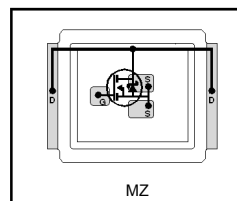


### Features

- Latest MOSFET silicon technology
- Key parameters optimized for Class-D audio amplifier applications
- Low  $R_{DS(on)}$  for improved efficiency
- Low  $Q_g$  for better THD and improved efficiency
- Low  $Q_{rr}$  for better THD and lower EMI
- Low package stray inductance for reduced ringing and lower EMI
- Can deliver up to 400 W per channel into  $8\Omega$  load in half-bridge configuration amplifier
- Dual sided cooling compatible
- Compatible with existing surface mount technologies
- RoHS compliant, halogen-free
- Lead-free (qualified up to  $260^\circ\text{C}$  reflow)

### Key Parameters

|   |     |                  |
|---|-----|------------------|
| $V_{DS}$                                  | 200 | V                |
| $R_{DS(on)}$ typ. @ $V_{GS} = 10\text{V}$ | 51  | $\text{m}\Omega$ |
| $Q_g$ typ.                                | 34  | nC               |
| $R_{G(int)}$ typ.                         | 1.0 | $\Omega$         |



Applicable DirectFET Outline and Substrate Outline (see p.6, 7 for details)

|    |    |    |    |    |    |    |    |           |  |  |
|----|----|----|----|----|----|----|----|-----------|--|--|
| SQ | SX | ST | SH | MQ | MX | MT | MN | <b>MZ</b> |  |  |
|----|----|----|----|----|----|----|----|-----------|--|--|

### Description

This Digital Audio MOSFET is specifically designed for Class-D audio amplifier applications. This MOSFET utilizes the latest processing techniques to achieve low on-resistance per silicon area. Furthermore, gate charge, body-diode reverse recovery and internal gate resistance are optimized to improve key Class-D audio amplifier performance factors such as efficiency, THD, and EMI.

The IRF6641PbF device utilizes DirectFET® packaging technology. DirectFET® packaging technology offers lower parasitic inductance and resistance when compared to conventional wirebonded SOIC packaging. Lower inductance improves EMI performance by reducing the voltage ringing that accompanies fast current transients. 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 method and processes. The DirectFET® package also allows dual sided cooling to maximize thermal transfer in power systems, improving thermal resistance and power dissipation. These features combine to make this MOSFET a highly efficient, robust and reliable device for Class-D audio amplifier applications.

| Base part number | Package Type         | Standard Pack |          | Orderable Part Number |
|------------------|----------------------|---------------|----------|-----------------------|
|                  |                      | Form          | Quantity |                       |
| IRF6641PbF       | DirectFET Medium Can | Tape and Reel | 4800     | IRF6641TRPbF          |

### Absolute Maximum Ratings

|                                | Parameter                                       | Max.         | Units                     |
|--------------------------------|---|--------------|---------------------------|
| $V_{GS}$                       | Gate-to-Source Voltage                          | $\pm 20$     | V                         |
| $I_D @ T_C = 25^\circ\text{C}$ | Continuous Drain Current, $V_{GS} @ 10\text{V}$ | 26           | A                         |
| $I_D @ T_A = 25^\circ\text{C}$ | Continuous Drain Current, $V_{GS} @ 10\text{V}$ | 4.6          |                           |
| $I_D @ T_A = 70^\circ\text{C}$ | Continuous Drain Current, $V_{GS} @ 10\text{V}$ | 3.7          |                           |
| $I_{DM}$                       | Pulsed Drain Current ①                          | 37           |                           |
| $P_D @ T_C = 25^\circ\text{C}$ | Power Dissipation                               | 89           | W                         |
| $P_D @ T_A = 25^\circ\text{C}$ | Power Dissipation ③                             | 2.8          |                           |
| $P_D @ T_A = 70^\circ\text{C}$ | Power Dissipation ③                             | 1.8          |                           |
| $E_{AS}$                       | Single Pulse Avalanche Energy ②                 | 46           | mJ                        |
| $I_{AR}$                       | Avalanche Current ①                             | 11           | A                         |
|                                | Linear Derating Factor                          | 0.022        | $\text{W}/^\circ\text{C}$ |
| $T_J$                          | Operating Junction and                          | -40 to + 150 | $^\circ\text{C}$          |
| $T_{STG}$                      | Storage Temperature Range                       |              |                           |

Notes ① through ③ are on page 9

**Thermal Resistance**

|                    | Parameter               | Typ. | Max. | Units |
|--------------------|-------------------------|------|------|-------|
| $R_{\theta JA}$    | Junction-to-Ambient ③   | —    | 45   | °C/W  |
| $R_{\theta JA}$    | Junction-to-Ambient ⑥   | 12.5 | —    |       |
| $R_{\theta JA}$    | Junction-to-Ambient ⑦   | 20   | —    |       |
| $R_{\theta JC}$    | Junction-to-Case ⑧⑨     | —    | 1.4  |       |
| $R_{\theta J-PCB}$ | Junction-to-PCB Mounted | 1.0  | —    |       |

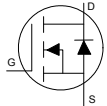
**Static @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)**

