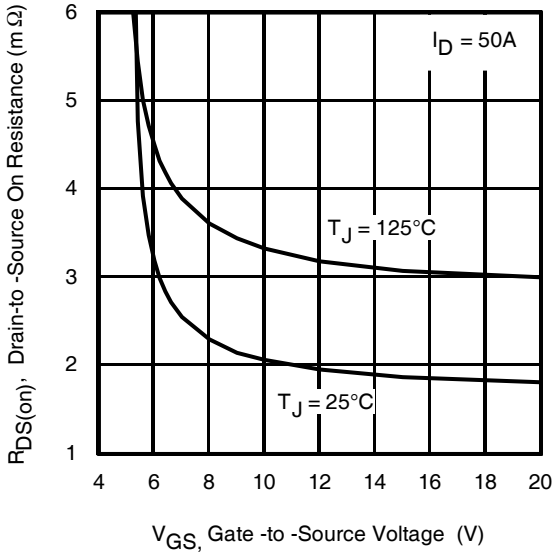



**Fig 12.** On-Resistance vs. Gate Voltage

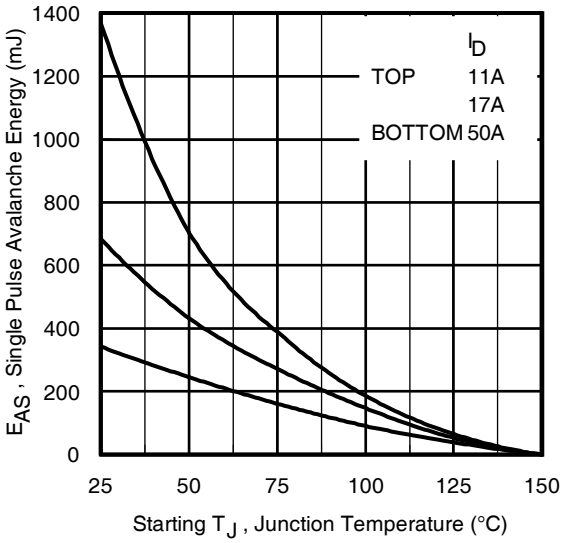



