

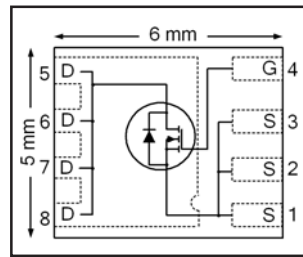
HEXFET® Power MOSFET

## Applications

- Brushed Motor drive applications
- BLDC Motor drive applications
- PWM Inverterized topologies
- Battery powered circuits
- Half-bridge and full-bridge topologies
- Electronic ballast applications
- Synchronous rectifier applications
- Resonant mode power supplies
- OR-ing and redundant power switches
- DC/DC and AC/DC converters

## Benefits

- Improved Gate, Avalanche and Dynamic  $dV/dt$  Ruggedness
- Fully Characterized Capacitance and Avalanche SOA
- Enhanced body diode  $dV/dt$  and  $dI/dt$  Capability
- RoHS Compliant containing no Lead, no Bromide, and no Halogen



|                         |                              |
|-------------------------|------------------------------|
| $V_{DS}$                | <b>40V</b>                   |
| $R_{DS(on)}$ typ. max.  | <b>1.8mΩ</b><br><b>2.4mΩ</b> |
| $I_D$ (Silicon Limited) | <b>159A</b> ①                |
| $I_D$ (Package Limited) | <b>85A</b>                   |



| Base Part Number | Package Type   | Standard Pack |          | Orderable Part Number |
|------------------|----------------|---------------|----------|-----------------------|
|                  |                | Form          | Quantity |                       |
| IRFH7440PBF      | PQFN 5mm x 6mm | Tape and Reel | 4000     | IRFH7440TRPBF         |
|                  | PQFN 5mm x 6mm | Tape and Reel | 400      | IRFH7440TR2PBF        |

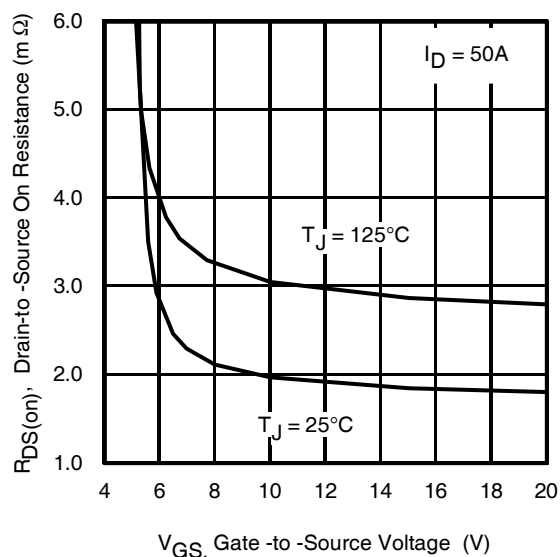


Fig 1. Typical On-Resistance vs. Gate Voltage

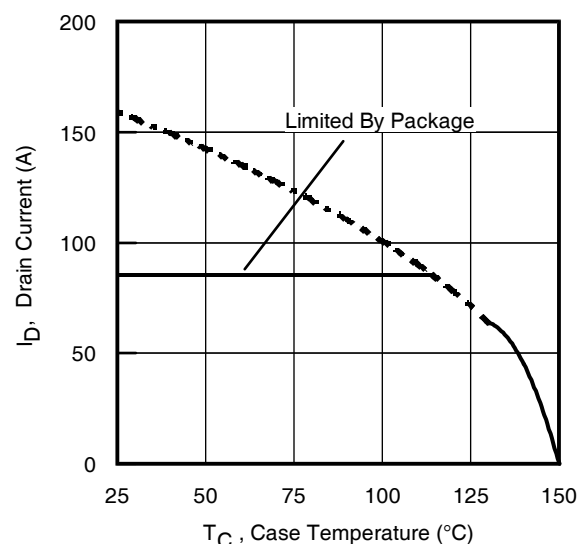


Fig 2. Maximum Drain Current vs. Case Temperature

**Absolute Maximum Ratings**

| Symbol                            | Parameter                                                  | Max.             | Units |
|-----------------------------------|------------------------------------------------------------|------------------|-------|
| $I_D$ @ $T_C = 25^\circ\text{C}$  | Continuous Drain Current, $V_{GS}$ @ 10V (Silicon Limited) | 159 <sup>①</sup> | A     |
| $I_D$ @ $T_C = 100^\circ\text{C}$ | Continuous Drain Current, $V_{GS}$ @ 10V (Silicon Limited) | 101 <sup>①</sup> |       |
| $I_D$ @ $T_C = 25^\circ\text{C}$  | Continuous Drain Current, $V_{GS}$ @ 10V (Package Limited) | 85               |       |
| $I_{DM}$                          | Pulsed Drain Current <sup>②</sup>                          | 624              |       |
| $P_D$ @ $T_C = 25^\circ\text{C}$  | Maximum Power Dissipation                                  | 104              | W     |
|                                   | Linear Derating Factor                                     | 0.83             | W/°C  |
| $V_{GS}$                          | Gate-to-Source Voltage                                     | ± 20             | V     |
| dv/dt                             | Peak Diode Recovery <sup>④</sup>                           | 3.0              | V/ns  |
| $T_J$                             | Operating Junction and                                     | -55 to + 150     | °C    |
| $T_{STG}$                         | Storage Temperature Range                                  |                  |       |

**Avalanche Characteristics**

|                              |                                                         |                           |    |
|------------------------------|---------------------------------------------------------|---------------------------|----|
| $E_{AS}$ (Thermally limited) | Single Pulse Avalanche Energy <sup>③</sup>              | 121                       | mJ |
| $E_{AS}$ (tested)            | Single Pulse Avalanche Energy Tested Value <sup>⑩</sup> | 273                       |    |
| $I_{AR}$                     | Avalanche Current <sup>②</sup>                          | See Fig. 14, 15, 22a, 22b | A  |
| $E_{AR}$                     | Repetitive Avalanche Energy <sup>②</sup>                |                           | mJ |

**Thermal Resistance**

| Symbol                   | Parameter                        | Typ. | Max. | Units |
|--------------------------|----------------------------------|------|------|-------|
| $R_{\theta JC}$ (Bottom) | Junction-to-Case <sup>⑨</sup>    | —    | 1.2  | °C/W  |
| $R_{\theta JC}$ (Top)    | Junction-to-Case <sup>⑨</sup>    | —    | 31   |       |
| $R_{\theta JA}$          | Junction-to-Ambient <sup>③</sup> | —    | 35   |       |
| $R_{\theta JA}$ (<10s)   | Junction-to-Ambient <sup>③</sup> | —    | 22   |       |

