

# International Rectifier

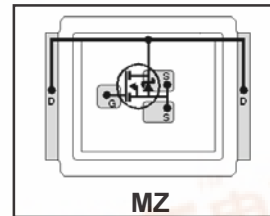
## IRF6641TRPbF

DirectFET™ Power MOSFET ②

Typical values (unless otherwise specified)

| $V_{DS}$     | $V_{GS}$ | $R_{DS(on)}$ |
|--------------|----------|--------------|
| 200V max     | ±20V max | 51mΩ @ 10V   |
| $Q_{g\ tot}$ | $Q_{gd}$ | $V_{gs(th)}$ |
| 34nC         | 9.5nC    | 4.0V         |

- RoHS Compliant ①
- Lead-Free (Qualified up to 260°C Reflow)
- Application Specific MOSFETs
- Ideal for High Performance Isolated Converter Primary Switch Socket
- Optimized for Synchronous Rectification
- Low Conduction Losses
- High Cdv/dt Immunity
- Dual Sided Cooling Compatible ①
- Compatible with existing Surface Mount Techniques ①



Applicable DirectFET Outline and Substrate Outline (see p.7,8 for details)①

| SH | SJ | SP | MZ | MN |  |  |  |  |  |
|----|----|----|----|----|--|--|--|--|--|
|----|----|----|----|----|--|--|--|--|--|

### Description

The IRF6641PbF combines the latest HEXFET® Power MOSFET Silicon technology with the advanced DirectFET™ packaging to achieve the lowest on-state resistance in a package that has the footprint of an Micro8 and only 0.7 mm profile. The DirectFET package is compatible with existing layout geometries used in power applications, PCB assembly equipment and vapor phase, infra-red or convection soldering techniques, when application note AN-1035 is followed regarding the manufacturing methods and processes. The DirectFET package allows dual sided cooling to maximize thermal transfer in power systems, improving previous best thermal resistance by 80%.

The IRF6641PbF is optimized for primary side sockets in forward and push-pull isolated DC-DC topologies, for wide range 36V-75V input voltage range systems. The reduced total losses in the device coupled with the high level of thermal performance enables high efficiency and low temperatures, which are key for system reliability improvements, and makes this device ideal for high performance isolated DC-DC converters.

### Absolute Maximum Ratings

|                                  | Parameter                                  | Max. | Units |
|----------------------------------|--------------------------------------------|------|-------|
| $V_{DS}$                         | Drain-to-Source Voltage                    | 200  | V     |
| $V_{GS}$                         | Gate-to-Source Voltage                     | ±20  |       |
| $I_D$ @ $T_A = 25^\circ\text{C}$ | Continuous Drain Current, $V_{GS}$ @ 10V ③ | 4.6  | A     |
| $I_D$ @ $T_A = 70^\circ\text{C}$ | Continuous Drain Current, $V_{GS}$ @ 10V ③ | 3.7  |       |
| $I_D$ @ $T_C = 25^\circ\text{C}$ | Continuous Drain Current, $V_{GS}$ @ 10V ④ | 26   |       |
| $I_{DM}$                         | Pulsed Drain Current ⑤                     | 37   |       |
| $E_{AS}$                         | Single Pulse Avalanche Energy ⑥            | 46   | mJ    |
| $I_{AR}$                         | Avalanche Current ⑤                        | 11   | A     |

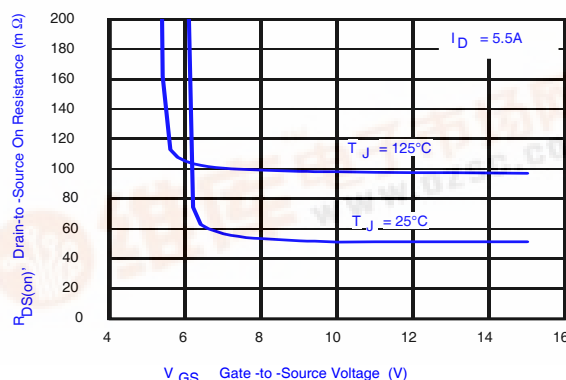


Fig 1. Typical On-Resistance vs. Gate Voltage

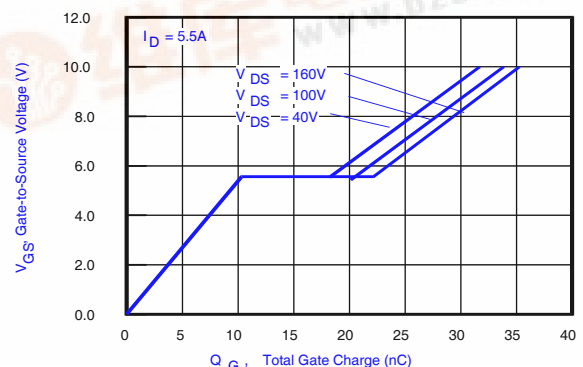


Fig 2. Typical Total Gate Charge vs. Gate-to-Source Voltage

① Click on this section to link to the appropriate technical paper.

② Click on this section to link to the DirectFET Website.

③ Surface mounted on 1 in. square Cu board, steady state.

④  $T_C$  measured with thermocouple mounted to top (Drain) of part.

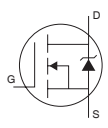
⑤ Repetitive rating; pulse width limited by max. junction temperature.

⑥ Starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.77\text{mH}$ ,  $R_G = 25\Omega$ ,  $I_{AS} = 11\text{A}$ .

