

# IRF8513PbF

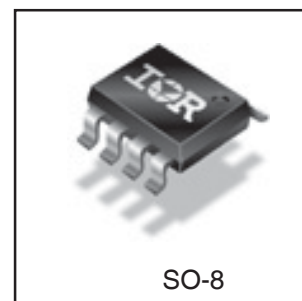
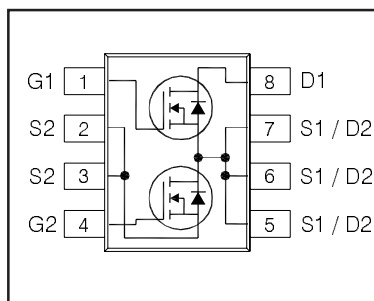
HEXFET® Power MOSFET

## Applications

- Dual SO-8 MOSFET for POL Converters in Notebook Computers, Servers, Graphics Cards, Game Consoles and Set-Top Box

## Benefits

- Low Gate Charge and Low  $R_{DS(on)}$
- Fully Characterized Avalanche Voltage and Current
- 20V  $V_{GS}$  Max. Gate Rating
- 100% Tested for  $R_G$
- Lead-Free (Qualified to 260°C Reflow)
- RoHS Compliant (Halogen Free)



SO-8

## Description

The IRF8513PbF incorporates the latest HEXFET Power MOSFET Silicon Technology into the industry standard SO-8 package. The IRF8513PbF has been optimized for parameters that are critical in synchronous buck operation including  $R_{ds(on)}$  and gate charge to reduce both conduction and switching losses. The reduced total losses make this product ideal for high efficiency DC-DC converters that power the latest generation of processors for notebook and Netcom applications.

## Absolute Maximum Ratings

|                                        | Parameter                                           | Q1 Max.      | Q2 Max. | Units |
|----------------------------------------|-----------------------------------------------------|--------------|---------|-------|
| V <sub>DS</sub>                        | Drain-to-Source Voltage                             | 30           |         | V     |
| V <sub>GS</sub>                        | Gate-to-Source Voltage                              | ± 20         |         |       |
| I <sub>D</sub> @ T <sub>A</sub> = 25°C | Continuous Drain Current, V <sub>GS</sub> @ 10V     | 8.0          | 11      | A     |
| I <sub>D</sub> @ T <sub>A</sub> = 70°C | Continuous Drain Current, V <sub>GS</sub> @ 10V     | 6.2          | 9.0     |       |
| I <sub>DM</sub>                        | Pulsed Drain Current ①                              | 64           | 88      |       |
| P <sub>D</sub> @T <sub>A</sub> = 25°C  | Power Dissipation                                   | 1.5          | 2.4     | W     |
| P <sub>D</sub> @T <sub>A</sub> = 70°C  | Power Dissipation                                   | 1.05         | 1.68    |       |
|                                        | Linear Derating Factor                              | 0.01         | 0.02    | W/°C  |
| T <sub>J</sub><br>T <sub>STG</sub>     | Operating Junction and<br>Storage Temperature Range | -55 to + 175 |         | °C    |

## Thermal Resistance

|                 | Parameter                | Q1 Max. | Q2 Max. | Units |
|-----------------|--------------------------|---------|---------|-------|
| $R_{\theta JL}$ | Junction-to-Drain Lead ⑤ | 42      | 42      | °C/W  |
| $R_{\theta JA}$ | Junction-to-Ambient ④⑤   | 100     | 62.5    |       |

Notes ① through ⑤ are on page 11

## ORDERING INFORMATION:

See detailed ordering and shipping information on the last page of this data sheet.

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

|                                | Parameter                                  |       | Min. | Typ.  | Max. | Units                | Conditions                                                                                                                                                        |
|--------------------------------|--------------------------------------------|-------|------|-------|------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $BV_{DS}$                      | Drain-to-Source Breakdown Voltage          | Q1&Q2 | 30   | —     | —    | V                    | $V_{GS} = 0V, I_D = 250\mu A$                                                                                                                                     |
| $\Delta BV_{DS}/\Delta T_J$    | Breakdown Voltage Temp. Coefficient        | Q1    | —    | 0.021 | —    | V/ $^\circ\text{C}$  | Reference to $25^\circ\text{C}$ , $I_D = 1mA$                                                                                                                     |
|                                |                                            | Q2    | —    | 0.021 | —    |                      |                                                                                                                                                                   |
| $R_{DS(on)}$                   | Static Drain-to-Source On-Resistance       | Q1    | —    | 12.5  | 15.5 | m $\Omega$           | $V_{GS} = 10V, I_D = 8.0A$ ③                                                                                                                                      |
|                                |                                            |       | —    | 18.1  | 22.2 |                      | $V_{GS} = 4.5V, I_D = 6.4A$ ③                                                                                                                                     |
|                                |                                            | Q2    | —    | 10.2  | 12.7 |                      | $V_{GS} = 10V, I_D = 11A$ ③                                                                                                                                       |
|                                |                                            |       | —    | 14.2  | 16.9 |                      | $V_{GS} = 4.5V, I_D = 8.6A$ ③                                                                                                                                     |
| $V_{GS(th)}$                   | Gate Threshold Voltage                     | Q1&Q2 | 1.35 | 1.8   | 2.35 | V                    | Q1: $V_{DS} = V_{GS}, I_D = 25\mu A$<br>Q2: $V_{DS} = V_{GS}, I_D = 25\mu A$                                                                                      |
| $\Delta V_{GS(th)}/\Delta T_J$ | Gate Threshold Voltage Coefficient         | Q1    | —    | -6.5  | —    | mV/ $^\circ\text{C}$ |                                                                                                                                                                   |
|                                |                                            | Q2    | —    | -6.9  | —    |                      |                                                                                                                                                                   |
| $I_{DSS}$                      | Drain-to-Source Leakage Current            | Q1&Q2 | —    | —     | 1.0  | $\mu A$              | $V_{DS} = 24V, V_{GS} = 0V$                                                                                                                                       |
|                                |                                            | Q1&Q2 | —    | —     | 150  |                      | $V_{DS} = 24V, V_{GS} = 0V, T_J = 125^\circ\text{C}$                                                                                                              |
| $I_{GSS}$                      | Gate-to-Source Forward Leakage             | Q1&Q2 | —    | —     | 100  | nA                   | $V_{GS} = 20V$                                                                                                                                                    |
|                                | Gate-to-Source Reverse Leakage             | Q1&Q2 | —    | —     | -100 |                      | $V_{GS} = -20V$                                                                                                                                                   |
| $g_{fs}$                       | Forward Transconductance                   | Q1    | 19   | —     | —    | S                    | $V_{DS} = 15V, I_D = 6.4A$                                                                                                                                        |
|                                |                                            | Q2    | 24   | —     | —    |                      | $V_{DS} = 15V, I_D = 8.6A$                                                                                                                                        |
| $Q_g$                          | Total Gate Charge                          | Q1    | —    | 5.7   | 8.6  | nC                   | Q1<br>$V_{DS} = 15V$<br>$V_{GS} = 4.5V, I_D = 6.4A$<br>Q2<br>$V_{DS} = 15V$<br>$V_{GS} = 4.5V, I_D = 8.6A$<br>See Fig. 31a & 31b                                  |
|                                |                                            | Q2    | —    | 7.6   | 11.4 |                      |                                                                                                                                                                   |
| $Q_{gs1}$                      | Pre-V <sub>th</sub> Gate-to-Source Charge  | Q1    | —    | 1.2   | —    |                      |                                                                                                                                                                   |
|                                |                                            | Q2    | —    | 1.7   | —    |                      |                                                                                                                                                                   |
| $Q_{gs2}$                      | Post-V <sub>th</sub> Gate-to-Source Charge | Q1    | —    | 0.68  | —    |                      |                                                                                                                                                                   |
|                                |                                            | Q2    | —    | 1.0   | —    |                      |                                                                                                                                                                   |
| $Q_{gd}$                       | Gate-to-Drain Charge                       | Q1    | —    | 2.2   | —    |                      |                                                                                                                                                                   |
|                                |                                            | Q2    | —    | 3.1   | —    |                      |                                                                                                                                                                   |
| $Q_{aodr}$                     | Gate Charge Overdrive                      | Q1    | —    | 1.6   | —    |                      |                                                                                                                                                                   |
|                                |                                            | Q2    | —    | 1.9   | —    |                      |                                                                                                                                                                   |
| $Q_{sw}$                       | Switch Charge ( $Q_{gs2} + Q_{gd}$ )       | Q1    | —    | 2.9   | —    | nC                   | See Fig. 31a & 31b                                                                                                                                                |
|                                |                                            | Q2    | —    | 4.0   | —    |                      |                                                                                                                                                                   |
| $Q_{oss}$                      | Output Charge                              | Q1    | —    | 3.9   | —    | nC                   | $V_{DS} = 16V, V_{GS} = 0V$                                                                                                                                       |
|                                |                                            | Q2    | —    | 5.2   | —    |                      |                                                                                                                                                                   |
| $R_G$                          | Gate Resistance                            | Q1    | —    | 2.1   | 3.2  | $\Omega$             |                                                                                                                                                                   |
|                                |                                            | Q2    | —    | 1.4   | 3.1  |                      |                                                                                                                                                                   |
| $t_{d(on)}$                    | Turn-On Delay Time                         | Q1    | —    | 8.0   | —    | ns                   | Q1<br>$V_{DD} = 15V, V_{GS} = 4.5V$<br>$I_D = 6.4A$<br>$R_G = 1.8\Omega$ See Fig.30a & 30b<br>Q2<br>$V_{DD} = 15V, V_{GS} = 4.5V$<br>$I_D = 8.6A$<br>$R_G = 1.8W$ |
|                                |                                            | Q2    | —    | 8.9   | —    |                      |                                                                                                                                                                   |
| $t_r$                          | Rise Time                                  | Q1    | —    | 8.5   | —    |                      |                                                                                                                                                                   |
|                                |                                            | Q2    | —    | 10.7  | —    |                      |                                                                                                                                                                   |
| $t_{d(off)}$                   | Turn-Off Delay Time                        | Q1    | —    | 8.8   | —    |                      |                                                                                                                                                                   |
|                                |                                            | Q2    | —    | 9.3   | —    |                      |                                                                                                                                                                   |
| $t_f$                          | Fall Time                                  | Q1    | —    | 5.7   | —    | pF                   | $V_{GS} = 0V$<br>$V_{DS} = 15V$<br>$f = 1.0MHz$                                                                                                                   |
|                                |                                            | Q2    | —    | 5.0   | —    |                      |                                                                                                                                                                   |
| $C_{iss}$                      | Input Capacitance                          | Q1    | —    | 766   | —    |                      |                                                                                                                                                                   |
|                                |                                            | Q2    | —    | 1024  | —    |                      |                                                                                                                                                                   |
| $C_{oss}$                      | Output Capacitance                         | Q1    | —    | 172   | —    |                      |                                                                                                                                                                   |
|                                |                                            | Q2    | —    | 238   | —    |                      |                                                                                                                                                                   |
| $C_{rss}$                      | Reverse Transfer Capacitance               | Q1    | —    | 83    | —    |                      |                                                                                                                                                                   |
|                                |                                            | Q2    | —    | 116   | —    |                      |                                                                                                                                                                   |