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

| Symbol                          | Parameter                            | Min. | Typ.  | Max. | Units | Conditions                                                   |
|---------------------------------|--------------------------------------|------|-------|------|-------|--------------------------------------------------------------|
| $V_{(BR)DSS}$                   | Drain-to-Source Breakdown Voltage    | 40   | —     | —    | V     | $V_{GS} = 0V$ , $I_D = 250\mu A$                             |
| $\Delta V_{(BR)DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient  | —    | 0.031 | —    | V/°C  | Reference to $25^\circ\text{C}$ , $I_D = 1.0mA$ <sup>②</sup> |
| $R_{DS(on)}$                    | Static Drain-to-Source On-Resistance | —    | 1.8   | 2.4  | mΩ    | $V_{GS} = 10V$ , $I_D = 50A$ <sup>⑤</sup>                    |
|                                 |                                      | —    | 2.7   | —    | mΩ    | $V_{GS} = 6.0V$ , $I_D = 25A$ <sup>⑤</sup>                   |
| $V_{GS(th)}$                    | Gate Threshold Voltage               | 2.2  | —     | 3.9  | V     | $V_{DS} = V_{GS}$ , $I_D = 100\mu A$                         |
| $I_{DSS}$                       | Drain-to-Source Leakage Current      | —    | —     | 1.0  | μA    | $V_{DS} = 40V$ , $V_{GS} = 0V$                               |
|                                 |                                      | —    | —     | 150  |       | $V_{DS} = 40V$ , $V_{GS} = 0V$ , $T_J = 125^\circ\text{C}$   |
| $I_{GSS}$                       | Gate-to-Source Forward Leakage       | —    | —     | 100  | nA    | $V_{GS} = 20V$                                               |
|                                 | Gate-to-Source Reverse Leakage       | —    | —     | -100 |       | $V_{GS} = -20V$                                              |
| $R_G$                           | Internal Gate Resistance             | —    | 2.6   | —    | Ω     |                                                              |

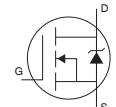
**Notes:**

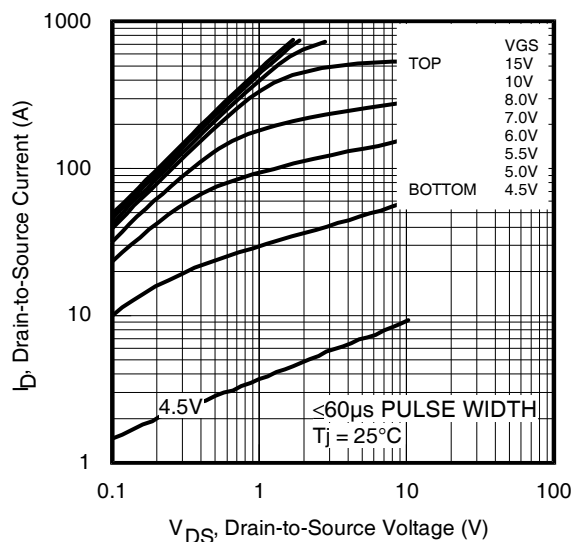
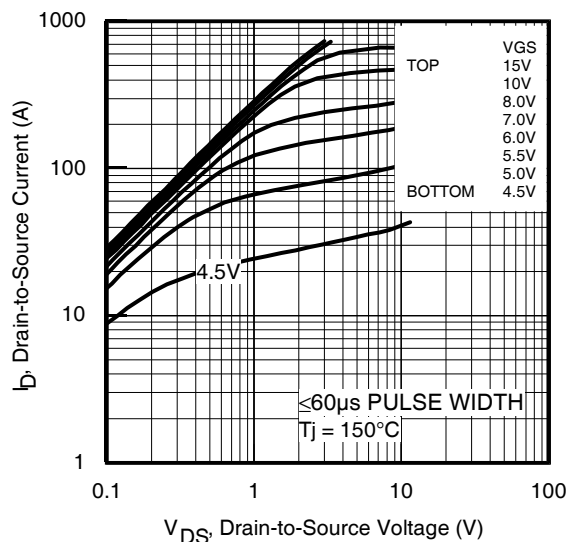
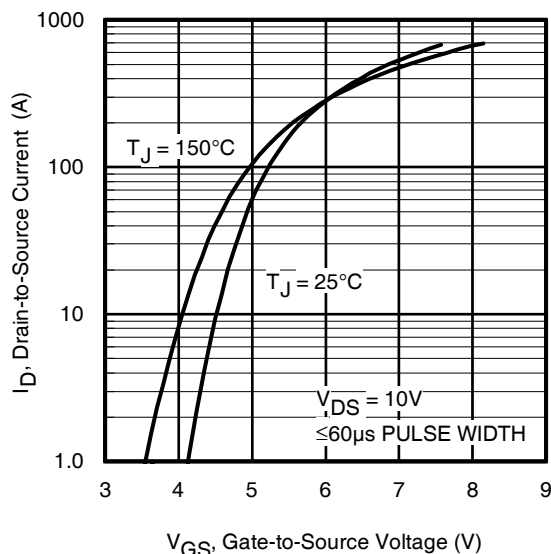
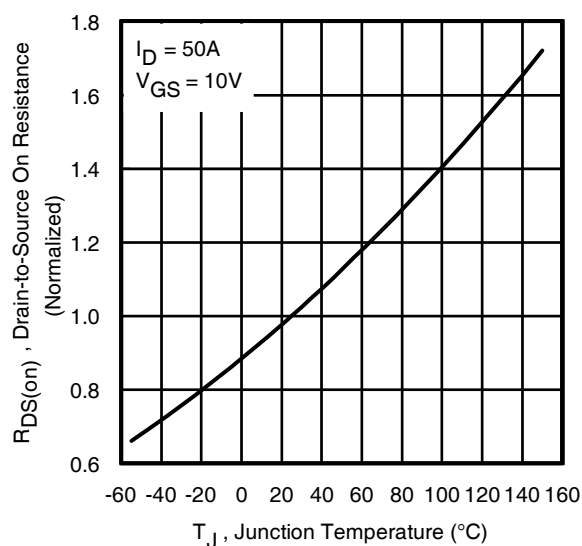
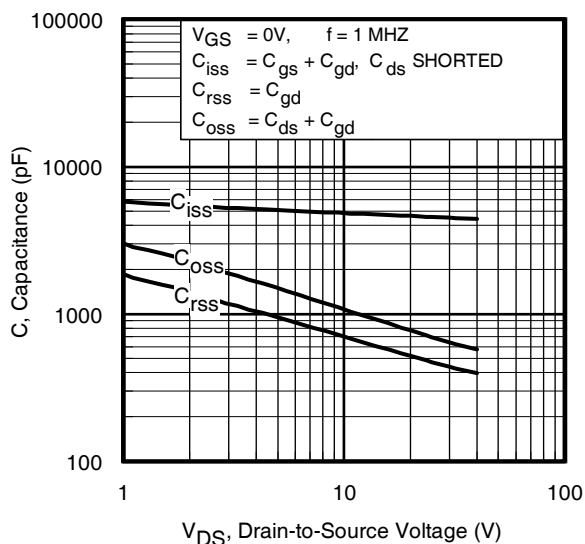
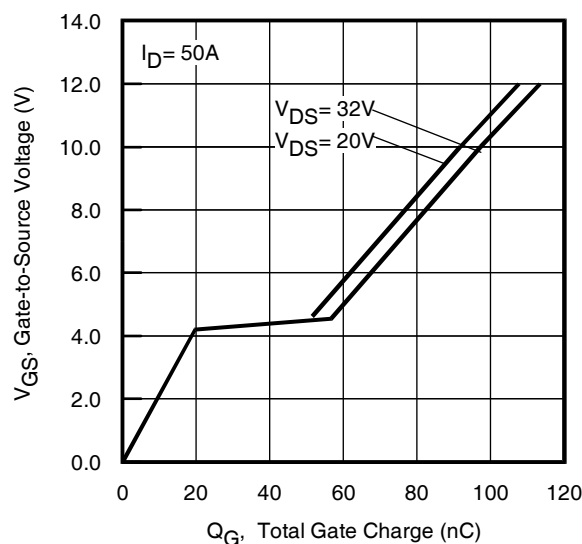
- ① Calculated continuous current based on maximum allowable junction temperature. Current is limited to 85A by source bond technology. Note that current limitations arising from heating of the device leads may occur with some lead mounting arrangements. (Refer to AN-1140)
- ② Repetitive rating; pulse width limited by max. junction temperature.
- ③ Limited by  $T_{Jmax}$ , starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.097mH$   
 $R_G = 50\Omega$ ,  $I_{AS} = 50A$ ,  $V_{GS} = 10V$ .
- ④  $I_{SD} \leq 50A$ ,  $di/dt \leq 1126A/\mu s$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_J \leq 150^\circ\text{C}$ .
- ⑤ Pulse width  $\leq 400\mu s$ ; duty cycle  $\leq 2\%$ .
- ⑥  $C_{OSS}$  eff. (TR) is a fixed capacitance that gives the same charging time as  $C_{OSS}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .
- ⑦  $C_{OSS}$  eff. (ER) is a fixed capacitance that gives the same energy as  $C_{OSS}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .
- ⑧ When mounted on 1 inch square 2 oz copper pad on 1.5 x 1.5 in. board of FR-4 material.
- ⑨  $R_\theta$  is measured at  $T_J$  approximately  $90^\circ\text{C}$ .
- ⑩ This value determined from sample failure population, starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.097mH$ ,  $R_G = 50\Omega$ ,  $I_{AS} = 50A$ ,  $V_{GS} = 10V$ .

