

# IRF2804S-7PPbF

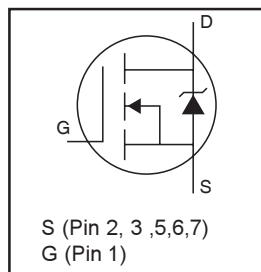
## Features

- Advanced Process Technology
- Ultra Low On-Resistance
- 175°C Operating Temperature
- Fast Switching
- Repetitive Avalanche Allowed up to  $T_{jmax}$
- Lead-Free

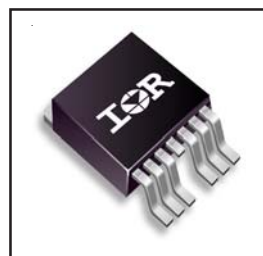
## Description

This HEXFET® Power MOSFET utilizes the latest processing techniques to achieve extremely low on-resistance per silicon area. Additional features of this design are a 175°C junction operating temperature, fast switching speed and improved repetitive avalanche rating. These features combine to make this design an extremely efficient and reliable device for use in a wide variety of applications.

## HEXFET® Power MOSFET



|                           |
|---------------------------|
| $V_{DSS} = 40V$           |
| $R_{DS(on)} = 1.6m\Omega$ |
| $I_D = 160A$              |



## Absolute Maximum Ratings

|                           | Parameter                                                  | Max.                      | Units |
|---------------------------|------------------------------------------------------------|---------------------------|-------|
| $I_D @ T_C = 25^\circ C$  | Continuous Drain Current, $V_{GS} @ 10V$ (Silicon Limited) | 320                       | A     |
| $I_D @ T_C = 100^\circ C$ | Continuous Drain Current, $V_{GS} @ 10V$ (See Fig. 9)      | 230                       |       |
| $I_D @ T_C = 25^\circ C$  | Continuous Drain Current, $V_{GS} @ 10V$ (Package Limited) | 160                       |       |
| $I_{DM}$                  | Pulsed Drain Current ①                                     | 1360                      |       |
| $P_D @ T_C = 25^\circ C$  | Maximum Power Dissipation                                  | 330                       | W     |
|                           | Linear Derating Factor                                     | 2.2                       | W/°C  |
| $V_{GS}$                  | Gate-to-Source Voltage                                     | $\pm 20$                  | V     |
| $E_{AS}$                  | Single Pulse Avalanche Energy (Thermally Limited) ②        | 630                       | mJ    |
| $E_{AS} (tested)$         | Single Pulse Avalanche Energy Tested Value ③               | 1050                      |       |
| $I_{AR}$                  | Avalanche Current ①                                        | See Fig. 12a, 12b, 15, 16 | A     |
| $E_{AR}$                  | Repetitive Avalanche Energy ⑤                              |                           | mJ    |
| $T_J$                     | Operating Junction and                                     | -55 to + 175              | °C    |
| $T_{STG}$                 | Storage Temperature Range                                  |                           |       |
|                           | Soldering Temperature, for 10 seconds                      | 300 (1.6mm from case )    |       |
|                           | Mounting torque, 6-32 or M3 screw                          | 10 lbf•in (1.1 N•m)       |       |

## Thermal Resistance

|                 | Parameter                                        | Typ. | Max. | Units |
|-----------------|--------------------------------------------------|------|------|-------|
| $R_{\theta JC}$ | Junction-to-Case ③                               | —    | 0.50 | °C/W  |
| $R_{\theta CS}$ | Case-to-Sink, Flat, Greased Surface              | 0.50 | —    |       |
| $R_{\theta JA}$ | Junction-to-Ambient ③                            | —    | 62   |       |
| $R_{\theta JA}$ | Junction-to-Ambient (PCB Mount, steady state) ⑦⑧ | —    | 40   |       |

HEXFET® is a registered trademark of International Rectifier.

