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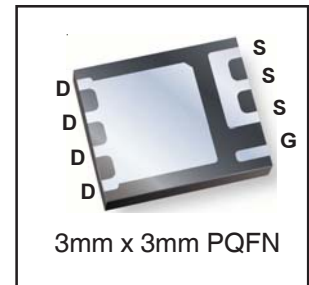
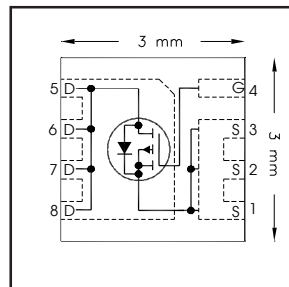
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|  |             |           |
|--|-------------|-----------|
| $V_{DS}$                                 | <b>-30</b>  | <b>V</b>  |
| $R_{DS(on) max}$<br>(@ $V_{GS} = -10V$ ) | <b>14.6</b> | <b>mΩ</b> |
| $Q_g$ (typical)                          | <b>32</b>   | <b>nC</b> |
| $I_D$<br>(@ $T_A = 25^\circ C$ )         | <b>-11</b>  | <b>A</b>  |



### Applications

- System/load switch

### Features and Benefits

#### Features

|  |
|--|
| Low Thermal Resistance to PCB (<6.0°C/W)                     |
| Compatible with Existing Surface Mount Techniques            |
| RoHS Compliant Containing no Lead, no Bromide and no Halogen |
| MSL1, Consumer Qualification                                 |

results in

⇒

#### Benefits

|                                   |
|-----------------------------------|
| Enable better thermal dissipation |
| Easier Manufacturing              |
| Environmentally Friendlier        |
| Increased Reliability             |

| Orderable part number | Package Type   | Standard Pack |          | Note             |
|-----------------------|----------------|---------------|----------|------------------|
|                       |                | Form          | Quantity |                  |
| IRFHM9331TRPbF        | PQFN 3mm x 3mm | Tape and Reel | 4000     |                  |
| IRFHM9331TR2PbF       | PQFN 3mm x 3mm | Tape and Reel | 400      | EOL notice # 259 |

### Absolute Maximum Ratings

|                            | Parameter   | Max.             | Units |
|----------------------------|---|------------------|-------|
| $V_{DS}$                   | Drain-to-Source Voltage                             | -30              | V     |
| $V_{GS}$                   | Gate-to-Source Voltage                              | ± 25             |       |
| $I_D$ @ $T_A = 25^\circ C$ | Continuous Drain Current, $V_{GS}$ @ -10V           | -11              | A     |
| $I_D$ @ $T_A = 70^\circ C$ | Continuous Drain Current, $V_{GS}$ @ -10V           | -9               |       |
| $I_D$ @ $T_C = 25^\circ C$ | Continuous Drain Current, $V_{GS}$ @ -10V           | -24 <sup>⑦</sup> |       |
| $I_D$ @ $T_C = 70^\circ C$ | Continuous Drain Current, $V_{GS}$ @ -10V           | -24              |       |
| $I_{DM}$                   | Pulsed Drain Current <sup>①</sup>                   | -90              |       |
| $P_D$ @ $T_A = 25^\circ C$ | Power Dissipation <sup>④</sup>                      | 2.8              | W     |
| $P_D$ @ $T_A = 70^\circ C$ | Power Dissipation <sup>④</sup>                      | 1.8              |       |
|                            | Linear Derating Factor                              | 0.02             | W/°C  |
| $T_J$<br>$T_{STG}$         | Operating Junction and<br>Storage Temperature Range | -55 to + 150     | °C    |

Notes <sup>①</sup> through <sup>⑦</sup> are on page 2

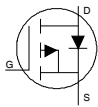
**Static @ T<sub>J</sub> = 25°C (unless otherwise specified)**

