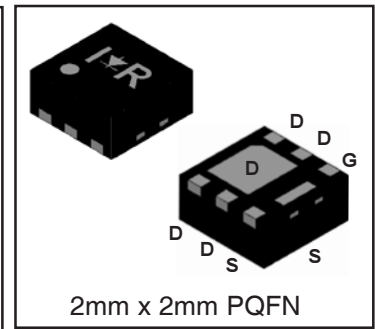
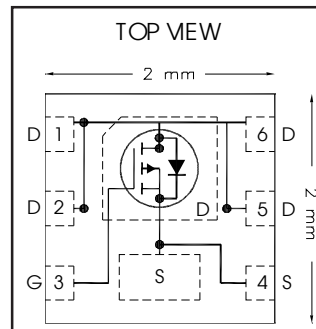


|                                           |              |           |
|-------------------------------------------|--------------|-----------|
| $V_{DS}$                                  | <b>-30</b>   | <b>V</b>  |
| $V_{GS\ max}$                             | <b>±20</b>   | <b>V</b>  |
| $R_{DS(on)\ max}$<br>(@ $V_{GS} = -10V$ ) | <b>37</b>    | <b>mΩ</b> |
| $Q_g$ (typical)                           | <b>13</b>    | <b>nC</b> |
| $I_D$<br>(@ $T_C = 25^\circ C$ )          | <b>-8.5②</b> | <b>A</b>  |



## Applications

- Charge and Discharge Switch for Battery Application
- System/load switch

## Features and Benefits

### Features

|                                                              |
|--------------------------------------------------------------|
| Low $R_{DS(on)}$ ( $\leq 37m\Omega$ )                        |
| Low Thermal Resistance to PCB ( $\leq 13^\circ C/W$ )        |
| Low Profile ( $\leq 1.0\ mm$ )                               |
| Compatible with Existing Surface Mount Techniques            |
| RoHS Compliant Containing no Lead, no Bromide and no Halogen |
| MSL1, Industrial Qualification                               |

results in

### Benefits

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

| Orderable part number | Package Type   | Standard Pack |          | Note             |
|-----------------------|----------------|---------------|----------|------------------|
|                       |                | Form          | Quantity |                  |
| IRFHS9301TRPBF        | PQFN 2mm x 2mm | Tape and Reel | 4000     |                  |
| IRFHS9301TR2PBF       | PQFN 2mm x 2mm | Tape and Reel | 400      | EOL notice # 259 |

## Absolute Maximum Ratings

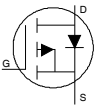
|                            | Parameter                                                  | Max.         | Units |
|----------------------------|------------------------------------------------------------|--------------|-------|
| $V_{DS}$                   | Drain-to-Source Voltage                                    | -30          | V     |
| $V_{GS}$                   | Gate-to-Source Voltage                                     | ± 20         |       |
| $I_D$ @ $T_A = 25^\circ C$ | Continuous Drain Current, $V_{GS}$ @ -10V                  | -6.0         | A     |
| $I_D$ @ $T_A = 70^\circ C$ | Continuous Drain Current, $V_{GS}$ @ -10V                  | -4.8         |       |
| $I_D$ @ $T_C = 25^\circ C$ | Continuous Drain Current, $V_{GS}$ @ -10V                  | -13②         |       |
| $I_D$ @ $T_C = 70^\circ C$ | Continuous Drain Current, $V_{GS}$ @ -10V                  | -10②         |       |
| $I_D$ @ $T_C = 25^\circ C$ | Continuous Drain Current, $V_{GS}$ @ 10V (Package Limited) | -8.5②        |       |
| $I_{DM}$                   | Pulsed Drain Current ①                                     | -52          |       |
| $P_D$ @ $T_A = 25^\circ C$ | Power Dissipation ④                                        | 2.1          | W     |
| $P_D$ @ $T_A = 70^\circ C$ | Power Dissipation ④                                        | 1.3          |       |
|                            | Linear Derating Factor                                     | 0.02         | W/°C  |
| $T_J$<br>$T_{STG}$         | Operating Junction and<br>Storage Temperature Range        | -55 to + 150 | °C    |

