

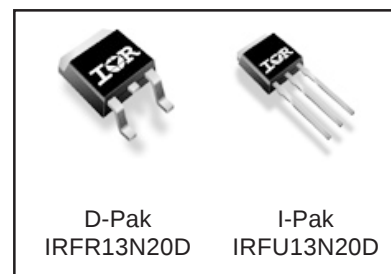
### Applications

- High frequency DC-DC converters

| $V_{DSS}$ | $R_{DS(on)}$ max | $I_D$ |
|-----------|------------------|-------|
| 200V      | 0.235 $\Omega$   | 13A   |

### Benefits

- Low Gate to Drain Charge to Reduce Switching Losses
- Fully Characterized Capacitance Including Effective  $C_{OSS}$  to Simplify Design, (See App. Note AN1001)
- Fully Characterized Avalanche Voltage and Current



### Absolute Maximum Ratings

|                                   | Parameter                                | Max.                   | Units               |
|-----------------------------------|------------------------------------------|------------------------|---------------------|
| $I_D$ @ $T_C = 25^\circ\text{C}$  | Continuous Drain Current, $V_{GS}$ @ 10V | 13                     | A                   |
| $I_D$ @ $T_C = 100^\circ\text{C}$ | Continuous Drain Current, $V_{GS}$ @ 10V | 9.2                    |                     |
| $I_{DM}$                          | Pulsed Drain Current ①                   | 52                     |                     |
| $P_D$ @ $T_C = 25^\circ\text{C}$  | Power Dissipation                        | 110                    | W                   |
|                                   | Linear Derating Factor                   | 0.71                   | W/ $^\circ\text{C}$ |
| $V_{GS}$                          | Gate-to-Source Voltage                   | $\pm 30$               | V                   |
| dv/dt                             | Peak Diode Recovery dv/dt ③              | 2.2                    | V/ns                |
| $T_J$                             | Operating Junction and                   | -55 to + 175           | $^\circ\text{C}$    |
| $T_{STG}$                         | Storage Temperature Range                |                        |                     |
|                                   | Soldering Temperature, for 10 seconds    | 300 (1.6mm from case ) |                     |

### Typical SMPS Topologies

- Telecom 48V input Forward Converters

# IRFR13N20D/IRFU13N20D

International  
**IR** Rectifier

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  | —    | 0.25 | —     | V/ $^\circ\text{C}$ | Reference to $25^\circ\text{C}, I_D = 1mA$            |
| $R_{DS(on)}$                    | Static Drain-to-Source On-Resistance | —    | —    | 0.235 | $\Omega$            | $V_{GS} = 10V, I_D = 8.0A$ ④                          |
| $V_{GS(th)}$                    | Gate Threshold Voltage               | 3.0  | —    | 5.5   | 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        | 6.2  | —    | —    | S     | $V_{DS} = 50V, I_D = 7.8A$                    |
| $Q_g$                  | Total Gate Charge               | —    | 25   | 38   | nC    | $I_D = 7.8A$                                  |
| $Q_{gs}$               | Gate-to-Source Charge           | —    | 7.3  | 11   |       | $V_{DS} = 160V$                               |
| $Q_{gd}$               | Gate-to-Drain ("Miller") Charge | —    | 12   | 18   |       | $V_{GS} = 10V$ ④                              |
| $t_{d(on)}$            | Turn-On Delay Time              | —    | 11   | —    | ns    | $V_{DD} = 100V$                               |
| $t_r$                  | Rise Time                       | —    | 27   | —    |       | $I_D = 7.8A$                                  |
| $t_{d(off)}$           | Turn-Off Delay Time             | —    | 17   | —    |       | $R_G = 6.8\Omega$                             |
| $t_f$                  | Fall Time                       | —    | 10   | —    |       | $V_{GS} = 10V$ ④                              |
| $C_{iss}$              | Input Capacitance               | —    | 830  | —    | pF    | $V_{GS} = 0V$                                 |
| $C_{oss}$              | Output Capacitance              | —    | 140  | —    |       | $V_{DS} = 25V$                                |
| $C_{rss}$              | Reverse Transfer Capacitance    | —    | 35   | —    |       | $f = 1.0MHz$                                  |
| $C_{oss}$              | Output Capacitance              | —    | 990  | —    |       | $V_{GS} = 0V, V_{DS} = 1.0V, f = 1.0MHz$      |
| $C_{oss}$              | Output Capacitance              | —    | 57   | —    |       | $V_{GS} = 0V, V_{DS} = 160V, f = 1.0MHz$      |
| $C_{oss \text{ eff.}}$ | Effective Output Capacitance    | —    | 59   | —    |       | $V_{GS} = 0V, V_{DS} = 0V \text{ to } 160V$ ⑤ |

