

# IRFP90N20DPbF

HEXFET® Power MOSFET

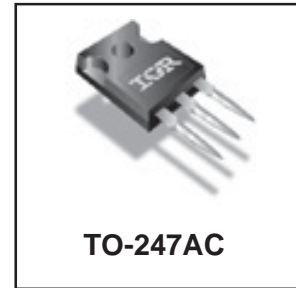
### Applications

- High frequency DC-DC converters
- Lead-Free

|                        |                               |                        |
|------------------------|-------------------------------|------------------------|
| <b>V<sub>DSS</sub></b> | <b>R<sub>DS(on) max</sub></b> | <b>I<sub>D</sub></b>   |
| <b>200V</b>            | <b>0.023Ω</b>                 | <b>94A<sup>Ⓓ</sup></b> |

### Benefits

- Low Gate-to-Drain Charge to Reduce Switching Losses
- Fully Characterized Capacitance Including Effective C<sub>OSS</sub> to Simplify Design, (See App. Note AN1001)
- Fully Characterized Avalanche Voltage and Current



### Absolute Maximum Ratings

|   | Parameter                                       | Max.               | Units |
|---|---|--------------------|-------|
| I <sub>D</sub> @ T <sub>C</sub> = 25°C  | Continuous Drain Current, V <sub>GS</sub> @ 10V | 94 <sup>Ⓓ</sup>    | A     |
| I <sub>D</sub> @ T <sub>C</sub> = 100°C | Continuous Drain Current, V <sub>GS</sub> @ 10V | 66                 |       |
| I <sub>DM</sub>                         | Pulsed Drain Current <sup>Ⓓ</sup>               | 380                |       |
| P <sub>D</sub> @ T <sub>C</sub> = 25°C  | Power Dissipation                               | 580                | W     |
|   | Linear Derating Factor                          | 3.8                | W/°C  |
| V <sub>GS</sub>                         | Gate-to-Source Voltage                          | ± 30               | V     |
| dv/dt                                   | Peak Diode Recovery dv/dt <sup>Ⓓ</sup>          | 6.7                | V/ns  |
| T <sub>J</sub>                          | Operating Junction and                          | -55 to + 175       | °C    |
| T <sub>STG</sub>                        | Storage Temperature Range                       |                    |       |
|   | Soldering Temperature, for 10 seconds           |                    |       |
|   | Mounting torque, 6-32 or M3 screw               | 10 lbf•in (1.1N•m) |       |

### Thermal Resistance

|                  | Parameter                           | Typ. | Max. | Units |
|------------------|-------------------------------------|------|------|-------|
| R <sub>θJC</sub> | Junction-to-Case                    | —    | 0.26 | °C/W  |
| R <sub>θCS</sub> | Case-to-Sink, Flat, Greased Surface | 0.24 | —    |       |
| R <sub>θJA</sub> | Junction-to-Ambient                 | —    | 40   |       |

Notes <sup>Ⓓ</sup> through <sup>Ⓔ</sup> are on page 8

## 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        | $V_{GS} = 0V, I_D = 250\mu A$                         |
| $\Delta V_{(BR)DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient  | —    | 0.24 | —     | V/°C     | Reference to $25^\circ\text{C}, I_D = 1\text{mA}$     |
| $R_{DS(on)}$                    | Static Drain-to-Source On-Resistance | —    | —    | 0.023 | $\Omega$ | $V_{GS} = 10V, I_D = 56A$ 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      | —    | —    | 25    | $\mu A$  | $V_{DS} = 200V, V_{GS} = 0V$                          |
|                                 |                                      | —    | —    | 250   |          | $V_{DS} = 160V, V_{GS} = 0V, T_J = 150^\circ\text{C}$ |
| $I_{GSS}$                       | Gate-to-Source Forward Leakage       | —    | —    | 100   | nA       | $V_{GS} = 30V$  |
|                                 | Gate-to-Source Reverse Leakage       | —    | —    | -100  |          | $V_{GS} = -30V$                                       |