Notes ① through ⑤ are on page 2

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

|                              | Parameter                            | Min. | Typ. | Max. | Units         | Conditions                                      |
|------------------------------|--------------------------------------|------|------|------|---------------|-------------------------------------------------|
| $BV_{DSS}$                   | Drain-to-Source Breakdown Voltage    | -30  | —    | —    | V             | $V_{GS} = 0V, I_D = -250\mu A$                  |
| $\Delta BV_{DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient  | —    | 0.02 | —    | $V/^\circ C$  | Reference to $25^\circ C, I_D = -1mA$           |
| $R_{DS(on)}$                 | Static Drain-to-Source On-Resistance | —    | 30   | 37   | $m\Omega$     | $V_{GS} = -10V, I_D = -7.8A$ ③                  |
|                              |                                      | —    | 52   | 65   |               | $V_{GS} = -4.5V, I_D = -6.2A$ ③                 |
| $V_{GS(th)}$                 | Gate Threshold Voltage               | -1.3 | -1.8 | -2.4 | V             | $V_{DS} = V_{GS}, I_D = -25\mu A$               |
| $\Delta V_{GS(th)}$          | Gate Threshold Voltage Coefficient   | —    | -4.8 | —    | $mV/^\circ C$ |                                                 |
| $I_{DSS}$                    | Drain-to-Source Leakage Current      | —    | —    | -1.0 | $\mu A$       | $V_{DS} = -24V, V_{GS} = 0V$                    |
|                              |                                      | —    | —    | -150 |               | $V_{DS} = -24V, V_{GS} = 0V, T_J = 125^\circ C$ |
| $I_{GSS}$                    | Gate-to-Source Forward Leakage       | —    | —    | -100 | $nA$          | $V_{GS} = -20V$                                 |
|                              | Gate-to-Source Reverse Leakage       | —    | —    | 100  |               | $V_{GS} = 20V$                                  |
| $g_{fs}$                     | Forward Transconductance             | 9.3  | —    | —    | S             | $V_{DS} = -10V, I_D = -7.8A$                    |
| $Q_g$                        | Total Gate Charge                    | —    | 6.9  | —    | nC            | $V_{DS} = -15V, V_{GS} = -4.5V, I_D = -7.8A$    |
| $Q_g$                        | Total Gate Charge                    | —    | 13   | —    | nC            | $V_{GS} = -10V$                                 |
| $Q_{gs}$                     | Gate-to-Source Charge                | —    | 2.1  | —    |               | $V_{DS} = -15V$                                 |
| $Q_{gd}$                     | Gate-to-Drain Charge                 | —    | 3.9  | —    |               | $I_D = -7.8A$                                   |
| $R_G$                        | Gate Resistance                      | —    | 17   | —    | $\Omega$      |                                                 |
| $t_{d(on)}$                  | Turn-On Delay Time                   | —    | 12   | —    | ns            | $V_{DD} = -15V, V_{GS} = -4.5V$ ③               |
| $t_r$                        | Rise Time                            | —    | 80   | —    |               | $I_D = -7.8A$                                   |
| $t_{d(off)}$                 | Turn-Off Delay Time                  | —    | 13   | —    |               | $R_G = 2.0\Omega$                               |
| $t_f$                        | Fall Time                            | —    | 25   | —    |               | See Figs. 19a & 19b                             |
| $C_{iss}$                    | Input Capacitance                    | —    | 580  | —    | pF            | $V_{GS} = 0V$                                   |
| $C_{oss}$                    | Output Capacitance                   | —    | 125  | —    |               | $V_{DS} = -25V$                                 |
| $C_{rss}$                    | Reverse Transfer Capacitance         | —    | 79   | —    |               | $f = 1.0KHz$                                    |