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

|                                | Parameter                                  | Min. | Typ. | Max. | Units                | Conditions                                                           |
|--------------------------------|--------------------------------------------|------|------|------|----------------------|----------------------------------------------------------------------|
| $BV_{DSS}$                     | Drain-to-Source Breakdown Voltage          | 200  | —    | —    | V                    | $V_{GS} = 0V, I_D = 250\mu A$                                        |
| $\Delta BV_{DSS}/\Delta T_J$   | Breakdown Voltage Temp. Coefficient        | —    | 0.23 | —    | V/ $^\circ\text{C}$  | Reference to $25^\circ\text{C}$ , $I_D = 1\text{mA}$                 |
| $R_{DS(on)}$                   | Static Drain-to-Source On-Resistance       | —    | 51   | 59.9 | m $\Omega$           | $V_{GS} = 10V, I_D = 5.5A$ ②                                         |
| $V_{GS(th)}$                   | Gate Threshold Voltage                     | 3.0  | 4.0  | 4.9  | V                    | $V_{DS} = V_{GS}, I_D = 150\mu A$                                    |
| $\Delta V_{GS(th)}/\Delta T_J$ | Gate Threshold Voltage Coefficient         | —    | -11  | —    | mV/ $^\circ\text{C}$ |                                                                      |
| $I_{DSS}$                      | Drain-to-Source Leakage Current            | —    | —    | 20   | $\mu A$              | $V_{DS} = 200V, V_{GS} = 0V$                                         |
|                                |                                            | —    | —    | 250  |                      | $V_{DS} = 160V, V_{GS} = 0V, T_J = 125^\circ\text{C}$                |
| $I_{GSS}$                      | Gate-to-Source Forward Leakage             | —    | —    | 100  | nA                   | $V_{GS} = 20V$                                                       |
|                                | Gate-to-Source Reverse Leakage             | —    | —    | -100 |                      | $V_{GS} = -20V$                                                      |
| $g_{fs}$                       | Forward Transconductance                   | 13   | —    | —    | S                    | $V_{DS} = 10V, I_D = 5.5A$                                           |
| $Q_g$                          | Total Gate Charge                          | —    | 34   | 48   | nC                   | $V_{DS} = 100V$<br>$V_{GS} = 10V$<br>$I_D = 5.5A$<br>See Fig. 15     |
| $Q_{gs1}$                      | Pre-V <sub>th</sub> Gate-to-Source Charge  | —    | 8.7  | —    |                      |                                                                      |
| $Q_{gs2}$                      | Post-V <sub>th</sub> Gate-to-Source Charge | —    | 1.9  | —    |                      |                                                                      |
| $Q_{gd}$                       | Gate-to-Drain Charge                       | —    | 9.5  | 14   |                      |                                                                      |
| $Q_{godr}$                     | Gate Charge Overdrive                      | —    | 14   | —    |                      |                                                                      |
| $Q_{sw}$                       | Switch Charge ( $Q_{gs2} + Q_{gd}$ )       | —    | 11   | —    |                      |                                                                      |
| $Q_{oss}$                      | Output Charge                              | —    | 12   | —    | nC                   | $V_{DS} = 16V, V_{GS} = 0V$                                          |
| $R_G$                          | Gate Resistance                            | —    | 1.0  | —    | $\Omega$             |                                                                      |
| $t_{d(on)}$                    | Turn-On Delay Time                         | —    | 16   | —    | ns                   | $V_{DD} = 100V, V_{GS} = 10V$ ②<br>$I_D = 5.5A$<br>$R_G = 6.2\Omega$ |
| $t_r$                          | Rise Time                                  | —    | 11   | —    |                      |                                                                      |
| $t_{d(off)}$                   | Turn-Off Delay Time                        | —    | 31   | —    |                      |                                                                      |
| $t_f$                          | Fall Time                                  | —    | 6.5  | —    |                      |                                                                      |
| $C_{iss}$                      | Input Capacitance                          | —    | 2290 | —    | pF                   | $V_{GS} = 0V$                                                        |
| $C_{oss}$                      | Output Capacitance                         | —    | 240  | —    |                      | $V_{DS} = 25V$                                                       |
| $C_{rss}$                      | Reverse Transfer Capacitance               | —    | 46   | —    |                      | $f = 1.0\text{MHz}$                                                  |
| $C_{oss}$                      | Output Capacitance                         | —    | 1780 | —    |                      | $V_{GS} = 0V, V_{DS} = 1.0V, f = 1.0\text{MHz}$                      |
| $C_{oss}$                      | Output Capacitance                         | —    | 100  | —    |                      | $V_{GS} = 0V, V_{DS} = 160V, f = 1.0\text{MHz}$                      |

## Diode Characteristics

|          | Parameter                                 | Min. | Typ. | Max. | Units | Conditions                                                                                                                                                       |
|----------|-------------------------------------------|------|------|------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $I_S$    | Continuous Source Current<br>(Body Diode) | —    | —    | 26   | A     | MOSFET symbol<br>showing the<br>integral reverse<br>p-n junction diode.<br> |
| $I_{SM}$ | Pulsed Source Current<br>(Body Diode) ⑤   | —    | —    | 37   |       |                                                                                                                                                                  |
| $V_{SD}$ | Diode Forward Voltage                     | —    | —    | 1.3  | V     | $T_J = 25^\circ\text{C}, I_S = 5.5A, V_{GS} = 0V$ ⑦                                                                                                              |
| $t_{rr}$ | Reverse Recovery Time                     | —    | 85   | 130  | ns    | $T_J = 25^\circ\text{C}, I_F = 5.5A, V_{DD} = 100V$<br>$di/dt = 100A/\mu s$ ①                                                                                    |
| $Q_{rr}$ | Reverse Recovery Charge                   | —    | 320  | 480  | nC    |                                                                                                                                                                  |

### Notes:

- ⑤ Repetitive rating; pulse width limited by max. junction temperature.  
⑦ Pulse width  $\leq 400\mu s$ ; duty cycle  $\leq 2\%$ .

