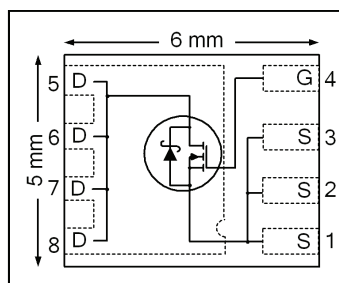


HEXFET® Power MOSFET

|                                                            |              |           |
|------------------------------------------------------------|--------------|-----------|
| <b>V<sub>DSS</sub></b>                                     | <b>25</b>    | <b>V</b>  |
| <b>R<sub>DS(on)</sub> max</b><br>(@ V <sub>GS</sub> = 10V) | <b>1.10</b>  | <b>mΩ</b> |
| (@ V <sub>GS</sub> = 4.5V)                                 | <b>1.35</b>  |           |
| <b>Qg (typical)</b>                                        | <b>37.0</b>  | <b>nC</b> |
| <b>I<sub>D</sub></b><br>(@T <sub>C (Bottom)</sub> = 25°C)  | <b>100</b> ⑦ | <b>A</b>  |



PQFN 5X6 mm

## Applications

- Synchronous Rectifier MOSFET for Synchronous Buck Converters

## Features

|                                                   |
|---------------------------------------------------|
| Low R <sub>DS(ON)</sub> (<1.10 mΩ)                |
| Schottky Intrinsic Diode with Low Forward Voltage |
| Low Thermal Resistance to PCB (<1.0°C/W)          |
| Low Profile (<0.9 mm)                             |
| Industry-Standard Pinout                          |
| Compatible with Existing Surface Mount Techniques |
| RoHS Compliant, Halogen-Free                      |
| MSL1, Industrial Qualification                    |

results in



## Benefits

|                                   |
|-----------------------------------|
| Lower Conduction Losses           |
| Lower Switching Losses            |
| Enable better thermal dissipation |
| Increased Power Density           |
| Multi-Vendor Compatibility        |
| Easier Manufacturing              |
| Environmentally Friendlier        |
| Increased Reliability             |

| Base part number | Package Type    | Standard Pack |          | Orderable Part Number |
|------------------|-----------------|---------------|----------|-----------------------|
|                  |                 | Form          | Quantity |                       |
| IRFH4210DPbF     | PQFN 5mm x 6 mm | Tape and Reel | 4000     | IRFH4210DTRPbF        |

## Absolute Maximum Ratings

|                                                 | Parameter                                                                              | Max.         | Units |
|-------------------------------------------------|----------------------------------------------------------------------------------------|--------------|-------|
| V <sub>GS</sub>                                 | Gate-to-Source Voltage                                                                 | ± 20         | V     |
| I <sub>D</sub> @ T <sub>A</sub> = 25°C          | Continuous Drain Current, V <sub>GS</sub> @ 10V                                        | 44           | A     |
| I <sub>D</sub> @ T <sub>C(Bottom)</sub> = 25°C  | Continuous Drain Current, V <sub>GS</sub> @ 10V                                        | 266⑥⑦        |       |
| I <sub>D</sub> @ T <sub>C(Bottom)</sub> = 100°C | Continuous Drain Current, V <sub>GS</sub> @ 10V                                        | 168⑥⑦        |       |
| I <sub>D</sub> @ T <sub>C(Bottom)</sub> = 25°C  | Continuous Drain Current, V <sub>GS</sub> @ 10V<br>(Source Bonding Technology Limited) | 100⑦         |       |
| I <sub>DM</sub>                                 | Pulsed Drain Current ①                                                                 | 400          |       |
| P <sub>D</sub> @ T <sub>A</sub> = 25°C          | Power Dissipation ⑤                                                                    | 3.5          | W     |
| P <sub>D</sub> @ T <sub>C(Bottom)</sub> = 25°C  | Power Dissipation                                                                      | 125          |       |
|                                                 | Linear Derating Factor                                                                 | 0.028        | W/°C  |
| T <sub>J</sub><br>T <sub>STG</sub>              | Operating Junction and<br>Storage Temperature Range                                    | -55 to + 150 | °C    |

Notes ① through ⑦ are on page 9

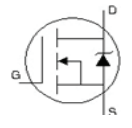
**Static @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)**