|                                     | Parameter                            | Min. | Typ. | Max. | Units | Conditions  |
|-------------------------------------|--------------------------------------|------|------|------|-------|---|
| BV <sub>DSS</sub>                   | Drain-to-Source Breakdown Voltage    | -30  | —    | —    | V     | V <sub>GS</sub> = 0V, I <sub>D</sub> = -250μA                           |
| ΔBV <sub>DSS</sub> /ΔT <sub>J</sub> | Breakdown Voltage Temp. Coefficient  | —    | 0.02 | —    | V/°C  | Reference to 25°C, I <sub>D</sub> = -1mA                                |
| R <sub>DS(on)</sub>                 | Static Drain-to-Source On-Resistance | —    | 10.0 | —    | mΩ    | V <sub>GS</sub> = -20V, I <sub>D</sub> = -11A ③                         |
|                                     |                                      | —    | 11.7 | 14.6 |       | V <sub>GS</sub> = -10V, I <sub>D</sub> = -11A ③                         |
| V <sub>GS(th)</sub>                 | Gate Threshold Voltage               | -1.3 | -1.8 | -2.4 | V     | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = -25μA              |
| ΔV <sub>GS(th)</sub>                | Gate Threshold Voltage Coefficient   | —    | -5.1 | —    | mV/°C |   |
| I <sub>DSS</sub>                    | Drain-to-Source Leakage Current      | —    | —    | -1.0 | μA    | V <sub>DS</sub> = -24V, V <sub>GS</sub> = 0V                            |
|                                     |                                      | —    | —    | -150 |       | V <sub>DS</sub> = -24V, V <sub>GS</sub> = 0V, T <sub>J</sub> = 125°C    |
| I <sub>GSS</sub>                    | Gate-to-Source Forward Leakage       | —    | —    | -10  | μA    | V <sub>GS</sub> = -25V  |
|                                     | Gate-to-Source Reverse Leakage       | —    | —    | 10   |       | V <sub>GS</sub> = 25V   |
| g <sub>fs</sub>                     | Forward Transconductance             | 16   | —    | —    | S     | V <sub>DS</sub> = -10V, I <sub>D</sub> = -9.0A                          |
| Q <sub>g</sub>                      | Total Gate Charge ⑥                  | —    | 16   | —    | nC    | V <sub>DS</sub> = -15V, V <sub>GS</sub> = -4.5V, I <sub>D</sub> = -9.0A |
| Q <sub>g</sub>                      | Total Gate Charge ⑥                  | —    | 32   | 48   | nC    | V <sub>GS</sub> = -10V  |
| Q <sub>gs</sub>                     | Gate-to-Source Charge ⑥              | —    | 4.4  | —    |       | V <sub>DS</sub> = -15V  |
| Q <sub>gd</sub>                     | Gate-to-Drain Charge ⑥               | —    | 8    | —    |       | I <sub>D</sub> = -9.0A  |
| R <sub>G</sub>                      | Gate Resistance ⑥                    | —    | 16   | —    | Ω     |   |
| t <sub>d(on)</sub>                  | Turn-On Delay Time                   | —    | 11   | —    | ns    | V <sub>DD</sub> = -15V, V <sub>GS</sub> = -4.5V ③                       |
| t <sub>r</sub>                      | Rise Time                            | —    | 27   | —    |       | I <sub>D</sub> = -1.0A  |
| t <sub>d(off)</sub>                 | Turn-Off Delay Time                  | —    | 72   | —    |       | R <sub>G</sub> = 6.8Ω   |
| t <sub>f</sub>                      | Fall Time                            | —    | 60   | —    |       | See Figs. 19a & 19b   |
| C <sub>iss</sub>                    | Input Capacitance                    | —    | 1543 | —    | pF    | V <sub>GS</sub> = 0V  |
| C <sub>oss</sub>                    | Output Capacitance                   | —    | 310  | —    |       | V <sub>DS</sub> = -25V  |
| C <sub>rss</sub>                    | Reverse Transfer Capacitance         | —    | 208  | —    |       | f = 1.0KHz  |

**Avalanche Characteristics**

|                 | Parameter                       | Typ. | Max. | Units |
|-----------------|---------------------------------|------|------|-------|
| E <sub>AS</sub> | Single Pulse Avalanche Energy ② | —    | 76   | mJ    |
| I <sub>AR</sub> | Avalanche Current ①             | —    | -9.0 | A     |