## Avalanche Characteristics

|          | Parameter                       | Typ. | Q1 Max. | Q2 Max. | Units |
|----------|---------------------------------|------|---------|---------|-------|
| $E_{AS}$ | Single Pulse Avalanche Energy ② | —    | 49      | 70      | mJ    |
| $I_{AR}$ | Avalanche Current ①             | —    | 6.4     | 8.6     | A     |

## Diode Characteristics

|                 | Parameter                              |                                                                        | Min. | Typ. | Max. | Units | Conditions                                                                                                                                                                             |
|-----------------|----------------------------------------|------------------------------------------------------------------------|------|------|------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| I <sub>S</sub>  | Continuous Source Current (Body Diode) | Q1                                                                     | —    | —    | 1.9  | A     | MOSFET symbol showing the integral reverse p-n junction diode.                                    |
|                 |                                        | Q2                                                                     | —    | —    | 3.0  |       |                                                                                                                                                                                        |
| I <sub>SM</sub> | Pulsed Source Current (Body Diode) ①   | Q1                                                                     | —    | —    | 64   | A     |                                                                                                                                                                                        |
|                 |                                        | Q2                                                                     | —    | —    | 88   |       |                                                                                                                                                                                        |
| V <sub>SD</sub> | Diode Forward Voltage                  | Q1                                                                     | —    | —    | 1.0  | V     | T <sub>J</sub> = 25°C, I <sub>S</sub> = 6.4A, V <sub>GS</sub> = 0V ③                                                                                                                   |
|                 |                                        | Q2                                                                     | —    | —    | 1.0  |       | T <sub>J</sub> = 25°C, I <sub>S</sub> = 8.6A, V <sub>GS</sub> = 0V ③                                                                                                                   |
| t <sub>rr</sub> | Reverse Recovery Time                  | Q1                                                                     | —    | 15   | 23   | ns    | Q1 T <sub>J</sub> = 25°C, I <sub>F</sub> = 6.4A, V <sub>DD</sub> = 15V, di/dt = 100A/μs ③<br>Q2 T <sub>J</sub> = 25°C, I <sub>F</sub> = 8.6A, V <sub>DD</sub> = 15V, di/dt = 100A/μs ③ |
|                 |                                        | Q2                                                                     | —    | 17   | 26   |       |                                                                                                                                                                                        |
| Q <sub>rr</sub> | Reverse Recovery Charge                | Q1                                                                     | —    | 7.2  | 11   | nC    |                                                                                                                                                                                        |
|                 |                                        | Q2                                                                     | —    | 9.3  | 14   |       |                                                                                                                                                                                        |
| t <sub>on</sub> | Forward Trun-On Time                   | Intrinsic turn -on time is negligible (turn -on is dominated by LS+LD) |      |      |      |       |                                                                                                                                                                                        |