|                              | Parameter                            | Min. | Typ. | Max. | Units                | Conditions                                                        |
|------------------------------|--------------------------------------|------|------|------|----------------------|-------------------------------------------------------------------|
| $BV_{DSS}$                   | Drain-to-Source Breakdown Voltage    | 25   | —    | —    | V                    | $V_{GS} = 0V, I_D = 1mA$                                          |
| $\Delta BV_{DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient  | —    | 19   | —    | mV/ $^\circ\text{C}$ | Reference to $25^\circ\text{C}$ , $I_D = 10mA$                    |
| $R_{DS(on)}$                 | Static Drain-to-Source On-Resistance | —    | 0.85 | 1.10 | m $\Omega$           | $V_{GS} = 10V, I_D = 50A$ ③                                       |
|                              |                                      | —    | 1.10 | 1.35 |                      | $V_{GS} = 4.5V, I_D = 50A$ ③                                      |
| $V_{GS(th)}$                 | Gate Threshold Voltage               | 1.1  | 1.6  | 2.1  | V                    | $V_{DS} = V_{GS}, I_D = 100\mu A$                                 |
| $\Delta V_{GS(th)}$          | Gate Threshold Voltage Coefficient   | —    | -10  | —    | mV/ $^\circ\text{C}$ |                                                                   |
| $I_{DSS}$                    | Drain-to-Source Leakage Current      | —    | —    | 250  | $\mu A$              | $V_{DS} = 20V, V_{GS} = 0V$                                       |
| $I_{GSS}$                    | Gate-to-Source Forward Leakage       | —    | —    | 100  | nA                   | $V_{GS} = 20V$                                                    |
|                              | Gate-to-Source Reverse Leakage       | —    | —    | -100 |                      | $V_{GS} = -20V$                                                   |
| $g_{fs}$                     | Forward Transconductance             | 392  | —    | —    | S                    | $V_{DS} = 13V, I_D = 50A$                                         |
| $Q_g$                        | Total Gate Charge                    | —    | 77.0 | —    | nC                   | $V_{GS} = 10V, V_{DS} = 13V, I_D = 50A$                           |
| $Q_g$                        | Total Gate Charge                    | —    | 37.0 | 55.5 | nC                   | $V_{DS} = 13V$<br>$V_{GS} = 4.5V$<br>$I_D = 50A$                  |
| $Q_{gs1}$                    | Pre-Vth Gate-to-Source Charge        | —    | 7.6  | —    |                      |                                                                   |
| $Q_{gs2}$                    | Post-Vth Gate-to-Source Charge       | —    | 6.4  | —    |                      |                                                                   |
| $Q_{gd}$                     | Gate-to-Drain Charge                 | —    | 13.2 | —    |                      |                                                                   |
| $Q_{godr}$                   | Gate Charge Overdrive                | —    | 9.8  | —    |                      |                                                                   |
| $Q_{sw}$                     | Switch Charge ( $Q_{gs2} + Q_{gd}$ ) | —    | 19.6 | —    |                      |                                                                   |
| $Q_{oss}$                    | Output Charge                        | —    | 37   | —    | nC                   | $V_{DS} = 16V, V_{GS} = 0V$                                       |
| $R_G$                        | Gate Resistance                      | —    | 1.3  | —    | $\Omega$             |                                                                   |
| $t_{d(on)}$                  | Turn-On Delay Time                   | —    | 19   | —    | ns                   | $V_{DD} = 13V, V_{GS} = 4.5V$<br>$I_D = 50A$<br>$R_G = 1.8\Omega$ |
| $t_r$                        | Rise Time                            | —    | 45   | —    |                      |                                                                   |
| $t_{d(off)}$                 | Turn-Off Delay Time                  | —    | 24   | —    |                      |                                                                   |
| $t_f$                        | Fall Time                            | —    | 16   | —    |                      |                                                                   |
| $C_{iss}$                    | Input Capacitance                    | —    | 4812 | —    | pF                   | $V_{GS} = 0V$<br>$V_{DS} = 13V$<br>$f = 1.0MHz$                   |
| $C_{oss}$                    | Output Capacitance                   | —    | 1459 | —    |                      |                                                                   |
| $C_{rss}$                    | Reverse Transfer Capacitance         | —    | 355  | —    |                      |                                                                   |