**Diode Characteristics**

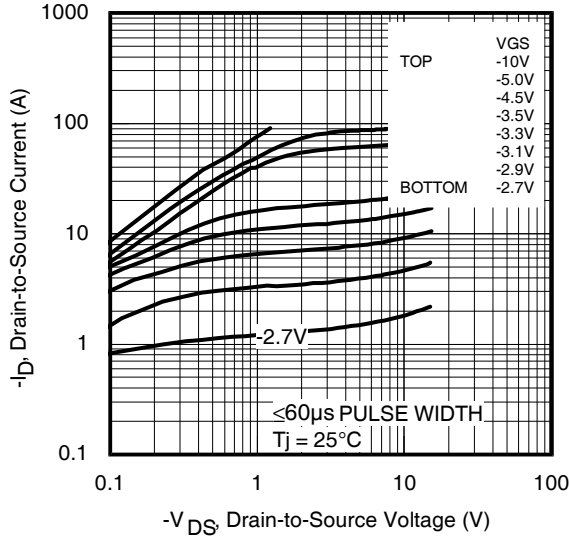
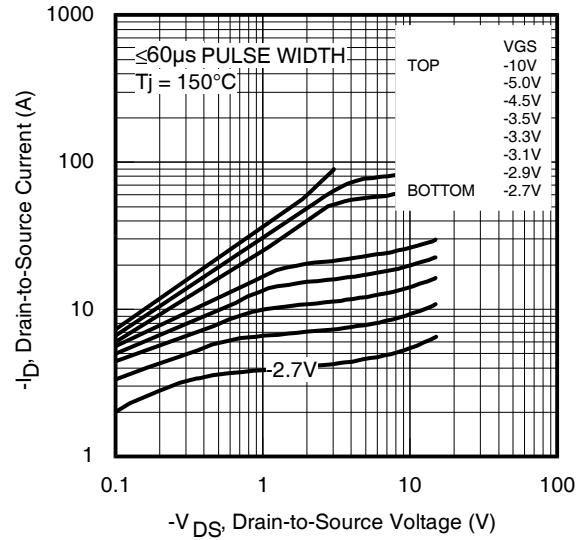
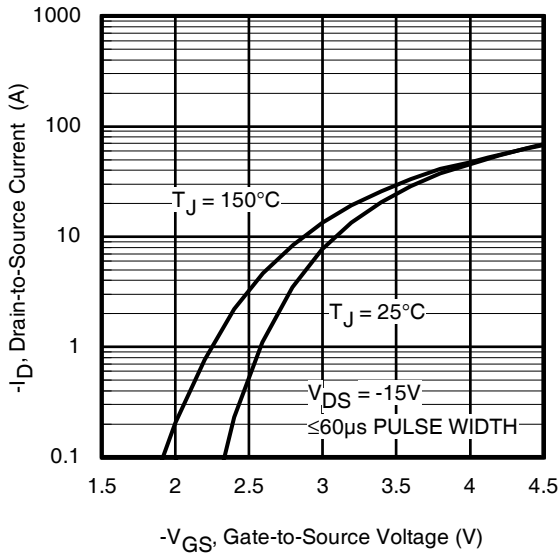
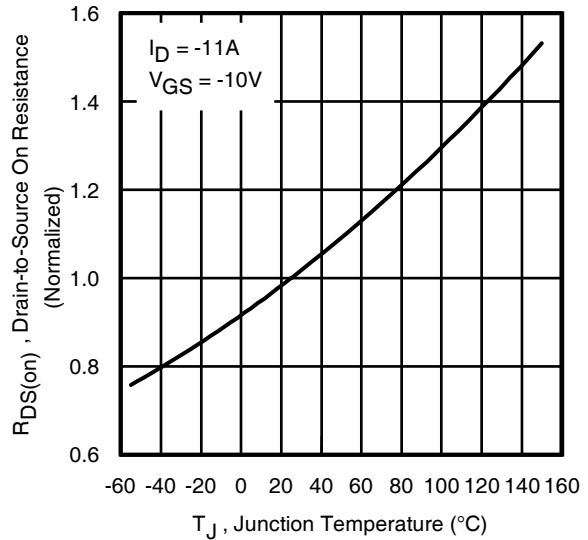
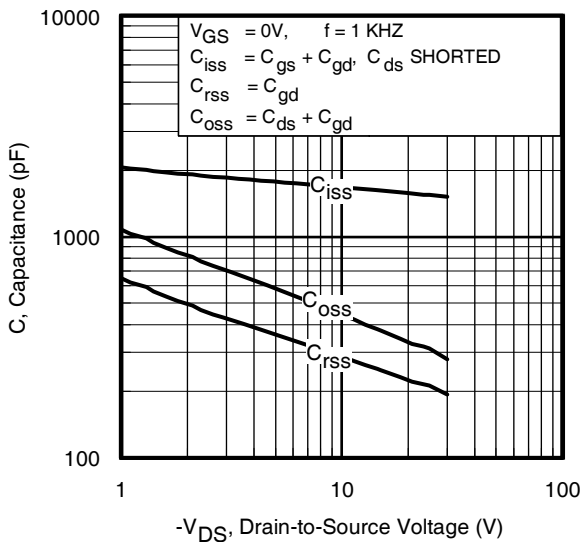
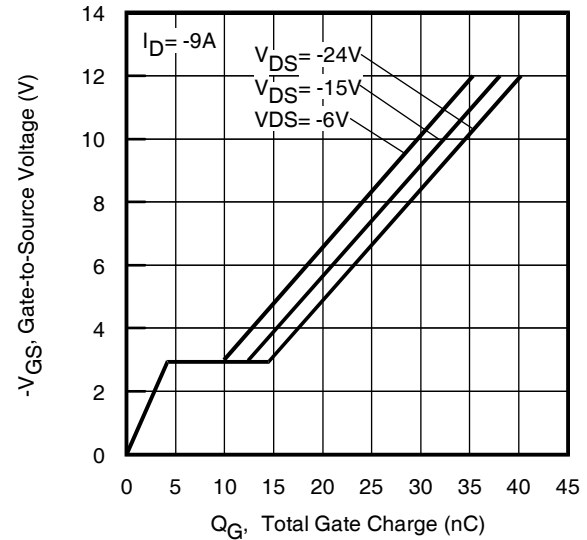
|                 | Parameter                              | Min. | Typ. | Max. | Units | Conditions   |
|-----------------|--|------|------|------|-------|--|
| I <sub>S</sub>  | Continuous Source Current (Body Diode) | —    | —    | -2.8 | A     | MOSFET symbol showing the integral reverse p-n junction diode.  |
| I <sub>SM</sub> | Pulsed Source Current (Body Diode) ①   | —    | —    | -90  |       |  |
| V <sub>SD</sub> | Diode Forward Voltage                  | —    | —    | -1.2 | V     | T <sub>J</sub> = 25°C, I <sub>S</sub> = -2.8A, V <sub>GS</sub> = 0V ③  |
| t <sub>rr</sub> | Reverse Recovery Time                  | —    | 64   | 96   | ns    | T <sub>J</sub> = 25°C, I <sub>F</sub> = -2.8A, V <sub>DD</sub> = -24V  |
| Q <sub>rr</sub> | Reverse Recovery Charge                | —    | 25   | 38   | nC    | di/dt = 100/μs ③   |