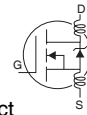
www.irf.com

# IRF2804S-7PPbF

International  
IR Rectifier

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

|                              | Parameter                            | Min. | Typ.  | Max. | Units               | Conditions                                                                  |
|------------------------------|--------------------------------------|------|-------|------|---------------------|-----------------------------------------------------------------------------|
| $V_{(BR)DSS}$                | Drain-to-Source Breakdown Voltage    | 40   | —     | —    | V                   | $V_{GS} = 0V, I_D = 250\mu A$                                               |
| $\Delta BV_{DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient  | —    | 0.028 | —    | V/ $^\circ\text{C}$ | Reference to $25^\circ\text{C}$ , $I_D = 1\text{mA}$                        |
| $R_{DS(on)SMD}$              | Static Drain-to-Source On-Resistance | —    | 1.2   | 1.6  | m $\Omega$          | $V_{GS} = 10V, I_D = 160A$ ③                                                |
| $V_{GS(th)}$                 | Gate Threshold Voltage               | 2.0  | —     | 4.0  | V                   | $V_{DS} = V_{GS}, I_D = 250\mu A$                                           |
| $g_{fs}$                     | Forward Transconductance             | 220  | —     | —    | S                   | $V_{DS} = 10V, I_D = 160A$                                                  |
| $I_{DSS}$                    | Drain-to-Source Leakage Current      | —    | —     | 20   | $\mu A$             | $V_{DS} = 40V, V_{GS} = 0V$                                                 |
|                              |                                      | —    | —     | 250  |                     | $V_{DS} = 40V, V_{GS} = 0V, T_J = 125^\circ\text{C}$                        |
| $I_{GSS}$                    | Gate-to-Source Forward Leakage       | —    | —     | 200  | nA                  | $V_{GS} = 20V$                                                              |
|                              | Gate-to-Source Reverse Leakage       | —    | —     | -200 |                     | $V_{GS} = -20V$                                                             |
| $Q_g$                        | Total Gate Charge                    | —    | 170   | 260  | nC                  | $I_D = 160A$                                                                |
| $Q_{gs}$                     | Gate-to-Source Charge                | —    | 63    | —    |                     | $V_{DS} = 32V$                                                              |
| $Q_{gd}$                     | Gate-to-Drain ("Miller") Charge      | —    | 71    | —    |                     | $V_{GS} = 10V$ ③                                                            |
| $t_{d(on)}$                  | Turn-On Delay Time                   | —    | 17    | —    | ns                  | $V_{DD} = 20V$                                                              |
| $t_r$                        | Rise Time                            | —    | 150   | —    |                     | $I_D = 160A$                                                                |
| $t_{d(off)}$                 | Turn-Off Delay Time                  | —    | 110   | —    |                     | $R_G = 2.6\Omega$                                                           |
| $t_f$                        | Fall Time                            | —    | 105   | —    |                     | $V_{GS} = 10V$ ②                                                            |
| $L_D$                        | Internal Drain Inductance            | —    | 4.5   | —    | nH                  | Between lead,<br>6mm (0.25in.)<br>from package<br>and center of die contact |
| $L_S$                        | Internal Source Inductance           | —    | 7.5   | —    |                     |                                                                             |
| $C_{iss}$                    | Input Capacitance                    | —    | 6930  | —    | pF                  | $V_{GS} = 0V$                                                               |
| $C_{oss}$                    | Output Capacitance                   | —    | 1750  | —    |                     | $V_{DS} = 25V$                                                              |
| $C_{rss}$                    | Reverse Transfer Capacitance         | —    | 970   | —    |                     | $f = 1.0\text{MHz}$ , See Fig. 5                                            |
| $C_{oss}$                    | Output Capacitance                   | —    | 5740  | —    |                     | $V_{GS} = 0V, V_{DS} = 1.0V, f = 1.0\text{MHz}$                             |
| $C_{oss}$                    | Output Capacitance                   | —    | 1570  | —    |                     | $V_{GS} = 0V, V_{DS} = 32V, f = 1.0\text{MHz}$                              |
| $C_{oss \text{ eff.}}$       | Effective Output Capacitance         | —    | 2340  | —    |                     | $V_{GS} = 0V, V_{DS} = 0V \text{ to } 32V$                                  |



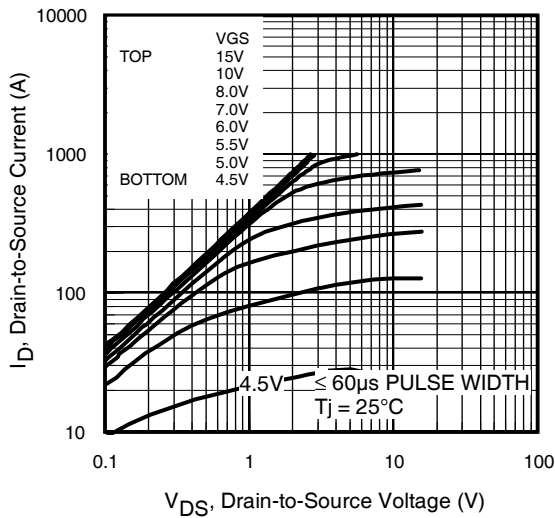
## Diode Characteristics

|          | Parameter                                 | Min. | Typ. | Max. | Units | Conditions                                                              |
|----------|-------------------------------------------|------|------|------|-------|-------------------------------------------------------------------------|
| $I_S$    | Continuous Source Current<br>(Body Diode) | —    | —    | 320  | A     | MOSFET symbol<br>showing the<br>integral reverse<br>p-n junction diode. |
| $I_{SM}$ | Pulsed Source Current<br>(Body Diode) ①   | —    | —    | 1360 |       |                                                                         |
| $V_{SD}$ | Diode Forward Voltage                     | —    | —    | 1.3  | V     | $T_J = 25^\circ\text{C}, I_S = 160A, V_{GS} = 0V$ ⑤                     |
| $t_{rr}$ | Reverse Recovery Time                     | —    | 43   | 65   | ns    | $T_J = 25^\circ\text{C}, I_F = 160A, V_{DD} = 20V$                      |
| $Q_{rr}$ | Reverse Recovery Charge                   | —    | 48   | 72   | nC    | $di/dt = 100A/\mu s$ ③                                                  |