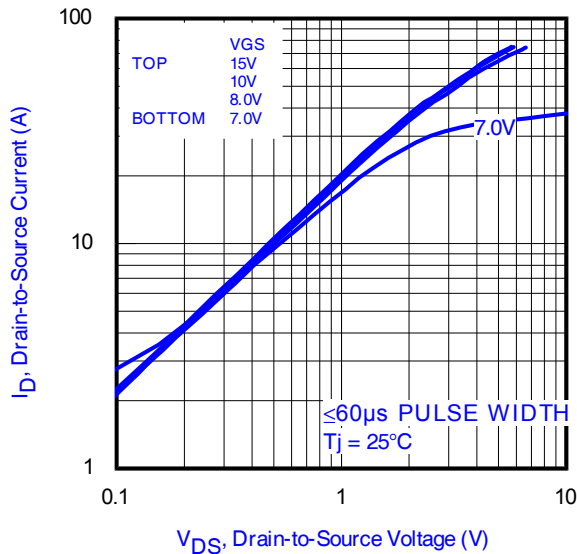
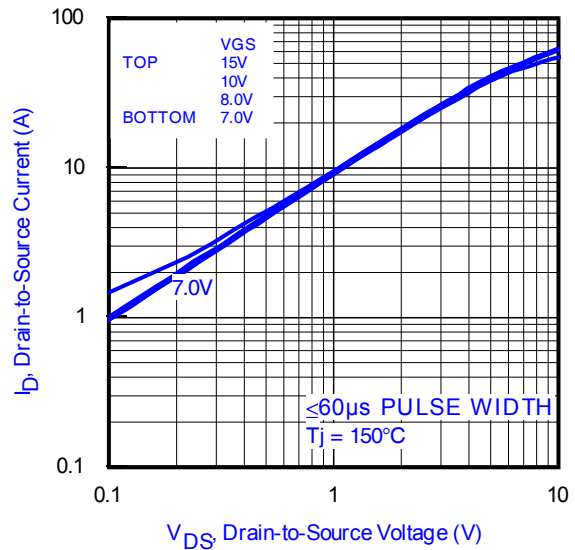
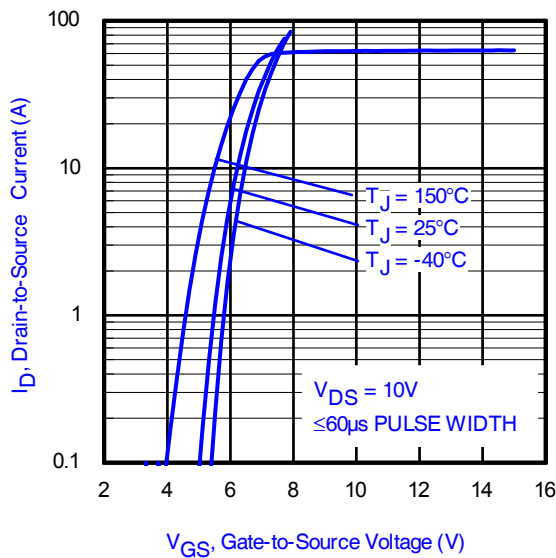
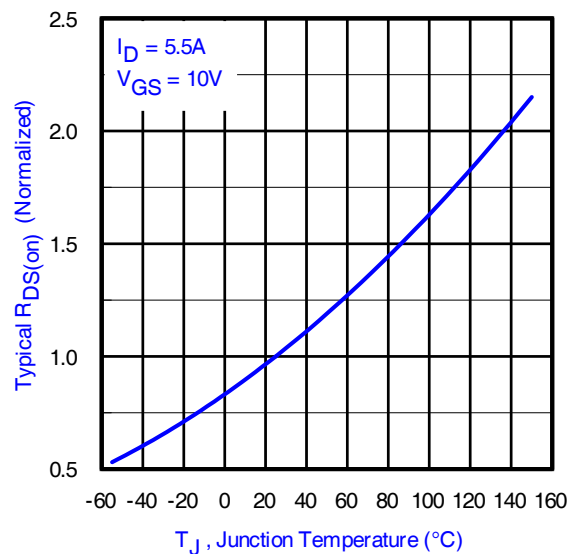
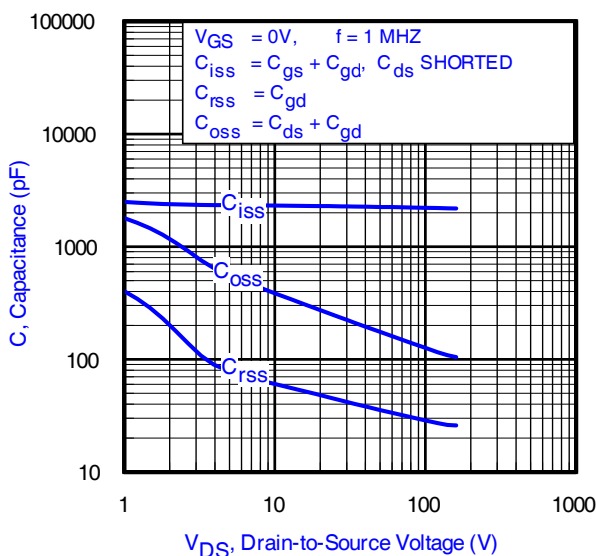
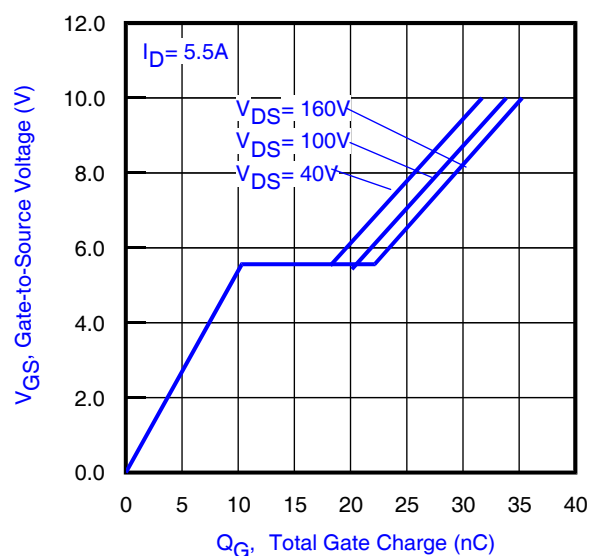
|                              | Parameter                            | Min. | Typ. | Max. | Units | Conditions  |
|------------------------------|--------------------------------------|------|------|------|-------|---|
| $V_{(BR)DSS}$                | Drain-to-Source Breakdown Voltage    | 200  | —    | —    | V     | $V_{GS} = 0V, I_D = 250\mu A$                         |
| $\Delta BV_{DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient  | —    | 0.23 | —    | V/°C  | Reference to $25^\circ\text{C}, I_D = 1.0\text{mA}$   |
| $R_{DS(on)}$                 | Static Drain-to-Source On-Resistance | —    | 51   | 59.9 | mΩ    | $V_{GS} = 10V, I_D = 5.5A$ ④                          |
| $V_{GS(th)}$                 | Gate Threshold Voltage               | 3.0  | 4.0  | 4.9  | V     | $V_{DS} = V_{GS}, I_D = 150\mu A$                     |
| $\Delta V_{GS(th)}$          | Gate Threshold Voltage Coefficient   | —    | -11  | —    | mV/°C |   |
| $I_{DSS}$                    | Drain-to-Source Leakage Current      | —    | —    | 20   | μA    | $V_{DS} = 200V, V_{GS} = 0V$                          |
|                              |                                      | —    | —    | 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 |       | $V_{GS} = -20V$                                       |