**Thermal Resistance**

|                  | Parameter                     | Typ. | Max. | Units |
|------------------|-------------------------------|------|------|-------|
| R <sub>θJC</sub> | Junction-to-Case ④            | —    | 6    | °C/W  |
| R <sub>θJA</sub> | Junction-to-Ambient ④         | —    | 45   |       |
| R <sub>θJA</sub> | Junction-to-Ambient (t<10s) ④ | —    | 30   |       |

**Notes:**

- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Starting T<sub>J</sub> = 25°C, L = 1.904mH, R<sub>G</sub> = 50Ω, I<sub>AS</sub> = -9A.
- ③ Pulse width ≤ 400μs; duty cycle ≤ 2%.
- ④ When mounted on 1 inch square copper board.
- ⑤ R<sub>θ</sub> is measured at T<sub>J</sub> of approximately 90°C.
- ⑥ For DESIGN AID ONLY, not subject to production testing.
- ⑦ Current limited by package.


**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

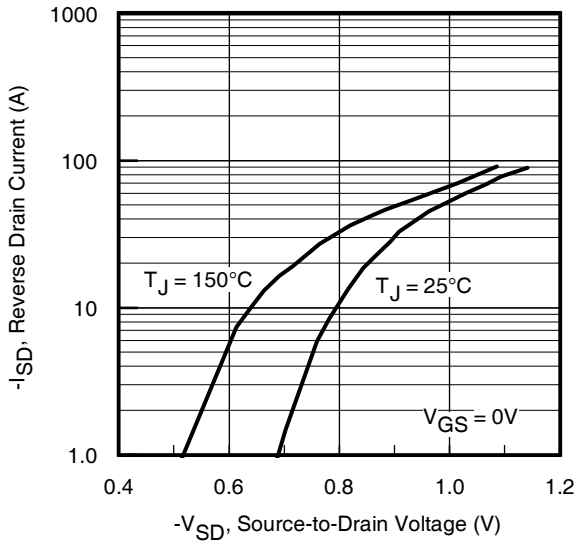


Fig 7. Typical Source-Drain Diode Forward Voltage

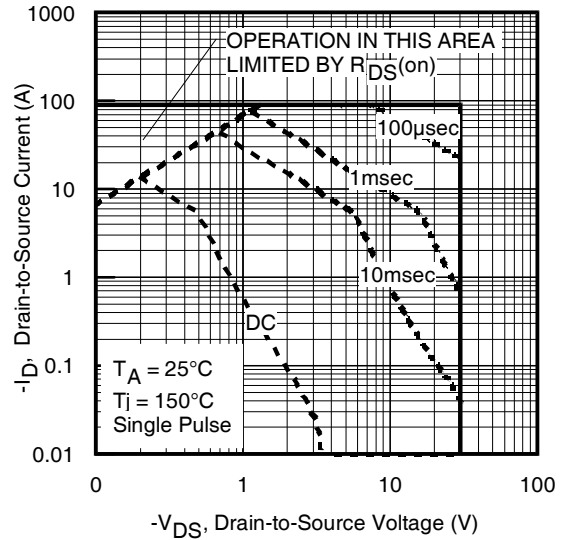