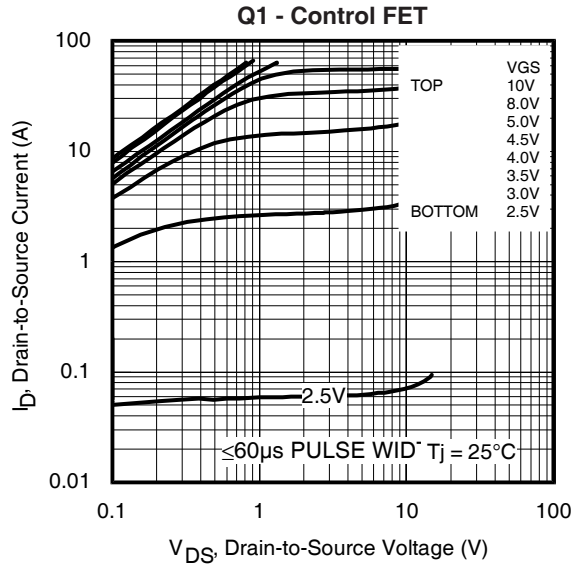


**Fig 1.** Typical Output Characteristics

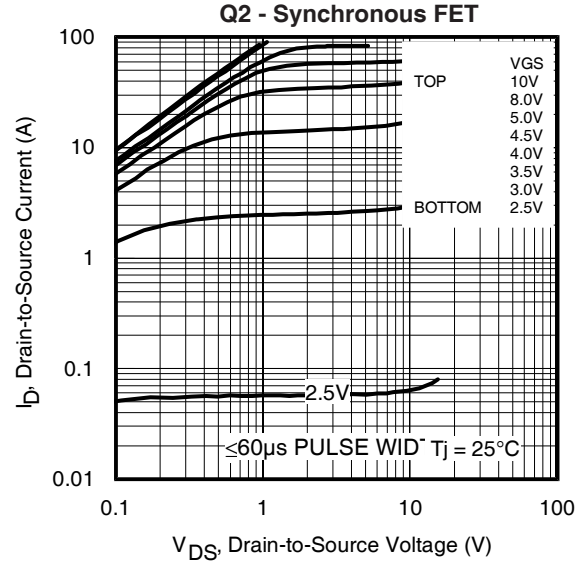


**Fig 2.** Typical Output Characteristics

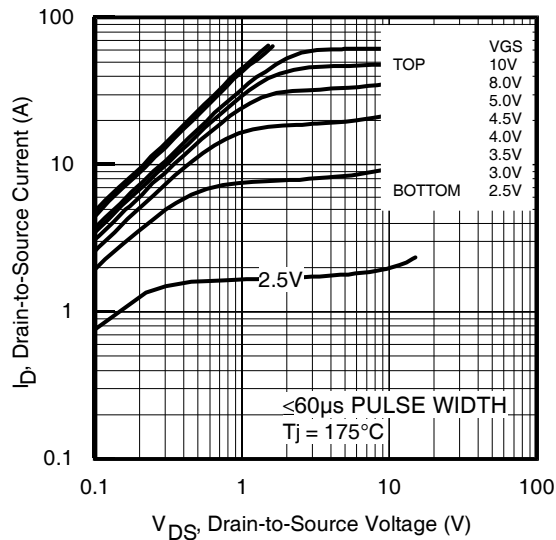


**Fig 3.** Typical Output Characteristics

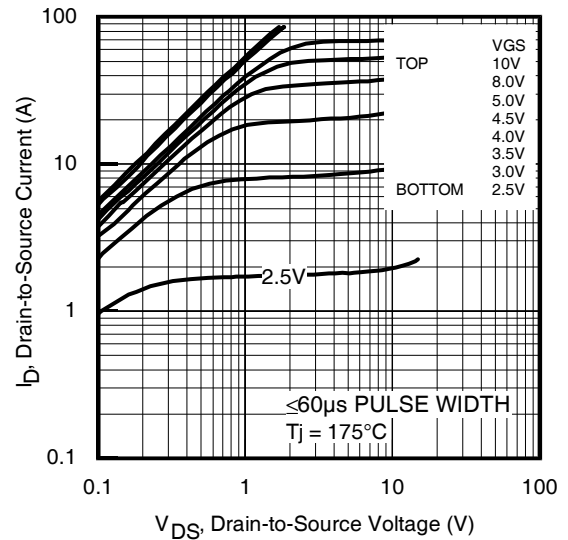


**Fig 4.** Typical Output Characteristics

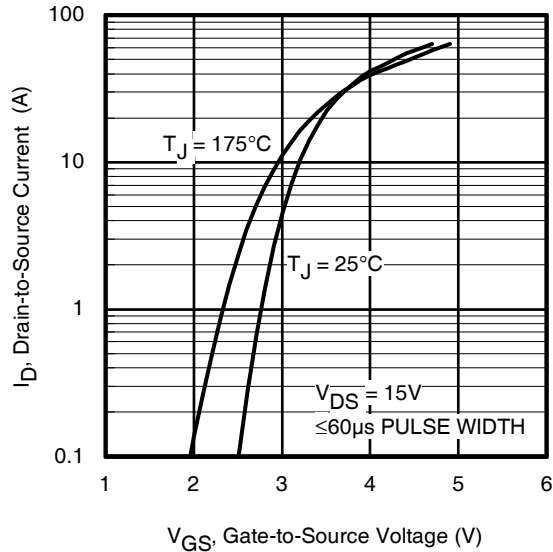


**Fig 5.** Typical Transfer Characteristics

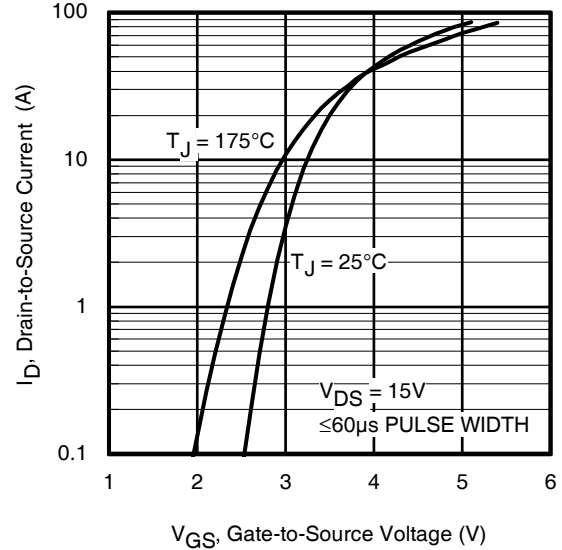


**Fig 6.** Typical Transfer Characteristics

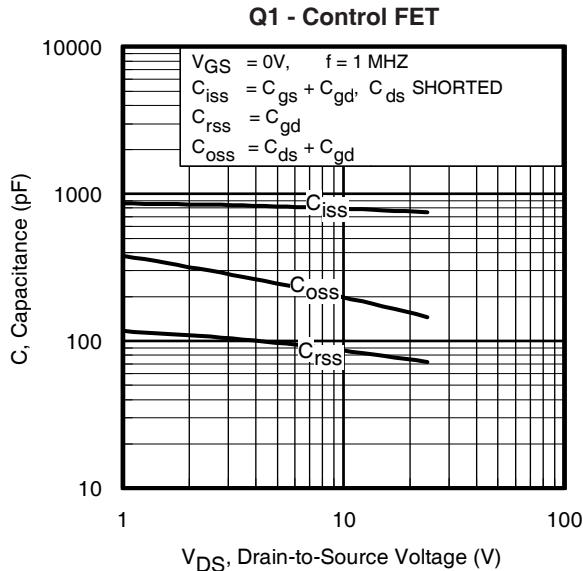


**Fig 7.** Typical Capacitance vs. Drain-to-Source Voltage

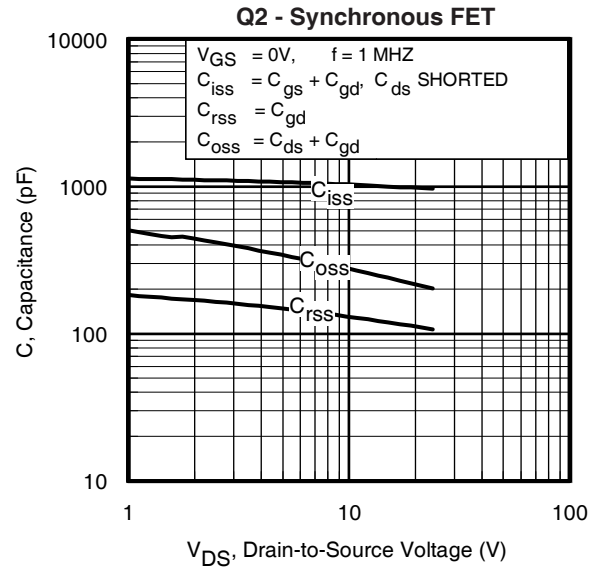