### Absolute Maximum Ratings

|                                        | Parameter                  | Max.         | Units |
|----------------------------------------|----------------------------|--------------|-------|
| P <sub>D</sub> @ T <sub>A</sub> = 25°C | Power Dissipation ③        | 2.8          | W     |
| P <sub>D</sub> @ T <sub>A</sub> = 70°C | Power Dissipation ③        | 1.8          |       |
| P <sub>D</sub> @ T <sub>C</sub> = 25°C | Power Dissipation ④        | 89           |       |
| T <sub>P</sub>                         | Peak Soldering Temperature | 270          | °C    |
| T <sub>J</sub>                         | Operating Junction and     | -40 to + 150 |       |
| T <sub>STG</sub>                       | Storage Temperature Range  |              |       |

### Thermal Resistance

|                    | Parameter               | Typ. | Max. | Units              |
|--------------------|-------------------------|------|------|--------------------|
| $R_{\theta JA}$    | Junction-to-Ambient ③ ⑩ | —    | 45   | $^\circ\text{C/W}$ |
| $R_{\theta JA}$    | Junction-to-Ambient ⑧ ⑩ | 12.5 | —    |                    |
| $R_{\theta JA}$    | Junction-to-Ambient ⑨ ⑩ | 20   | —    |                    |
| $R_{\theta JC}$    | Junction-to-Case ④ ⑩    | —    | 1.4  |                    |
| $R_{\theta J-PCB}$ | Junction-to-PCB Mounted | 1.0  | —    |                    |

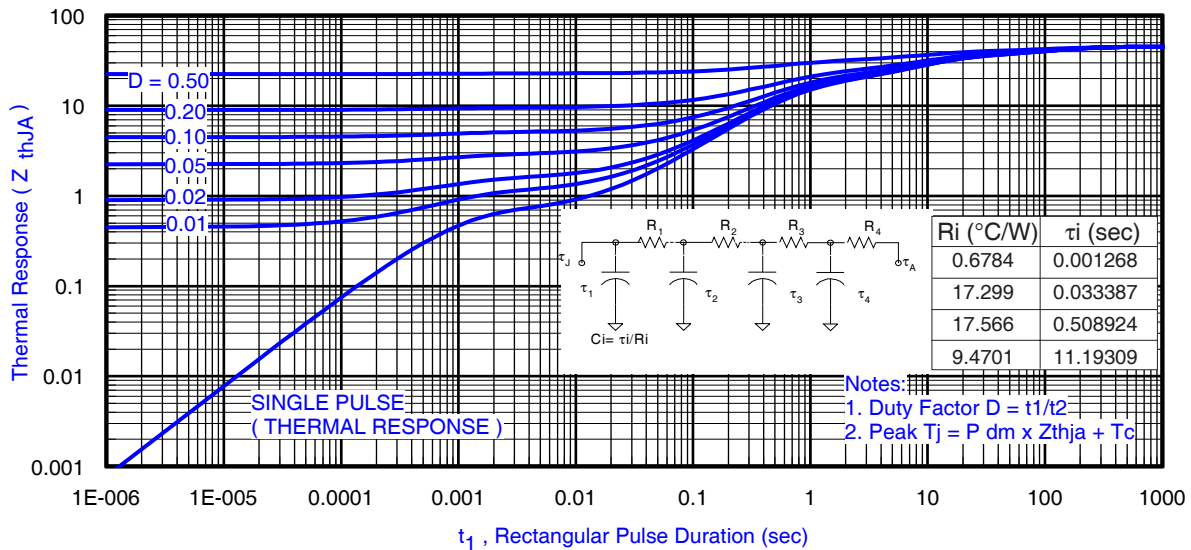


Fig 3. Maximum Effective Transient Thermal Impedance, Junction-to-Ambient ①

#### Notes:

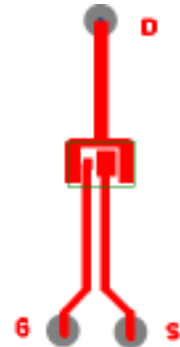
- ③ Surface mounted on 1 in. square Cu board, steady state.
- ④  $T_C$  measured with thermocouple incontact with top (Drain) of part.
- ⑧ Used double sided cooling, mounting pad with large heatsink.
- ⑨ Mounted on minimum footprint full size board with metalized back and with small clip heatsink.
- ⑩  $R_{\theta}$  is measured at  $T_J$  of approximately  $90^\circ\text{C}$ .



③ Surface mounted on 1 in. square Cu board (still air).

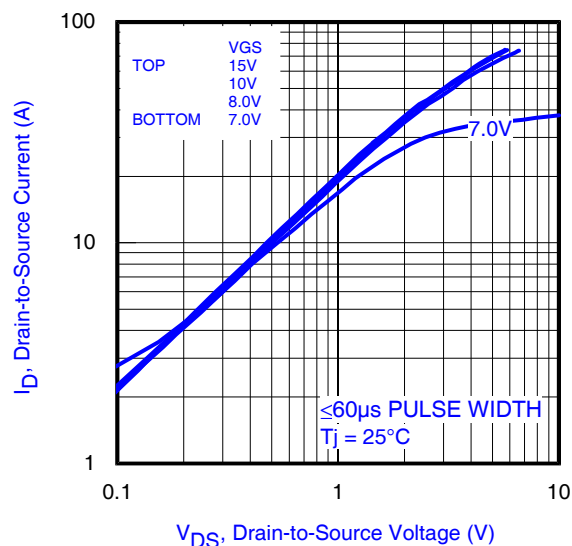


⑨ Mounted on minimum footprint full size board with metalized back and with small clip heatsink. (still air)