**Fig 13.** Maximum Avalanche Energy vs. Drain Current

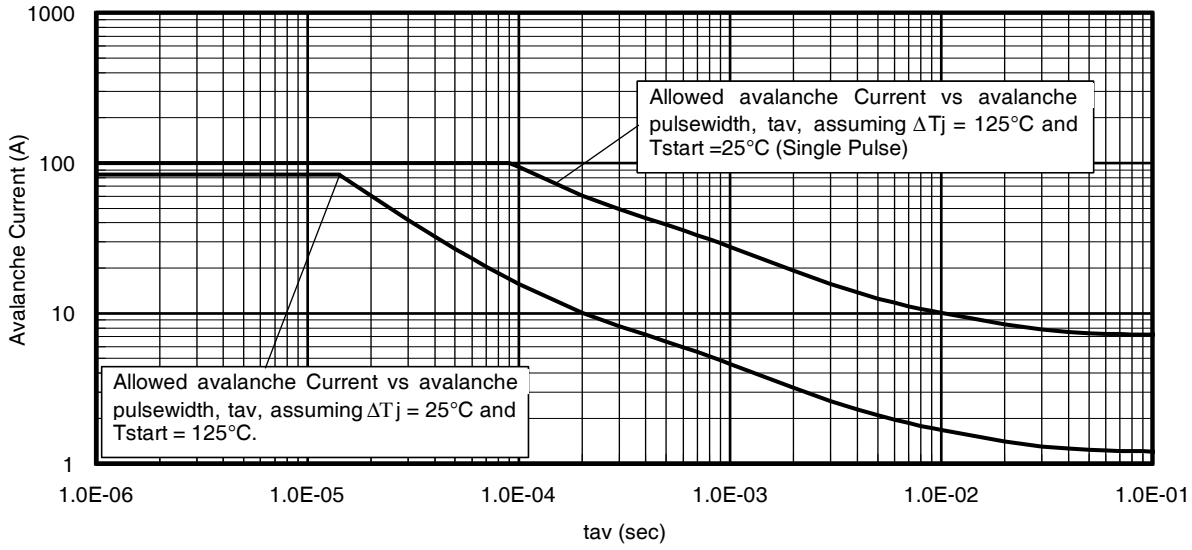
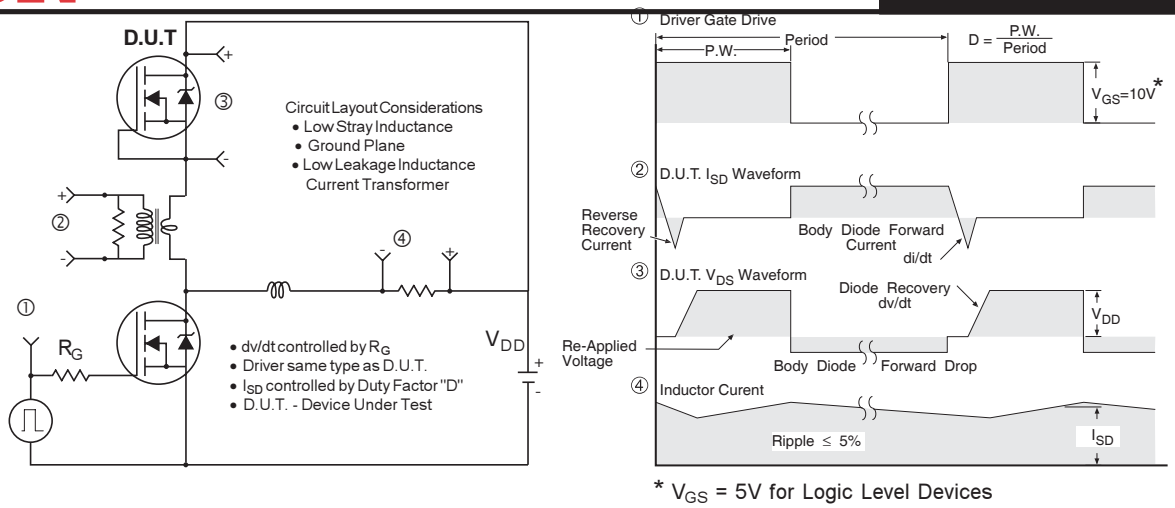