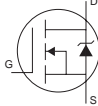
## Dynamic @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

|                        | Parameter                       | Min. | Typ. | Max. | Units | Conditions  |   |
|------------------------|---------------------------------|------|------|------|-------|---|---|
| $g_{fs}$               | Forward Transconductance        | 39   | —    | —    | S     | $V_{DS} = 50V, I_D = 56A$   |   |
| $Q_g$                  | Total Gate Charge               | —    | 180  | 270  | nC    | $I_D = 56A$<br>$V_{DS} = 160V$<br>$V_{GS} = 10V, \text{④}$                      |   |
| $Q_{gs}$               | Gate-to-Source Charge           | —    | 45   | 67   |       |   |   |
| $Q_{gd}$               | Gate-to-Drain ("Miller") Charge | —    | 87   | 130  |       |   |   |
| $t_{d(on)}$            | Turn-On Delay Time              | —    | 23   | —    | ns    | $V_{DD} = 100V$<br>$I_D = 56A$<br>$R_G = 1.2\Omega$<br>$V_{GS} = 10V, \text{④}$ |   |
| $t_r$                  | Rise Time                       | —    | 160  | —    |       |   |   |
| $t_{d(off)}$           | Turn-Off Delay Time             | —    | 43   | —    |       |   |   |
| $t_f$                  | Fall Time                       | —    | 79   | —    |       |   |   |
| $C_{iss}$              | Input Capacitance               | —    | 6040 | —    | pF    | $V_{GS} = 0V$<br>$V_{DS} = 25V$<br>$f = 1.0\text{MHz}$                          |   |
| $C_{oss}$              | Output Capacitance              | —    | 1070 | —    |       |   |   |
| $C_{rss}$              | Reverse Transfer Capacitance    | —    | 170  | —    |       |   |   |
| $C_{oss}$              | Output Capacitance              | —    | 8350 | —    |       |   | $V_{GS} = 0V, V_{DS} = 1.0V, f = 1.0\text{MHz}$       |
| $C_{oss}$              | Output Capacitance              | —    | 420  | —    |       |   | $V_{GS} = 0V, V_{DS} = 160V, f = 1.0\text{MHz}$       |
| $C_{oss \text{ eff.}}$ | Effective Output Capacitance    | —    | 870  | —    |       |   | $V_{GS} = 0V, V_{DS} = 0V \text{ to } 160V \text{ ⑤}$ |

## Avalanche Characteristics

|          | Parameter                      | Typ. | Max. | Units |
|----------|--------------------------------|------|------|-------|
| $E_{AS}$ | Single Pulse Avalanche Energy② | —    | 1010 | mJ    |
| $I_{AR}$ | Avalanche Current①             | —    | 56   | A     |
| $E_{AR}$ | Repetitive Avalanche Energy①   | —    | 58   | mJ    |

## Diode Characteristics

|          | Parameter                              | Min.  | Typ. | Max. | Units   | Conditions   |
|----------|--|---|------|------|---------|--|
| $I_S$    | Continuous Source Current (Body Diode) | —   | —    | 94⑥  | A       | MOSFET symbol showing the integral reverse p-n junction diode.  |
| $I_{SM}$ | Pulsed Source Current (Body Diode) ①   | —   | —    | 380  |         |  |
| $V_{SD}$ | Diode Forward Voltage                  | —   | —    | 1.5  | V       | $T_J = 25^\circ\text{C}, I_S = 56A, V_{GS} = 0V, \text{④}$   |
| $t_{rr}$ | Reverse Recovery Time                  | —   | 230  | 340  | ns      | $T_J = 25^\circ\text{C}, I_F = 56A$  |
| $Q_{rr}$ | Reverse Recovery Charge                | —   | 1.9  | 2.8  | $\mu C$ | $di/dt = 100A/\mu s, \text{④}$   |
| $t_{on}$ | Forward Turn-On Time                   | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S + L_D$ ) |      |      |         |  |