**Avalanche Characteristics**

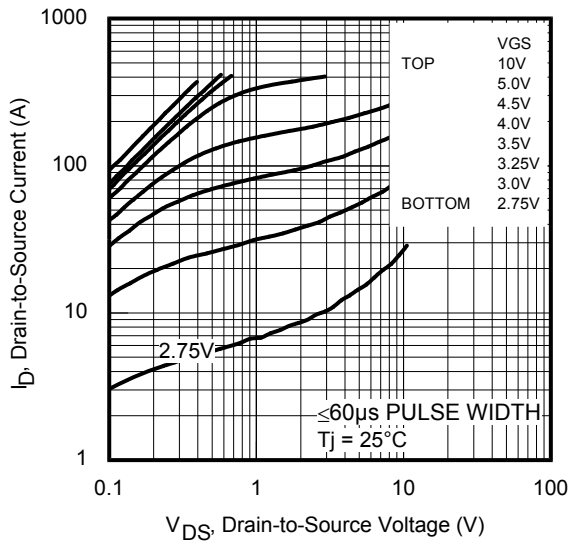
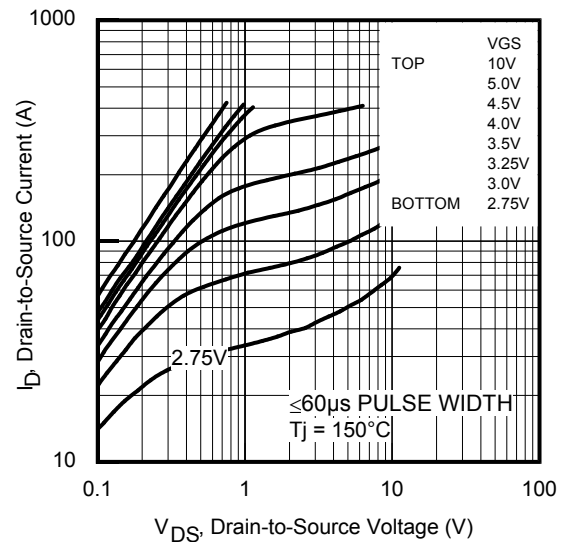
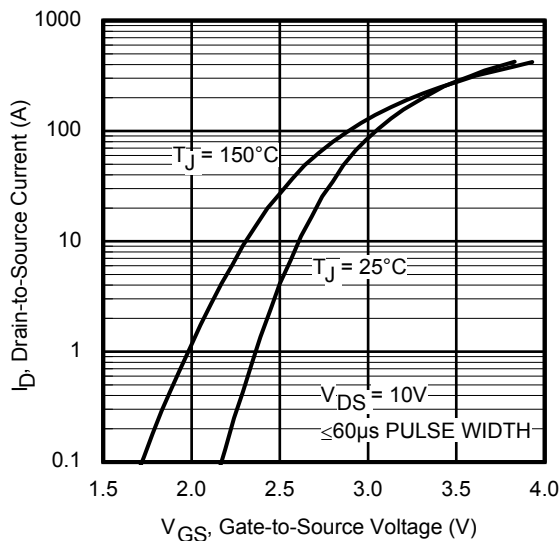
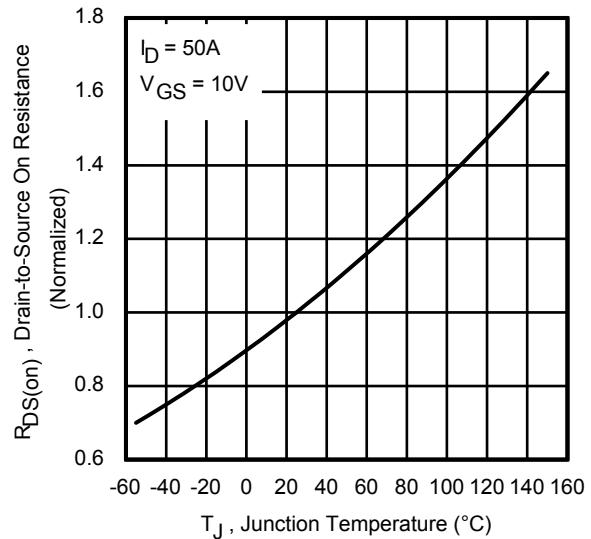
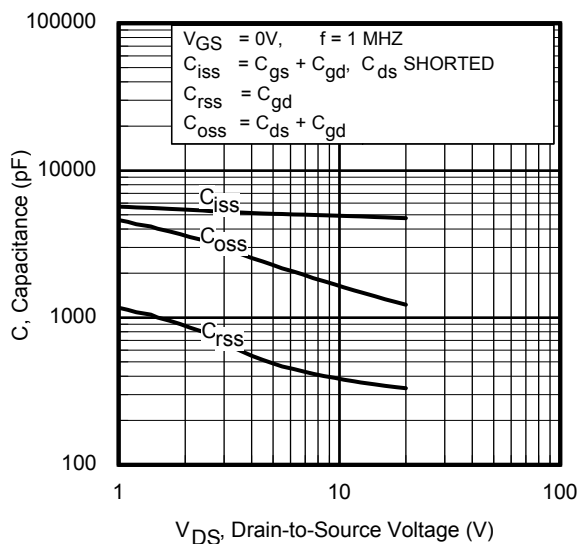
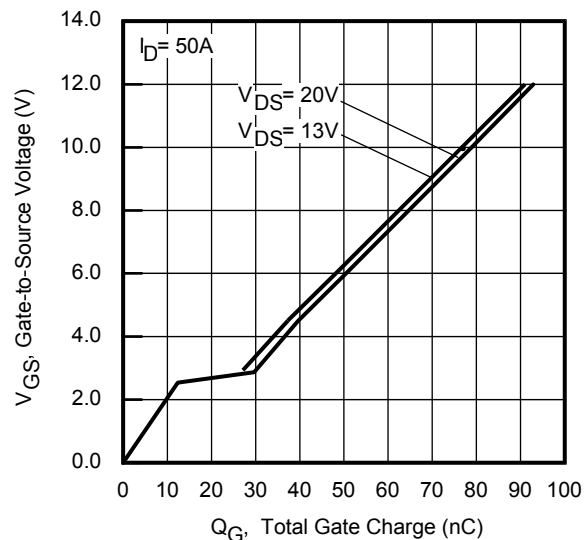
|          | Parameter                       | Typ. | Max. |
|----------|---------------------------------|------|------|
| $E_{AS}$ | Single Pulse Avalanche Energy ② | —    | 247  |
| $I_{AR}$ | Avalanche Current ①             | —    | 50   |