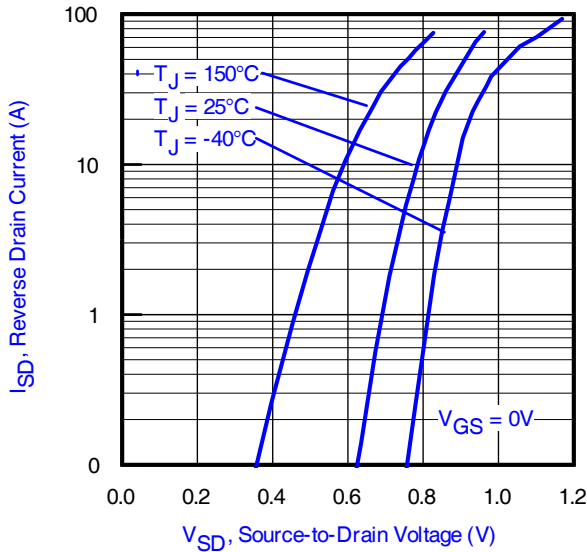
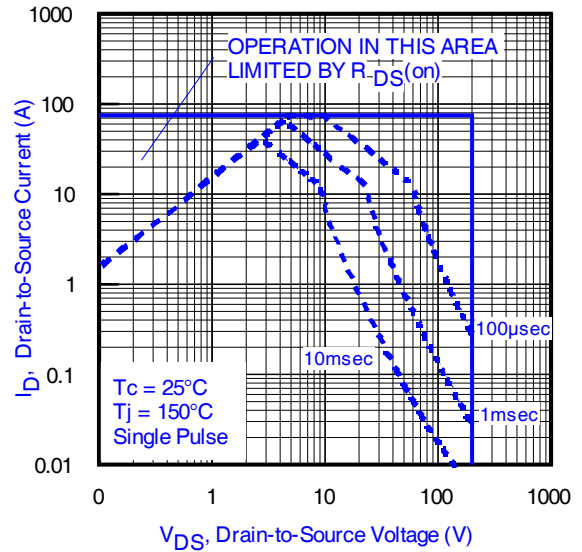
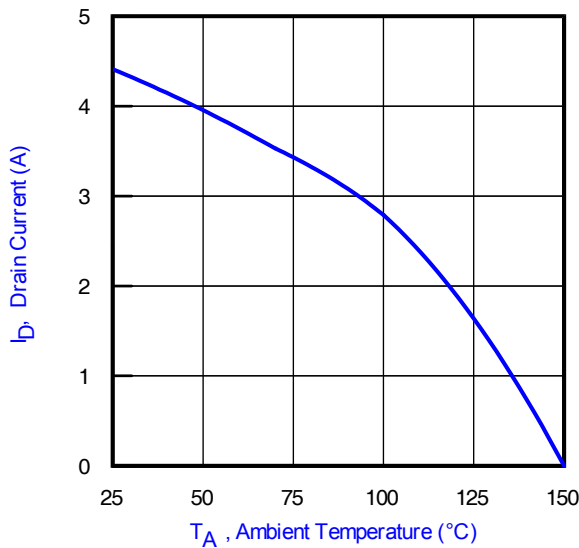
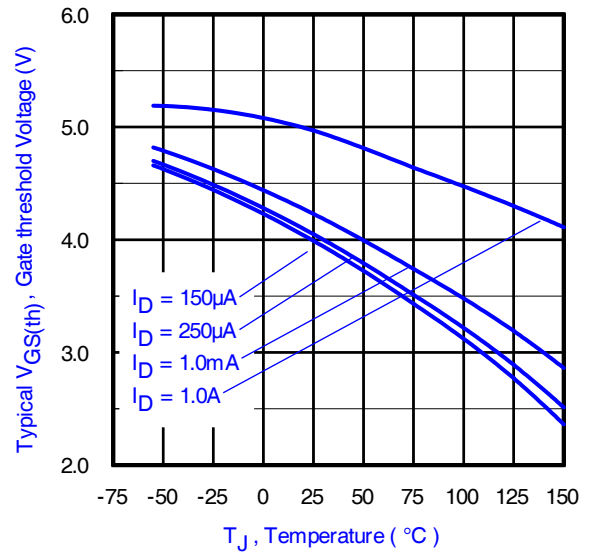
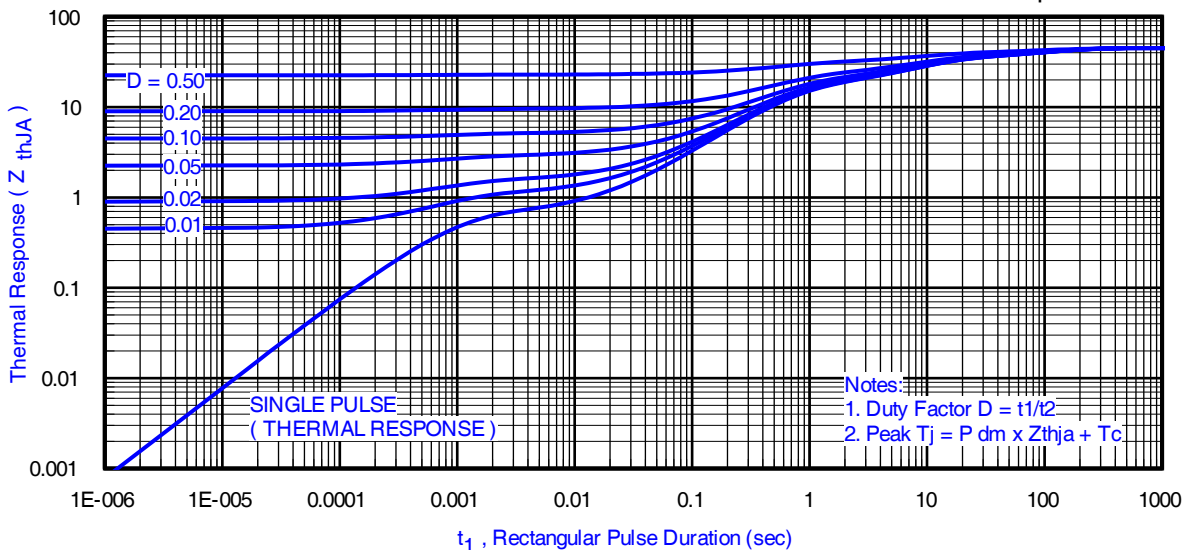
**Dynamic @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)**