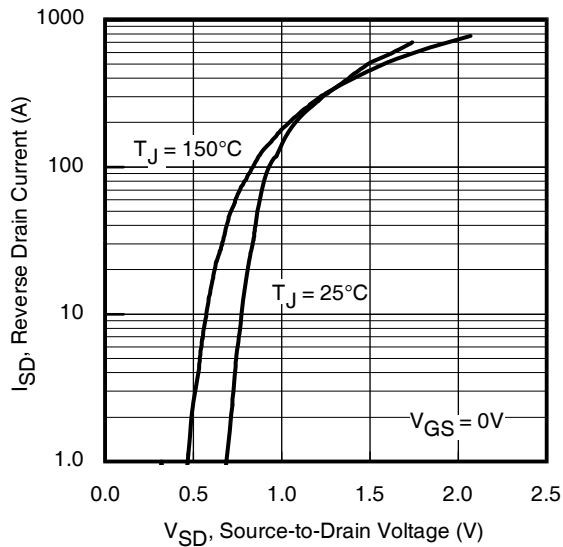
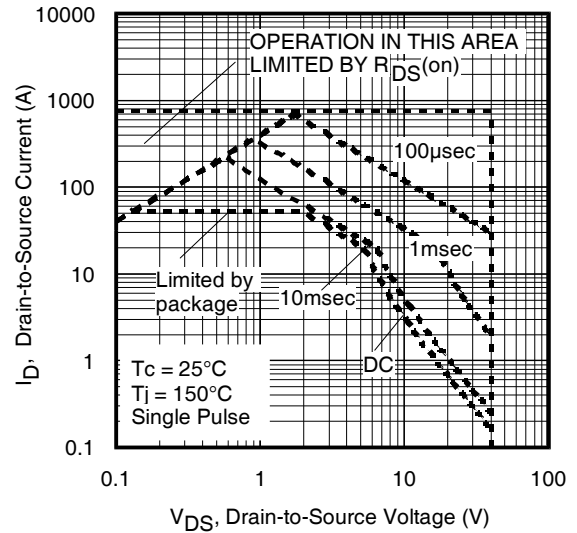
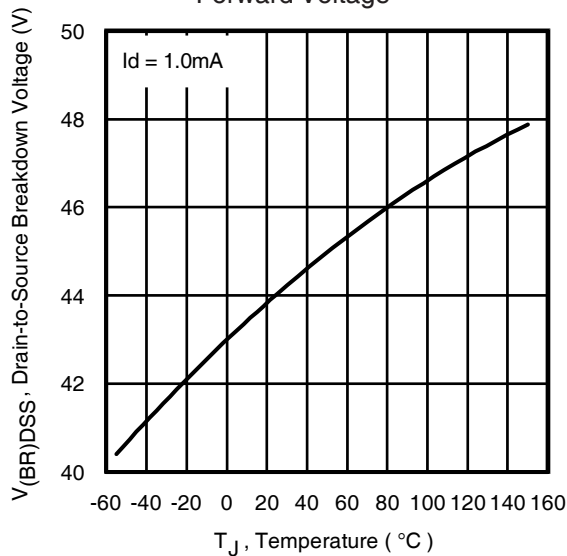
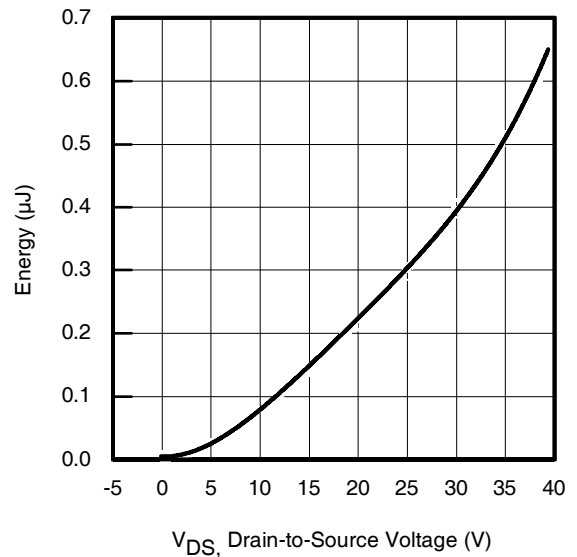
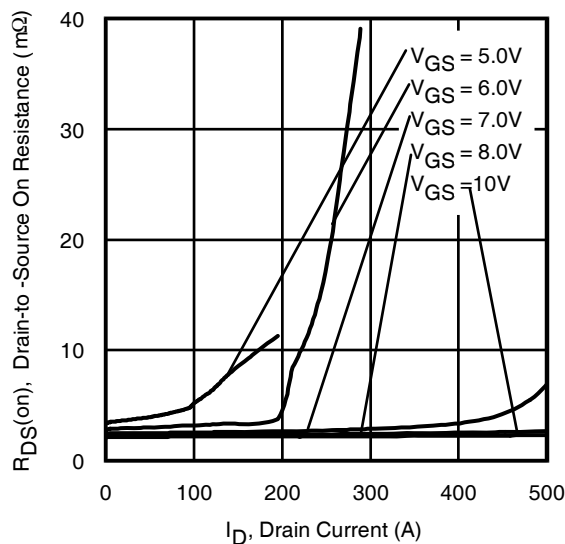
**Dynamic @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)**