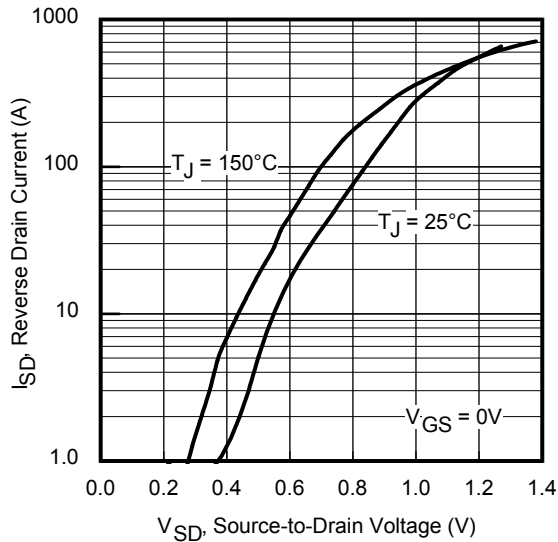
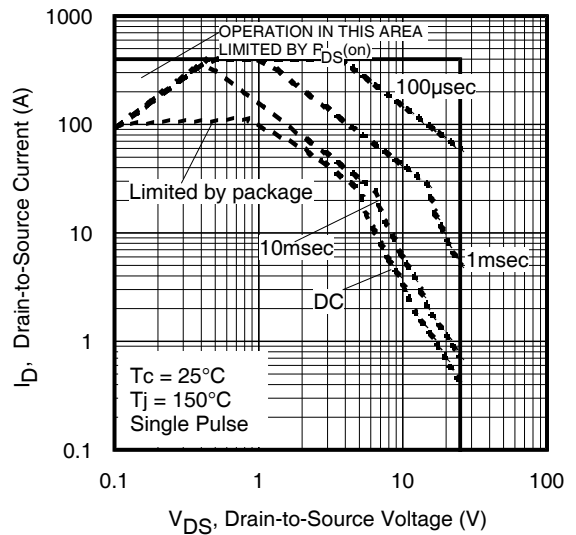
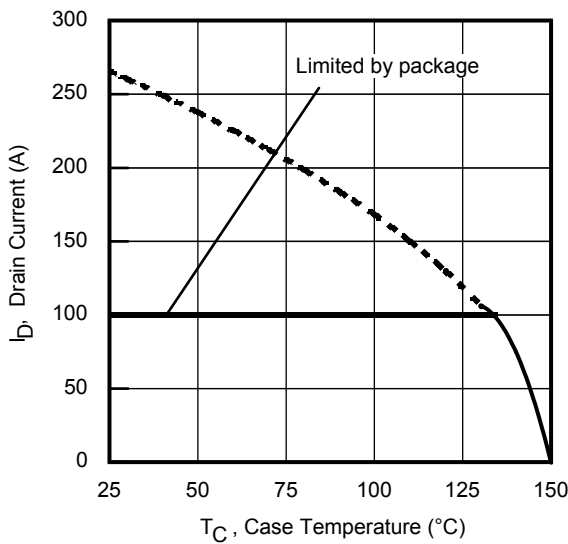
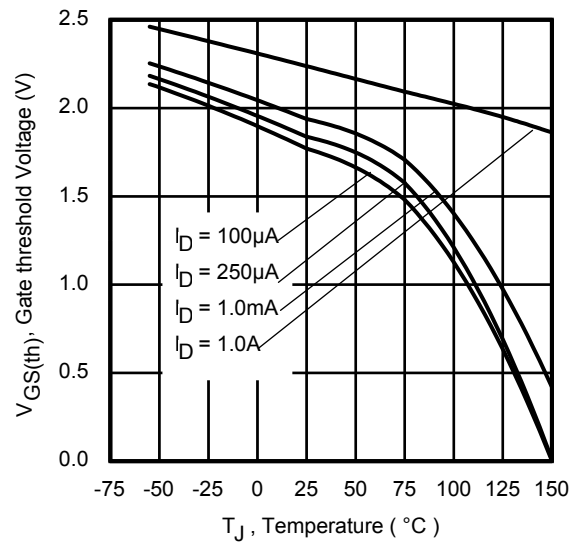
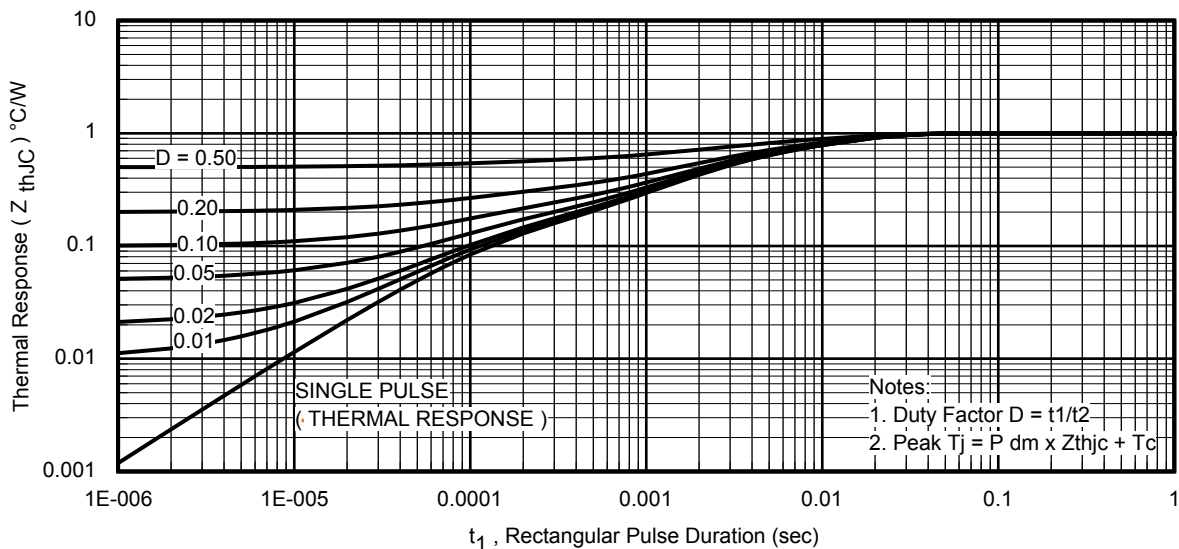
**Diode Characteristics**