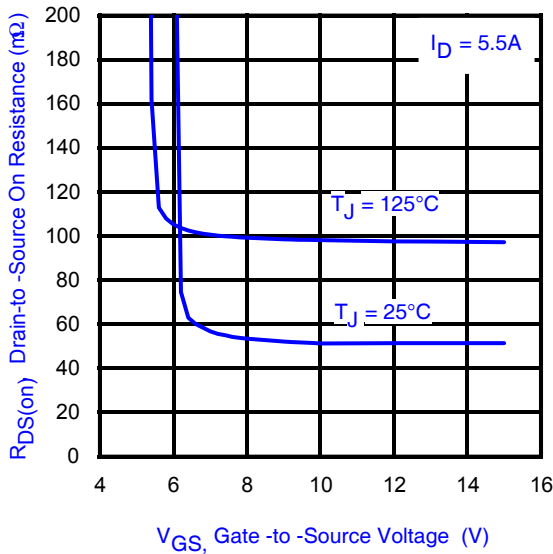
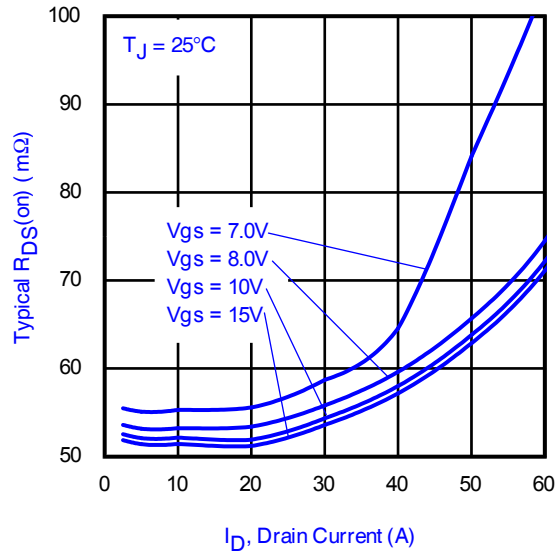
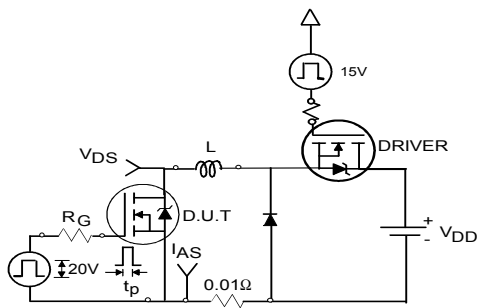
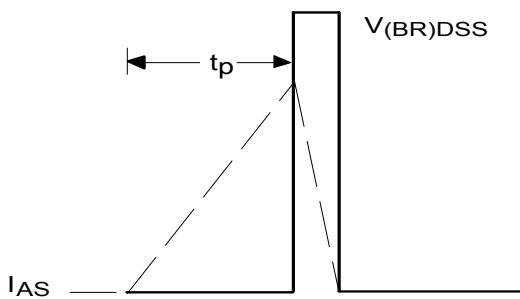
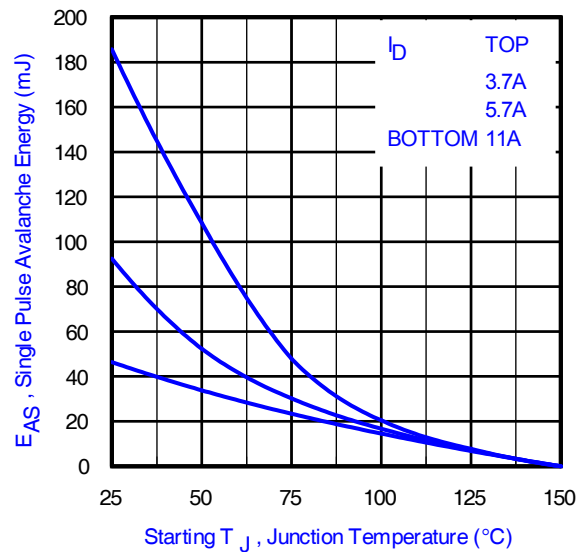
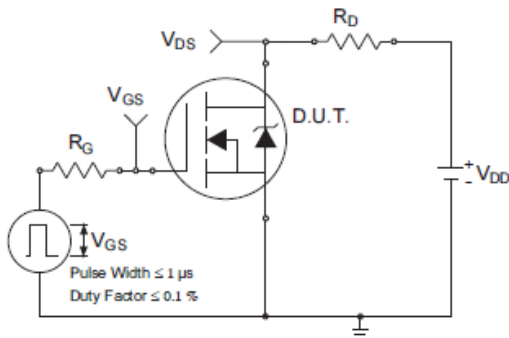
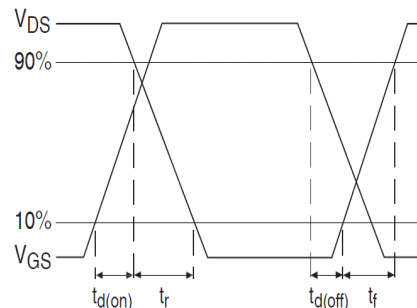
|              |  |    |      |    |    |  |
|--------------|--|----|------|----|----|--|
| $g_{fs}$     | Forward Transconductance                   | 13 | —    | —  | S  | $V_{DS} = 10V, I_D = 5.5A$   |
| $Q_g$        | Total Gate Charge                          | —  | 34   | 48 | nC | $V_{DS} = 100V$<br>$V_{GS} = 10V$<br>$I_D = 5.5A$                  |
| $Q_{gs1}$    | 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   | —  |    | $V_{DS} = 16V, V_{GS} = 0V$  |
| $t_{d(on)}$  | Turn-On Delay Time                         | —  | 16   | —  | ns | $V_{DD} = 100V, V_{GS} = 10V$<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  | —  |    | $V_{GS} = 0V, V_{DS} = 160V, f = 1.0\text{MHz}$                    |