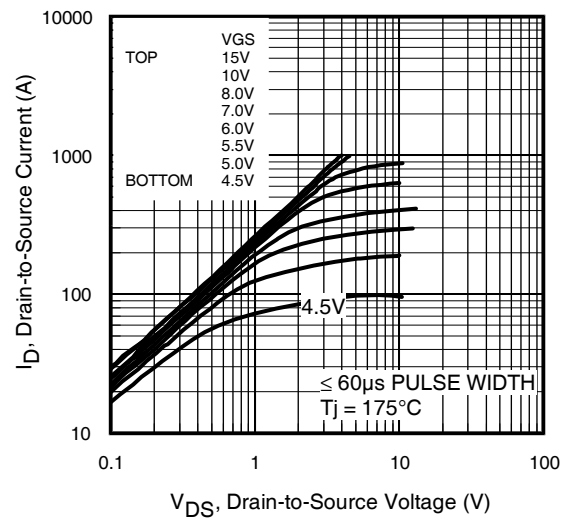
### Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature. (See fig. 11).
- ② Limited by  $T_{Jmax}$ , starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.049\text{mH}$ ,  $R_G = 25\Omega$ ,  $I_{AS} = 160A$ ,  $V_{GS} = 10V$ . Part not recommended for use above this value.
- ③ Pulse width  $\leq 1.0\text{ms}$ ; duty cycle  $\leq 2\%$ .
- ④  $C_{oss \text{ eff.}}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

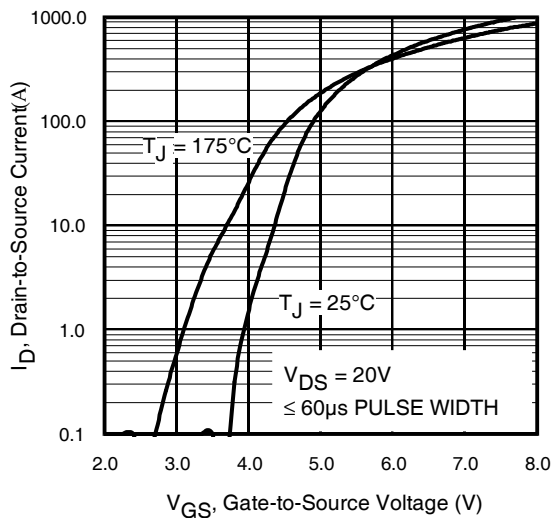
- ⑤ Limited by  $T_{Jmax}$ , see Fig.12a, 12b, 15, 16 for typical repetitive avalanche performance.
- ⑥ This value determined from sample failure population. 100% tested to this value in production.
- ⑦ This is applied to D<sup>2</sup>Pak, when mounted on 1" square PCB (FR-4 or G-10 Material). For recommended footprint and soldering techniques refer to application note #AN-994.
- ⑧  $R_\theta$  is measured at  $T_J$  of approximately  $90^\circ\text{C}$ .



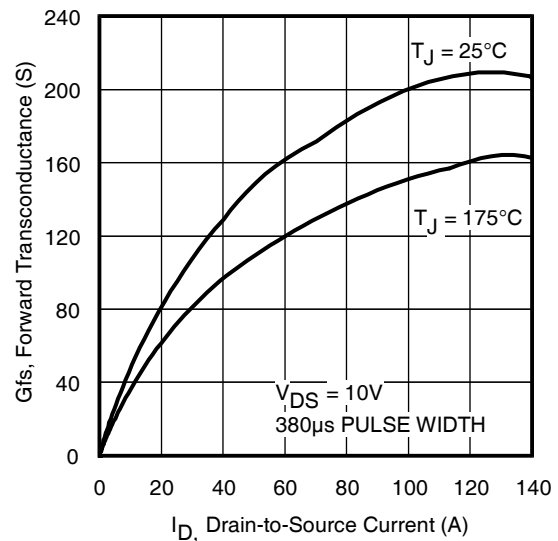
**Fig 1.** Typical Output Characteristics



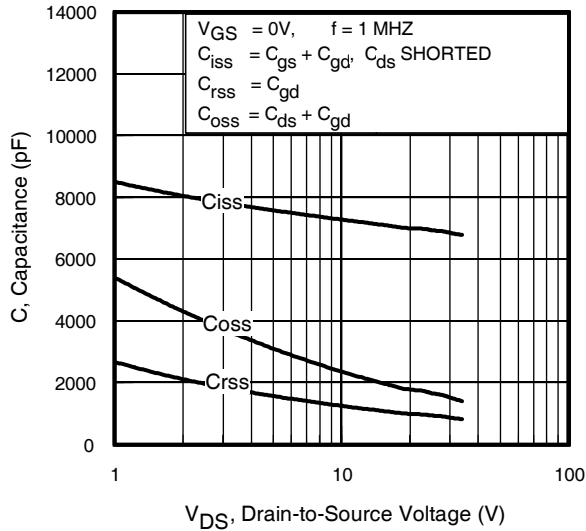
**Fig 2.** Typical Output Characteristics