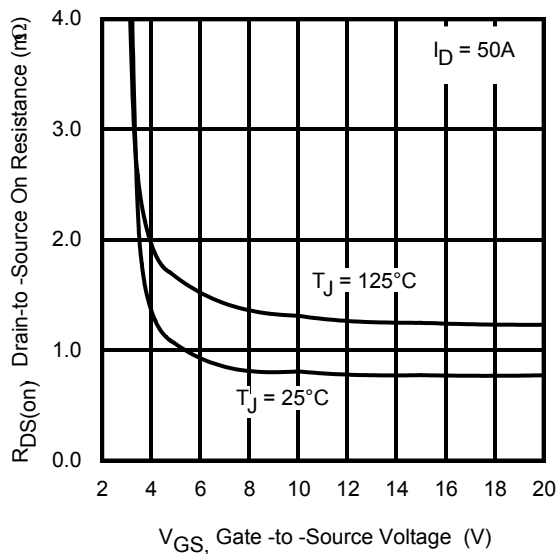
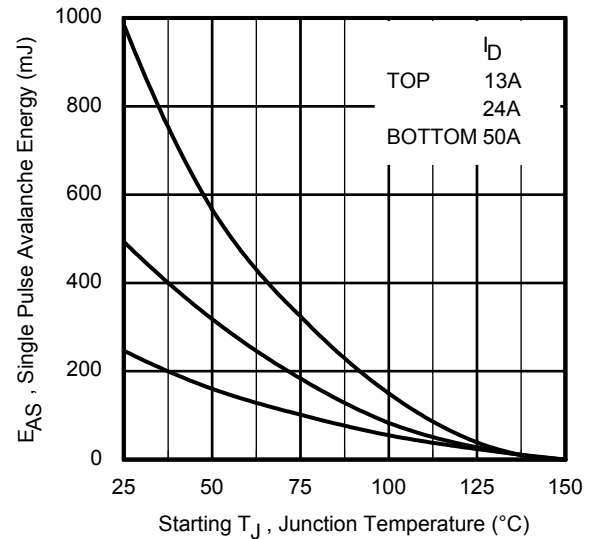
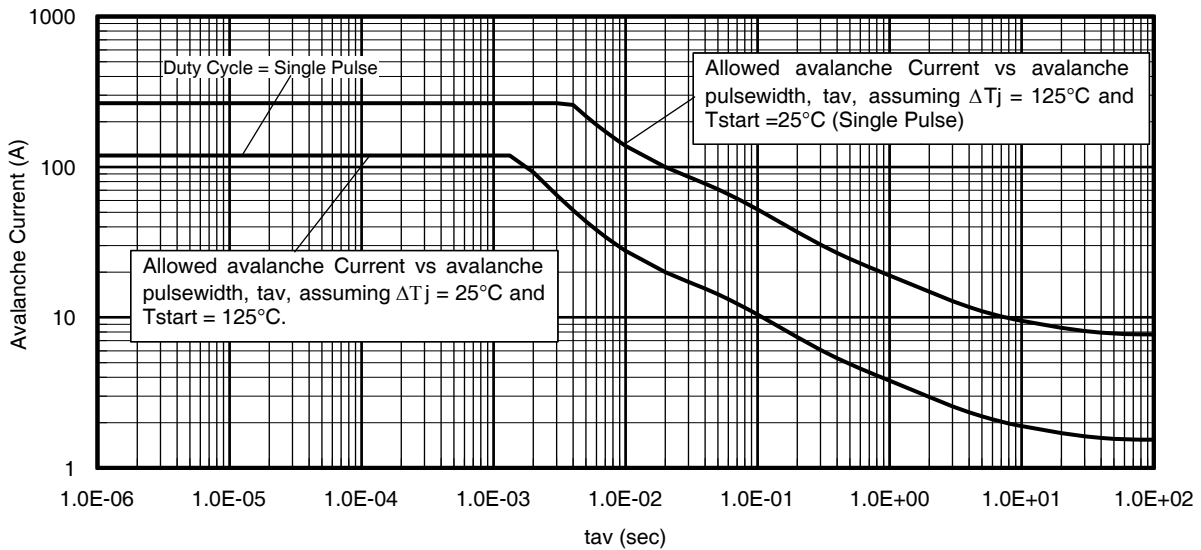
|          | Parameter                              | Min. | Typ. | Max.  | Units | Conditions                                                                                                                                           |
|----------|----------------------------------------|------|------|-------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| $I_S$    | Continuous Source Current (Body Diode) | —    | —    | 100 ⑦ | 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                  | —    | —    | 0.75  | V     | $T_J = 25^\circ\text{C}, I_S = 50A, V_{GS} = 0V$ ③                                                                                                   |
| $t_{rr}$ | Reverse Recovery Time                  | —    | 27   | 41    | ns    | $T_J = 25^\circ\text{C}, I_F = 50A, V_{DD} = 13V$<br>$di/dt = 300A/\mu s$ ③                                                                          |
| $Q_{rr}$ | Reverse Recovery Charge                | —    | 59   | 89    | nC    |                                                                                                                                                      |