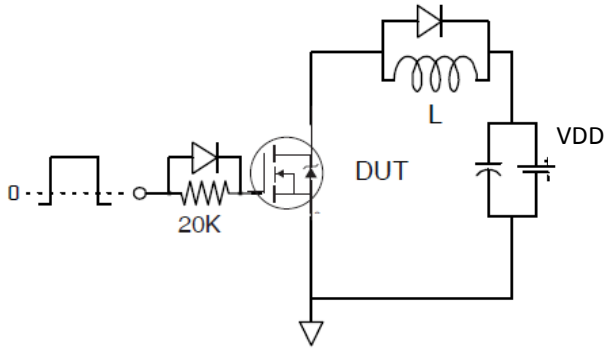
**Diode Characteristics**

|          | Parameter                              | Min. | Typ. | Max. | Units | Conditions   |
|----------|--|------|------|------|-------|--|
| $I_S$    | Continuous Source Current (Body Diode) | —    | —    | 26   | A     | MOSFET symbol showing the integral reverse p-n junction diode.  |
| $I_{SM}$ | Pulsed Source Current (Body Diode) ①   | —    | —    | 37   |       |  |
| $V_{SD}$ | Diode Forward Voltage                  | —    | —    | 1.3  | V     | $T_J = 25^\circ\text{C}, I_S = 5.5A, V_{GS} = 0V$ ④  |
| $t_{rr}$ | Reverse Recovery Time                  | —    | 85   | 130  | ns    | $T_J = 25^\circ\text{C}, I_F = 5.5A, V_{DD} = 100V$  |
| $Q_{rr}$ | Reverse Recovery Charge                | —    | 320  | 480  | nC    | $di/dt = 100A/\mu s$ ④   |