**Diode Characteristics**

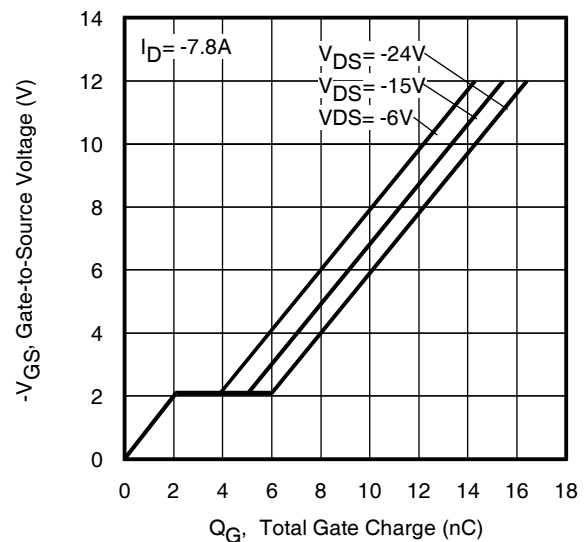
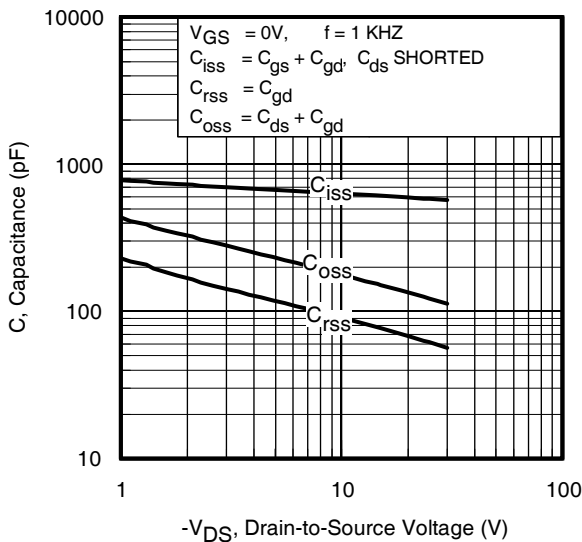
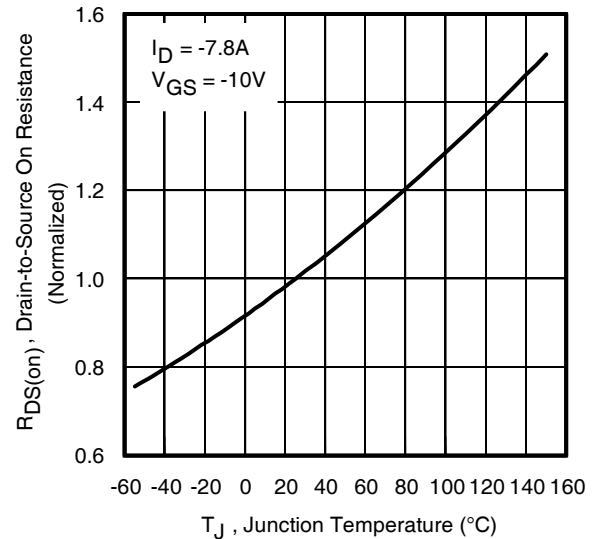
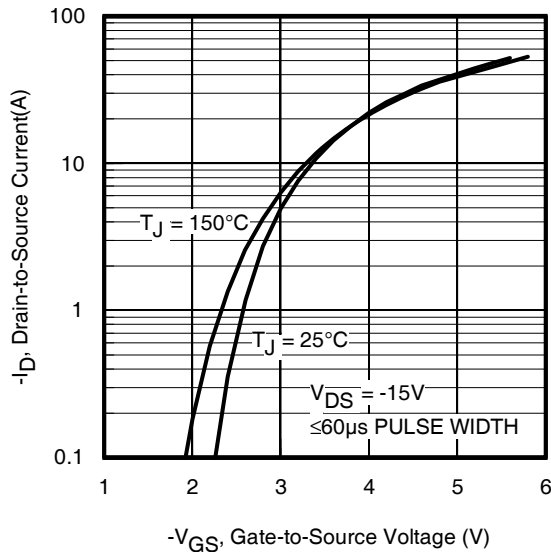
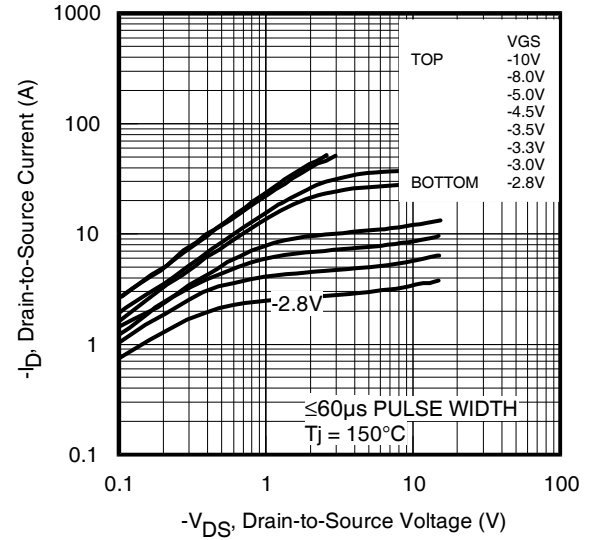
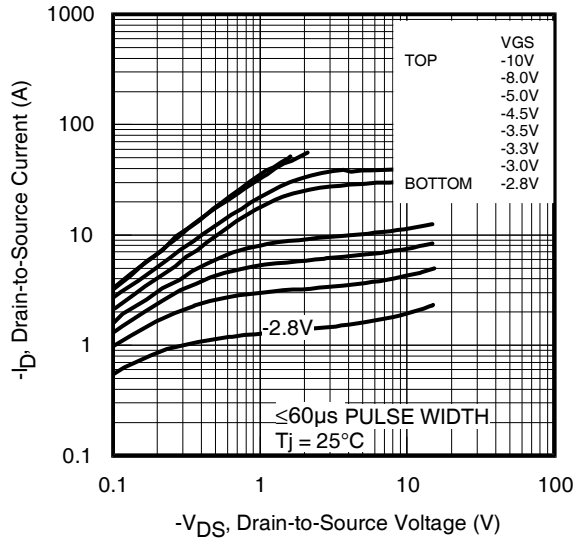
|          | Parameter                                 | Min. | Typ. | Max.  | Units | Conditions                                                                                                                                                       |
|----------|-------------------------------------------|------|------|-------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $I_S$    | Continuous Source Current<br>(Body Diode) | —    | —    | -8.5② | A     | MOSFET symbol<br>showing the<br>integral reverse<br>p-n junction diode.<br> |
| $I_{SM}$ | Pulsed Source Current<br>(Body Diode) ①   | —    | —    | -52   |       |                                                                                                                                                                  |
| $V_{SD}$ | Diode Forward Voltage                     | —    | —    | -1.2  | V     | $T_J = 25^\circ C, I_S = -7.8A, V_{GS} = 0V$ ③                                                                                                                   |
| $t_{rr}$ | Reverse Recovery Time                     | —    | 30   | 45    | ns    | $T_J = 25^\circ C, I_F = -7.8A, V_{DD} = -15V$                                                                                                                   |
| $Q_{rr}$ | Reverse Recovery Charge                   | —    | 110  | 170   | nC    | $di/dt = 280/\mu s$ ③                                                                                                                                            |