**Fig 14.** Typical Avalanche Current vs. Pulsewidth




* $V_{GS}$ = 5V for Logic Level Devices

**Fig 15.** Peak Diode Recovery dv/dt Test Circuit for N-Channel HEXFET® Power MOSFETs

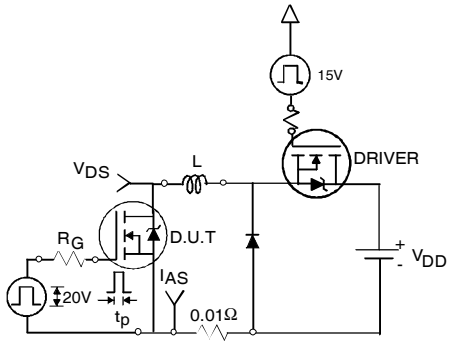



**Fig 16a.** Unclamped Inductive Test Circuit

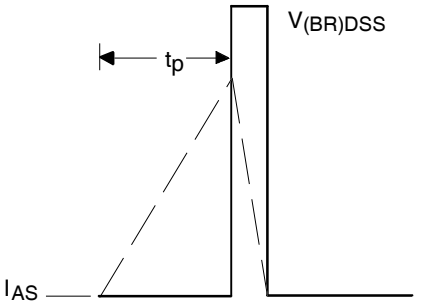



**Fig 16b.** Unclamped Inductive Waveforms

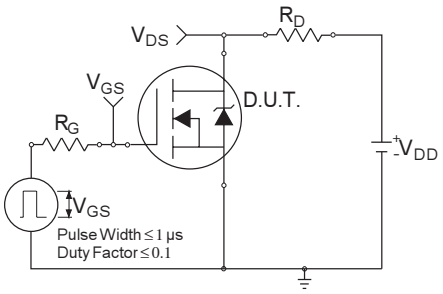



**Fig 17a.** Switching Time Test Circuit

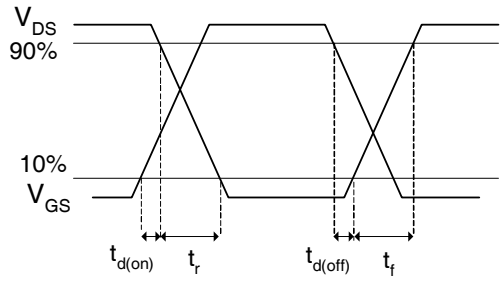



**Fig 17b.** Switching Time Waveforms

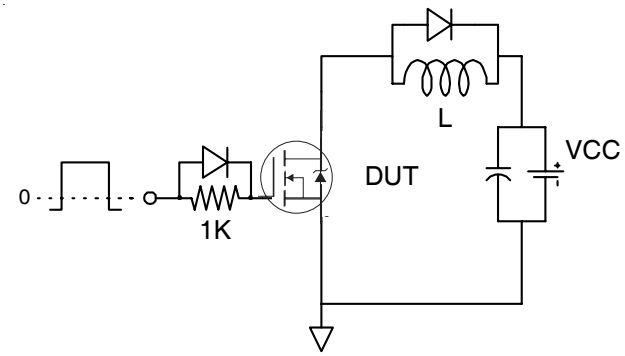



**Fig 18a.** Gate Charge Test Circuit

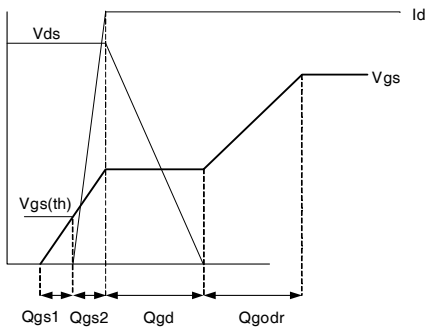
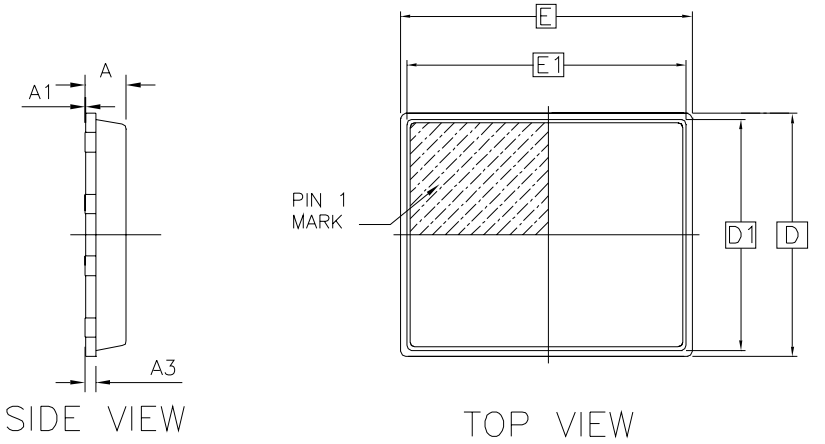
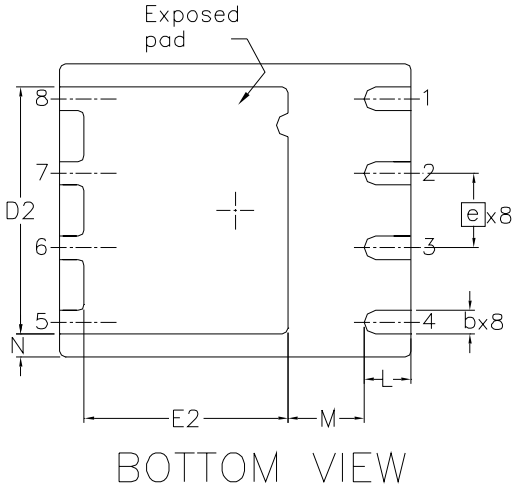