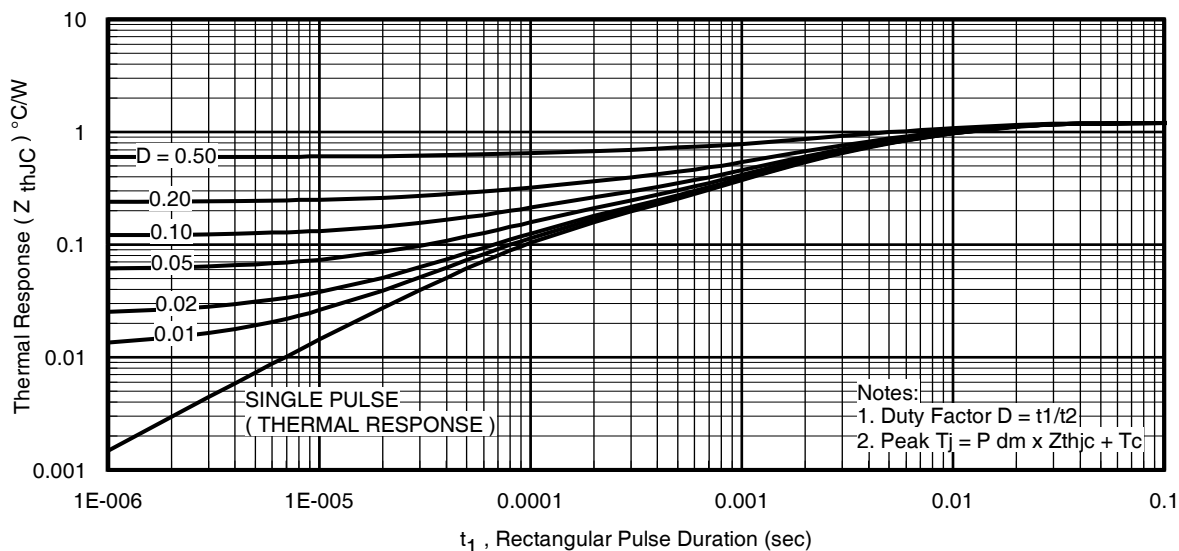
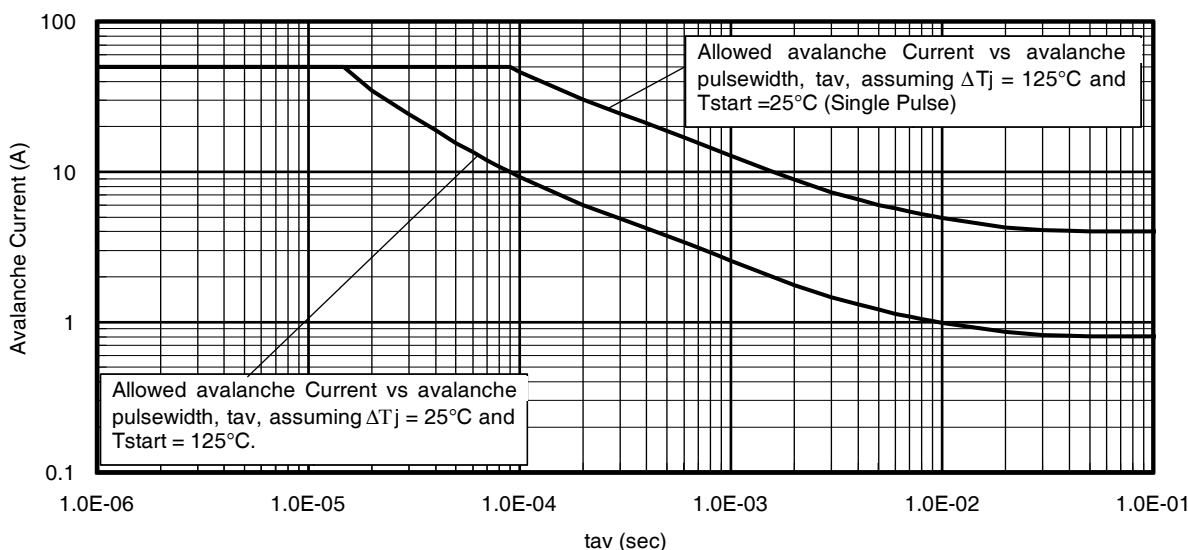
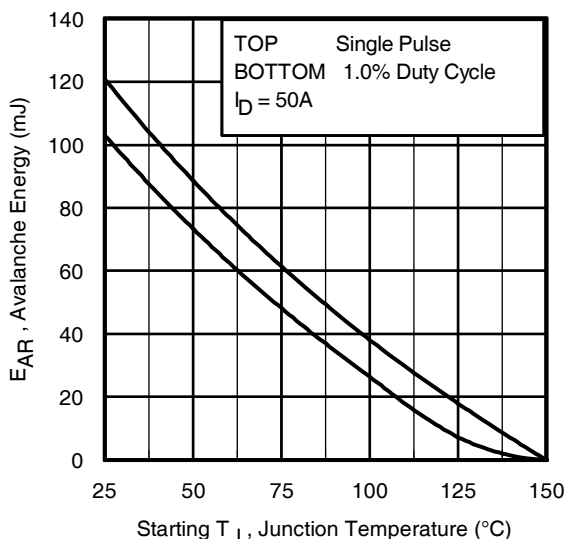
| Symbol                      | Parameter                                     | Min. | Typ. | Max. | Units | Conditions                                                        |
|-----------------------------|-----------------------------------------------|------|------|------|-------|-------------------------------------------------------------------|
| $g_{fs}$                    | Forward Transconductance                      | 149  | —    | —    | S     | $V_{DS} = 10\text{V}$ , $I_D = 50\text{A}$                        |
| $Q_g$                       | Total Gate Charge                             | —    | 92   | 138  | nC    | $I_D = 50\text{A}$                                                |
| $Q_{gs}$                    | Gate-to-Source Charge                         | —    | 22   | —    |       | $V_{DS} = 20\text{V}$                                             |
| $Q_{gd}$                    | Gate-to-Drain ("Miller") Charge               | —    | 29   | —    |       | $V_{GS} = 10\text{V}$ ⑤                                           |
| $Q_{sync}$                  | Total Gate Charge Sync. ( $Q_g - Q_{gd}$ )    | —    | 63   | —    |       | $I_D = 50\text{A}$ , $V_{DS} = 0\text{V}$ , $V_{GS} = 10\text{V}$ |
| $t_{d(on)}$                 | Turn-On Delay Time                            | —    | 12   | —    | ns    | $V_{DD} = 20\text{V}$                                             |
| $t_r$                       | Rise Time                                     | —    | 45   | —    |       | $I_D = 30\text{A}$                                                |
| $t_{d(off)}$                | Turn-Off Delay Time                           | —    | 53   | —    |       | $R_G = 2.7\Omega$                                                 |
| $t_f$                       | Fall Time                                     | —    | 42   | —    |       | $V_{GS} = 10\text{V}$ ⑤                                           |
| $C_{iss}$                   | Input Capacitance                             | —    | 4574 | —    | pF    | $V_{GS} = 0\text{V}$                                              |
| $C_{oss}$                   | Output Capacitance                            | —    | 700  | —    |       | $V_{DS} = 25\text{V}$                                             |
| $C_{rss}$                   | Reverse Transfer Capacitance                  | —    | 466  | —    |       | $f = 1.0\text{ MHz}$                                              |
| $C_{oss \text{ eff. (ER)}}$ | Effective Output Capacitance (Energy Related) | —    | 863  | —    |       | $V_{GS} = 0\text{V}$ , $V_{DS} = 0\text{V}$ to $32\text{V}$ ⑦     |
| $C_{oss \text{ eff. (TR)}}$ | Effective Output Capacitance (Time Related)   | —    | 1229 | —    |       | $V_{GS} = 0\text{V}$ , $V_{DS} = 0\text{V}$ to $32\text{V}$ ⑥     |