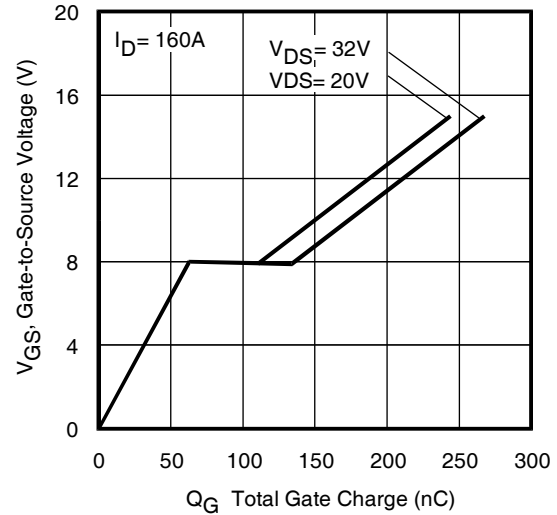
**Fig 3.** Typical Transfer Characteristics



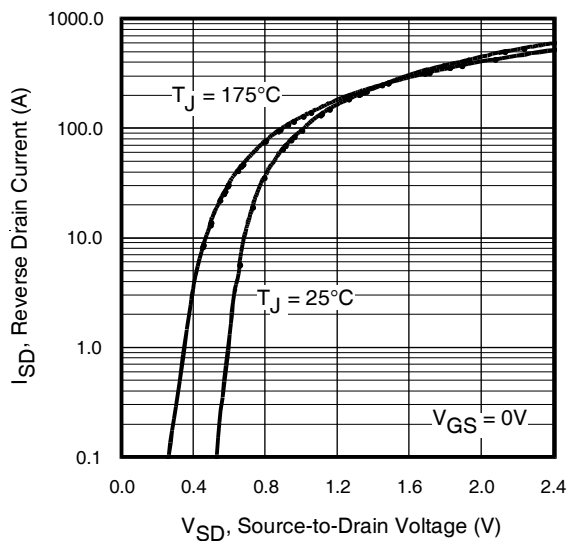
**Fig 4.** Typical Forward Transconductance vs. Drain Current



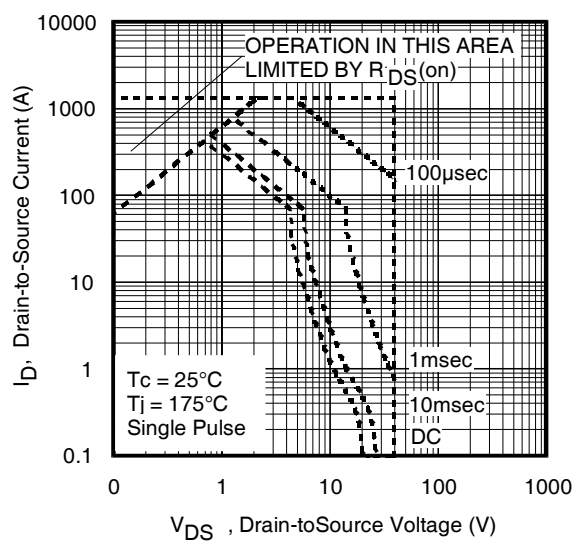
**Fig 5.** Typical Capacitance vs. Drain-to-Source Voltage



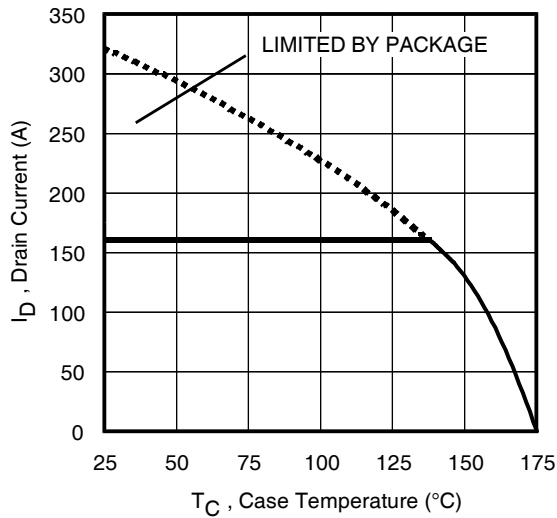
**Fig 6.** Typical Gate Charge vs. Gate-to-Source Voltage