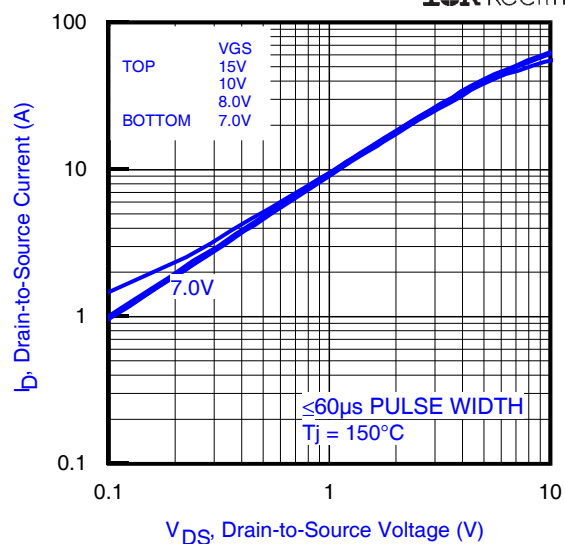


# IRF6641TRPbF

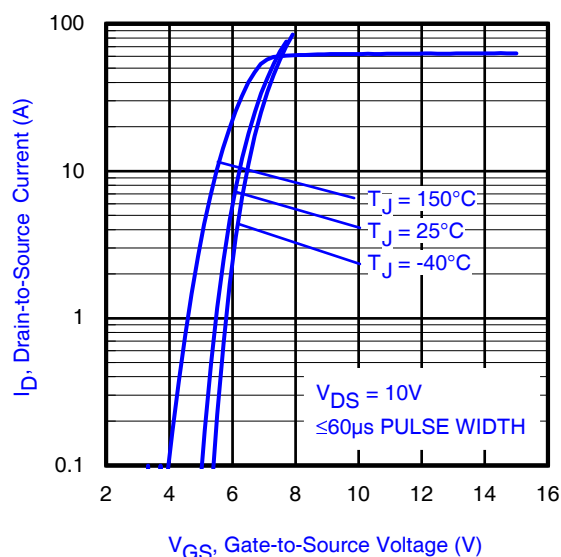
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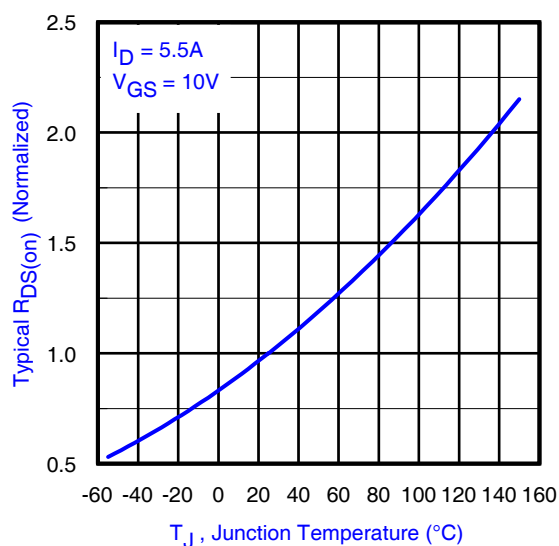
**Fig 4.** Typical Output Characteristics



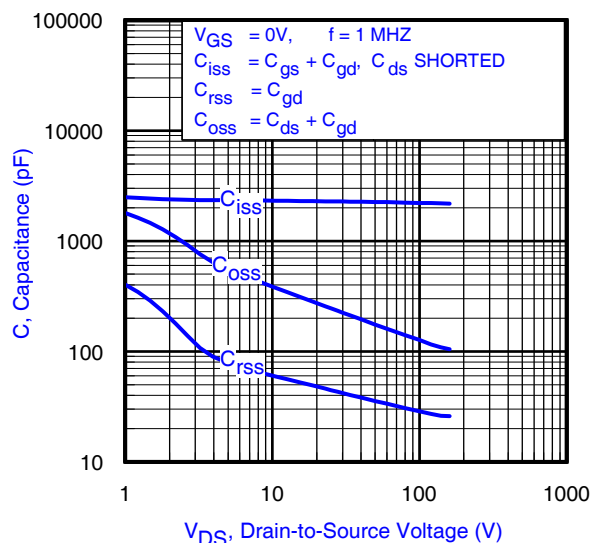
**Fig 5.** Typical Output Characteristics



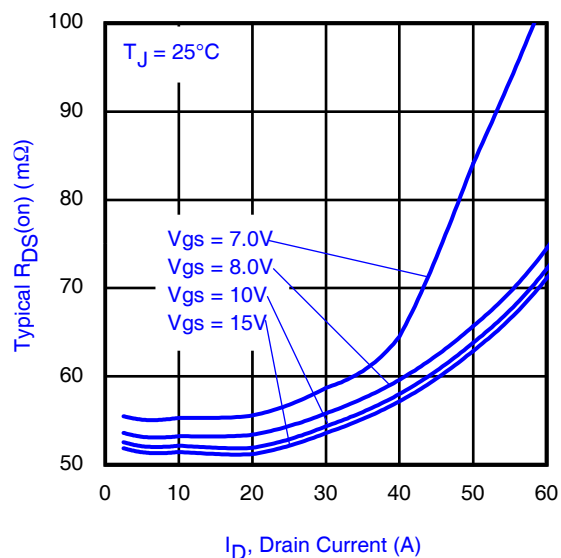
**Fig 6.** Typical Transfer Characteristics