**Diode Characteristics**

| Symbol    | Parameter                                 | Min. | Typ. | Max. | Units | Conditions                                                                                                                                         |
|-----------|-------------------------------------------|------|------|------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| $I_S$     | Continuous Source Current<br>(Body Diode) | —    | —    | 85①  | A     | MOSFET symbol showing the integral reverse p-n junction diode.  |
| $I_{SM}$  | Pulsed Source Current<br>(Body Diode) ②   | —    | —    | 745  | A     |                                                                                                                                                    |
| $V_{SD}$  | Diode Forward Voltage                     | —    | 0.9  | 1.3  | V     | $T_J = 25^\circ\text{C}$ , $I_S = 50\text{A}$ , $V_{GS} = 0\text{V}$ ③                                                                             |
| $t_{rr}$  | Reverse Recovery Time                     | —    | 25   | —    | ns    | $T_J = 25^\circ\text{C}$                                                                                                                           |
|           |                                           | —    | 27   | —    |       | $T_J = 125^\circ\text{C}$                                                                                                                          |
| $Q_{rr}$  | Reverse Recovery Charge                   | —    | 16   | —    | nC    | $T_J = 25^\circ\text{C}$                                                                                                                           |
|           |                                           | —    | 17   | —    |       | $T_J = 125^\circ\text{C}$                                                                                                                          |
| $I_{RRM}$ | Reverse Recovery Current                  | —    | 1.2  | —    | A     | $T_J = 25^\circ\text{C}$                                                                                                                           |