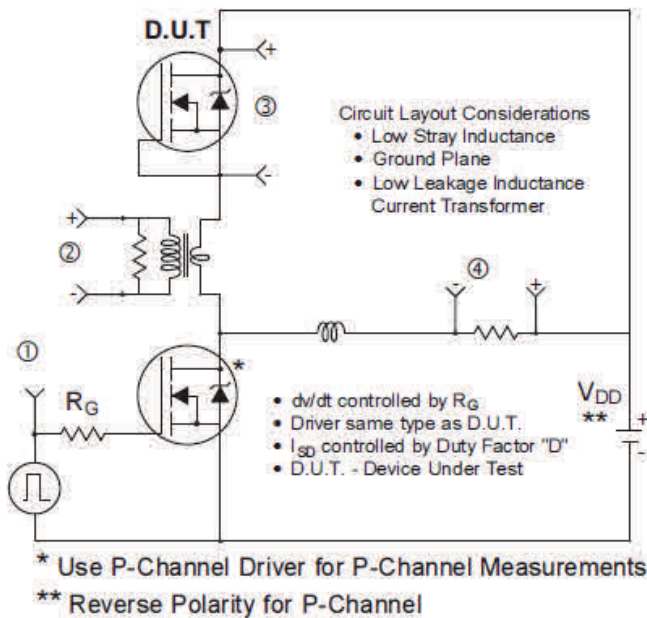
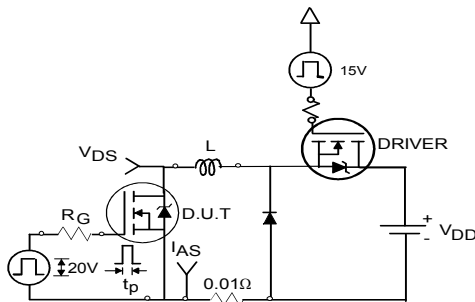
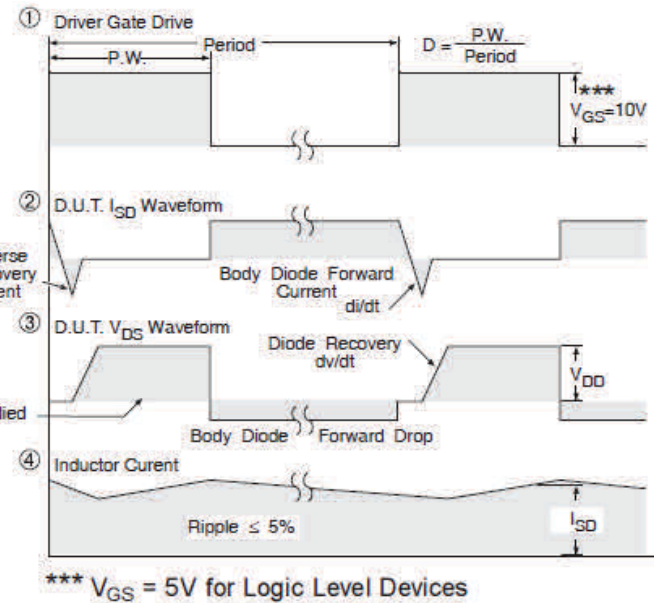
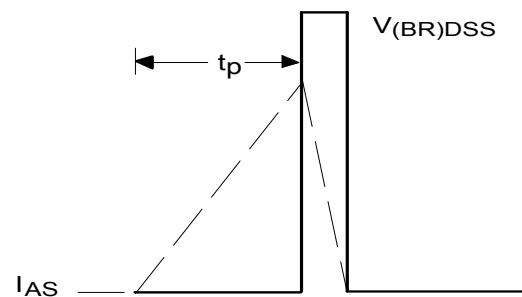
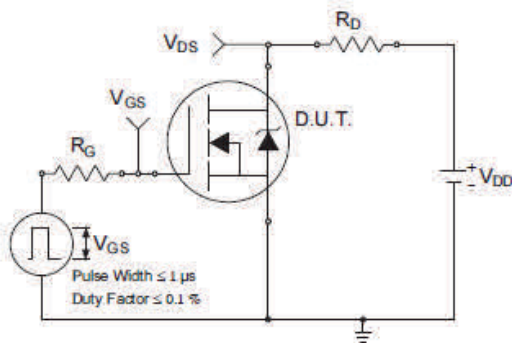
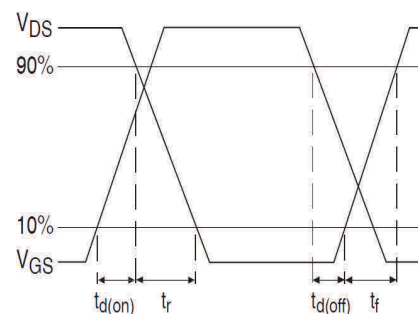
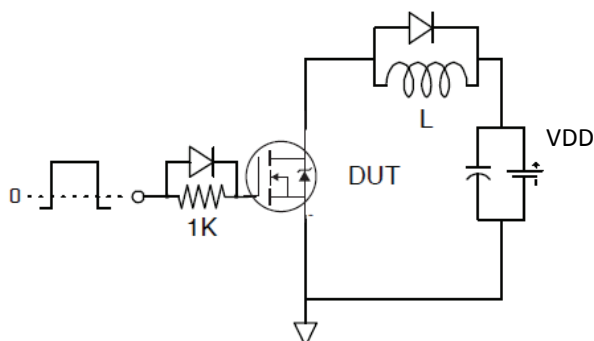
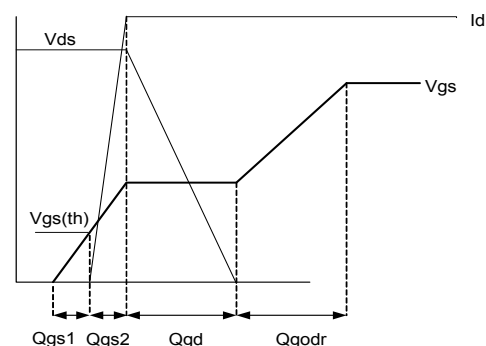
**Thermal Resistance**