**Thermal Resistance**

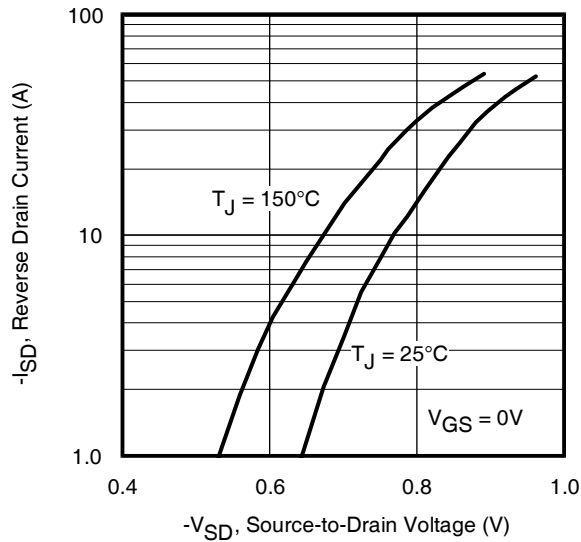
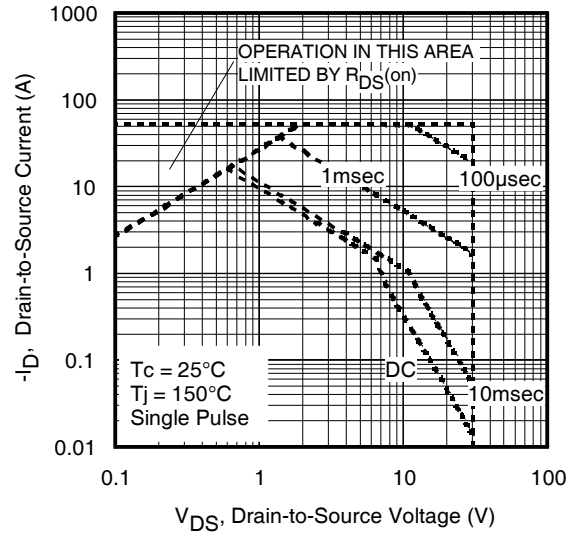
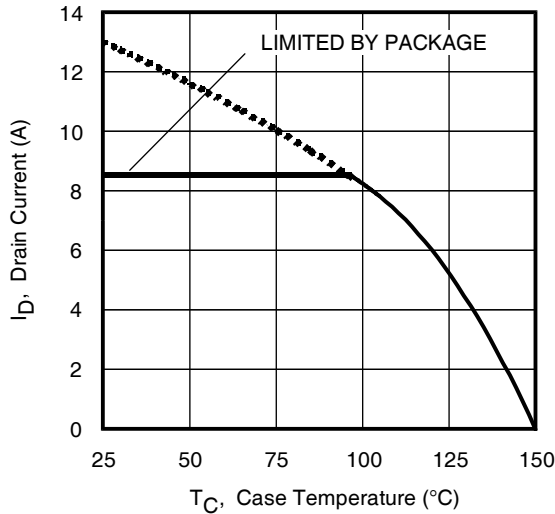
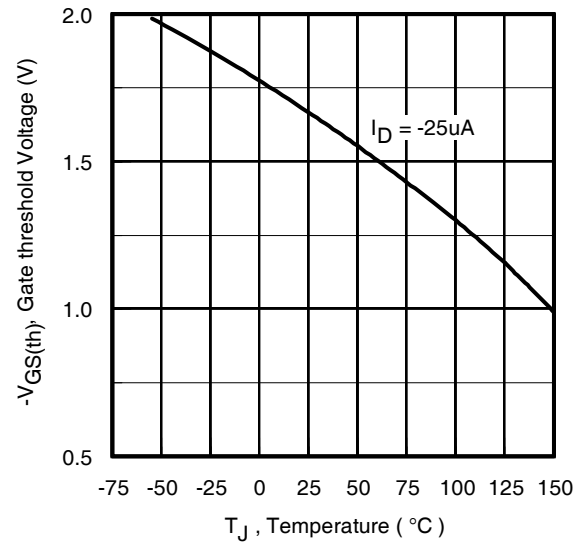
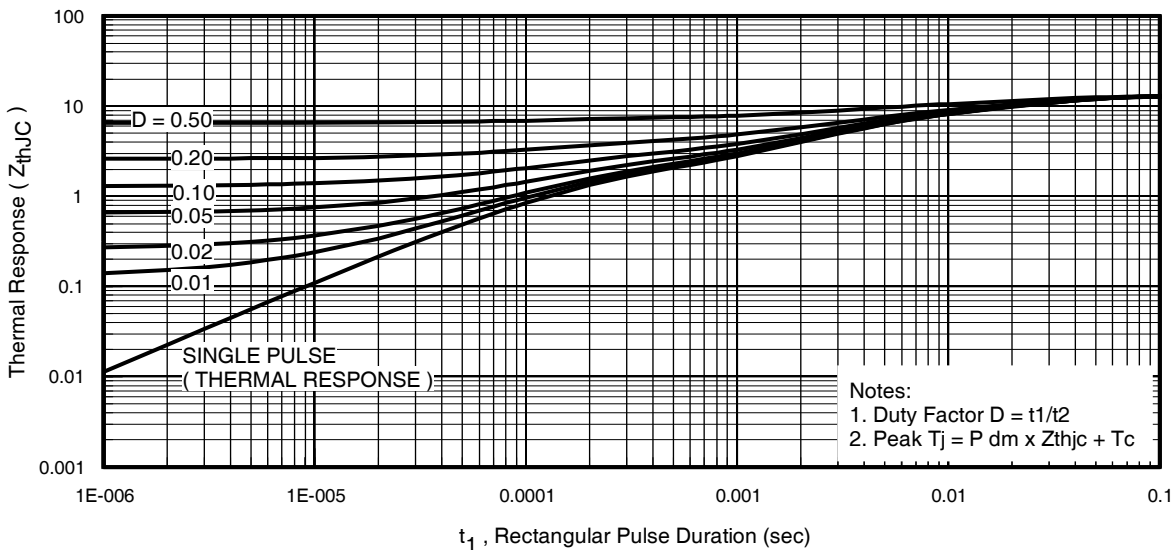
|                          | Parameter                           | Typ. | Max. | Units        |
|--------------------------|-------------------------------------|------|------|--------------|
| $R_{\theta JC}$ (Bottom) | Junction-to-Case ⑤                  | —    | 13   | $^\circ C/W$ |
| $R_{\theta JC}$ (Top)    | Junction-to-Case ⑤                  | —    | 90   |              |
| $R_{\theta JA}$          | Junction-to-Ambient ④               | —    | 60   |              |
| $R_{\theta JA}$          | Junction-to-Ambient ( $t < 10s$ ) ④ | —    | 42   |              |