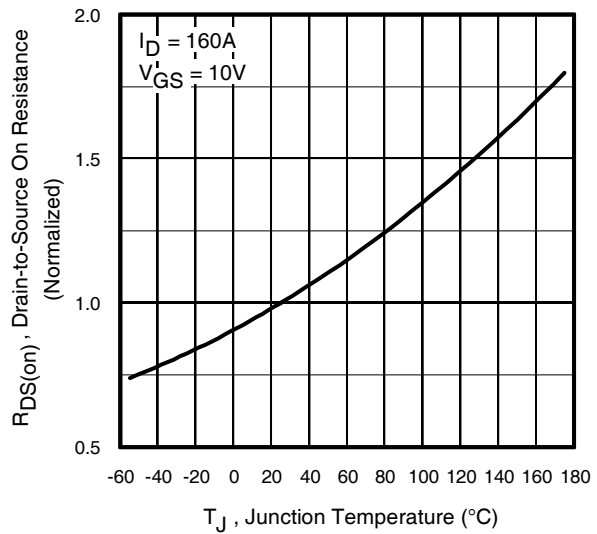
**Fig 7.** Typical Source-Drain Diode Forward Voltage



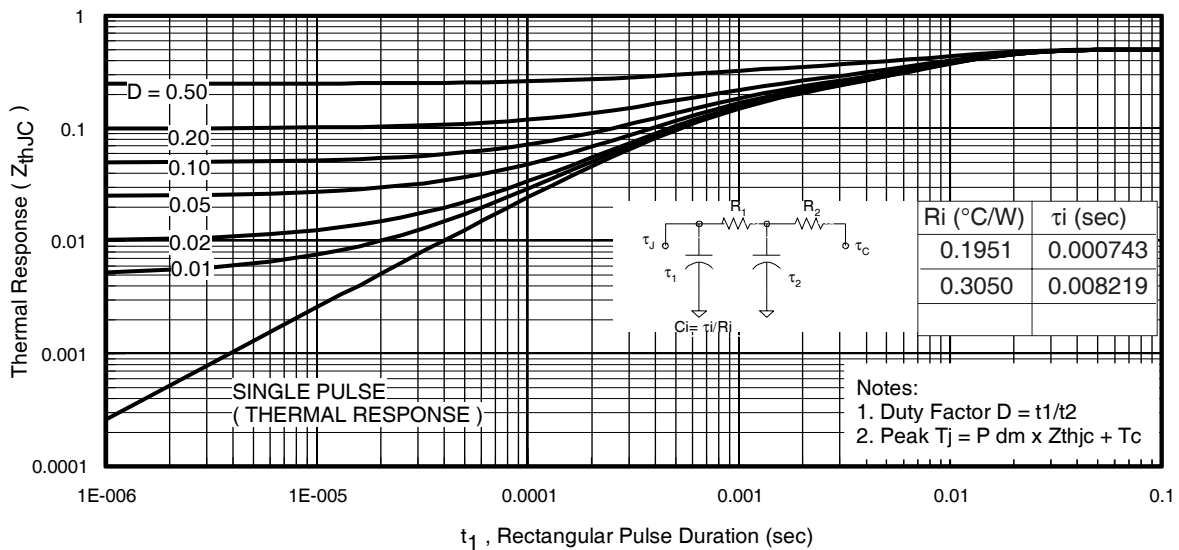
**Fig 8.** Maximum Safe Operating Area



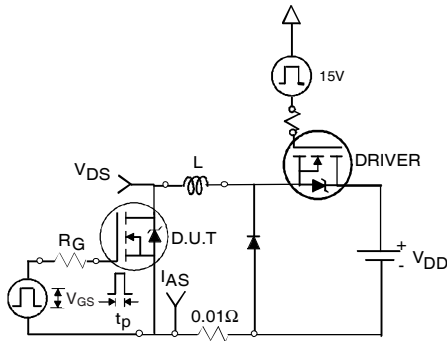
**Fig 9.** Maximum Drain Current vs. Case Temperature



**Fig 10.** Normalized On-Resistance vs. Temperature



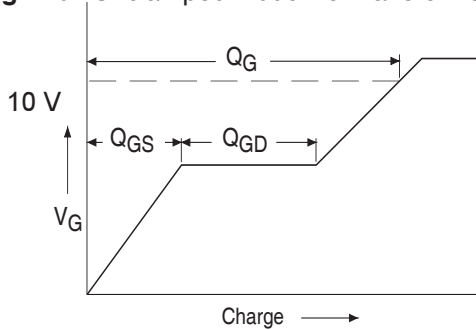
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case



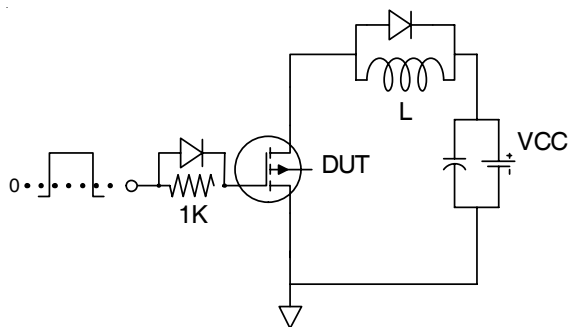
**Fig 12a.** Unclamped Inductive Test Circuit