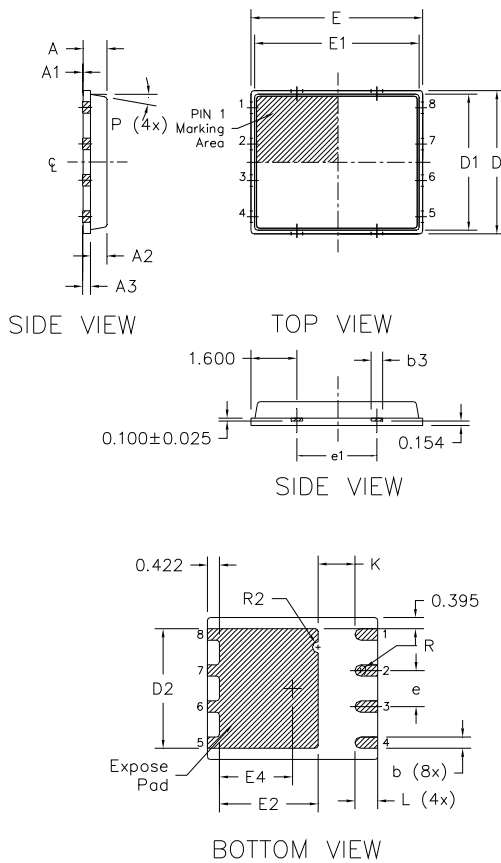
|                          | Parameter             | Typ. | Max. | Units              |
|--------------------------|-----------------------|------|------|--------------------|
| $R_{\theta JC}$ (Bottom) | Junction-to-Case ④    | —    | 1.0  | $^\circ\text{C/W}$ |
| $R_{\theta JC}$ (Top)    | Junction-to-Case ④    | —    | 22   |                    |
| $R_{\theta JA}$          | Junction-to-Ambient ⑤ | —    | 36   |                    |
| $R_{\theta JA} (<10s)$   | Junction-to-Ambient ⑤ | —    | 21   |                    |


**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.** Drain-to-Source Breakdown Voltage

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


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

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

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


**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 18. Gate Charge Test Circuit**

**Fig 19. Gate Charge Waveform**

**PQFN 5x6 Outline "B" Package Details**


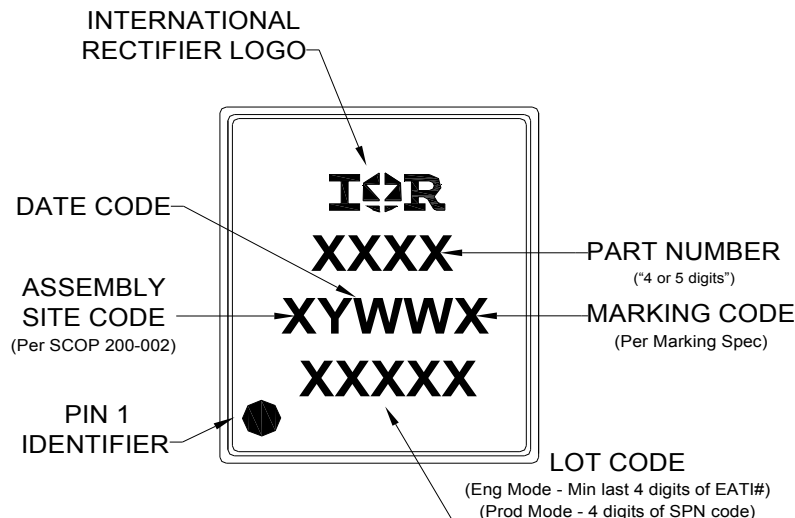
| DIM<br>SYMBOL | MILLIMETERS |       | INCH   |        |
|---------------|-------------|-------|--------|--------|
|               | MIN         | MAX   | MIN    | MAX    |
| A             | 0.800       | 0.900 | 0.0315 | 0.0543 |
| A1            | 0.000       | 0.050 | 0.0000 | 0.0020 |
| A3            | 0.200       | REF   | 0.0079 | REF    |
| b             | 0.350       | 0.470 | 0.0138 | 0.0185 |
| b1            | 0.025       | 0.125 | 0.0010 | 0.0049 |
| b2            | 0.210       | 0.410 | 0.0083 | 0.0161 |
| b3            | 0.150       | 0.450 | 0.0059 | 0.0177 |
| D             | 5.000       | BSC   | 0.1969 | BSC    |
| D1            | 4.750       | BSC   | 0.1870 | BSC    |
| D2            | 4.100       | 4.300 | 0.1614 | 0.1693 |
| E             | 6.000       | BSC   | 0.2362 | BSC    |
| E1            | 5.750       | BSC   | 0.2264 | BSC    |
| E2            | 3.380       | 3.780 | 0.1331 | 0.1488 |
| e             | 1.270       | REF   | 0.0500 | REF    |
| e1            | 2.800       | REF   | 0.1102 | REF    |
| K             | 1.200       | 1.420 | 0.0472 | 0.0559 |
| L             | 0.710       | 0.900 | 0.0280 | 0.0354 |
| P             | 0°          | 12°   | 0°     | 12°    |
| R             | 0.200       | REF   | 0.0079 | REF    |
| R2            | 0.150       | 0.200 | 0.0059 | 0.0079 |

**Note:**

1. Dimensions and tolerancing conform to ASME Y14.5M-1994
2. Dimension L represents terminal full back from package edge up to 0.1mm is acceptable
3. Coplanarity applies to the expose Heat Slug as well as the terminal
4. Radius on terminal is Optional