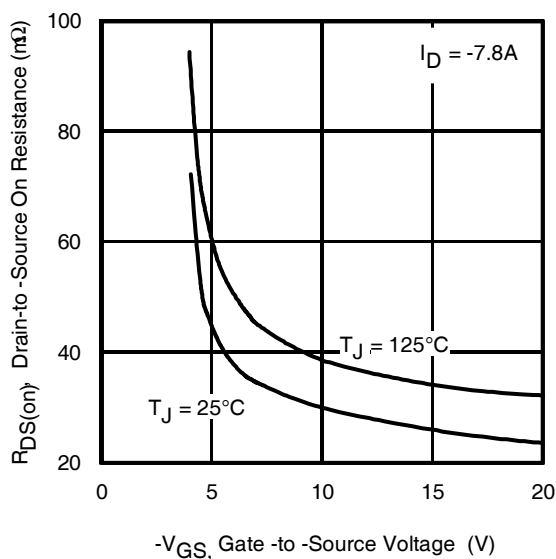
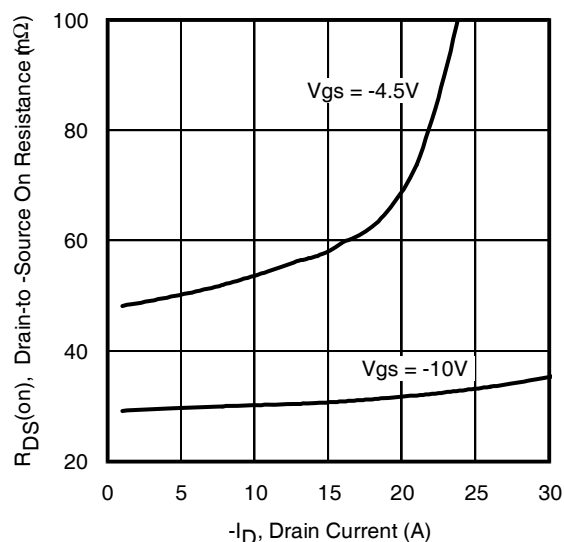
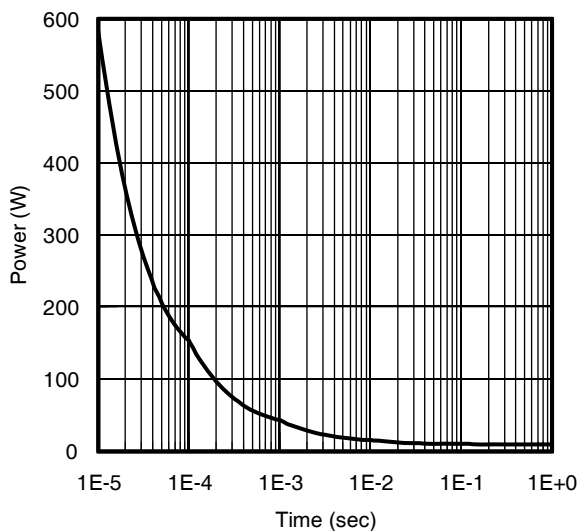
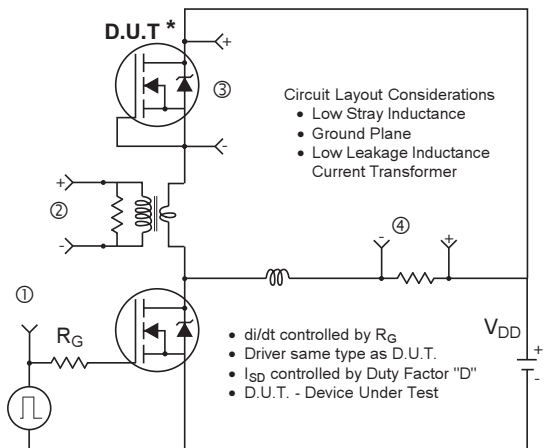
**Notes:**

- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Current limited by package.
- ③ Pulse width  $\leq 400\mu s$ ; duty cycle  $\leq 2\%$ .
- ④ When mounted on 1 inch square copper board.
- ⑤  $R_\theta$  is measured at  $T_J$  of approximately  $90^\circ C$ .

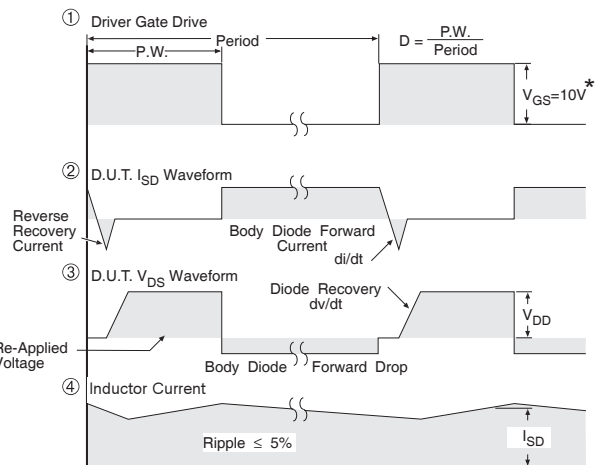

**Fig 5.** Typical Capacitance vs. Drain-to-Source Voltage

**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-Case

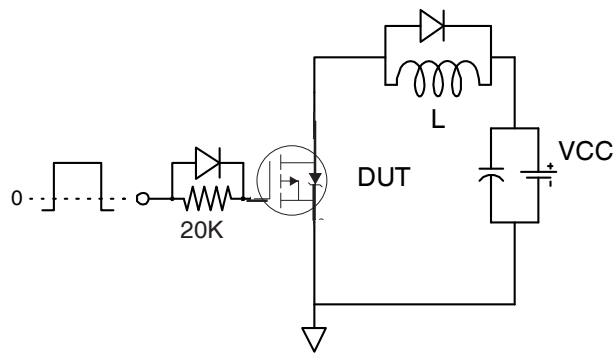
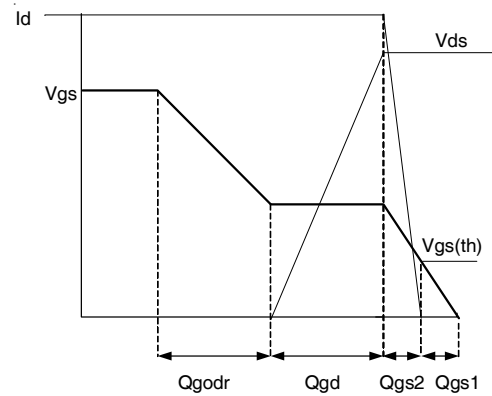
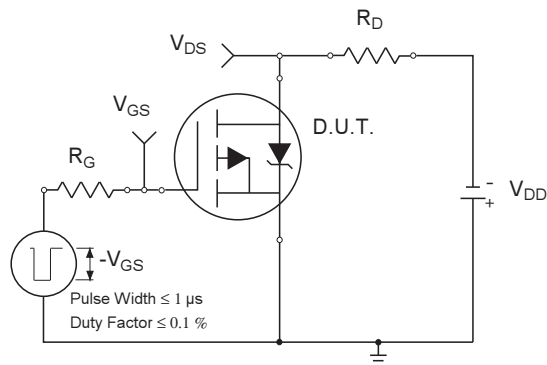
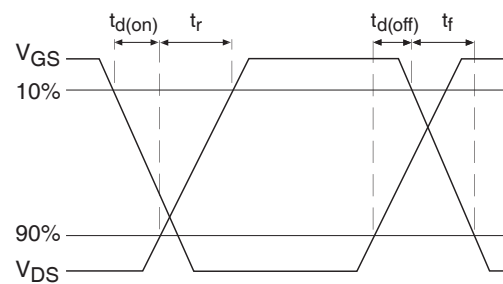