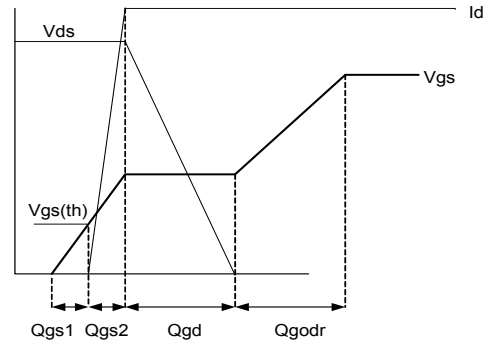

**Fig 1. Typical Output Characteristics**

**Fig 2. Typical Output Characteristics**

**Fig 3. Typical Transfer Characteristics**

**Fig 4. Normalized On-Resistance vs. Temperature**

**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. Ambient Temperature

**Fig 10.** Typical Threshold Voltage vs. Junction Temperature

**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Ambient ③

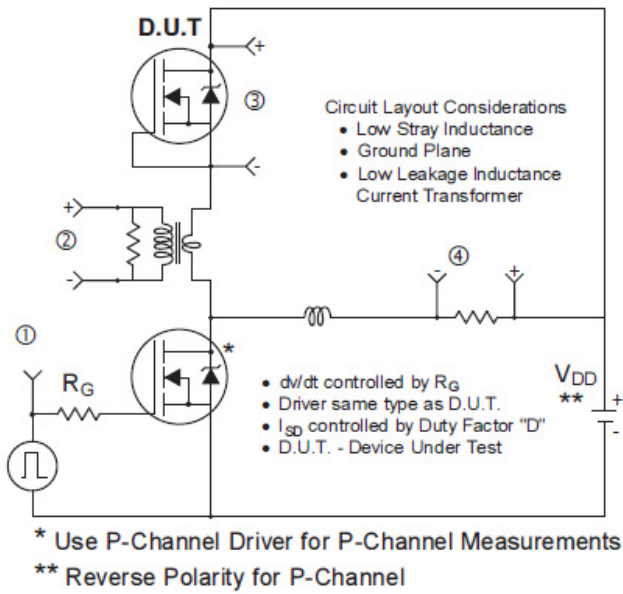

**Fig 12.** Typical On-Resistance vs. Gate Voltage

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

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

**Fig 15b.** Unclamped Inductive Waveforms

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