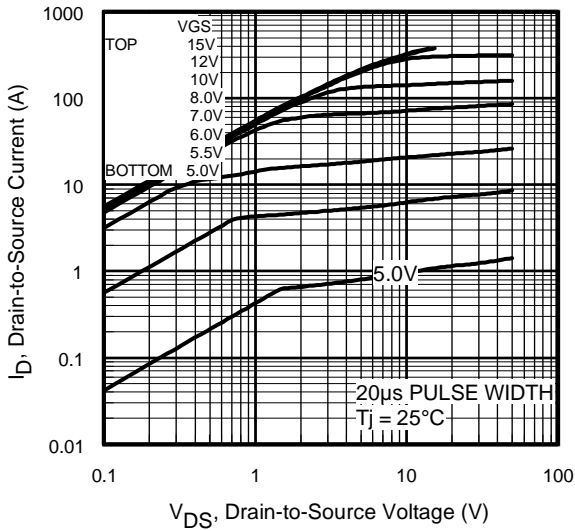


Fig 1. Typical Output Characteristics

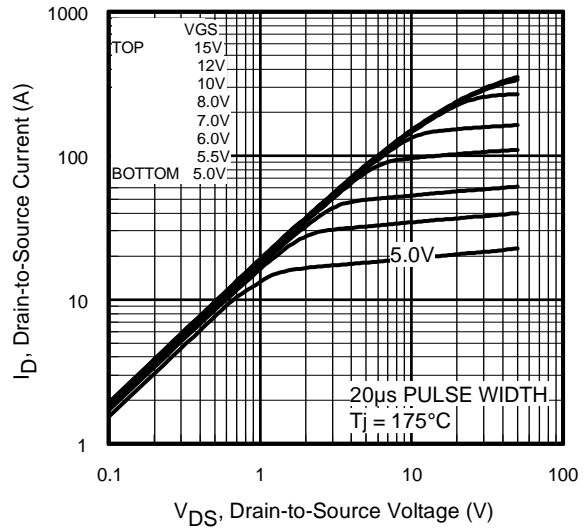


Fig 2. Typical Output Characteristics

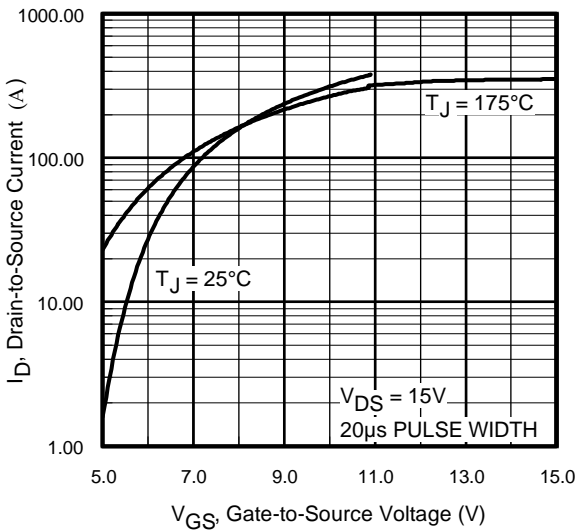


Fig 3. Typical Transfer Characteristics

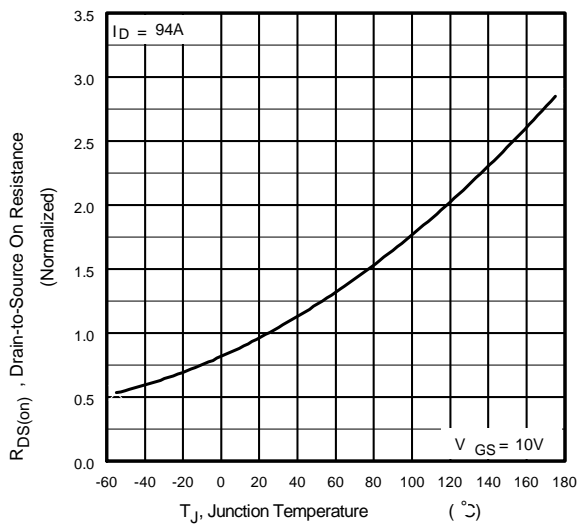
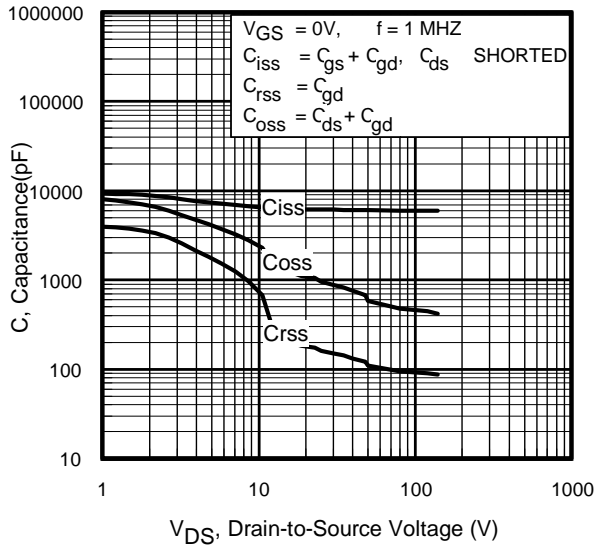
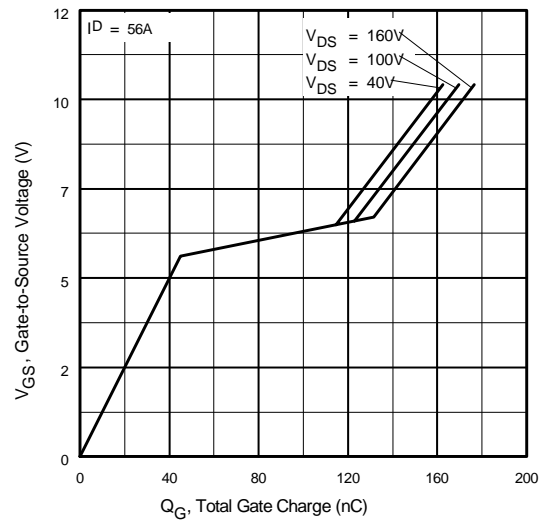