**Fig 12.** On-Resistance vs. Gate Voltage

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

**Fig 14.** Typical Power vs. Time


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

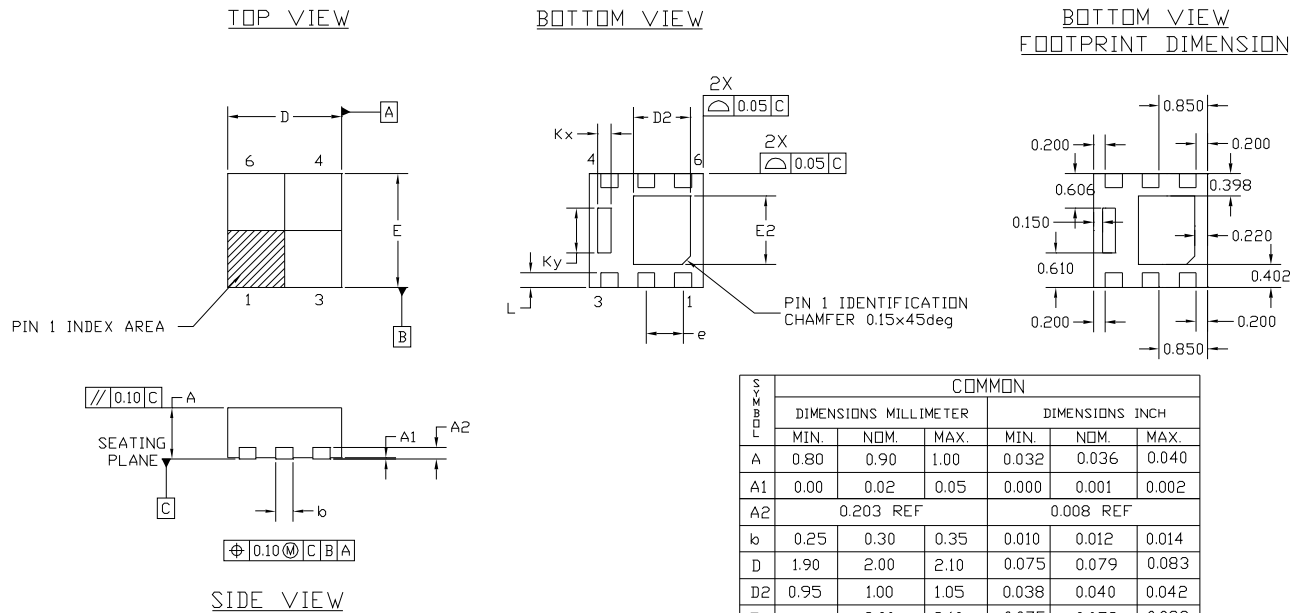


\*  $V_{GS} = 5V$  for Logic Level Devices

**Fig 15.** Diode Reverse Recovery Test Circuit for P-Channel HEXFET® Power MOSFETs


**Fig 16a.** Gate Charge Test Circuit

**Fig 16b.** Gate Charge Waveform

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

**Fig 17b.** Switching Time Waveforms

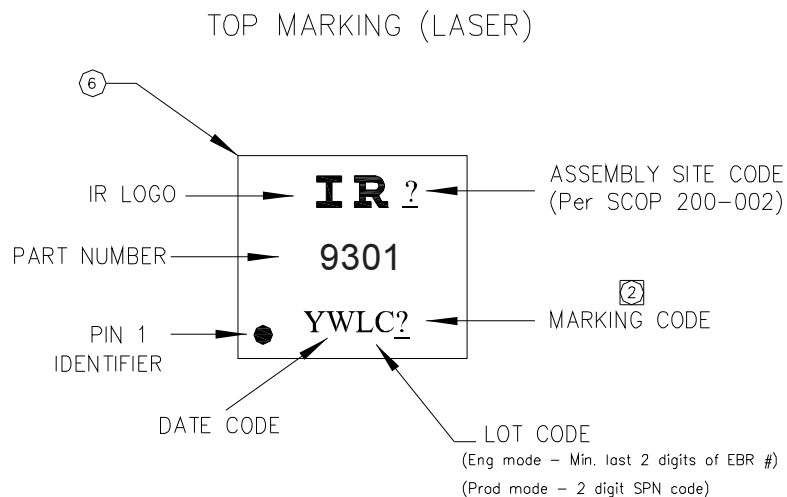
## PQFN Package Details



**NOTES :**

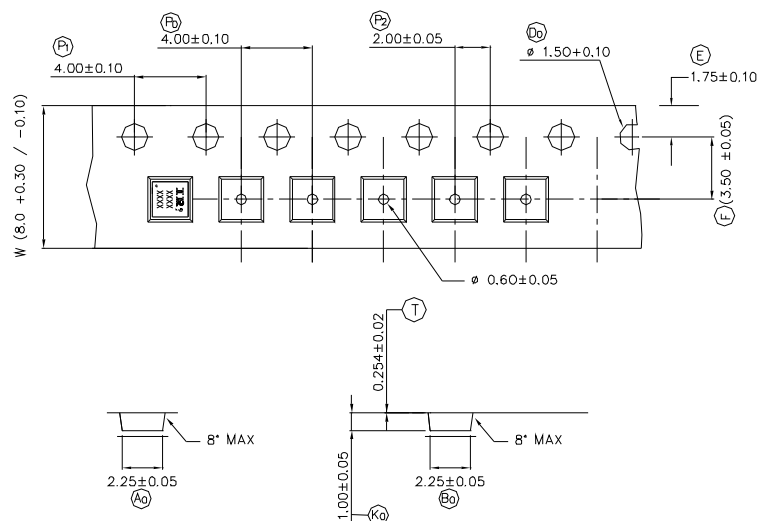
1. DIMENSION AND TOLERANCING CONFORM TO ASME Y14.5M-1994.
2. CONTROLLING DIMENSIONS : MILLIMETER
3. DIMENSION *b* APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30 mm. FROM TERMINAL TIP.

## PQFN Part Marking

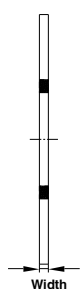


**Note:** For the most current drawing please refer to IR website at: <http://www.irf.com/package/>

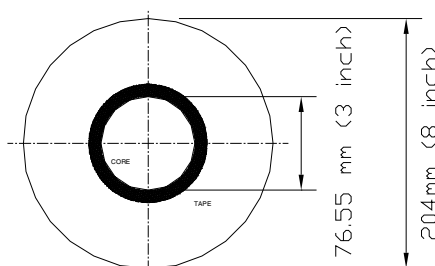
## PQFN Tape and Reel



NOTE: The Surface Resistivity is  $10^4 - 10^8$  OHM/SQ

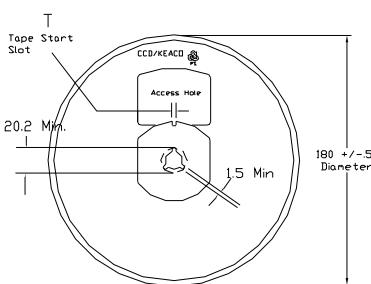


| COVER TAPE (WIDTH) | TOLERANCE  |
|--------------------|------------|
| 5.4 mm             | +/- 0.1 mm |
| 9.5 mm             | +/- 0.1 mm |

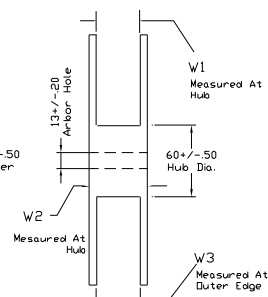


**Remark:**

- Dimension above are typical dimensions.
- Cover tape thickness is 0.048mm +/- 0.005mm.
- Surface resistivity  $10E5 < R_s < 10E9$ .



FRONT VIEW



SIDE VIEW

| TAPE WIDTH | T        | W1                                  | W2       | W3                   | PART NO. |
|------------|----------|-------------------------------------|----------|----------------------|----------|
| 8 MM       | 3 ± 0.50 | 8.4 <sup>+1.5</sup> <sub>-0.0</sub> | 14.4 Max | 7.90 Min<br>10.9 Max | 91586-1  |
| 12 MM      | 5 ± 0.50 | 12.4 ± 2.0                          | 18.4 Max | 11.9 Min<br>15.4 Max | 91586-2  |

Note: Surface resistivity is  $\geq 1 \times 10^5$  but  $< 1 \times 10^{12}$  ohm/sq.

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

**Qualification information<sup>†</sup>**

|                            |                                                                            |                                                    |
|----------------------------|----------------------------------------------------------------------------|----------------------------------------------------|
| Qualification level        | Industrial <sup>††</sup><br>(per JEDEC JESD47F <sup>†††</sup> guidelines ) |                                                    |
| Moisture Sensitivity Level | PQFN 2mm x 2mm                                                             | MSL1<br>(per IPC/JEDEC J-STD-020D <sup>†††</sup> ) |
| RoHS compliant             | Yes                                                                        |                                                    |

<sup>†</sup> Qualification standards can be found at International Rectifier's web site

<http://www.irf.com/product-info/reliability>

<sup>††</sup> 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/>

<sup>†††</sup> Applicable version of JEDEC standard at the time of product release.

**Revision History**

| Date      | Comment                                                                                                                                                                                                            |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5/12/2014 | <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 based on corporate template.</li> </ul> |
| 5/21/2014 | <ul style="list-style-type: none"> <li>Updated qual level from "Consumer" to "Industrial" on page 1 &amp; 9.</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/>

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