Fig 8. Maximum Safe Operating Area

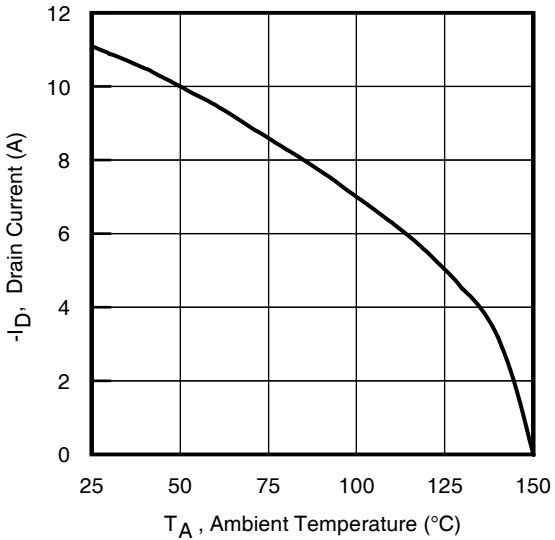


Fig 9. Maximum Drain Current vs. Ambient Temperature

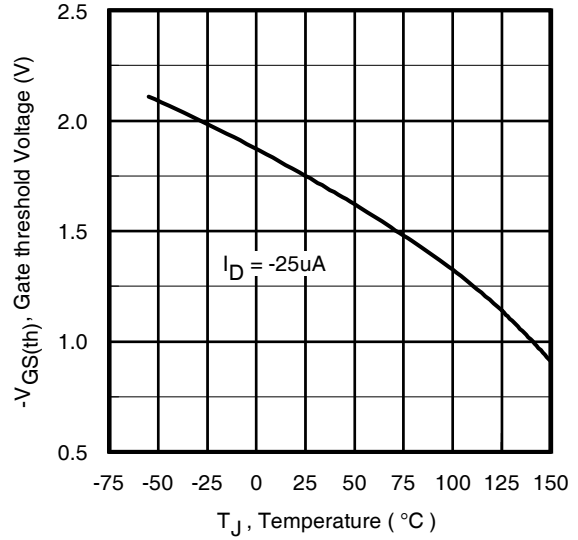


Fig 10. Threshold Voltage vs. Temperature

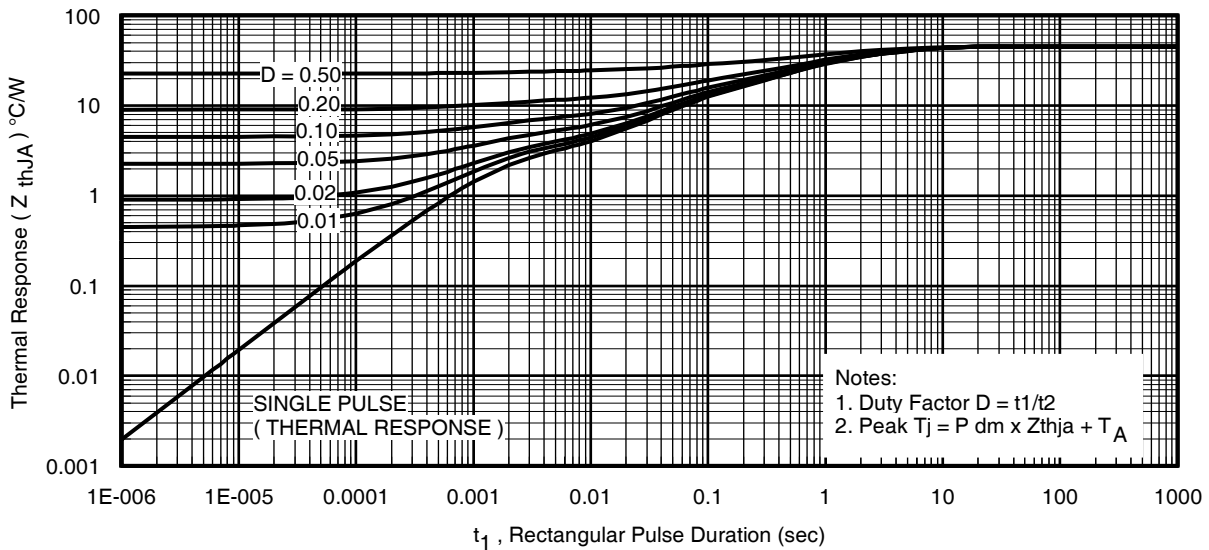
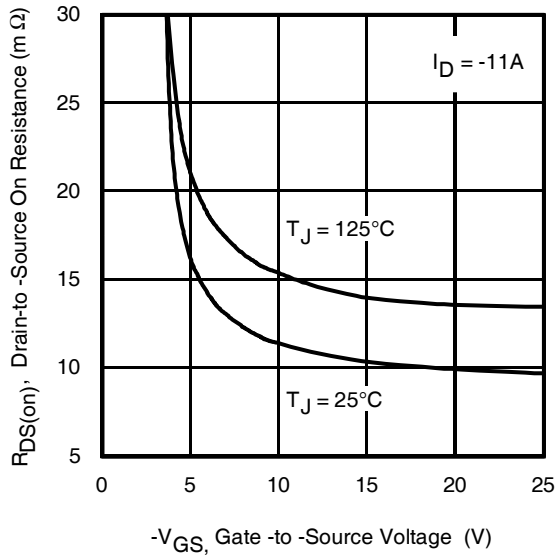
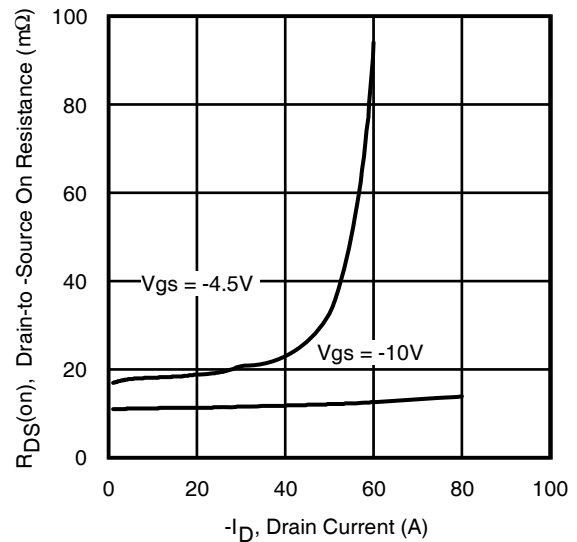
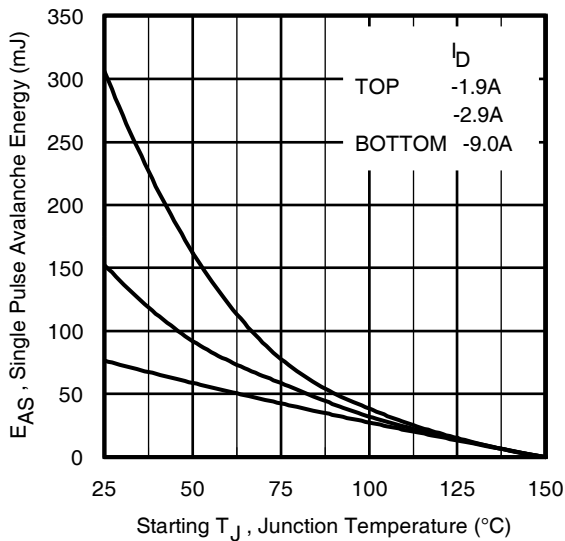
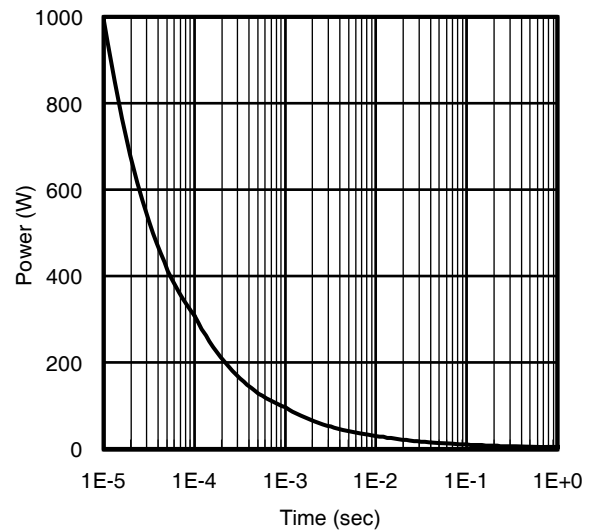
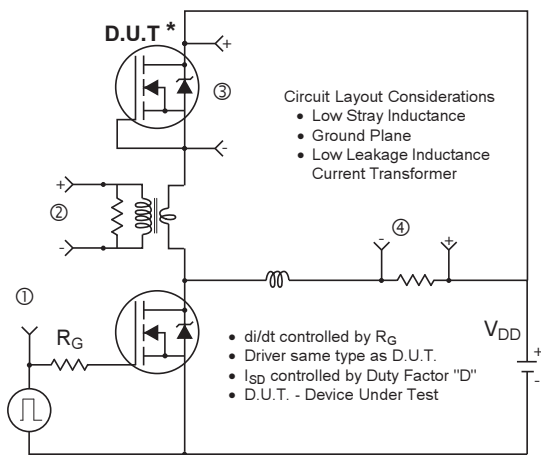
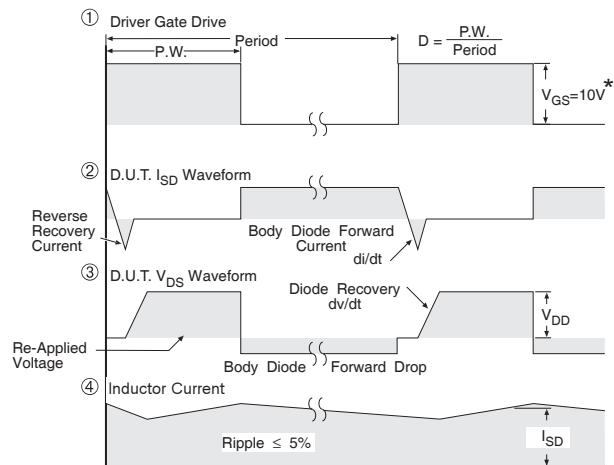