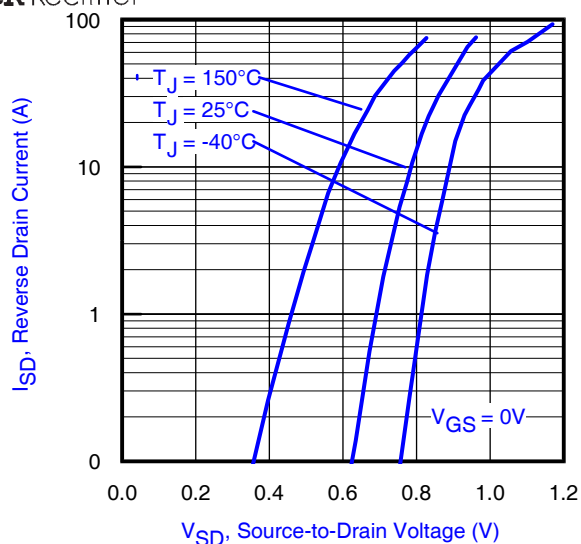
**Fig 7.** Normalized On-Resistance vs. Temperature



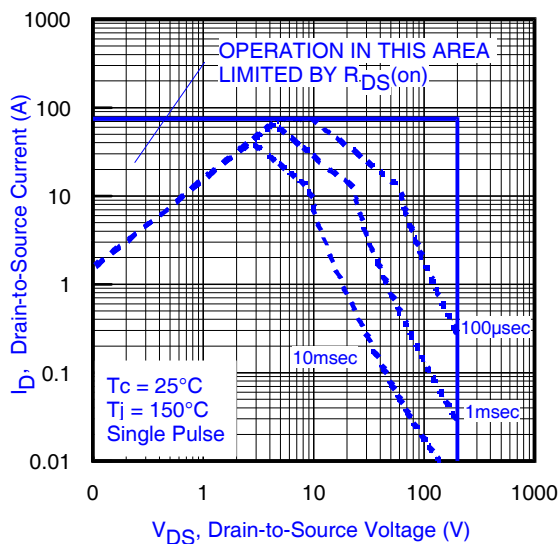
**Fig 8.** Typical Capacitance vs. Drain-to-Source Voltage



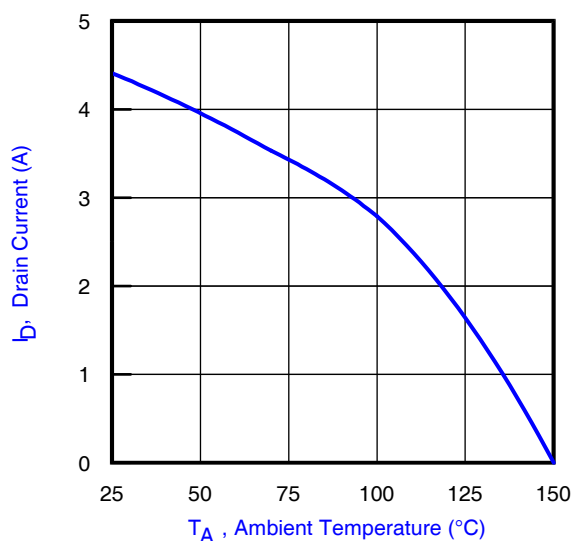
**Fig 9.** Typical On-Resistance vs. Drain Current



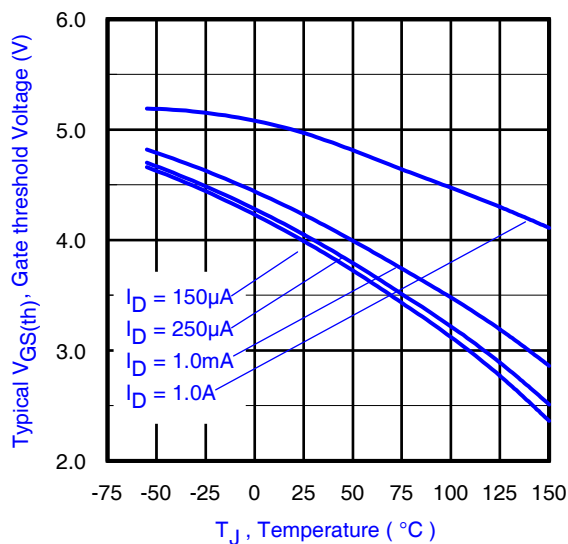
**Fig 10.** Typical Source-Drain Diode Forward Voltage



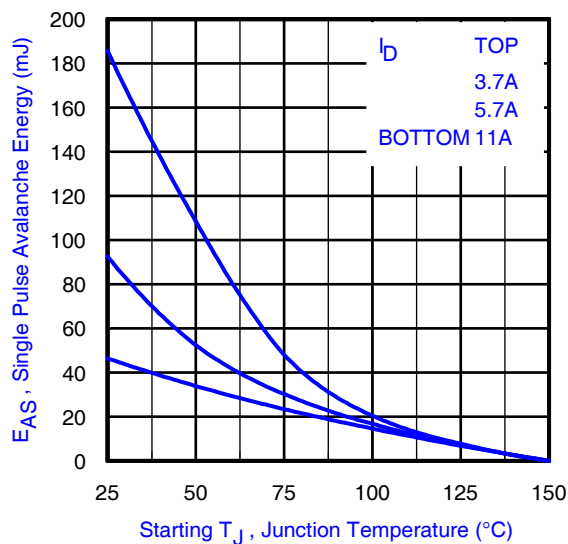
**Fig11.** Maximum Safe Operating Area



**Fig 12.** Maximum Drain Current vs. Ambient Temperature



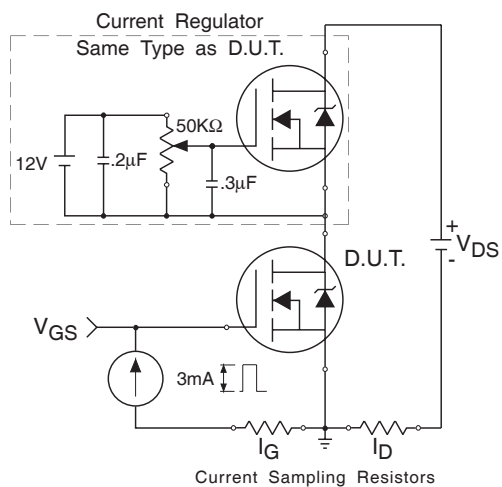
**Fig 13.** Typical Threshold Voltage vs. Junction Temperature