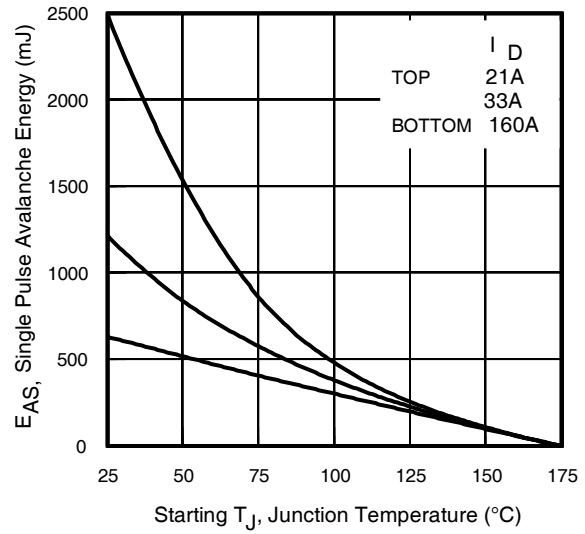
**Fig 12b.** Unclamped Inductive Waveforms



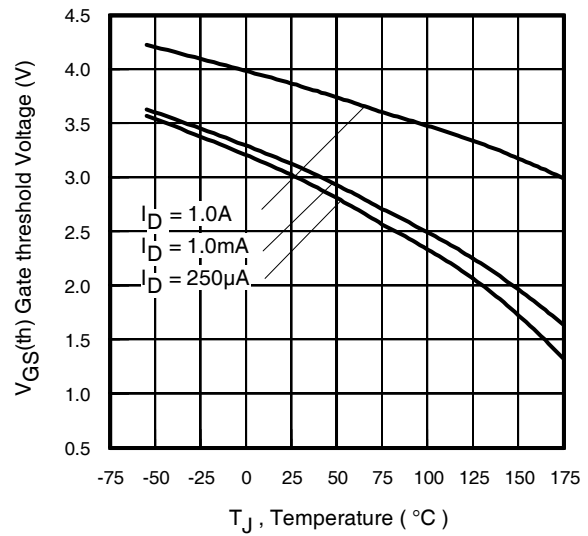
**Fig 13a.** Basic Gate Charge Waveform



**Fig 13b.** Gate Charge Test Circuit



**Fig 12c.** Maximum Avalanche Energy vs. Drain Current



**Fig 14.** Threshold Voltage vs. Temperature

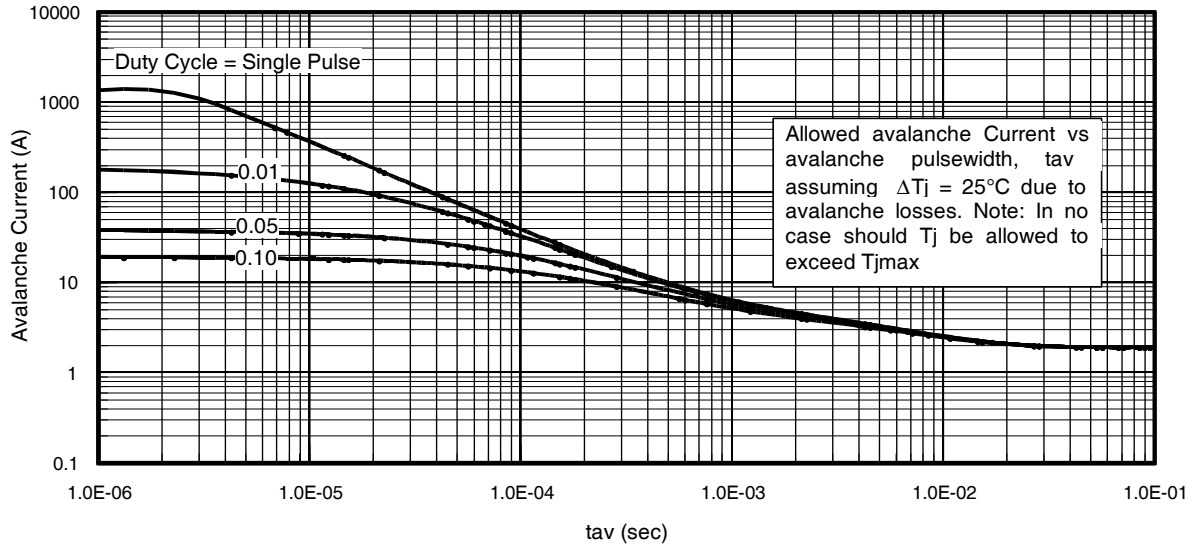


Fig 15. Typical Avalanche Current vs. Pulsewidth

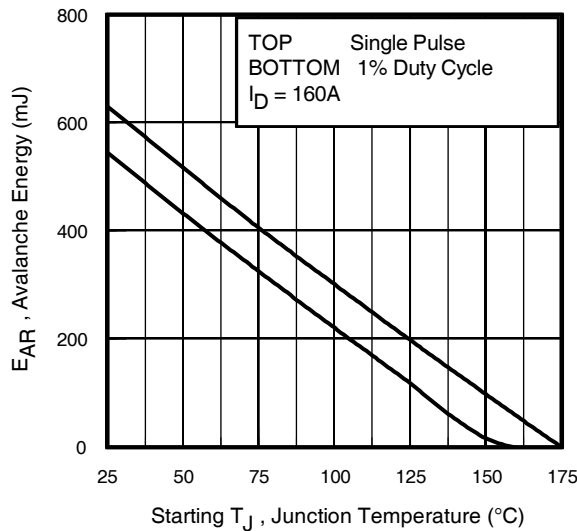


Fig 16. Maximum Avalanche Energy vs. Temperature

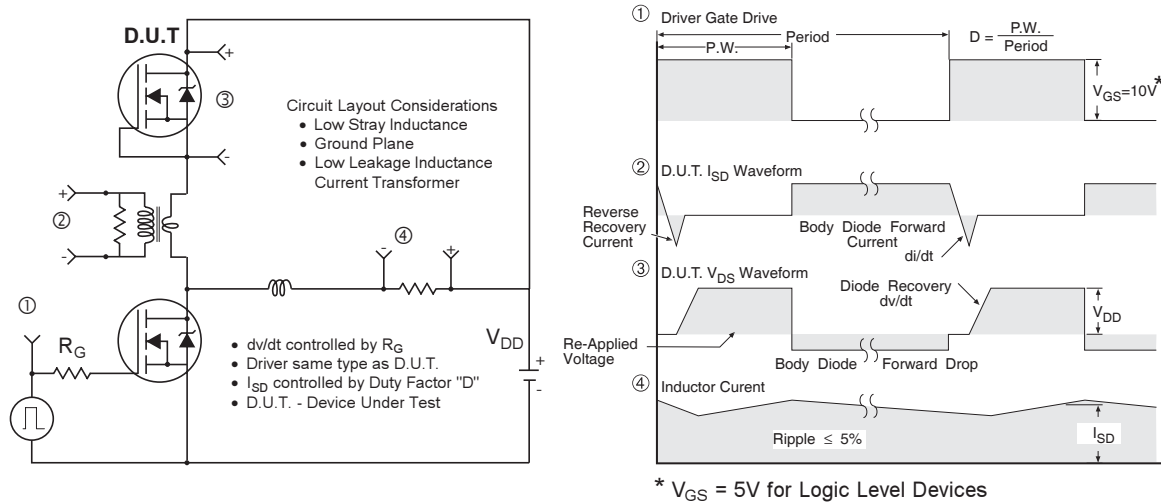
**Notes on Repetitive Avalanche Curves , Figures 15, 16:**  
(For further info, see AN-1005 at [www.irf.com](http://www.irf.com))