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Ambient


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

**Fig 13. Typical On-Resistance vs. Drain Current**

**Fig 14. Maximum Avalanche Energy vs. Drain Current**

**Fig 15. Typical Power vs. Time**


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



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

**Fig 16. Diode Reverse Recovery Test Circuit for P-Channel HEXFET<sup>®</sup> Power MOSFETs**

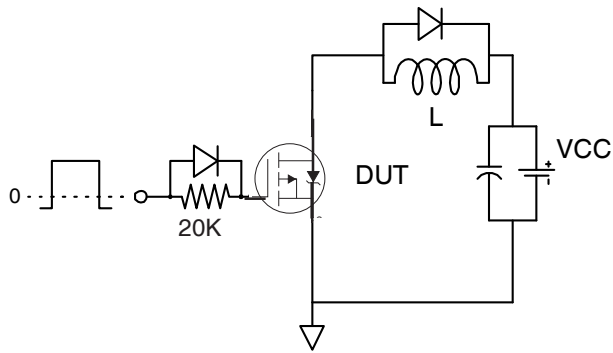


Fig 17a. Gate Charge Test Circuit

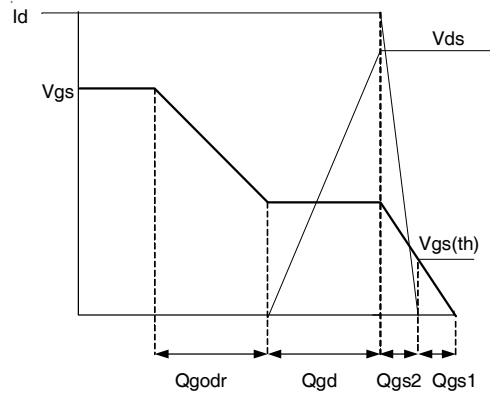


Fig 17b. Gate Charge Waveform

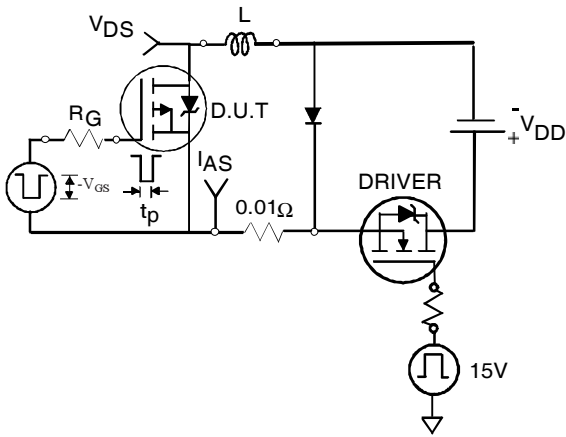


Fig 18a. Unclamped Inductive Test Circuit

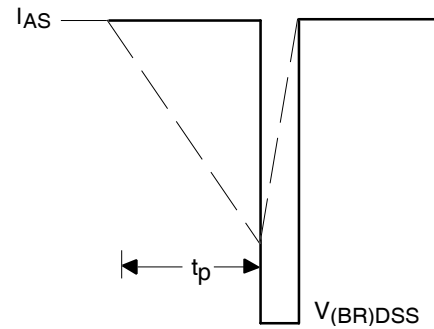


Fig 18b. Unclamped Inductive Waveforms

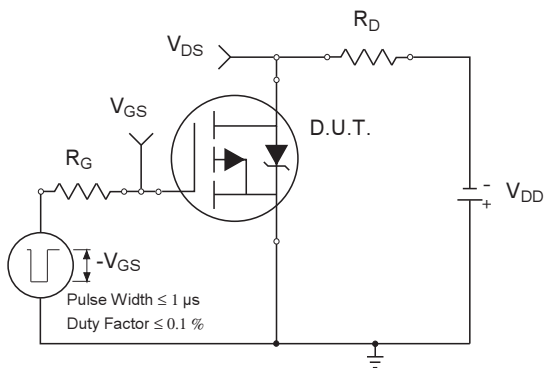


Fig 19a. Switching Time Test Circuit

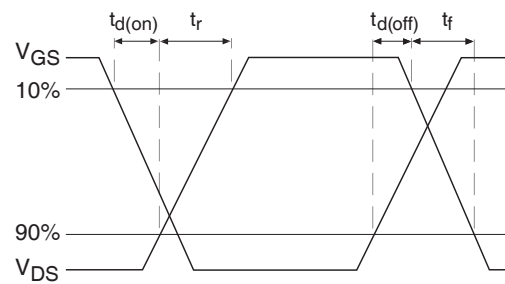
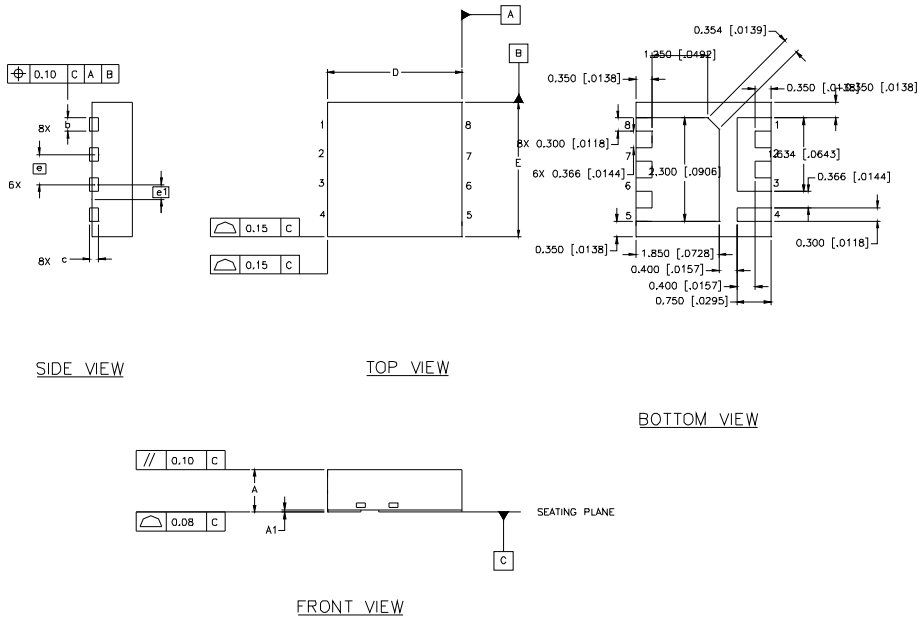