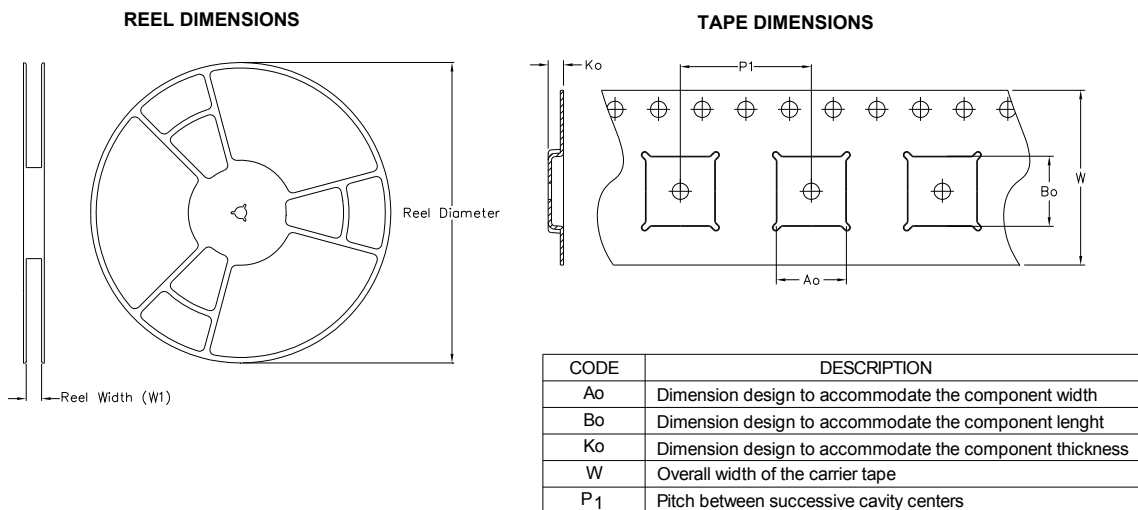
For more information on board mounting, including footprint and stencil recommendation, please refer to application note AN-1136: <http://www.irf.com/technical-info/appnotes/an-1136.pdf>

For more information on package inspection techniques, please refer to application note AN-1154: <http://www.irf.com/technical-info/appnotes/an-1154.pdf>

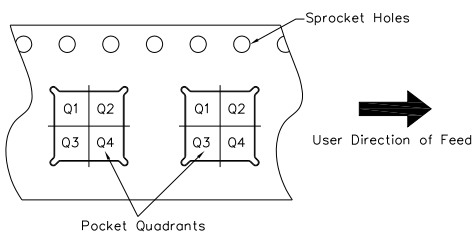
**PQFN 5x6 Part Marking**


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

# PQFN 5x6 Tape and Reel



## QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



Note: All dimension are nominal

| Package Type | Reel Diameter (Inch) | QTY  | Reel Width W1 (mm) | Ao (mm) | Bo (mm) | Ko (mm) | P1 (mm) | W (mm) | Pin 1 Quadrant |
|--------------|----------------------|------|--------------------|---------|---------|---------|---------|--------|----------------|
| 5 X 6 PQFN   | 13                   | 4000 | 12.4               | 6.300   | 5.300   | 1.20    | 8.00    | 12     | Q1             |

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

### Qualification Information†

|                            |                                                |                                  |
|----------------------------|------------------------------------------------|----------------------------------|
| Qualification Level        | Industrial<br>(per JEDEC JESD47F†† guidelines) |                                  |
| Moisture Sensitivity Level | PQFN 5mm x 6mm                                 | MSL1<br>(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>

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

### Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Starting  $T_J = 25^{\circ}\text{C}$ ,  $L = 0.20\text{mH}$ ,  $R_G = 50\Omega$ ,  $I_{AS} = 50\text{A}$ .
- ③ Pulse width  $\leq 400\text{ }\mu\text{s}$ ; duty cycle  $\leq 2\%$ .
- ④  $R_{\theta}$  is measured at  $T_J$  of approximately  $90^{\circ}\text{C}$ .
- ⑤ When mounted on 1 inch square PCB (FR-4). Please refer to AN-994 for more details:  
<http://www.irf.com/technical-info/appnotes/an-994.pdf>
- ⑥ Calculated continuous current based on maximum allowable junction temperature.
- ⑦ Current is limited to 100A by source bonding technology.

### Revision History

| Date      | Comments                                                                                                                                                                                                                                  |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4/30/2013 | <ul style="list-style-type: none"> <li>Release of final data sheet.</li> </ul>                                                                                                                                                            |
| 5/17/2013 | <ul style="list-style-type: none"> <li>Updated package 3D drawing, on page 1.</li> <li>Added Continuous Drain Current limited by source bonding technology, on page 1.</li> <li>Divided note 6 into note 6 &amp; 7, on page 8.</li> </ul> |
| 8/14/2013 | <ul style="list-style-type: none"> <li>Added "Fast/RFET™" above the part number, on page 1.</li> </ul>                                                                                                                                    |
| 3/16/2015 | <ul style="list-style-type: none"> <li>Updated package outline and tape and reel on pages 7 and 8.</li> </ul>                                                                                                                             |

International  
 Rectifier

IR WORLD HEADQUARTERS: 101 N. Sepulveda Blvd., El Segundo, California 90245, USA

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