

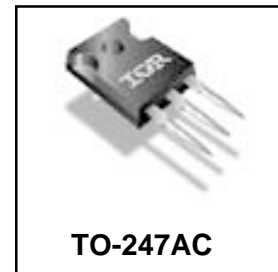
**Applications**

- Switch Mode Power Supply (SMPS)
- Uninterruptible Power Supply
- High Speed Power Switching
- ZVS and High Frequency Circuit
- PWM Inverters

|                        |                                |                      |
|------------------------|--------------------------------|----------------------|
| <b>V<sub>DSS</sub></b> | <b>R<sub>DS(on) typ.</sub></b> | <b>I<sub>D</sub></b> |
| <b>500V</b>            | <b>0.15Ω</b>                   | <b>31A</b>           |

**Benefits**

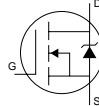
- Low Gate Charge Qg results in Simple Drive Requirement
- Improved Gate, Avalanche and Dynamic dv/dt Ruggedness
- Fully Characterized Capacitance and Avalanche Voltage and Current
- Low Trr and Soft Diode Recovery
- High Performance Optimised Anti-parallel Diode



**Absolute Maximum Ratings**

|   | Parameter   | Max.               | Units |
|---|---|--------------------|-------|
| I <sub>D</sub> @ T <sub>C</sub> = 25°C  | Continuous Drain Current, V <sub>GS</sub> @ 10V         | 31                 | A     |
| I <sub>D</sub> @ T <sub>C</sub> = 100°C | Continuous Drain Current, V <sub>GS</sub> @ 10V         | 20                 |       |
| I <sub>DM</sub>                         | Pulsed Drain Current ①                                  | 124                |       |
| P <sub>D</sub> @ T <sub>C</sub> = 25°C  | Power Dissipation                                       | 460                | W     |
|   | Linear Derating Factor                                  | 3.7                | W/°C  |
| V <sub>GS</sub>                         | Gate-to-Source Voltage                                  | ± 30               | V     |
| dv/dt                                   | Peak Diode Recovery dv/dt ③                             | 19                 | V/ns  |
| T <sub>J</sub><br>T <sub>STG</sub>      | Operating Junction and Storage Temperature Range        | -55 to + 150       | °C    |
|   | Soldering Temperature, for 10 seconds (1.6mm from case) | 300                |       |
|   | Mounting torque, 6-32 or M3 screw                       | 10 lbf•in (1.1N•m) |       |

**Diode Characteristics**

| Symbol           | Parameter                              | Min.   | Typ. | Max. | Units | Conditions   |
|------------------|--|--|------|------|-------|--|
| I <sub>S</sub>   | Continuous Source Current (Body Diode) | —  | —    | 31   | A     | MOSFET symbol showing the integral reverse p-n junction diode.  |
| I <sub>SM</sub>  | Pulsed Source Current (Body Diode) ①   | —  | —    | 124  |       |  |
| V <sub>SD</sub>  | Diode Forward Voltage                  | —  | —    | 1.5  | V     | T <sub>J</sub> = 25°C, I <sub>S</sub> = 31A, V <sub>GS</sub> = 0V ④  |
| t <sub>rr</sub>  | Reverse Recovery Time                  | —  | 170  | 250  | ns    | T <sub>J</sub> = 25°C I <sub>F</sub> = 31A<br>T <sub>J</sub> = 125°C di/dt = 100A/μs ④   |
| Q <sub>rr</sub>  | Reverse Recovery Charge                | —  | 220  | 330  |       |  |
| Q <sub>rr</sub>  | Reverse Recovery Charge                | —  | 570  | 860  | nC    | T <sub>J</sub> = 25°C  |
| I <sub>RRM</sub> | Reverse Recovery Current               | —  | 1.2  | 1.8  |       |  |
| t <sub>on</sub>  | Forward Turn-On Time                   | Intrinsic turn-on time is negligible (turn-on is dominated by L <sub>S</sub> +L <sub>D</sub> ) |      |      |       |  |