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

**Fig 16b.** Switching Time Waveforms



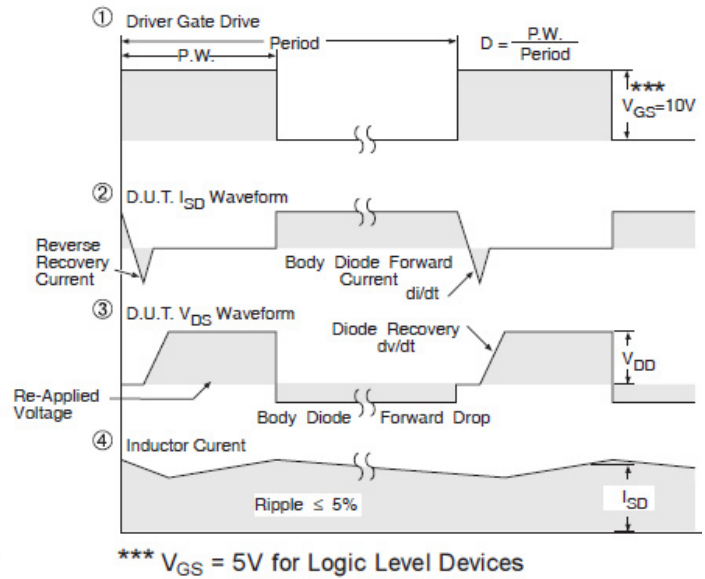
**Fig 17a. Gate Charge Test Circuit**



**Fig 17b. Gate Charge Waveform**



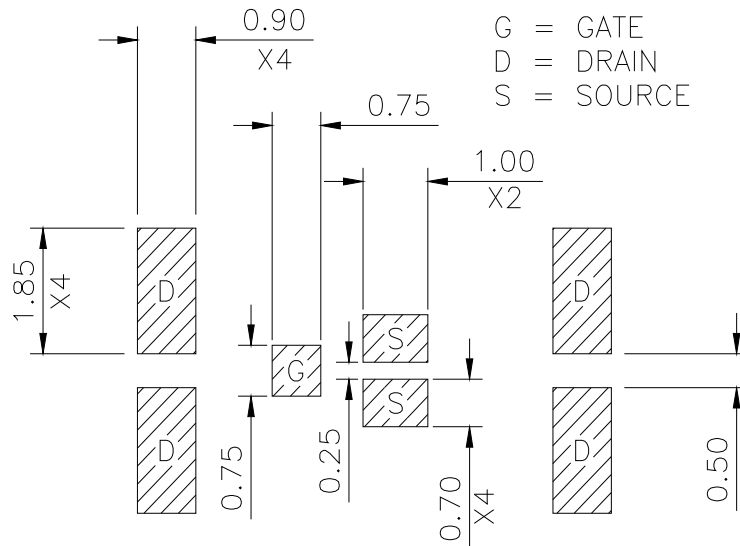
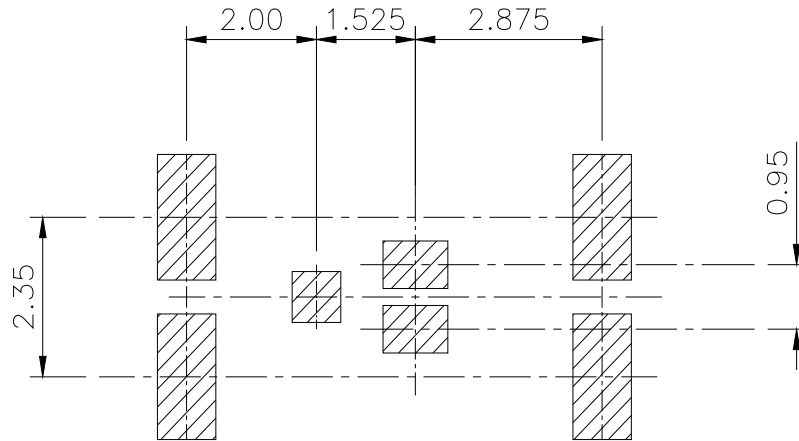
**Fig 18. Peak Diode Recovery dv/dt Test Circuit for N-Channel HEXFET® Power MOSFETs**



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

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

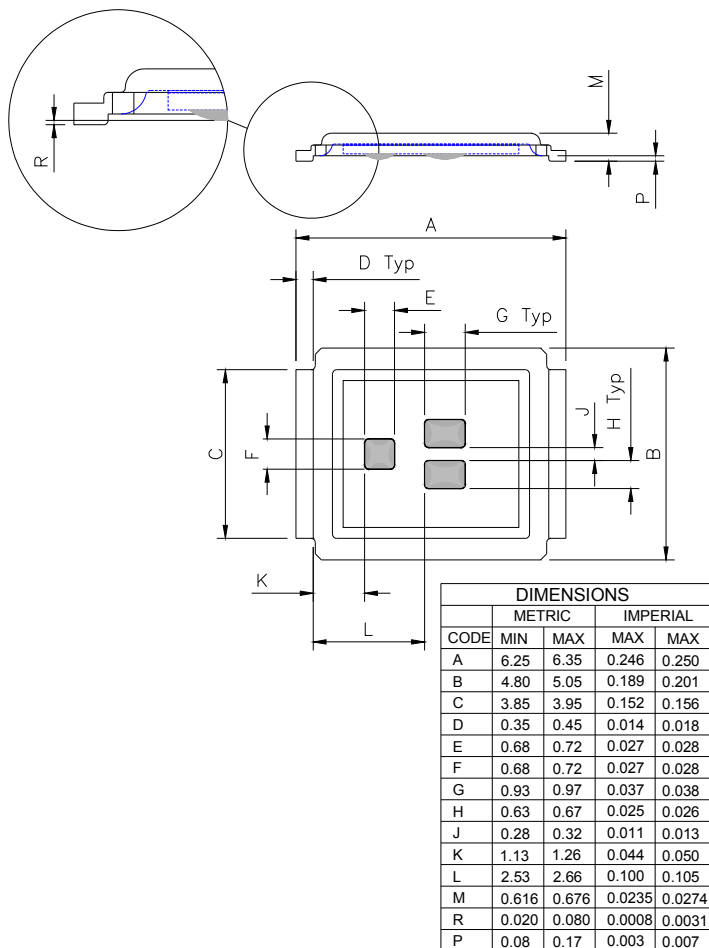
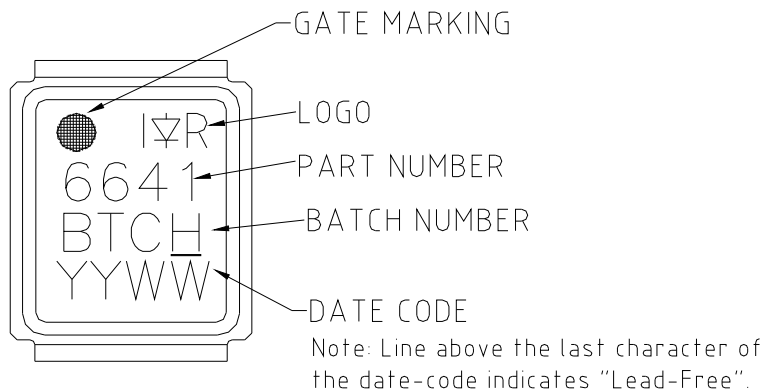
Please see DirectFET application note AN-1035 for all details regarding the assembly of DirectFET. This includes all recommendations for stencil and substrate designs.