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 12a, 12b.
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 15, 16).  
 $t_{av}$  = Average time in avalanche.  
 $D$  = Duty cycle in avalanche =  $t_{av} \cdot f$   
 $Z_{thJC}(D, t_{av})$  = Transient thermal resistance, see figure 11)

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

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

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



**Fig 17. Peak Diode Recovery  $dv/dt$  Test Circuit for N-Channel HEXFET® Power MOSFETs**



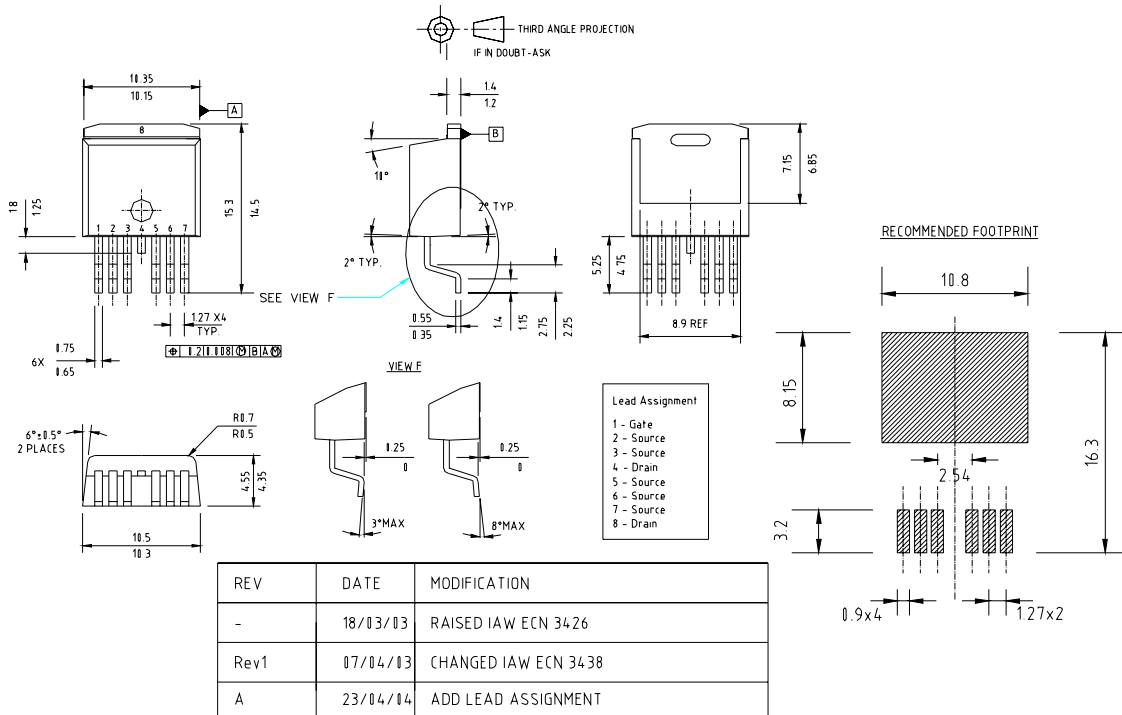
**Fig 18a. Switching Time Test Circuit**