Fig 4. Normalized On-Resistance vs. Temperature

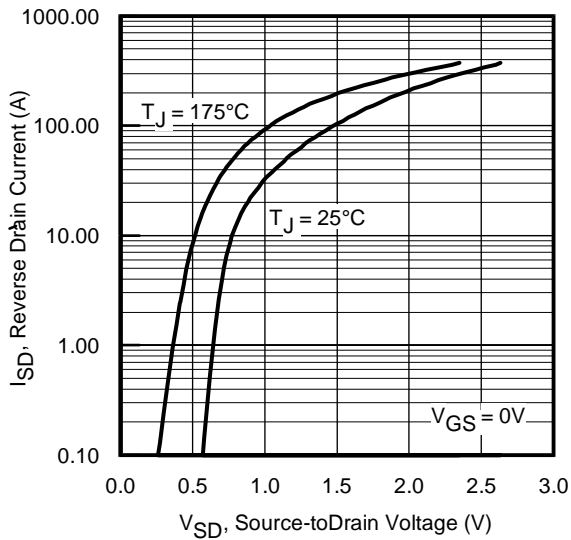
# IRFP90N20DPbF



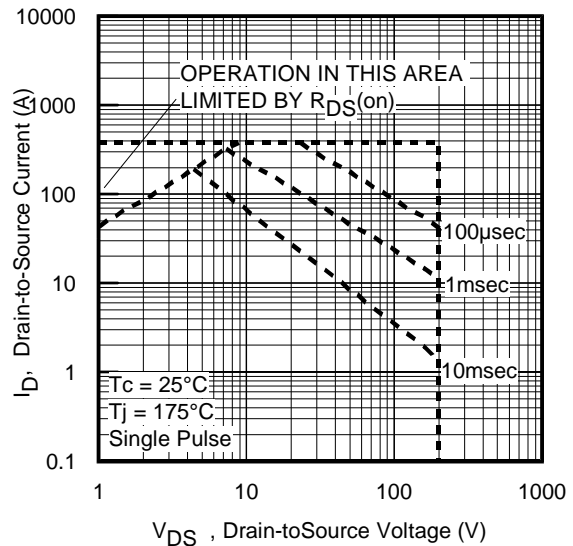
**Fig 5.** Typical Capacitance vs. Drain-to-Source Voltage