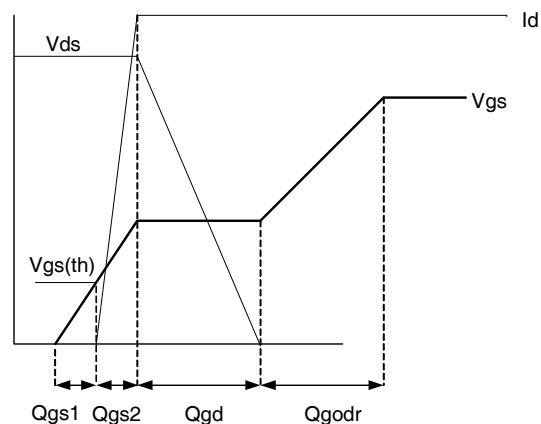
**Fig 14.** Maximum Avalanche Energy vs. Drain Current

# IRF6641TRPbF

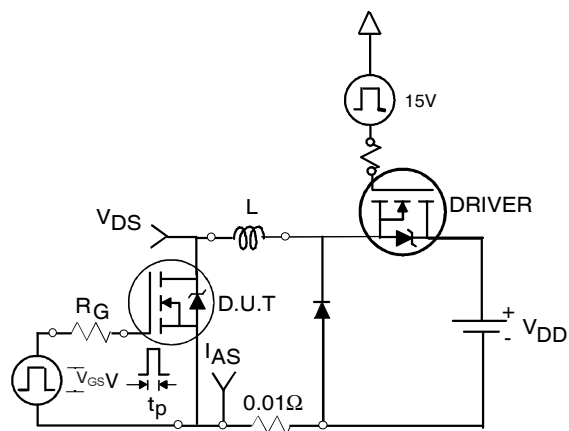
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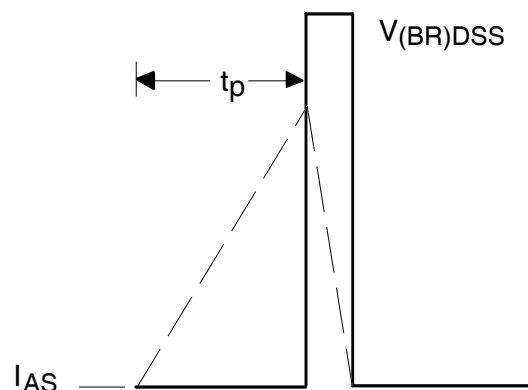
**Fig 14a.** Gate Charge Test Circuit



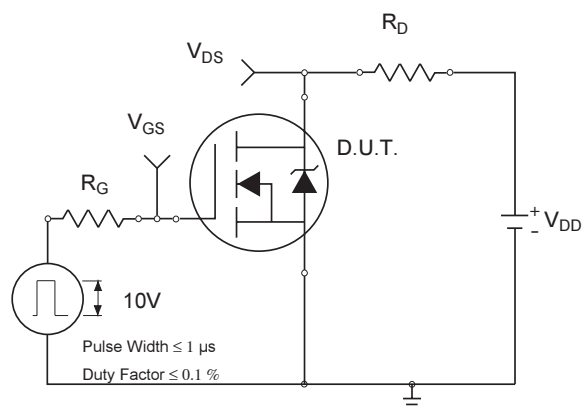
**Fig 14b.** Gate Charge Waveform



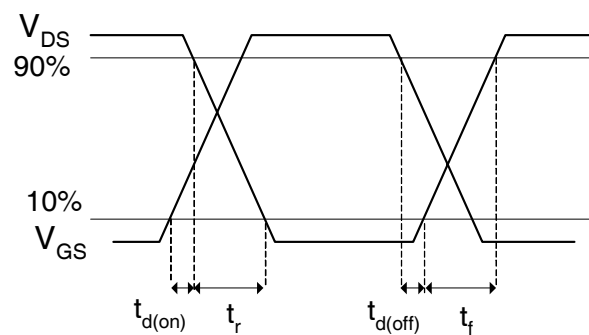
**Fig 15a.** Unclamped Inductive Test Circuit



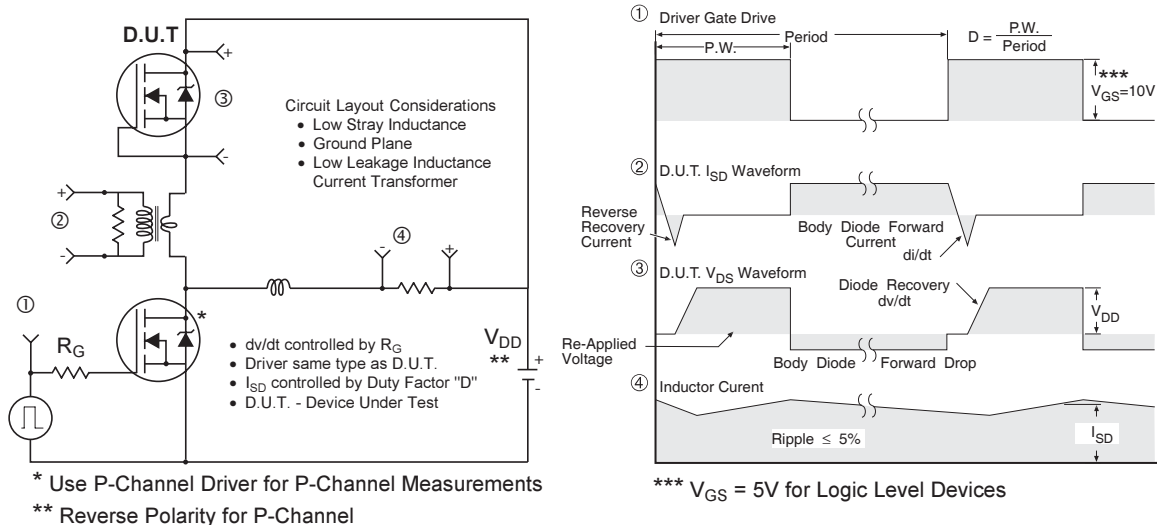
**Fig 15b.** Unclamped Inductive Waveforms