**Fig 8.** Typical Capacitance vs. Drain-to-Source Voltage

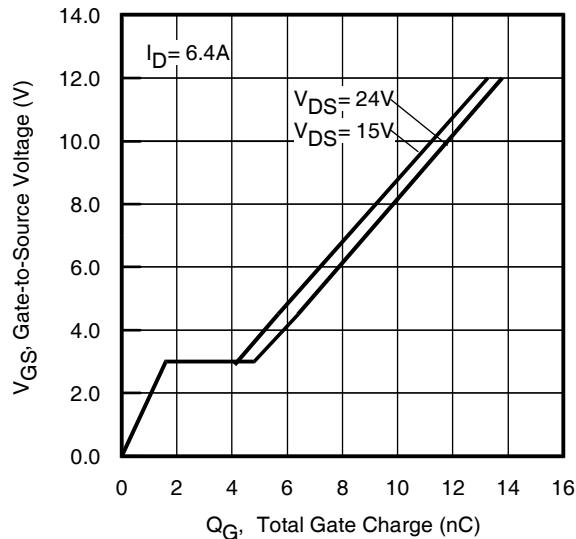


**Fig 9.** Typical Gate Charge vs. Gate-to-Source Voltage

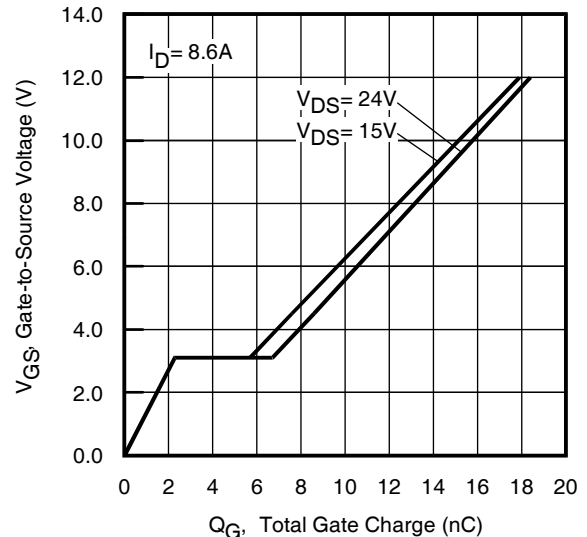


**Fig 10.** Typical Gate Charge vs. Gate-to-Source Voltage

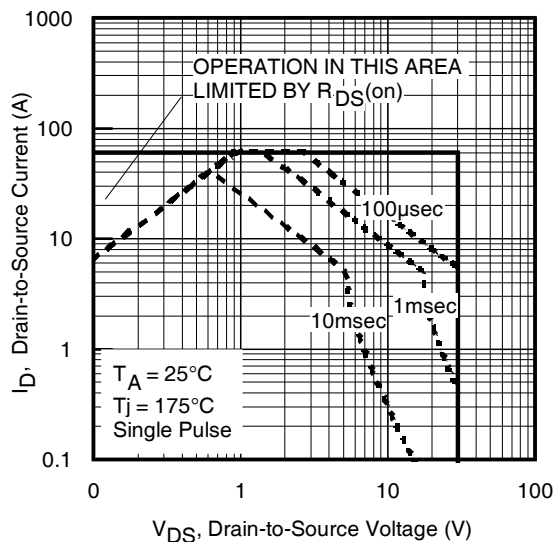


**Fig 11.** Maximum Safe Operating Area

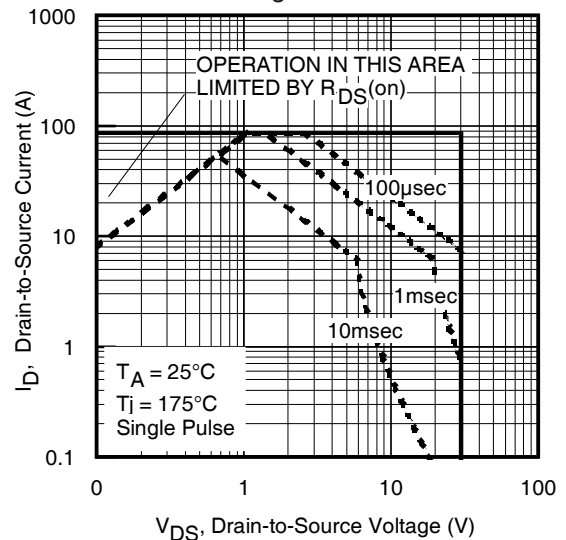


**Fig 12.** Maximum Safe Operating Area

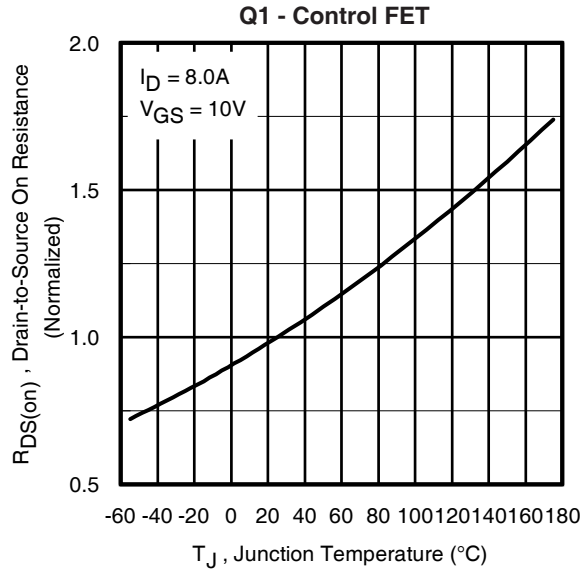


**Fig 13.** Normalized On-Resistance vs. Temperature

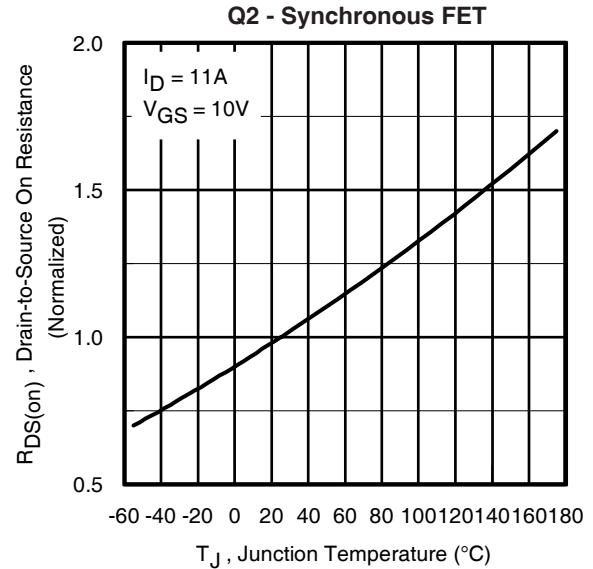