**Typical SMPS Topologies**

- Bridge Converters
- All Zero Voltage Switching

# IRFP31N50L

International  
IR Rectifier

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

| Symbol                          | Parameter                            | Min. | Typ. | Max. | Units    | Conditions  |
|---------------------------------|--------------------------------------|------|------|------|----------|---|
| $V_{(BR)DSS}$                   | Drain-to-Source Breakdown Voltage    | 500  | —    | —    | V        | $V_{GS} = 0V, I_D = 250\mu A$                         |
| $\Delta V_{(BR)DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient  | —    | 0.28 | —    | V/°C     | Reference to $25^\circ\text{C}, I_D = 1\text{mA}$ Ⓞ   |
| $R_{DS(on)}$                    | Static Drain-to-Source On-Resistance | —    | 0.15 | 0.18 | $\Omega$ | $V_{GS} = 10V, I_D = 19A$ ④                           |
| $V_{GS(th)}$                    | Gate Threshold Voltage               | 3.0  | —    | 5.0  | V        | $V_{DS} = V_{GS}, I_D = 250\mu A$                     |
| $I_{DSS}$                       | Drain-to-Source Leakage Current      | —    | —    | 50   | $\mu A$  | $V_{DS} = 500V, V_{GS} = 0V$                          |
|                                 |                                      | —    | —    | 2.0  | mA       | $V_{DS} = 400V, V_{GS} = 0V, T_J = 125^\circ\text{C}$ |
| $I_{GSS}$                       | Gate-to-Source Forward Leakage       | —    | —    | 100  | nA       | $V_{GS} = 30V$  |
|                                 | Gate-to-Source Reverse Leakage       | —    | —    | -100 |          | $V_{GS} = -30V$                                       |

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

| Symbol                 | Parameter                       | Min. | Typ. | Max. | Units | Conditions  |
|------------------------|---------------------------------|------|------|------|-------|---|
| $g_{fs}$               | Forward Transconductance        | 15   | —    | —    | S     | $V_{DS} = 50V, I_D = 19A$ ④   |
| $Q_g$                  | Total Gate Charge               | —    | —    | 210  | nC    | $I_D = 31A$<br>$V_{DS} = 400V$<br>$V_{GS} = 10V$ , See Fig. 6 and 13 ④                |
| $Q_{gs}$               | Gate-to-Source Charge           | —    | —    | 58   |       |   |
| $Q_{gd}$               | Gate-to-Drain ("Miller") Charge | —    | —    | 100  |       |   |
| $t_{d(on)}$            | Turn-On Delay Time              | —    | 28   | —    | ns    | $V_{DD} = 250V$<br>$I_D = 31A$<br>$R_G = 4.3\Omega$<br>$V_{GS} = 10V$ , See Fig. 10 ④ |
| $t_r$                  | Rise Time                       | —    | 115  | —    |       |   |
| $t_{d(off)}$           | Turn-Off Delay Time             | —    | 54   | —    |       |   |
| $t_f$                  | Fall Time                       | —    | 53   | —    |       |   |
| $C_{iss}$              | Input Capacitance               | —    | 5000 | —    | pF    | $V_{GS} = 0V$<br>$V_{DS} = 25V$<br>$f = 1.0\text{MHz}$ , See Fig. 5                   |
| $C_{oss}$              | Output Capacitance              | —    | 553  | —    |       |   |
| $C_{riss}$             | Reverse Transfer Capacitance    | —    | 59   | —    |       |   |
| $C_{oss}$              | Output Capacitance              | —    | 6630 | —    |       |   |
| $C_{oss}$              | Output Capacitance              | —    | 155  | —    |       |   |
| $C_{oss}$              | Output Capacitance              | —    | 155  | —    |       |   |
| $C_{oss \text{ eff.}}$ | Effective Output Capacitance    | —    | 276  | —    |       |   |

## Avalanche Characteristics

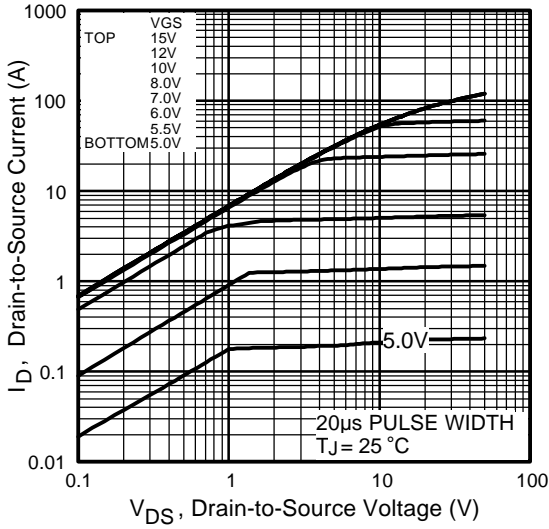
| Symbol   | Parameter                      | Typ. | Max. | Units |
|----------|--------------------------------|------|------|-------|
| $E_{AS}$ | Single Pulse Avalanche Energy② | —    | 460  | mJ    |
| $I_{AR}$ | Avalanche Current①             | —    | 31   | A     |
| $E_{AR}$ | Repetitive Avalanche Energy①   | —    | 46   | mJ    |