**Fig 18b.** Gate Charge Waveform

# PQFN 5x6 Outline "B" Package Details

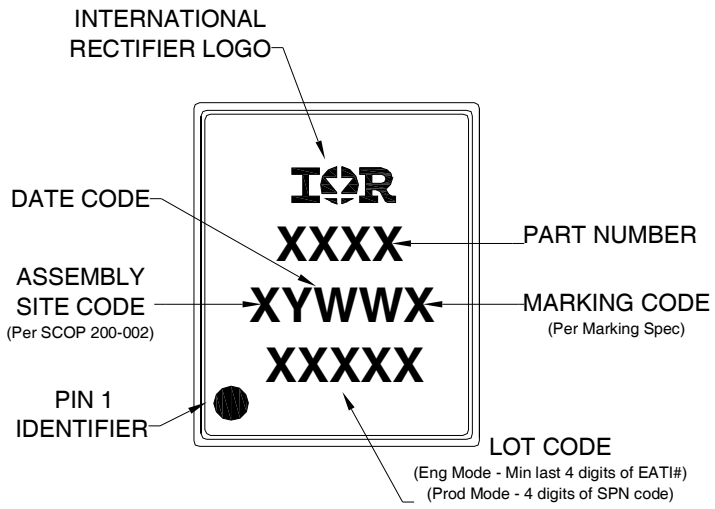



| OUTLINE PQFN 5x6B | | | |
|---|---|---|---|
| DIM / SYMBOL | MIN | NOM | MAX |
| A | 0.80 | 0.83 | 0.90 |
| A1 | 0 | 0.020 | 0.05 |
| A3 | | 0.20 REF | |
| b | 0.35 | 0.40 | 0.47 |
| D | | 5.00 BSC | |
| D1 | | 4.75 BSC | |
| D2 | 4.10 | 4.21 | 4.30 |
| e | | 1.27 BSC | |
| E | | 6.00 BSC | |
| E1 | | 5.75 BSC | |
| E2 | 3.38 | 3.48 | 3.58 |
| L | 0.70 | 0.80 | 0.90 |
| M | | 1.30 REF | |
| N | | 0.40 REF | |



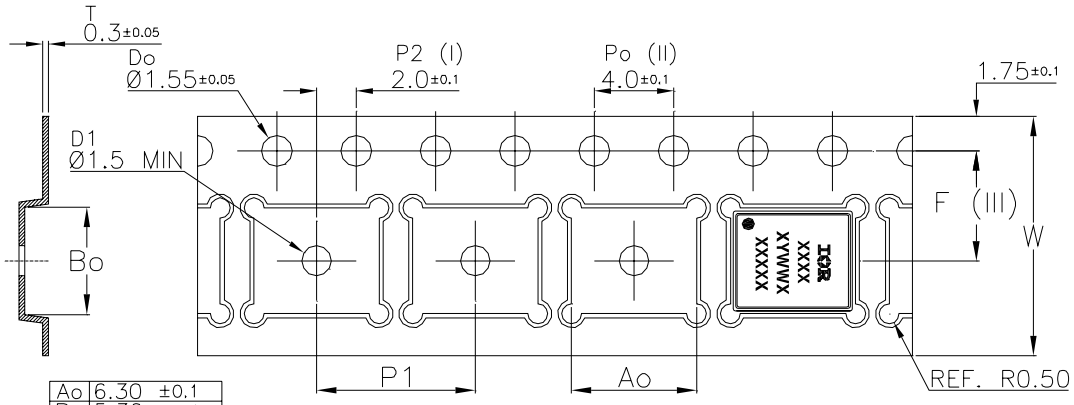

For more information on board mounting, including footprint and stencil recommendation, please refer to application note AN-1136: http://www.irf.com/technical-info/appnotes/an-1136.pdf
For more information on package inspection techniques, please refer to application note AN-1154: http://www.irf.com/technical-info/appnotes/an-1154.pdf

# PQFN 5x6 Outline "B" Part Marking




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

# PQFN 5x6 Outline "B" Tape and Reel




| | |
|---|---|
| Ao | 6.30 ±0.1 |
| Bo | 5.30 ±0.1 |
| F | 5.50 ±0.1 |
| P1 | 8.00 ±0.1 |
| W | 12.00 ±0.3 |

## Qualification information†

| | | |
|---|---|---|
| Qualification level | Industrial†† (per JEDEC JESD47F ††† guidelines ) | |
| Moisture Sensitivity Level | PQFN 5mm x 6mm | MSL1 (per JEDEC J-STD-020D††† ) |
| RoHS compliant | Yes | |

† Qualification standards can be found at International Rectifier's web site http://www.irf.com/product-info/reliability

†† Higher qualification ratings may be available should the user have such requirements. Please contact your International Rectifier sales representative for further information: http://www.irf.com/whoto-call/salesrep/

††† Applicable version of JEDEC standard at the time of product release.

**Notes:**

① Repetitive rating; pulse width limited by max. junction temperature.

② Starting $T_J$ = 25°C, L = 0.27mH, $R_G$ = 50Ω, $I_{AS}$ = 50A.

③ Pulse width ≤ 400µs; duty cycle ≤ 2%.

④ $R_\theta$ is measured at $T_J$ of approximately 90°C.

⑤ When mounted on 1 inch square 2 oz copper pad on 1.5x1.5 in. board of FR-4 material.

⑥ Calculated continuous current based on maximum allowable junction temperature. Package is limited to 100A by production test capability.

## Revision History

| Date | Comment |
|---|---|
| 1/13/2014 | • Updated ordering information to reflect the End-Of-Life (EOL) of the mini-reel option (EOL notice #259).<br>• Updated data sheet with the new IR corporate template. |

International IOR Rectifier

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To contact International Rectifier, please visit http://www.irf.com/whoto-call/