**Fig 14.** Normalized On-Resistance vs. Temperature

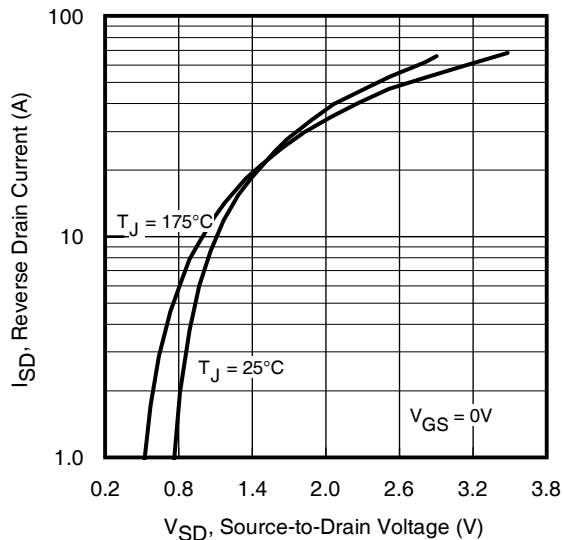


**Fig 15.** Typical Source-Drain Diode Forward Voltage

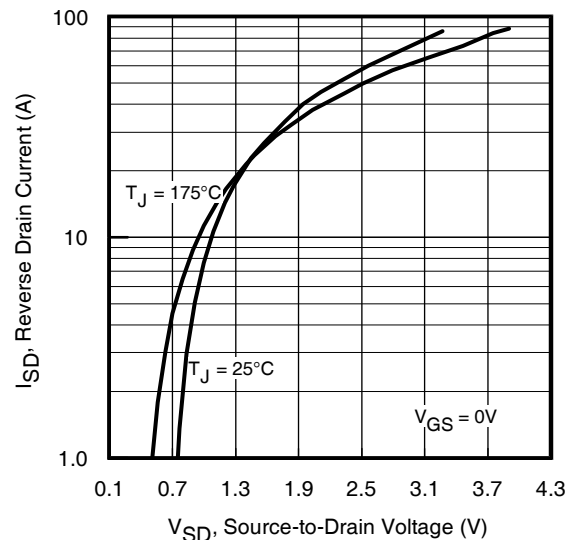


**Fig 16.** Typical Source-Drain Diode Forward Voltage

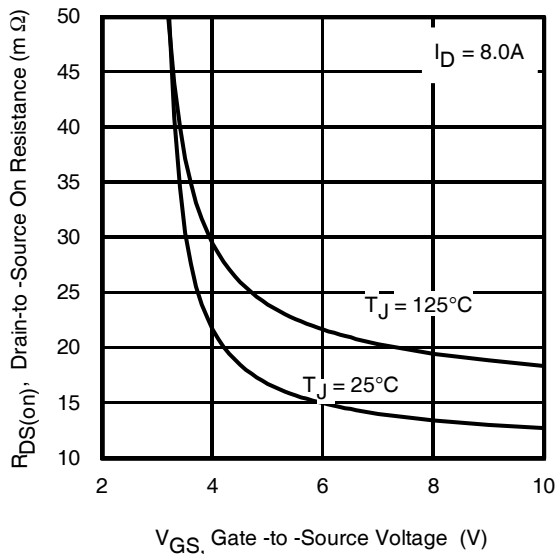


**Fig 17.** Typical On-Resistance vs. Gate Voltage

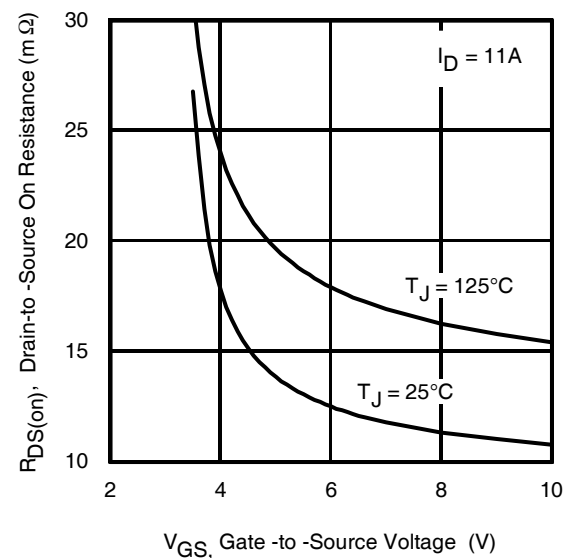


**Fig 18.** Typical On-Resistance vs. Gate Voltage

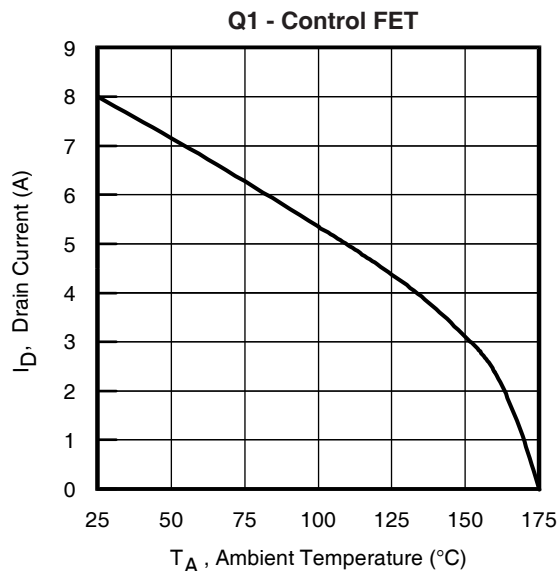


**Fig 19.** Maximum Drain Current vs. Ambient Temp.

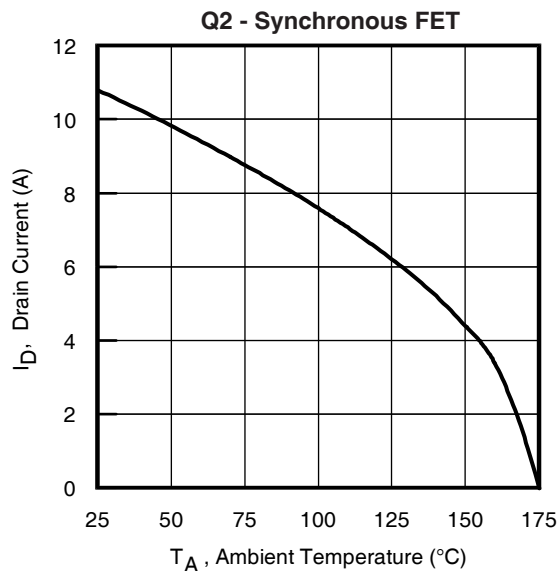


**Fig 20.** Maximum Drain Current vs. Ambient Temp.

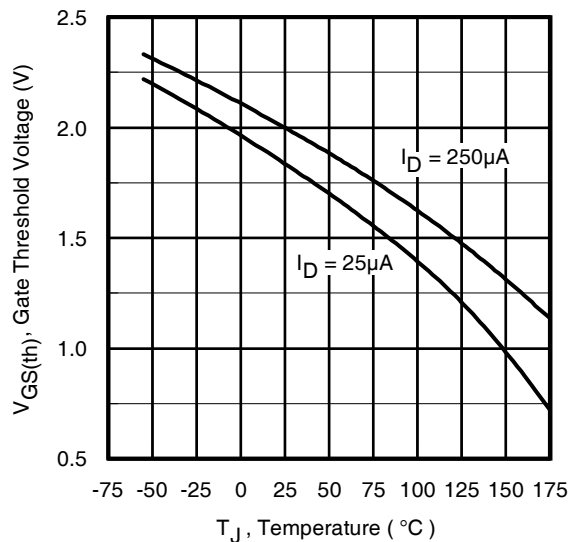