**Fig 3.** Typical Output Characteristics

**Fig 4.** Typical Output Characteristics

**Fig 5.** Typical Transfer Characteristics

**Fig 6.** Normalized On-Resistance vs. Temperature

**Fig 7.** Typical Capacitance vs. Drain-to-Source Voltage

**Fig 8.** Typical Gate Charge vs. Gate-to-Source Voltage


**Fig 9.** Typical Source-Drain Diode Forward Voltage

**Fig 10.** Maximum Safe Operating Area

**Fig 11.** Drain-to-Source Breakdown Voltage

**Fig 12.** Typical  $C_{OSS}$  Stored Energy

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


**Fig 14.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

**Fig 15.** Typical Avalanche Current vs. Pulsewidth

**Fig 16.** Maximum Avalanche Energy vs. Temperature

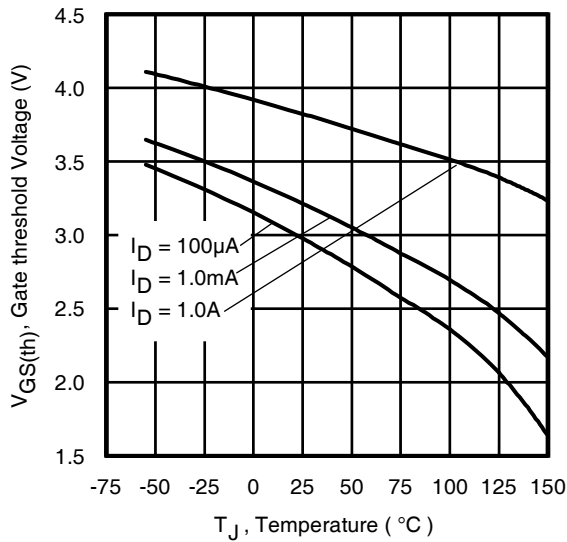
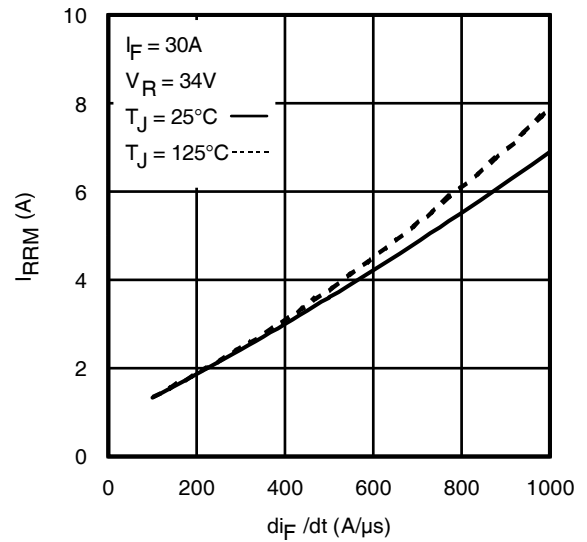
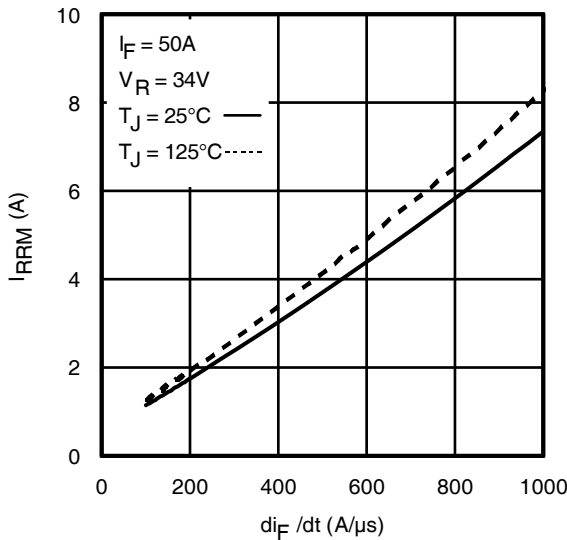
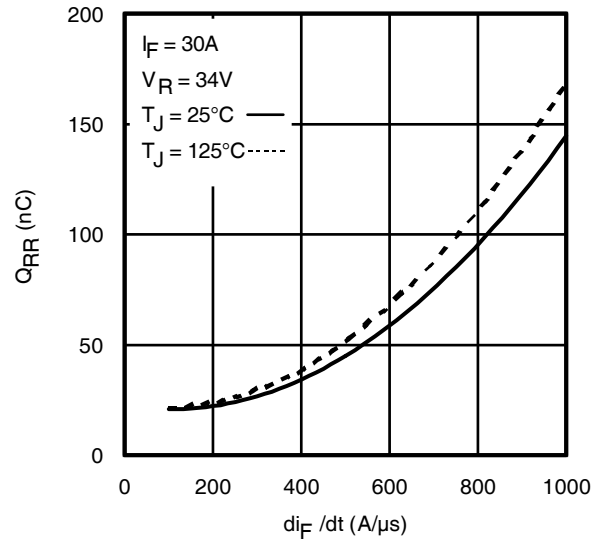
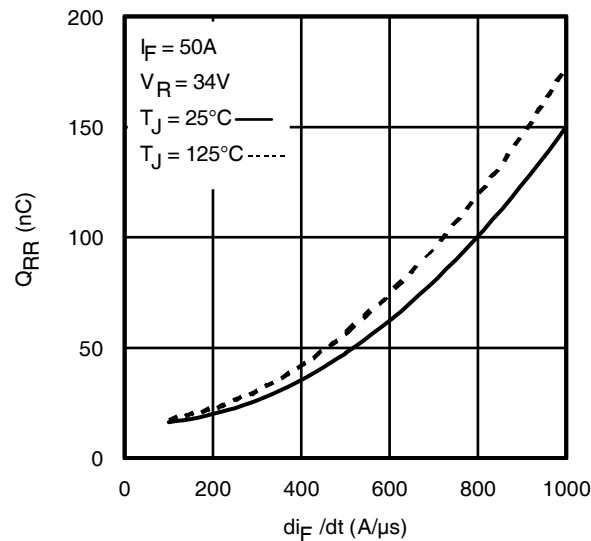
**Notes on Repetitive Avalanche Curves , Figures 14, 15:**  
**(For further info, see AN-1005 at [www.irf.com](http://www.irf.com))**

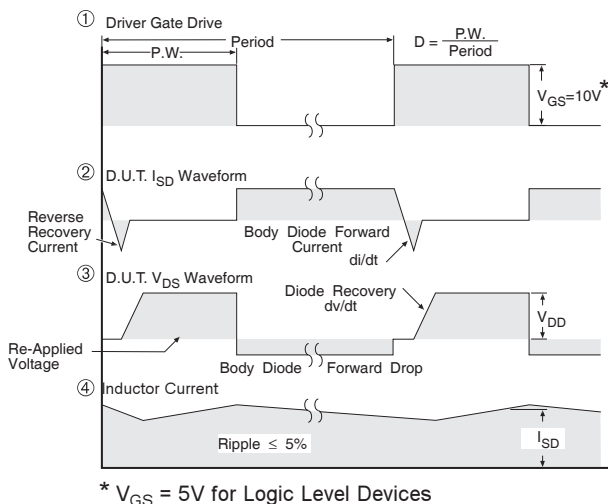
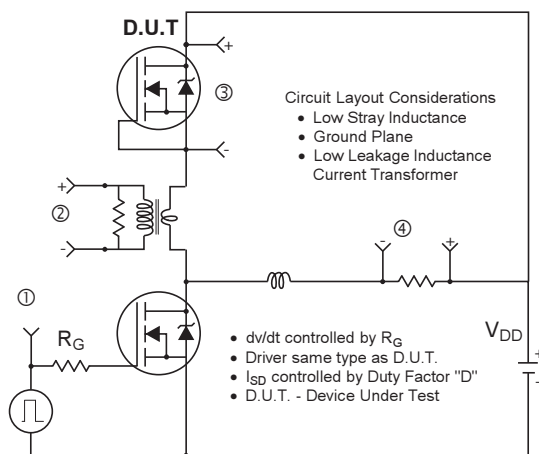
1. Avalanche failures assumption:  
Purely a thermal phenomenon and failure occurs at a temperature far in excess of  $T_{jmax}$ . This is validated for every part type.
2. Safe operation in Avalanche is allowed as long as  $T_{jmax}$  is not exceeded.
3. Equation below based on circuit and waveforms shown in Figures 16a, 16b.
4.  $P_{D(ave)}$  = Average power dissipation per single avalanche pulse.
5.  $BV$  = Rated breakdown voltage (1.3 factor accounts for voltage increase during avalanche).
6.  $I_{av}$  = Allowable avalanche current.
7.  $\Delta T$  = Allowable rise in junction temperature, not to exceed  $T_{jmax}$  (assumed as 25°C in Figure 14, 15).  
 $t_{av}$  = Average time in avalanche.  
 $D$  = Duty cycle in avalanche =  $t_{av} \cdot f$   
 $Z_{thJC}(D, t_{av})$  = Transient thermal resistance, see Figures 13)