**Fig 18b. Switching Time Waveforms**

## D<sup>2</sup>Pak - 7 Pin Package Outline

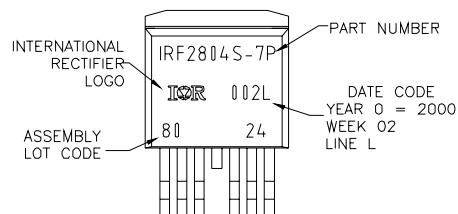
Dimensions are shown in millimeters (inches)



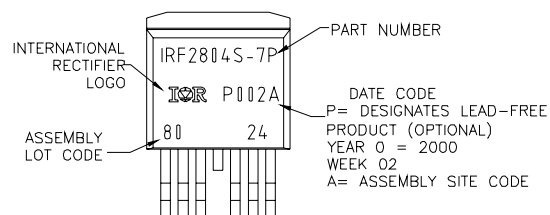
## D<sup>2</sup>Pak - 7 Pin Part Marking Information

EXAMPLE: THIS IS AN IRF2804S-7P WITH  
LOT CODE 8024  
ASSEMBLED ON WW02,2000  
IN THE ASSEMBLY LINE "L"

Note: "P" in assembly line  
position indicates "Lead Free"



OR



### Notes:

1. For an Automotive Qualified version of this part please see <http://www.irf.com/product-info/datasheets/data/auirf2804s-7p.pdf>
2. For the most current drawing please refer to IR website at <http://www.irf.com/package/>

# IRF2804S-7PPbF

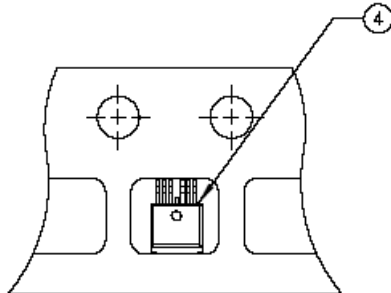
International  
**IR** Rectifier

## D<sup>2</sup>Pak - 7 Pin Tape and Reel

### NOTES, TAPE & REEL, LABELING:

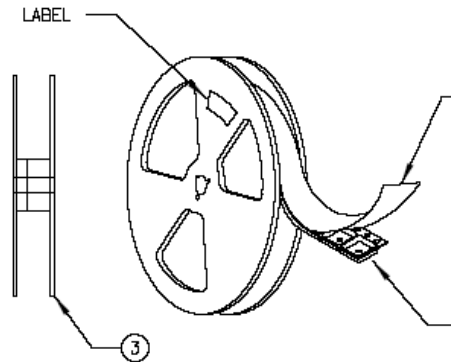
#### 1. TAPE AND REEL.

- 1.1 REEL SIZE 13 INCH DIAMETER.
- 1.2 EACH REEL CONTAINING 800 DEVICES.
- 1.3 THERE SHALL BE A MINIMUM OF 42 SEALED POCKETS CONTAINED IN THE LEADER AND A MINIMUM OF 15 SEALED POCKETS IN THE TRAILER.
- 1.4 PEEL STRENGTH MUST CONFORM TO THE SPEC. NO. 71-9667.
- 1.5 PART ORIENTATION SHALL BE AS SHOWN BELOW.
- 1.6 REEL MAY CONTAIN A MAXIMUM OF TWO UNIQUE LOT CODE/DATE CODE COMBINATIONS. REWORKED REELS MAY CONTAIN A MAXIMUM OF THREE UNIQUE LOT CODE/DATE CODE COMBINATIONS. HOWEVER, THE LOT CODES AND DATE CODES WITH THEIR RESPECTIVE QUANTITIES SHALL APPEAR ON THE BAR CODE LABEL FOR THE AFFECTED REEL.



#### 2. LABELLING (REEL AND SHIPPING BAG).

- 2.1 CUST. PART NUMBER (BAR CODE): IRF2804STRL-7P
- 2.2 CUST. PART NUMBER (TEXT CODE): IRF2804STRL-7P
- 2.3 I.R. PART NUMBER: IRF2804STRL-7P
- 2.4 QUANTITY:
- 2.5 VENDOR CODE: IR
- 2.6 LOT CODE:
- 2.7 DATE CODE:



Data and specifications subject to change without notice.  
This product has been designed and qualified for the Industrial market.  
Qualification Standards can be found on IR's Web site.

International  
**IR** Rectifier

**IR WORLD HEADQUARTERS:** 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105  
TAC Fax: (310) 252-7903

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