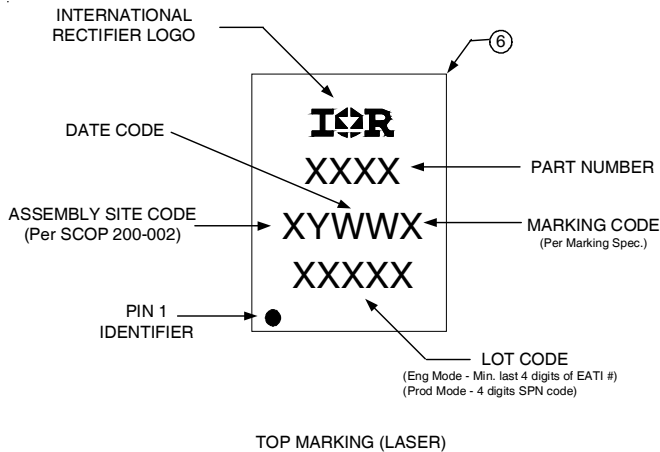
Fig 19b. Switching Time Waveforms

## PQFN Package Details



| DIM | INCHES      |       | MILLIMETERS |       |
|-----|-------------|-------|-------------|-------|
|     | MIN         | MAX   | MIN         | MAX   |
| A   | .0315       | .0394 | 0.800       | 1.000 |
| A1  | .0000       | .0020 | 0.000       | 0.050 |
| b   | .0098       | .0138 | 0.250       | 0.350 |
| c   | .0080 REF.  |       | 0.203 REF.  |       |
| D   | .1181 BASIC |       | 3.000 BASIC |       |
| E   | .1181 BASIC |       | 3.000 BASIC |       |
| e   | .0262 BASIC |       | 0.666 BASIC |       |
| e1  | .0131 BASIC |       | 0.333 BASIC |       |

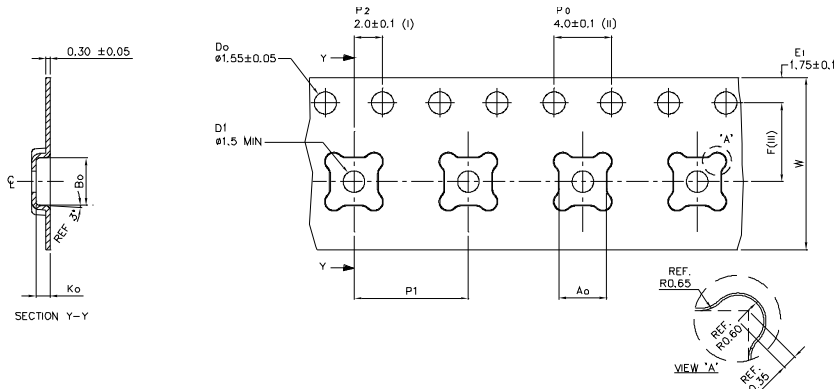
## PQFN Part Marking



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



**PQFN Tape and Reel**



|    |       |         |
|----|-------|---------|
| Ao | 3.30  | +/- 0.1 |
| Bo | 3.30  | +/- 0.1 |
| Ko | 1.00  | +/- 0.1 |
| F  | 5.50  | +/- 0.1 |
| P1 | 8.00  | +/- 0.1 |
| W  | 12.00 | +/- 0.3 |

(i) Measured from centreline of sprocket hole to centreline of pocket.  
 (ii) Cumulative tolerance of 10 sprocket holes is ± 0.20.  
 (iii) Measured from centreline of sprocket hole to centreline of pocket.  
 (iv) Other material available.  
 ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.

**Qualification information†**

|                            |   |  |
|----------------------------|---|--|
| Qualification level        | Consumer <sup>††</sup><br>(per JEDEC JESD47F <sup>†††</sup> guidelines) |  |
| Moisture Sensitivity Level | PQFN 3mm x 3mm  | MSL1<br>(per IPC/JEDEC J-STD-020D <sup>†††</sup> ) |
| 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.

**Revision History**

| Date       | Comments   |
|------------|--|
| 12/16/2013 | <ul style="list-style-type: none"> <li>• Updated ordering information to reflect the End-Of-life (EOL) of the mini-reel option (EOL notice #259)</li> <li>• Updated data sheet with new IR corporate template</li> </ul> |