## Thermal Resistance

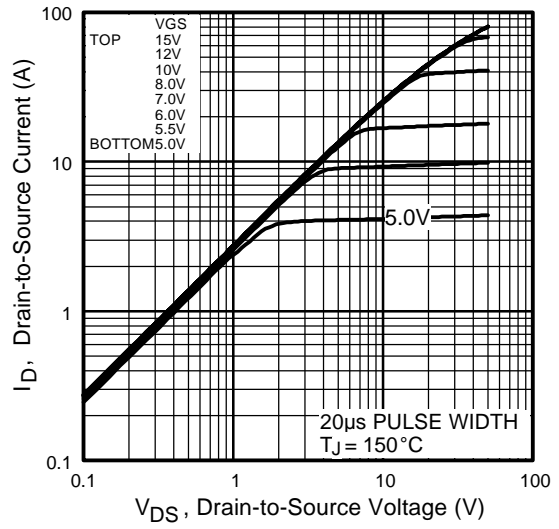
| Symbol          | Parameter                           | Typ. | Max. | Units |
|-----------------|-------------------------------------|------|------|-------|
| $R_{\theta JC}$ | Junction-to-Case                    | —    | 0.26 | °C/W  |
| $R_{\theta CS}$ | Case-to-Sink, Flat, Greased Surface | 0.24 | —    |       |
| $R_{\theta JA}$ | Junction-to-Ambient                 | —    | 40   |       |

### Notes:

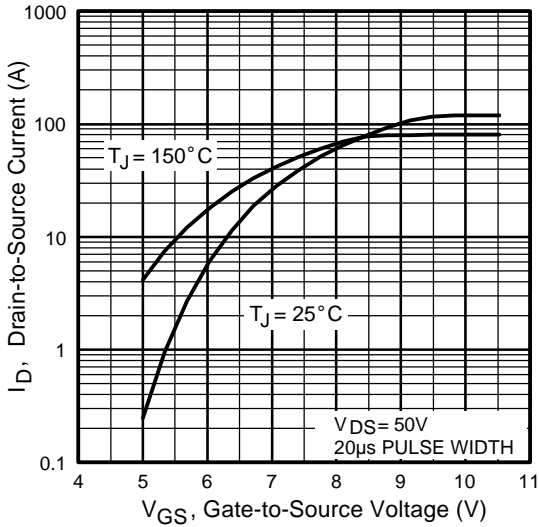
- ① Repetitive rating; pulse width limited by max. junction temperature. (See Fig. 11)
- ② Starting  $T_J = 25^\circ\text{C}$ ,  $L = 1\text{mH}$ ,  $R_G = 25\Omega$ ,  $I_{AS} = 31A$  (See Figure 12a).
- ③  $I_{SD} = 31A$ ,  $di/dt \leq 422A/\mu s$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_J \leq 150^\circ\text{C}$ .
- ④ Pulse width  $\leq 300\mu s$ ; duty cycle  $\leq 2\%$ .
- ⑤  $C_{oss \text{ eff.}}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .



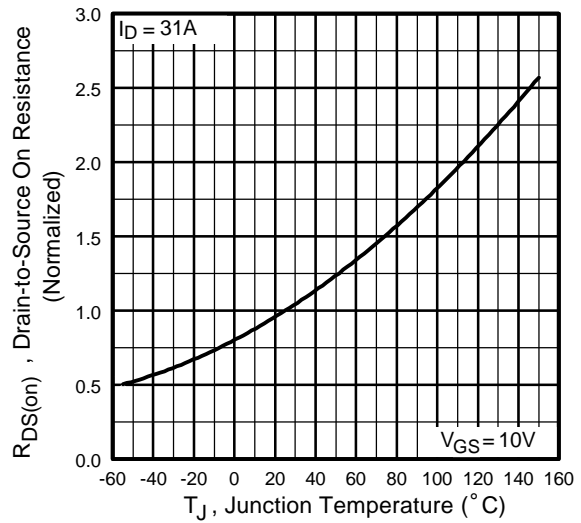
**Fig 1.** Typical Output Characteristics