$$P_{D(ave)} = 1/2 (1.3 \cdot BV \cdot I_{av}) = \Delta T / Z_{thJC}$$

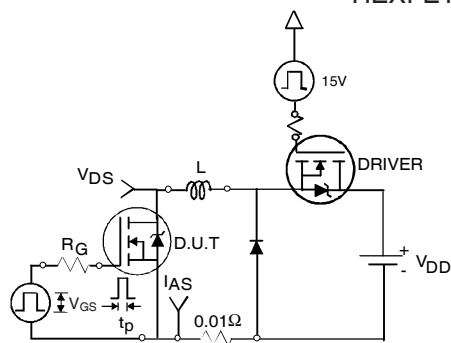
$$I_{av} = 2\Delta T / [1.3 \cdot BV \cdot Z_{thJC}]$$

$$E_{AS(AR)} = P_{D(ave)} \cdot t_{av}$$

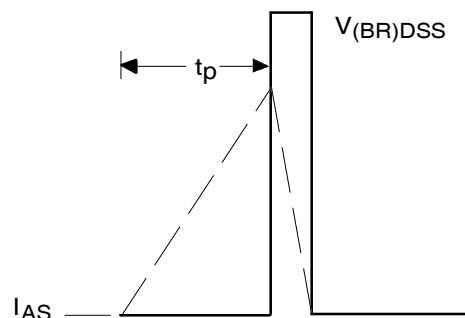

**Fig 17.** Threshold Voltage vs. Temperature

**Fig. 18 -** Typical Recovery Current vs.  $di_F/dt$ 

**Fig. 19 -** Typical Recovery Current vs.  $di_F/dt$ 

**Fig. 20 -** Typical Stored Charge vs.  $di_F/dt$ 

**Fig. 21 -** Typical Stored Charge vs.  $di_F/dt$



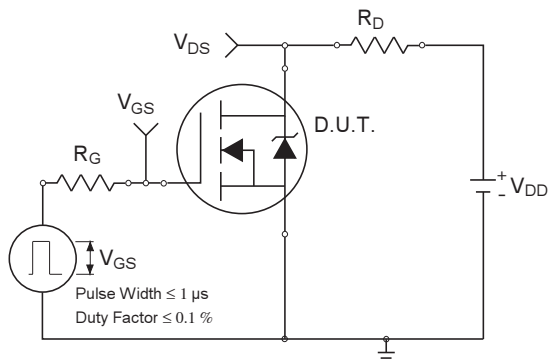
**Fig 22. Peak Diode Recovery  $dv/dt$  Test Circuit for N-Channel HEXFET® Power MOSFETs**



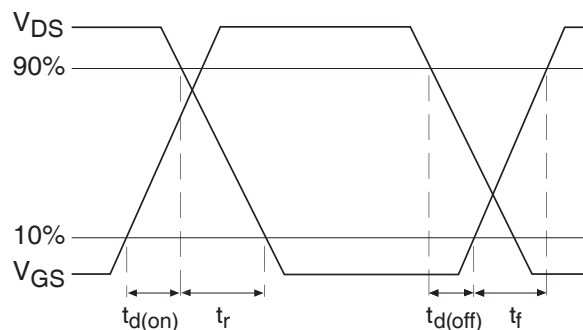
**Fig 22a. Unclamped Inductive Test Circuit**



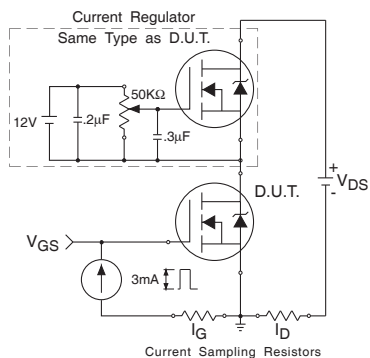
**Fig 22b. Unclamped Inductive Waveforms**



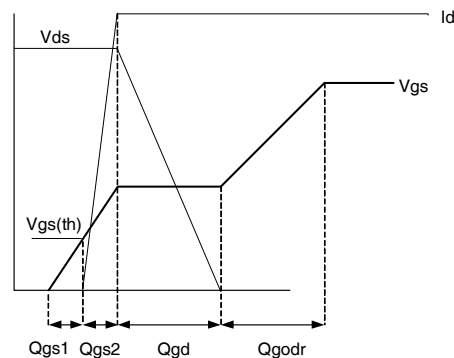
**Fig 23a. Switching Time Test Circuit**



**Fig 23b. Switching Time Waveforms**

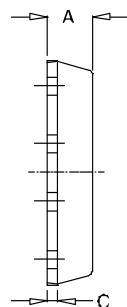


**Fig 24a. Gate Charge Test Circuit**

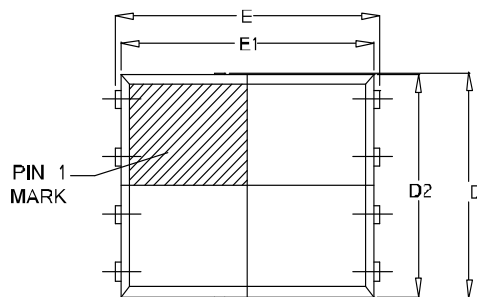


**Fig 24b. Gate Charge Waveform**

## PQFN 5x6 Outline "E" Package Details

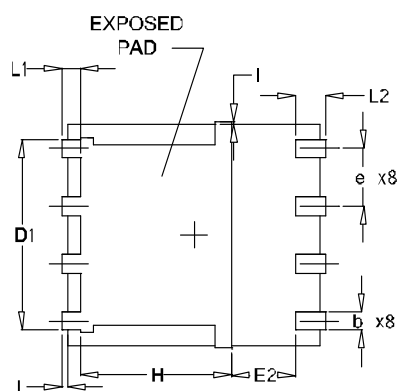


SIDEVIEW



TOP VIEW

| SYMBOL | OUTLINE PQFN 5X6E |      |      |
|--------|-------------------|------|------|
|        | MIN.              | NOM  | MAX. |
| A      | 0.90              | 1.03 | 1.17 |
| b      | 0.33              | 0.41 | 0.48 |
| C      | 0.20              | 0.25 | 0.35 |
| D      | 4.80              | 4.98 | 5.15 |
| D1     | 3.91              | 4.11 | 4.31 |
| D2     | 4.80              | 4.90 | 5.00 |
| E      | 5.90              | 6.02 | 6.15 |
| E1     | 5.65              | 5.75 | 5.85 |
| E2     | 1.10              | —    | —    |
| e      | 1.27 BSC          |      |      |
| L      | 0.05              | 0.15 | 0.25 |
| L1     | 0.38              | 0.44 | 0.50 |
| L2     | 0.51              | 0.68 | 0.86 |
| H      | 3.32              | 3.45 | 3.58 |
| I      | —                 | —    | 0.18 |