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



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



**Fig 8.** Maximum Safe Operating Area

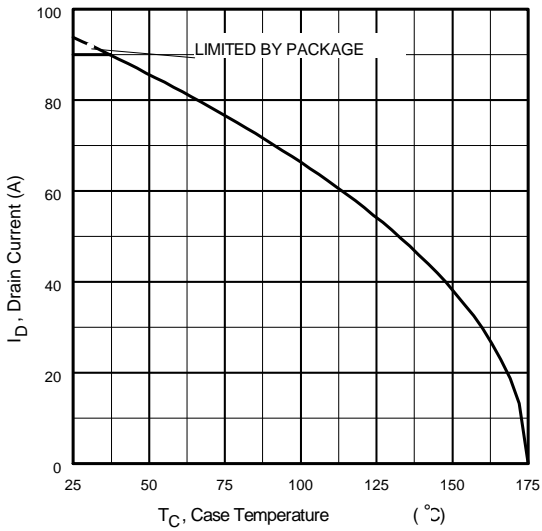


Fig 9. Maximum Drain Current vs. Case Temperature



Fig 10a. Switching Time Test Circuit

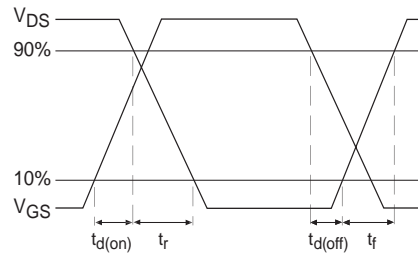


Fig 10b. Switching Time Waveforms

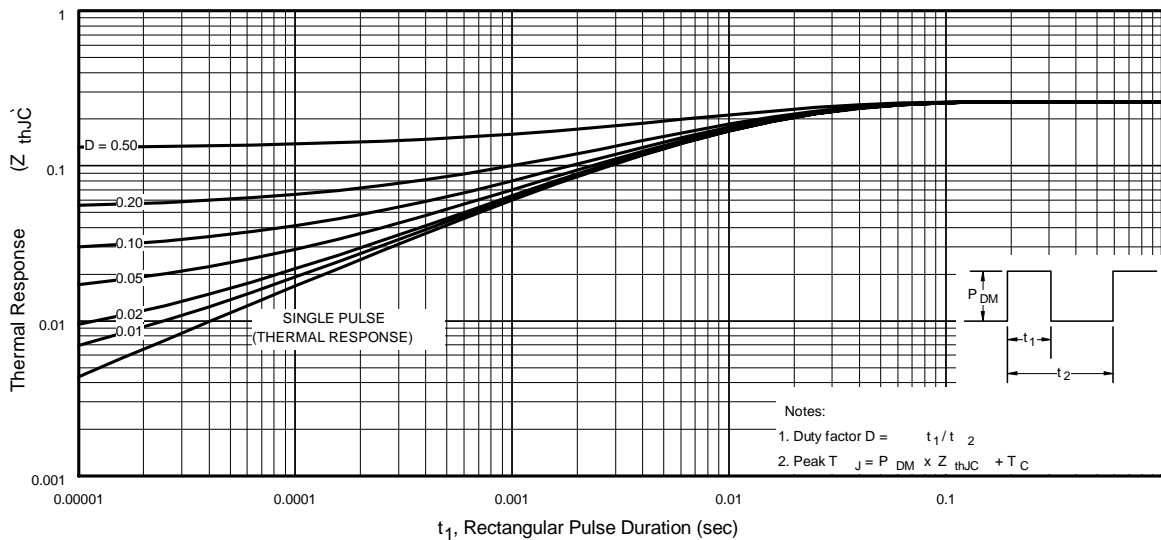
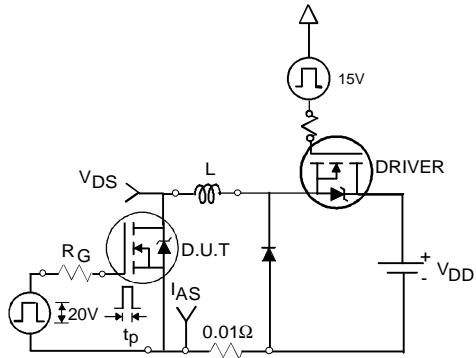


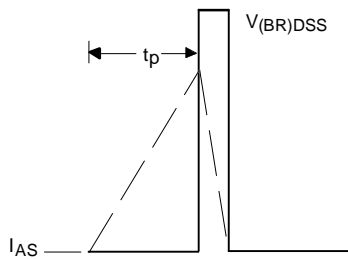
Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