**Fig 2.** Typical Output Characteristics



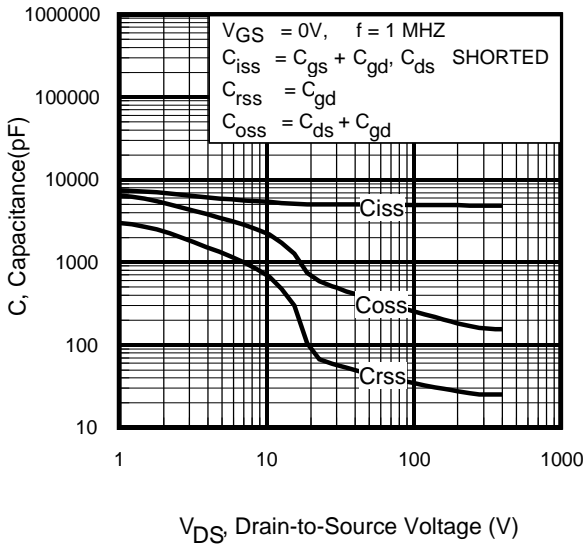
**Fig 3.** Typical Transfer Characteristics



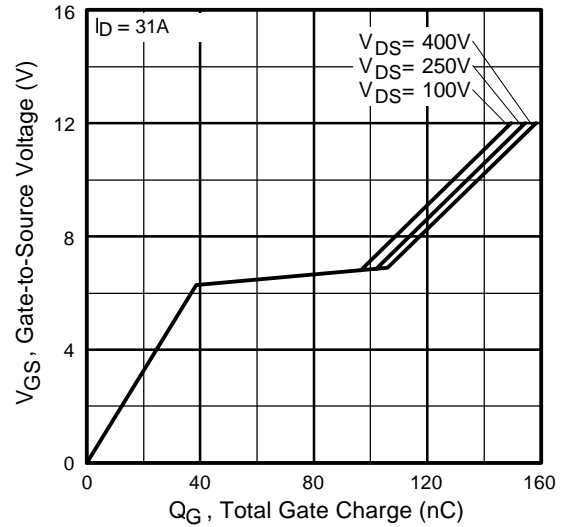
**Fig 4.** Normalized On-Resistance Vs. Temperature

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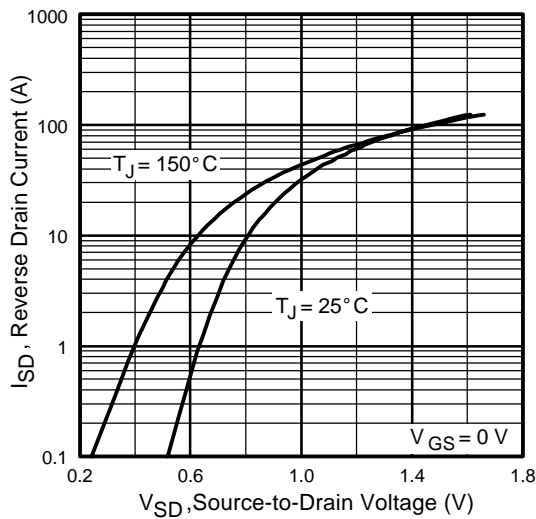
International  
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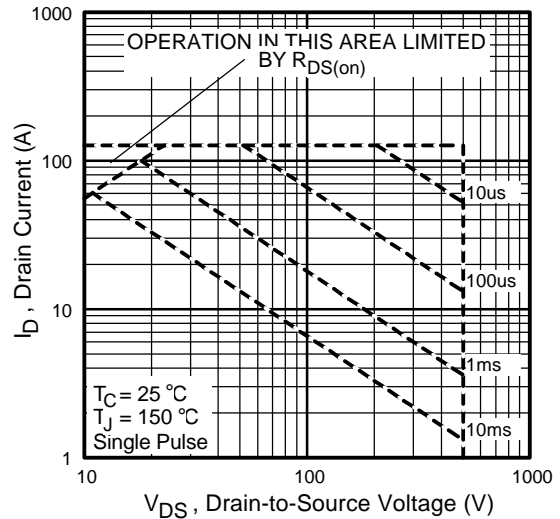
**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage