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

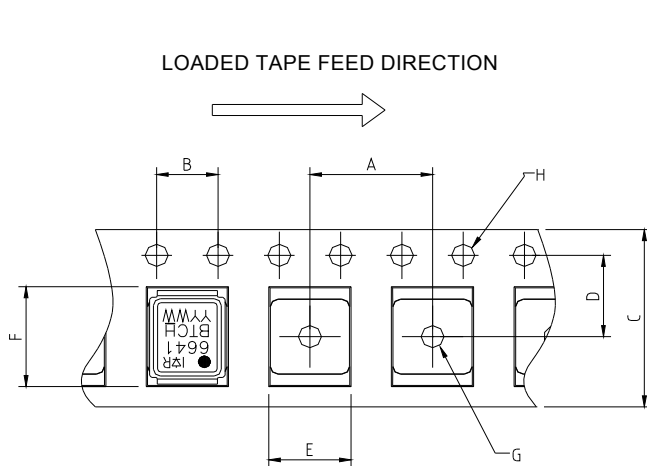
**DirectFET® Outline Dimension, MZ Outline  
(Medium Size Can, D-Designation).**

Please see DirectFET application note AN-1035 for all details regarding the assembly of DirectFET. This includes all recommendations for stencil and substrate designs.

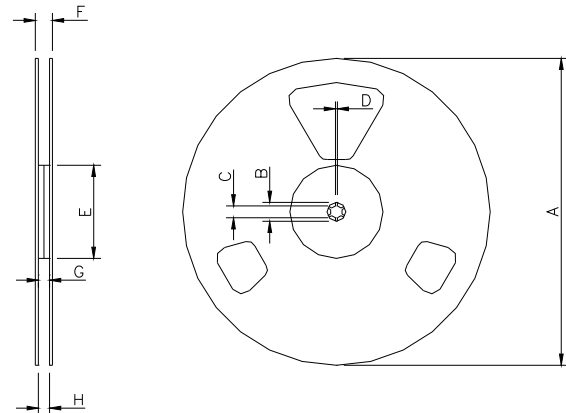

**DirectFET® Part Marking**


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



**DirectFET® Tape & Reel Dimension (Showing component orientation).**


| CODE | DIMENSIONS |       | DIMENSIONS |       |
|------|------------|-------|------------|-------|
|      | 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

| CODE | REEL DIMENSIONS            |      |          |       |                       |       |          |      |
|------|----------------------------|------|----------|-------|-----------------------|-------|----------|------|
|      | STANDARD OPTION (QTY 4800) |      |          |       | TR1 OPTION (QTY 1000) |       |          |      |
|      | METRIC                     |      | IMPERIAL |       | METRIC                |       | IMPERIAL |      |
| 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  |

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

**Qualification Information†**

|                                   |  |  |
|-----------------------------------|--|--|
| <b>Qualification Level</b>        | Consumer <sup>††</sup><br>(per JEDEC JESD47F) <sup>†††</sup> |  |
| <b>Moisture Sensitivity Level</b> | DirectFET  | MSL1<br>(per JEDEC J-STD-020D <sup>†††</sup> ) |
| <b>RoHS Compliant</b>             | Yes  |  |

† Qualification standards can be found at International Rectifier's web site: <http://www.irf.com/product-info/reliability/>

†† 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/>

††† Applicable version of JEDEC standard at the time of product release.

**Notes:**

- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.77\text{mH}$ ,  $R_G = 25\Omega$ ,  $I_{AS} = 11\text{A}$ .
- ③ Surface mounted on 1 in. square Cu board.
- ④ Pulse width  $\leq 400\mu\text{s}$ ; duty cycle  $\leq 2\%$ .
- ⑤  $C_{oss}$  eff. is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .

- ⑥ Used double sided cooling , mounting pad with large heatsink.
- ⑦ Mounted on minimum footprint full size board with metalized back and with small clip heatsink.
- ⑧  $T_C$  measured with thermal couple mounted to top (Drain) of part.
- ⑨  $R_\theta$  is measured at  $T_J$  of approximately  $90^\circ\text{C}$ .

**Revision History**

| <b>Date</b> | <b>Comments</b>  |
|-------------|--|
| 06/28/2013  | <ul style="list-style-type: none"><li>Added the Consumer qualification level information, on page 9.</li></ul>                                     |
| 05/17/2013  | <ul style="list-style-type: none"><li>Converted the data sheet to Class-D Audio formatting template. No change in electrical parameters.</li></ul> |

## **IMPORTANT NOTICE**

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