**Fig 21.** Threshold Voltage vs. Temperature

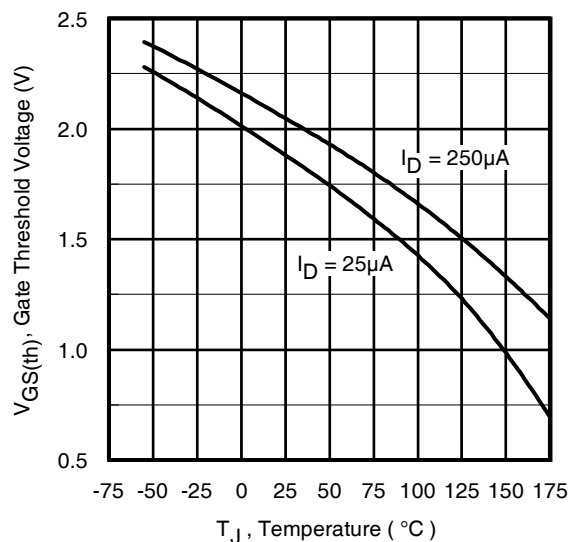


**Fig 22.** Threshold Voltage vs. Temperature

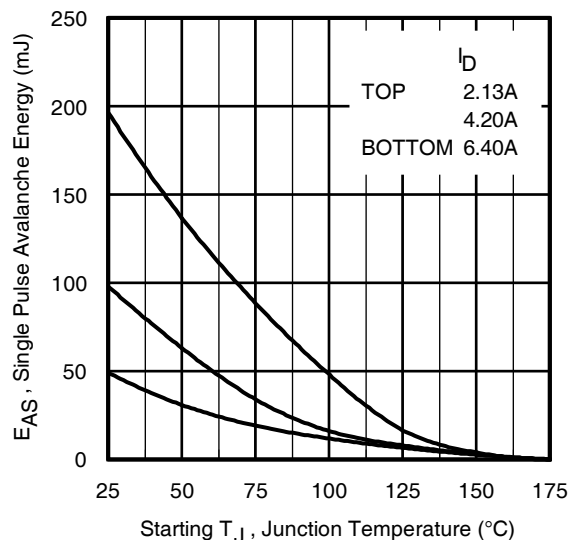


**Fig 23.** Maximum Avalanche Energy vs. Drain Current

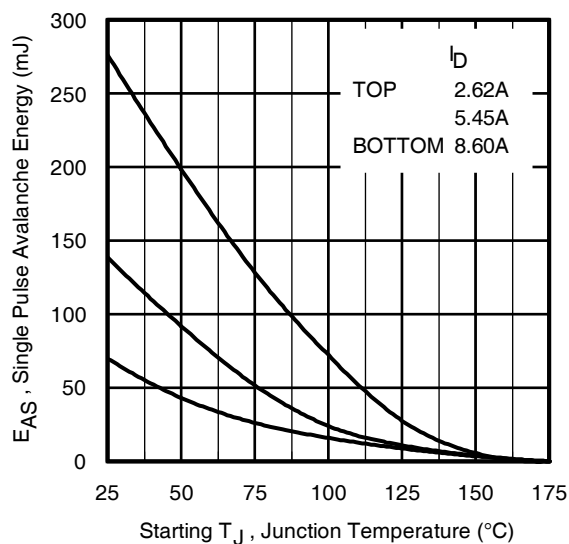


**Fig 24.** Maximum Avalanche Energy vs. Drain Current

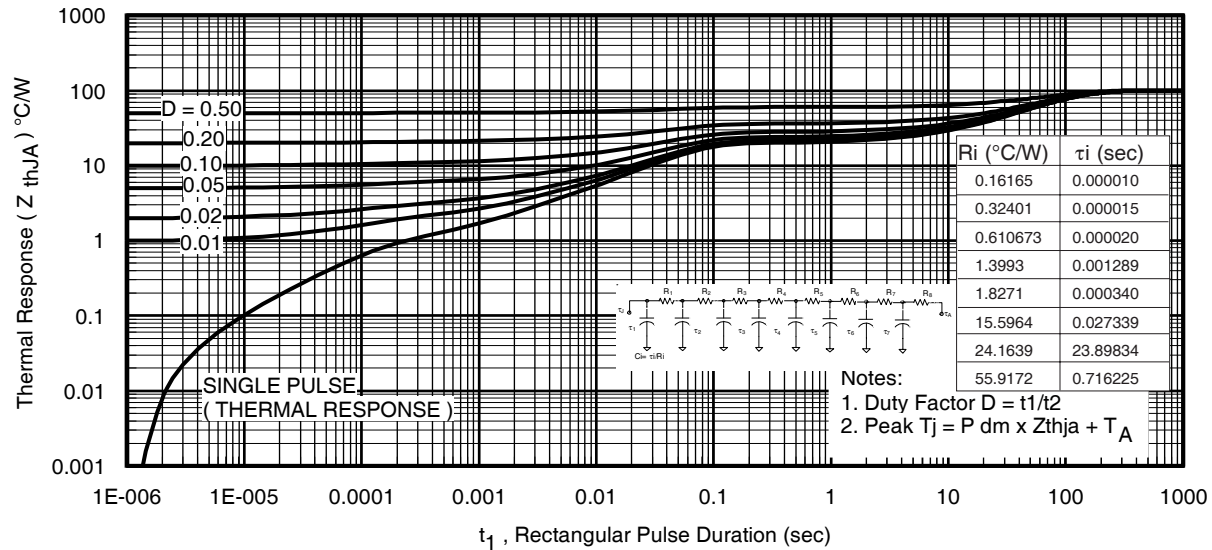


Fig 25. Maximum Effective Transient Thermal Impedance, Junction-to-Ambient (Q1)

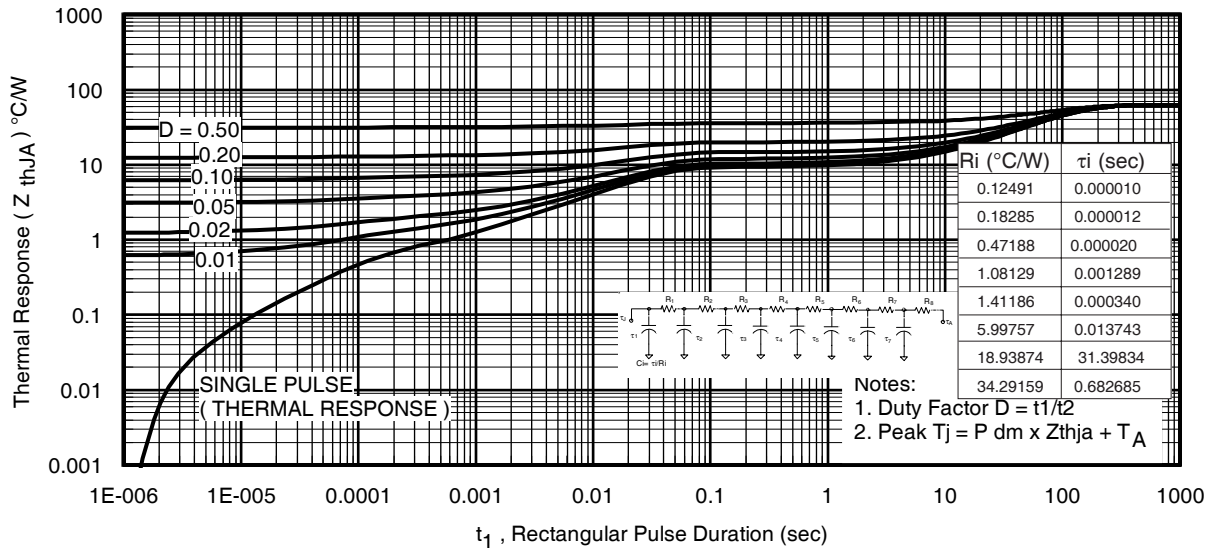


Fig 26. Maximum Effective Transient Thermal Impedance, Junction-to-Ambient (Q2)