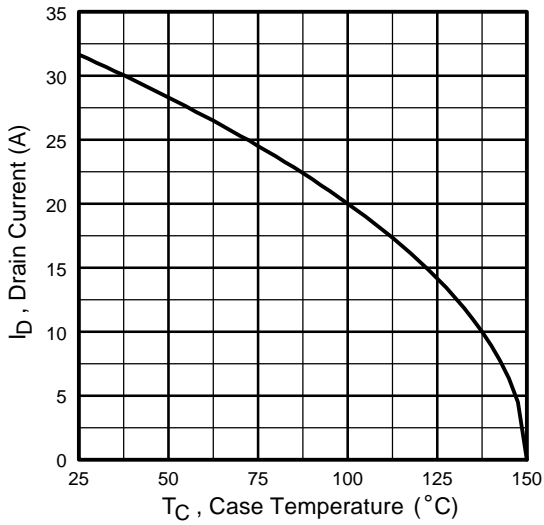
**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage



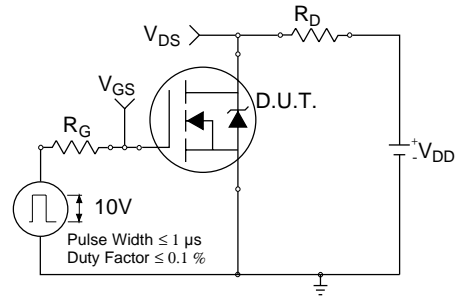
**Fig 7.** Typical Source-Drain Diode Forward Voltage



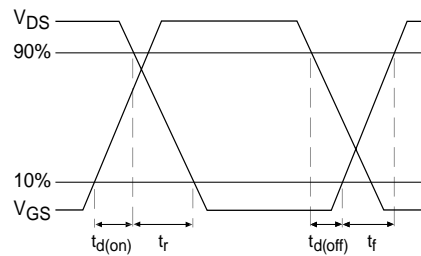
**Fig 8.** Maximum Safe Operating Area



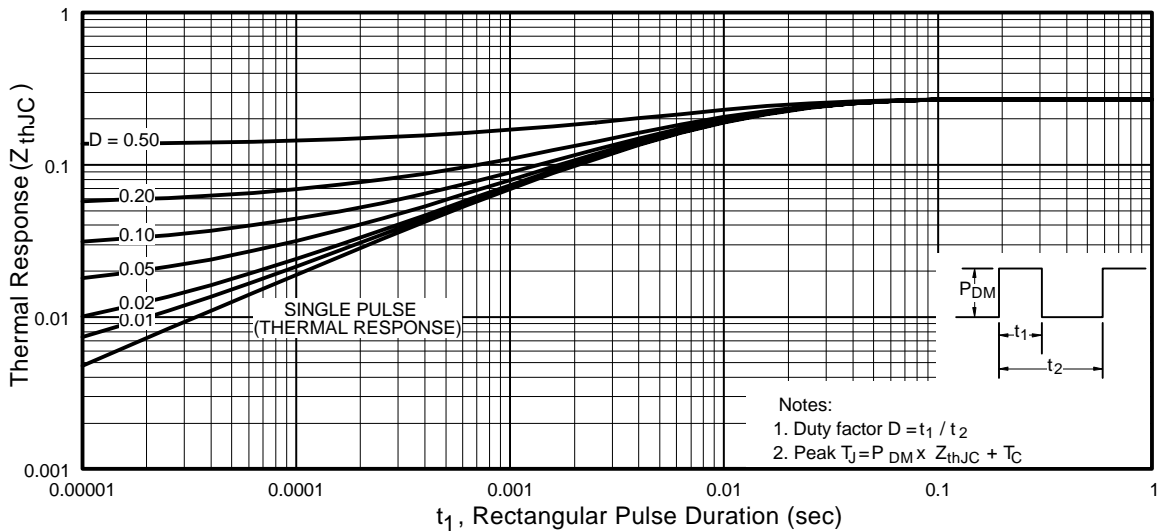
**Fig 9.** Maximum Drain Current Vs. Case Temperature