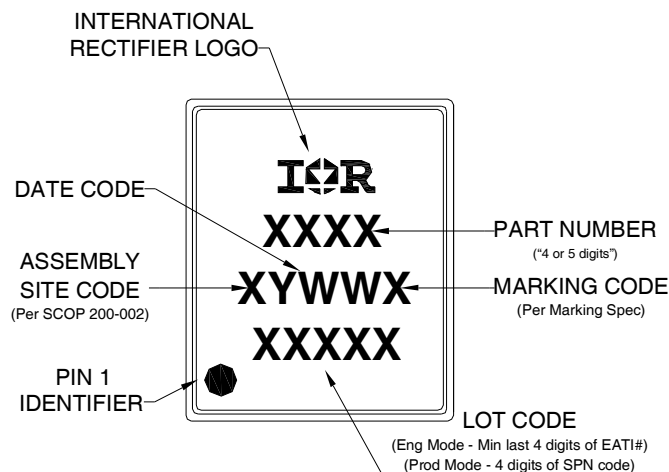


BOTTOM VIEW

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>

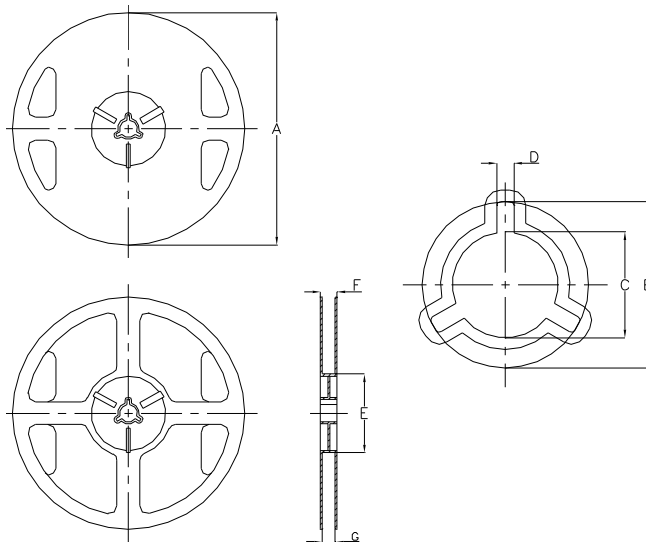
For more information on package inspection techniques, please refer to application note AN-1154: <http://www.irf.com/technical-info/appnotes/an-1154.pdf>

## PQFN 5x6 Outline "E" Part Marking



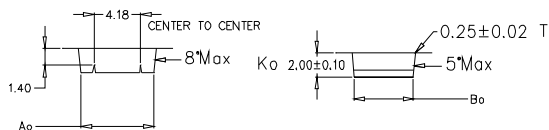
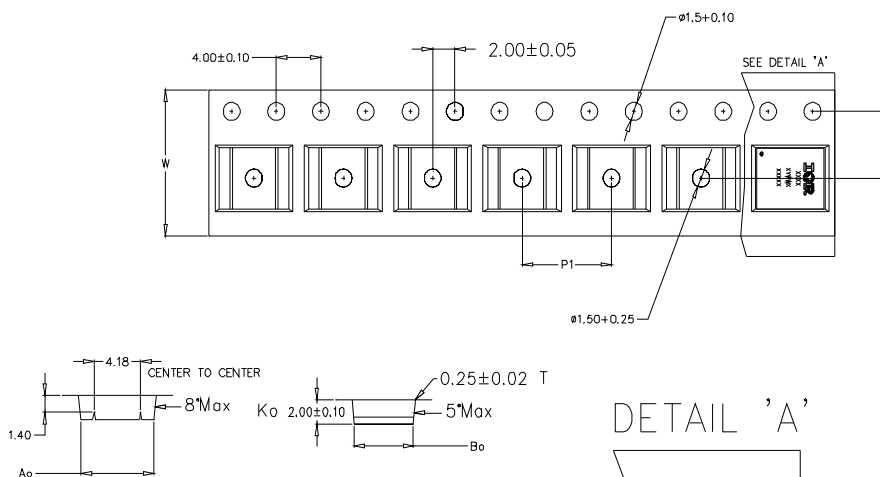
Note: For the most current drawing please refer to IR website at: <http://www.irf.com/package/>

## PQFN 5x6 Outline "E" Tape and Reel



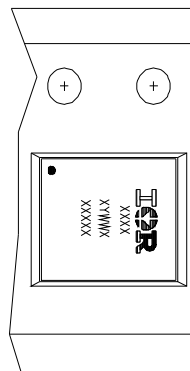
NOTE: Controlling dimensions in mm Std reel quantity is 4000 parts.

| REEL DIMENSIONS |                            |       |          |        |                      |       |          |       |
|-----------------|----------------------------|-------|----------|--------|----------------------|-------|----------|-------|
| CODE            | STANDARD OPTION (QTY 4000) |       |          |        | TR1 OPTION (QTY 400) |       |          |       |
|                 | METRIC                     |       | IMPERIAL |        | METRIC               |       | IMPERIAL |       |
|                 | MIN                        | MAX   | MIN      | MAX    | MIN                  | MAX   | MIN      | MAX   |
| A               | 329.5                      | 330.5 | 12.972   | 13.011 | 177.5                | 178.5 | 6.988    | 7.028 |
| B               | 20.9                       | 21.5  | 0.823    | 0.846  | 20.9                 | 21.5  | 0.823    | 0.846 |
| C               | 12.8                       | 13.5  | 0.504    | 0.532  | 13.2                 | 13.8  | 0.520    | 0.543 |
| D               | 1.7                        | 2.3   | 0.067    | 0.091  | 1.9                  | 2.3   | 0.075    | 0.091 |
| E               | 97                         | 99    | 3.819    | 3.898  | 65                   | 66    | 2.350    | 2.598 |
| F               | Ref                        | 17.4  |          |        | Ref                  | 12    |          |       |
| G               | 13                         | 14.5  | 0.512    | 0.571  | 13                   | 14.5  | 0.512    | 0.571 |



|    |             |
|----|-------------|
| Ao | 6.50 ±0.10  |
| Bo | 5.28 ±0.10  |
| F  | 5.50 ±0.05  |
| P1 | 8.00 ±0.10  |
| W  | 12.00 ±0.10 |

DETAIL 'A'



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

|                            |                                                              |                                               |
|----------------------------|--------------------------------------------------------------|-----------------------------------------------|
| Qualification level        | Industrial<br>(per JEDEC JE S D47F guidelines) <sup>††</sup> |                                               |
| Moisture Sensitivity Level | PQFN 5mm x 6mm                                               | MSL1<br>(per 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> Applicable version of JEDEC standard at the time of product release.

Data and specifications subject to change without notice.

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