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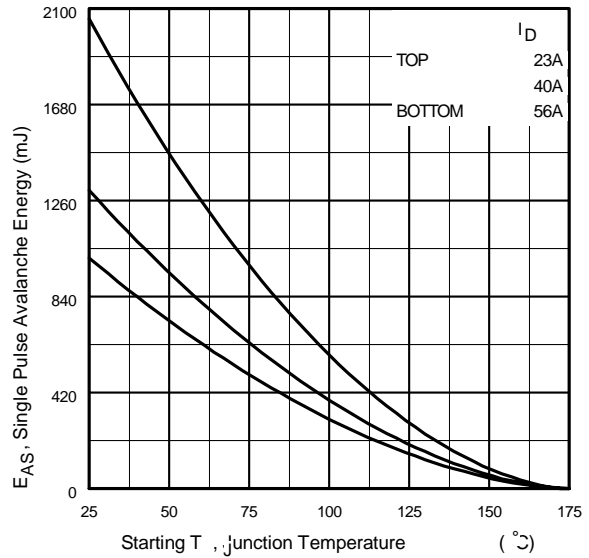
International  
**IR** Rectifier



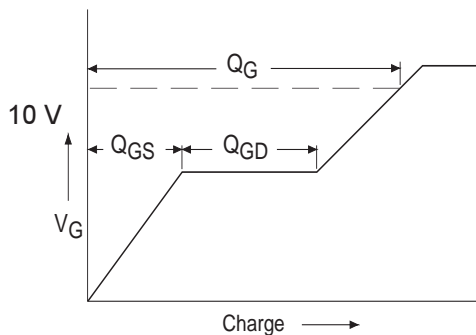
**Fig 12a.** Unclamped Inductive Test Circuit



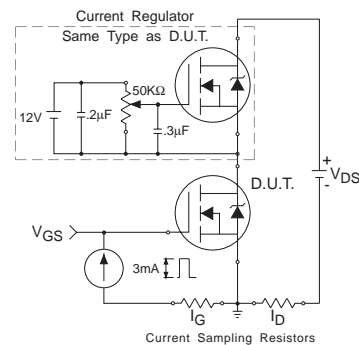
**Fig 12b.** Unclamped Inductive Waveforms



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

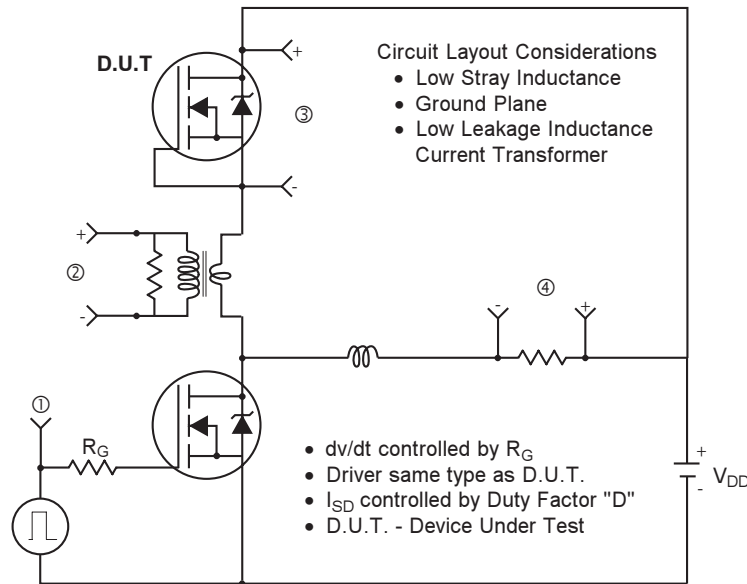


**Fig 13a.** Basic Gate Charge Waveform



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

**Peak Diode Recovery dv/dt Test Circuit**



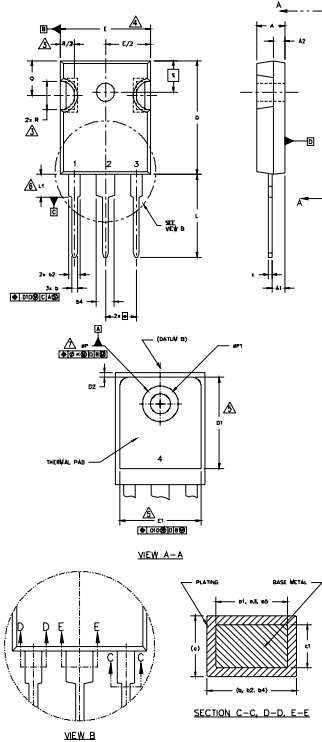
\*  $V_{GS} = 5V$  for Logic Level Devices

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

# IRFP90N20DPbF

TO-247AC Package Outline Dimensions are shown in millimeters (inches)

International  
**IR** Rectifier



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M 1994.
2. DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS]

△ CONTOUR OF SLOT OPTIONAL.

△ DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.

△ THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS D1 & E1.

△ LEAD FINISH UNCONTROLLED IN LI.

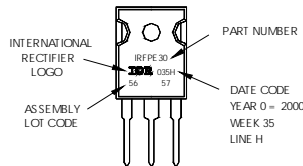
△ #P TO HAVE A MAXIMUM DRAFT ANGLE OF 1.5 ° TO THE TOP OF THE PART WITH A MAXIMUM HOLE DIAMETER OF .154" [3.91]

B. OUTLINE CONFORMS TO JEDEC OUTLINE TO-247 WITH THE EXCEPTION OF DIMENSION c.

| SYMBOL | INCHES  |      | MILLIMETERS |       | NOTES   |   |
|--------|---------|------|-------------|-------|---|---|
|        | MIN.    | MAX. | MIN.        | MAX.  |   |   |
| A      | .183    | .209 | 4.65        | 5.31  | LEAD ASSIGNMENTS<br><br>HEXFET<br>1 - GATE<br>2 - DRAIN<br>3 - SOURCE<br>4 - DRAIN<br><br>UGB Is. CoPACK<br>1 - GATE<br>2 - COLLECTOR<br>3 - EMITTER<br>4 - COLLECTOR |   |
| A1     | .087    | .102 | 2.21        | 2.59  |   |   |
| A2     | .059    | .098 | 1.50        | 2.49  |   |   |
| b      | .039    | .055 | 0.99        | 1.40  |   |   |
| b1     | .039    | .053 | 0.99        | 1.35  |   |   |
| b2     | .065    | .094 | 1.65        | 2.39  |   |   |
| b3     | .065    | .092 | 1.65        | 2.37  |   |   |
| b4     | .102    | .135 | 2.59        | 3.43  |   |   |
| b5     | .102    | .133 | 2.59        | 3.38  |   |   |
| c      | .015    | .034 | 0.38        | 0.86  |   |   |
| c1     | .015    | .030 | 0.38        | 0.76  |   |   |
| D      | .776    | .815 | 19.71       | 20.70 |   | 4 |
| D1     | .515    | -    | 13.08       | -     |   | 5 |
| D2     | .020    | .030 | 0.51        | 0.76  |   | 4 |
| E      | .602    | .625 | 15.29       | 15.87 | 4   |   |
| E1     | .540    | -    | 13.72       | -     |   |   |
| e      | 215 BSC |      | 5.46 BSC    |       |   |   |
| e#     | .010    |      | 2.54        |       |   |   |
| L      | .559    | .634 | 14.20       | 16.10 | DIODES<br>1 - ANODE/OPEN<br>2 - CATHODE<br>3 - ANODE  |   |
| L1     | .146    | .169 | 3.71        | 4.29  |   |   |
| N      | 3       |      | 7.62 BSC    |       |   |   |
| #P     | .140    | .144 | 3.56        | 3.66  |   |   |
| #P1    | -       | .275 | -           | 6.98  |   |   |
| O      | .209    | .224 | 5.31        | 5.69  |   |   |
| R      | .178    | .216 | 4.52        | 5.49  |   |   |
| S      | 217 BSC |      | 5.51 BSC    |       |   |   |

## TO-247AC Part Marking Information

EXAMPLE: THIS IS AN IRFPE30 WITH ASSEMBLY LOT CODE 5657 ASSEMBLED ON WW 35, 2000 IN THE ASSEMBLY LINE "H"  
Note: "P" in assembly line position indicates "Lead-Free"



### Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.64\text{mH}$   
 $R_G = 25\Omega$ ,  $I_{AS} = 56\text{A}$ .
- ③  $I_{SD} \leq 56\text{A}$ ,  $di/dt \leq 470\text{A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  
 $T_J \leq 175^\circ\text{C}$
- 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.

International  
**IR** Rectifier

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TAC Fax: (310) 252-7903

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