**Fig 10a.** Switching Time Test Circuit



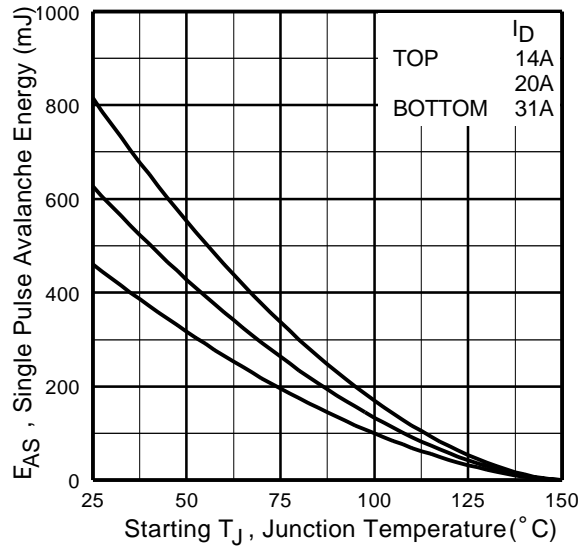
**Fig 10b.** Switching Time Waveforms



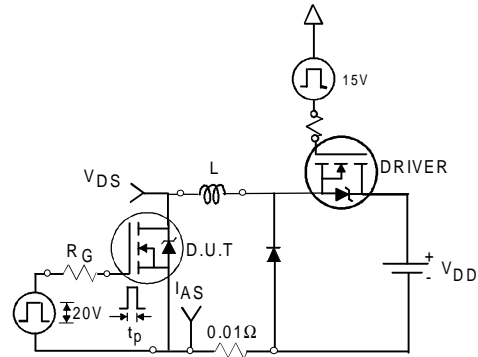
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

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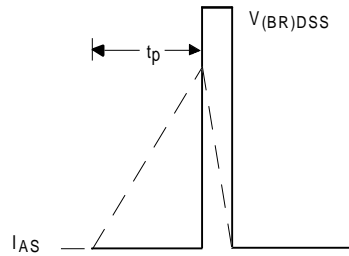
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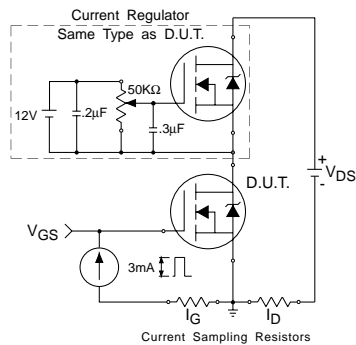
**Fig 12a.** Maximum Avalanche Energy Vs. Drain Current



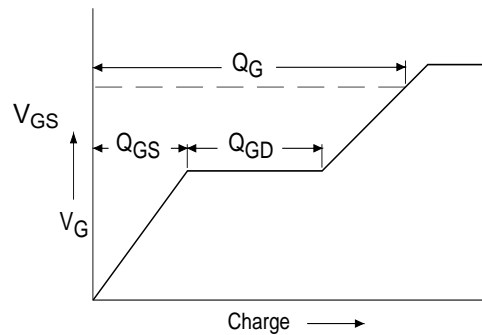
**Fig 12c.** Unclamped Inductive Test Circuit