**Fig 16a.** Switching Time Test Circuit



**Fig 16b.** Switching Time Waveforms

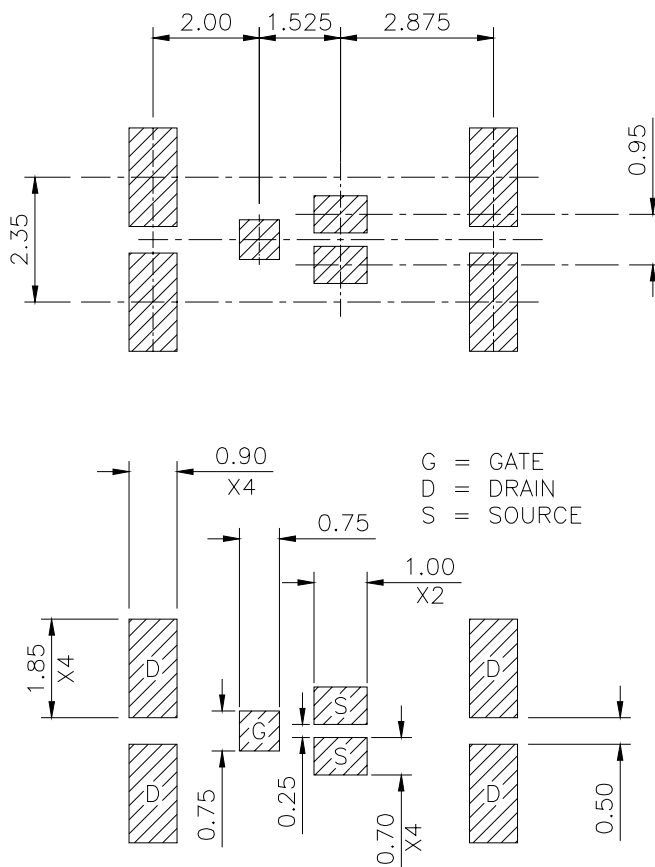


**Fig 18. Diode Reverse Recovery Test Circuit for HEXFET® Power MOSFETs**

## DirectFET™ Substrate and PCB Layout, MZ Outline (Medium Size Can, Z-Designation).

Please see DirectFET application note AN-1035 for all details regarding the assembly of DirectFET.

This includes all recommendations for stencil and substrate designs.



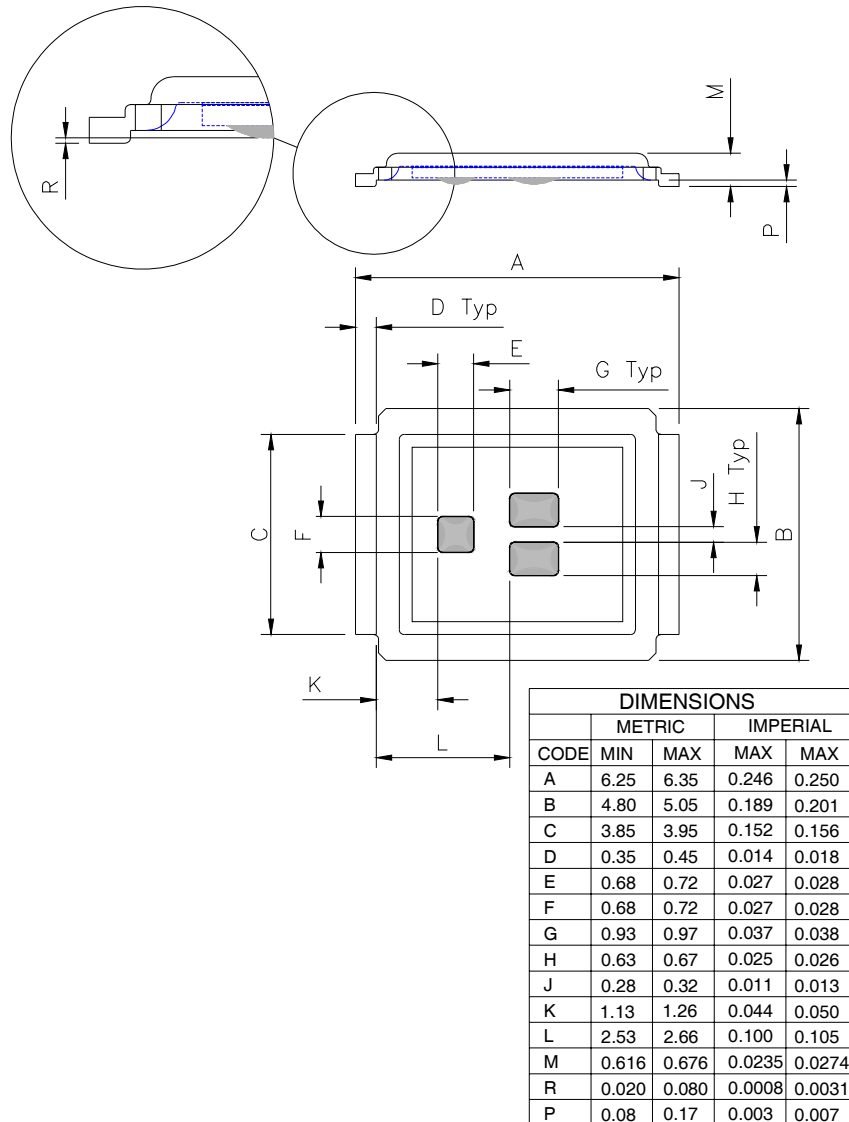
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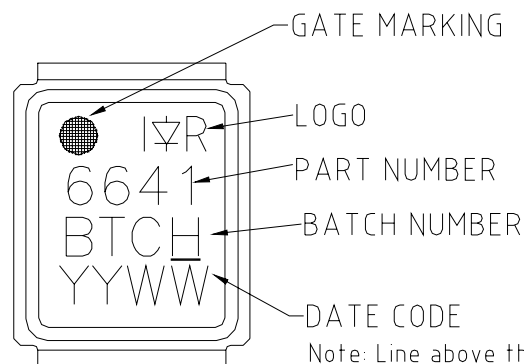
## DirectFET™ Outline Dimension, MZ Outline (Medium Size Can, Z-Designation).