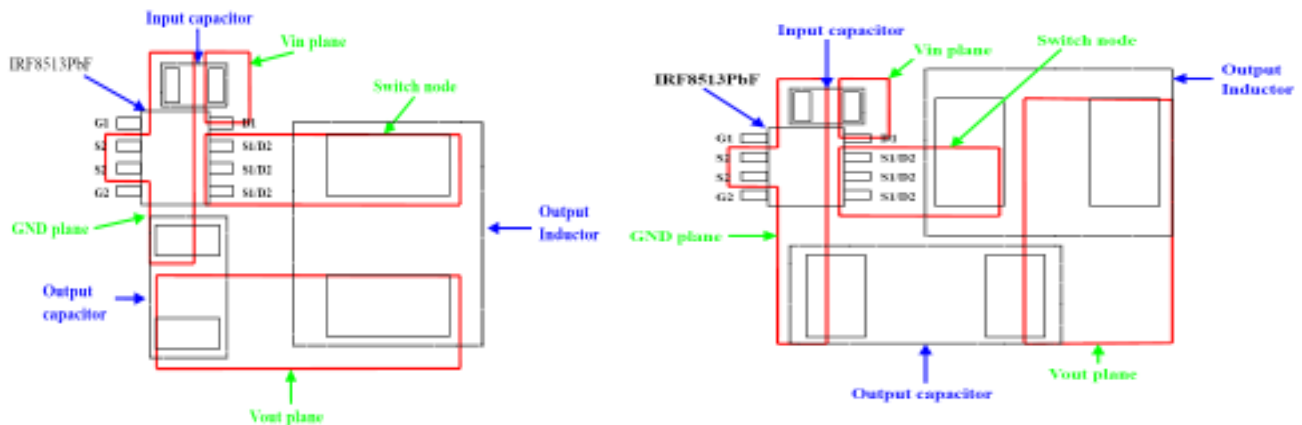


Fig 27. Layout Diagram

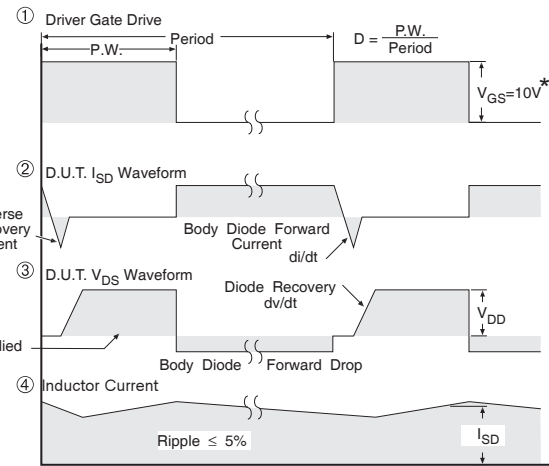
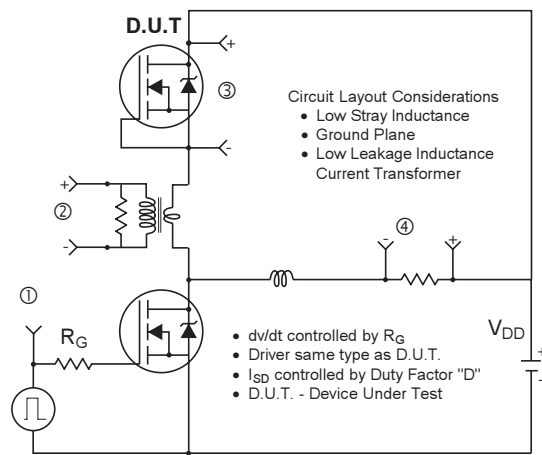


**Fig 28. Peak Diode Recovery  $dv/dt$  Test Circuit for N-Channel HEXFET® Power MOSFETs**

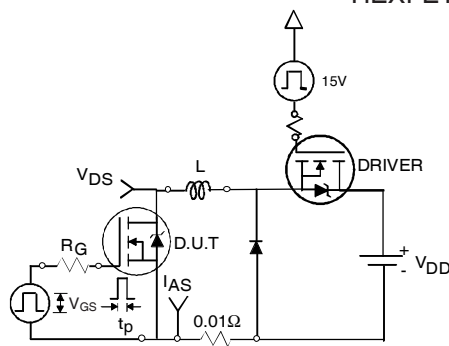


**Fig 29a. Unclamped Inductive Test Circuit**

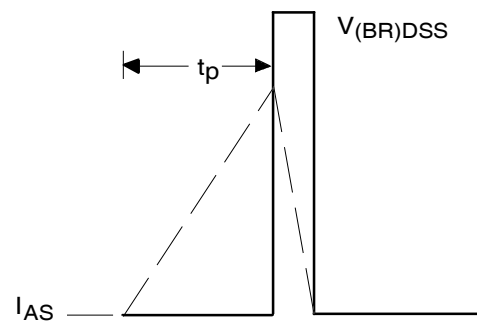


**Fig 29b. Unclamped Inductive Waveforms**

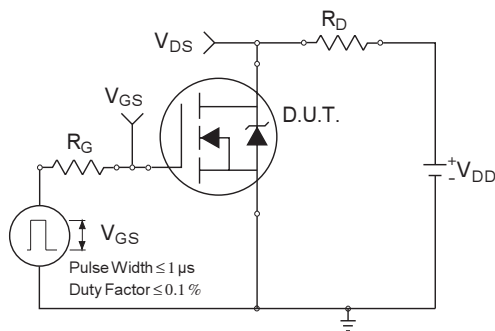


**Fig 30a. Switching Time Test Circuit**

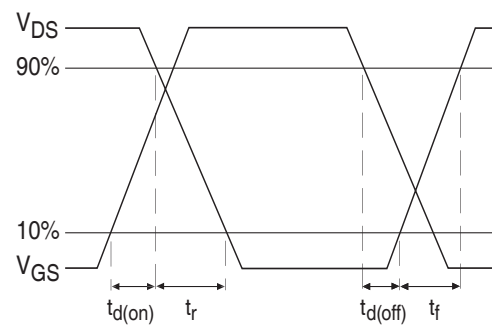


**Fig 30b. Switching Time Waveforms**

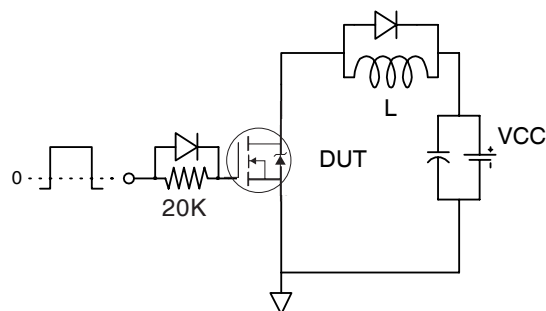


**Fig 31a. Gate Charge Test Circuit**

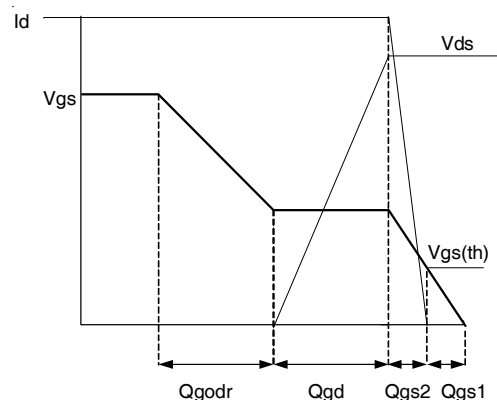
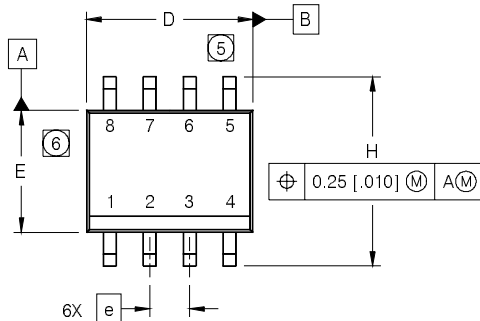


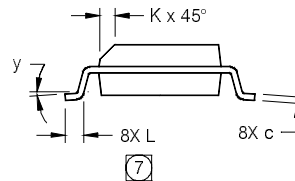
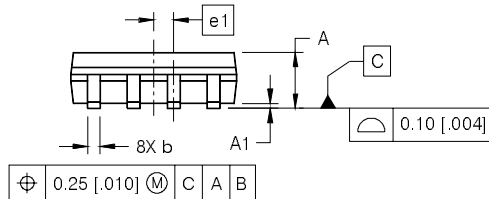
**Fig 31b. Gate Charge Waveform**