**Fig 12d.** Unclamped Inductive Waveforms

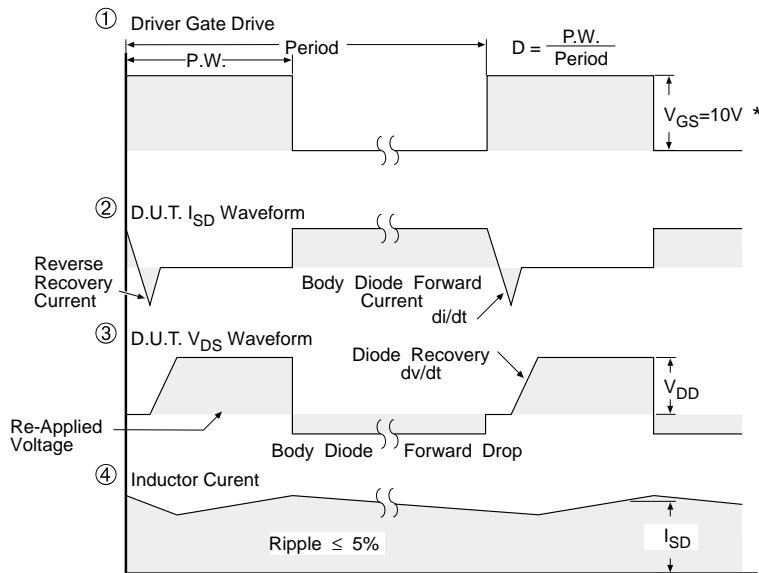
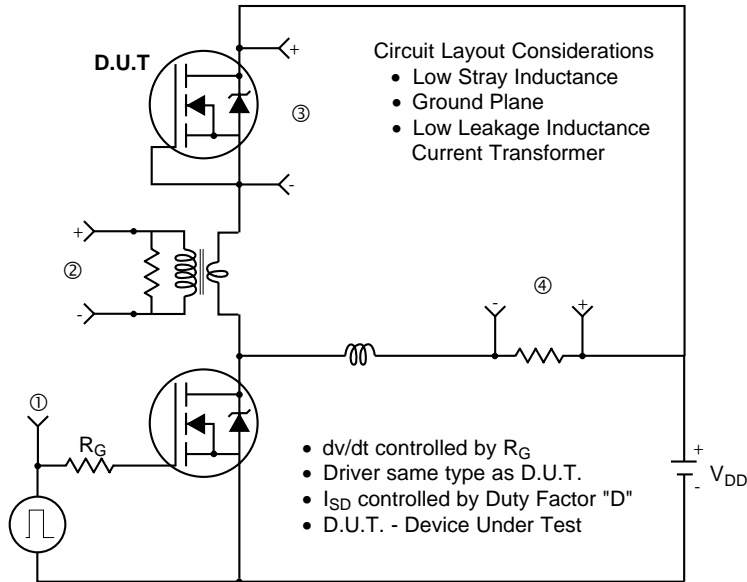


**Fig 13a.** Gate Charge Test Circuit



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

## Peak Diode Recovery dv/dt Test Circuit



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

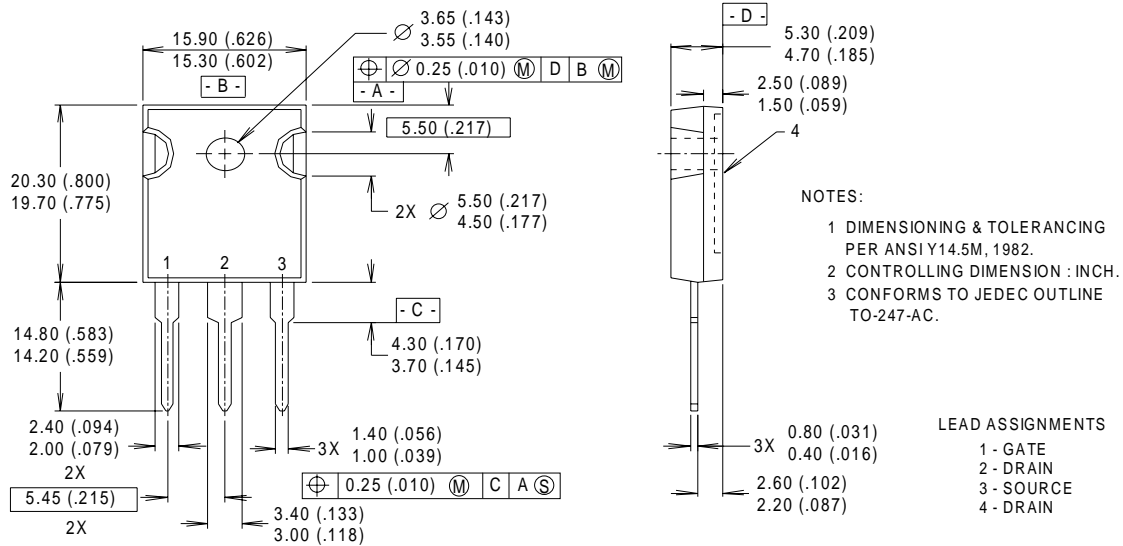
**Fig 14.** For N-Channel HEXFET® Power MOSFETs

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## TO - 247 Package Outline

Dimensions are shown in millimeters (inches)



### Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Starting  $T_J = 25^\circ\text{C}$ ,  $L = 4.3\text{mH}$   
 $R_G = 25\Omega$ ,  $I_{AS} = 24\text{A}$ .
- ③  $I_{SD} = 24\text{A}$ ,  $di/dt \leq \text{TBD A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  
 $T_J \leq 150^\circ\text{C}$
- ④ Pulse width  $\leq 300\mu\text{s}$ ; 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 Calculated continuous current based on maximum allowable junction temperature. Package limitation current is 90A

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.

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