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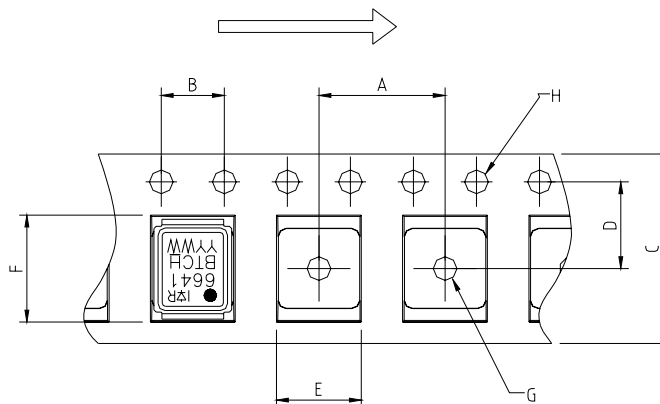
## DirectFET™ Part Marking



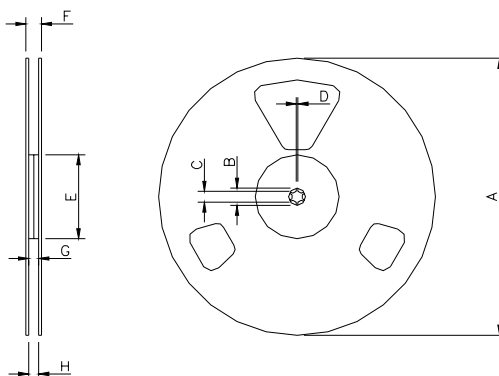
Note: Line above the last character of the date-code indicates "Lead-Free".

## DirectFET™ Tape & Reel Dimension (Showing component orientation).

LOADED TAPE FEED DIRECTION



| DIMENSIONS |        |       |          |       |
|------------|--------|-------|----------|-------|
|            | METRIC |       | IMPERIAL |       |
| CODE       | MIN    | MAX   | MIN      | MAX   |
| A          | 7.90   | 8.10  | 0.311    | 0.319 |
| B          | 3.90   | 4.10  | 0.154    | 0.161 |
| C          | 11.90  | 12.30 | 0.469    | 0.484 |
| D          | 5.45   | 5.55  | 0.215    | 0.219 |
| E          | 5.10   | 5.30  | 0.201    | 0.209 |
| F          | 6.50   | 6.70  | 0.256    | 0.264 |
| G          | 1.50   | N.C   | 0.059    | N.C   |
| H          | 1.50   | 1.60  | 0.059    | 0.063 |



NOTE: Controlling dimensions in mm  
Std reel quantity is 4800 parts. (ordered as IRF6641TRPbF). For 1000 parts on 7" reel, order IRF6641TR1PbF

| REEL DIMENSIONS            |        |      |          |       |                       |        |       |          |  |
|----------------------------|--------|------|----------|-------|-----------------------|--------|-------|----------|--|
| STANDARD OPTION (QTY 4800) |        |      |          |       | TR1 OPTION (QTY 1000) |        |       |          |  |
|                            | METRIC |      | IMPERIAL |       |                       | METRIC |       | IMPERIAL |  |
| CODE                       | MIN    | MAX  | MIN      | MAX   | MIN                   | MAX    | MIN   | MAX      |  |
| A                          | 330.0  | N.C  | 12.992   | N.C   | 177.77                | N.C    | 6.9   | N.C      |  |
| B                          | 20.2   | N.C  | 0.795    | N.C   | 19.06                 | N.C    | 0.75  | N.C      |  |
| C                          | 12.8   | 13.2 | 0.504    | 0.520 | 13.5                  | 12.8   | 0.53  | 0.50     |  |
| D                          | 1.5    | N.C  | 0.059    | N.C   | 1.5                   | N.C    | 0.059 | N.C      |  |
| E                          | 100.0  | N.C  | 3.937    | N.C   | 58.72                 | N.C    | 2.31  | N.C      |  |
| F                          | N.C    | 18.4 | N.C      | 0.724 | N.C                   | 13.50  | N.C   | 0.53     |  |
| G                          | 12.4   | 14.4 | 0.488    | 0.567 | 11.9                  | 12.01  | 0.47  | N.C      |  |
| H                          | 11.9   | 15.4 | 0.469    | 0.606 | 11.9                  | 12.01  | 0.47  | N.C      |  |

Data and specifications subject to change without notice.

This product has been designed and qualified for the Consumer market.

Qualification Standards can be found on IR's Web site.