## SO-8 Package Outline (MOSFET & Fetky)

Dimensions are shown in millimeters (inches)



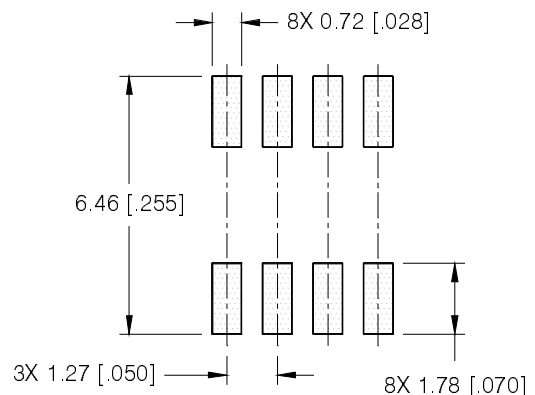
| DIM | INCHES     |       | MILLIMETERS |      |
|-----|------------|-------|-------------|------|
|     | MIN        | MAX   | MIN         | MAX  |
| A   | .0532      | .0688 | 1.35        | 1.75 |
| A1  | .0040      | .0098 | 0.10        | 0.25 |
| b   | .013       | .020  | 0.33        | 0.51 |
| c   | .0075      | .0098 | 0.19        | 0.25 |
| D   | .189       | .1968 | 4.80        | 5.00 |
| E   | .1497      | .1574 | 3.80        | 4.00 |
| e   | .050 BASIC |       | 1.27 BASIC  |      |
| e1  | .025 BASIC |       | 0.635 BASIC |      |
| H   | .2284      | .2440 | 5.80        | 6.20 |
| K   | .0099      | .0196 | 0.25        | 0.50 |
| L   | .016       | .050  | 0.40        | 1.27 |
| y   | 0°         | 8°    | 0°          | 8°   |



### NOTES:

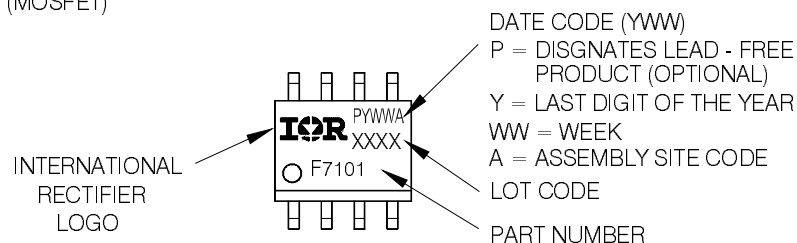
1. DIMENSIONING & TOLERANCING PER ASME Y14.5M-1994.
2. CONTROLLING DIMENSION: MILLIMETER
3. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
4. OUTLINE CONFORMS TO JEDEC OUTLINE MS-012AA.
5. DIMENSION DOES NOT INCLUDE MOLD PROTRUSIONS. MOLD PROTRUSIONS NOT TO EXCEED 0.15 [.006].
6. DIMENSION DOES NOT INCLUDE MOLD PROTRUSIONS. MOLD PROTRUSIONS NOT TO EXCEED 0.25 [.010].
7. DIMENSION IS THE LENGTH OF LEAD FOR SOLDERING TO A SUBSTRATE.

### FOOTPRINT



## SO-8 Part Marking Information

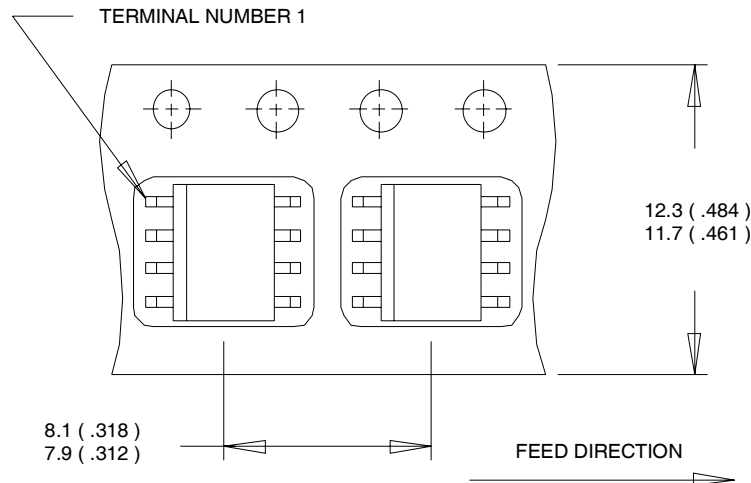
EXAMPLE: THIS IS AN IRF7101 (MOSFET)



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

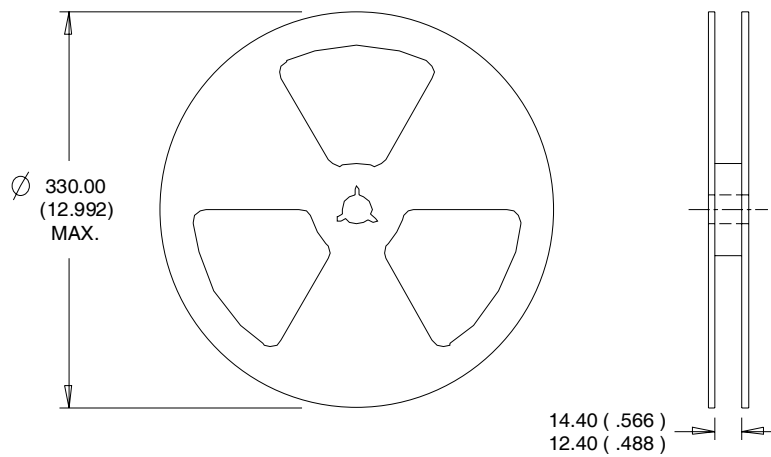
## SO-8 Tape and Reel

Dimensions are shown in millimeters (inches)



### NOTES:

1. CONTROLLING DIMENSION : MILLIMETER.
2. ALL DIMENSIONS ARE SHOWN IN MILLIMETERS(INCHES).
3. OUTLINE CONFORMS TO EIA-481 & EIA-541.



### NOTES :

1. CONTROLLING DIMENSION : MILLIMETER.
2. OUTLINE CONFORMS TO EIA-481 & EIA-541.

| Orderable part number | Package Type | Standard Pack |          | Note |
|-----------------------|--------------|---------------|----------|------|
|                       |              | Form          | Quantity |      |
| IRF8513PbF            | SO-8         | Tube/Bulk     | 95       |      |
| IRF8513TRPbF          | SO-8         | Tape and Reel | 4000     |      |

## Qualification Information<sup>†</sup>

| Qualification information  |                                                                         |                                                |
|----------------------------|-------------------------------------------------------------------------|------------------------------------------------|
| Qualification level        | Consumer <sup>††</sup><br>(per JEDEC JESD47F <sup>†††</sup> guidelines) |                                                |
| Moisture Sensitivity Level | SO-8                                                                    | 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>

<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.

## Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Starting  $T_J = 25^{\circ}\text{C}$ ,  $L = 2.4\text{mH}$ ,  $R_G = 25\Omega$ ,  $I_{AS} = 6.4\text{A}$  (Q1) &  
 $L = 1.87\text{mH}$ ,  $R_G = 25\Omega$ ,  $I_{AS} = 8.6\text{A}$  (Q2)
- ③ Pulse width  $\leq 400\mu\text{s}$ ; duty cycle  $\leq 2\%$ .
- ④ When mounted on 1 inch square copper board.
- ⑤  $R_{\theta}$  is measured at  $T_J$  of approximately  $90^{\circ}\text{C}$ .

Data and specifications subject to change without notice.

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