## Avalanche Characteristics

|          | Parameter                      | Typ. | Max. | Units |
|----------|--------------------------------|------|------|-------|
| $E_{AS}$ | Single Pulse Avalanche Energy② | —    | 130  | mJ    |
| $I_{AR}$ | Avalanche Current①             | —    | 7.8  | A     |
| $E_{AR}$ | Repetitive Avalanche Energy①   | —    | 11   | mJ    |

## Thermal Resistance

|                 | Parameter                        | Typ. | Max. | Units              |
|-----------------|----------------------------------|------|------|--------------------|
| $R_{\theta JC}$ | Junction-to-Case                 | —    | 1.4  | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Junction-to-Ambient (PCB mount)* | —    | 50   |                    |
| $R_{\theta JA}$ | Junction-to-Ambient              | —    | 110  |                    |

## Diode Characteristics

|          | Parameter                              | Min.                                                                        | Typ. | Max. | Units | Conditions                                                     |
|----------|----------------------------------------|-----------------------------------------------------------------------------|------|------|-------|----------------------------------------------------------------|
| $I_S$    | Continuous Source Current (Body Diode) | —                                                                           | —    | 13   | A     | MOSFET symbol showing the integral reverse p-n junction diode. |
| $I_{SM}$ | Pulsed Source Current (Body Diode) ①   | —                                                                           | —    | 52   |       |                                                                |
| $V_{SD}$ | Diode Forward Voltage                  | —                                                                           | —    | 1.3  | V     | $T_J = 25^\circ\text{C}, I_S = 7.8A, V_{GS} = 0V$ ④            |
| $t_{rr}$ | Reverse Recovery Time                  | —                                                                           | 140  | 210  | ns    | $T_J = 25^\circ\text{C}, I_F = 7.8A$                           |
| $Q_{rr}$ | Reverse Recovery Charge                | —                                                                           | 750  | 1120 | nC    | $di/dt = 100A/\mu s$ ④                                         |
| $t_{on}$ | Forward Turn-On Time                   | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S + L_D$ ) |      |      |       |                                                                |

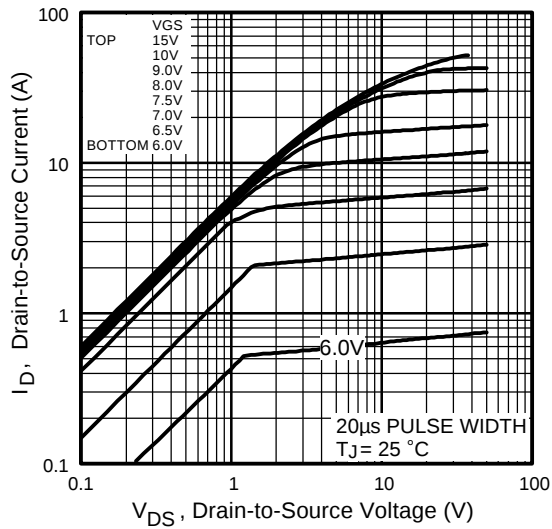


Fig 1. Typical Output Characteristics

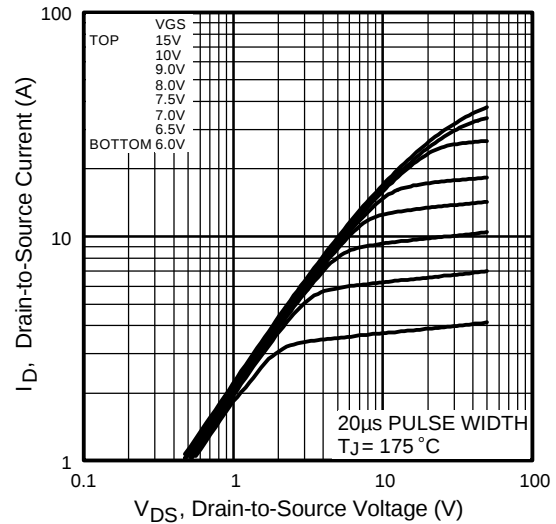


Fig 2. Typical Output Characteristics

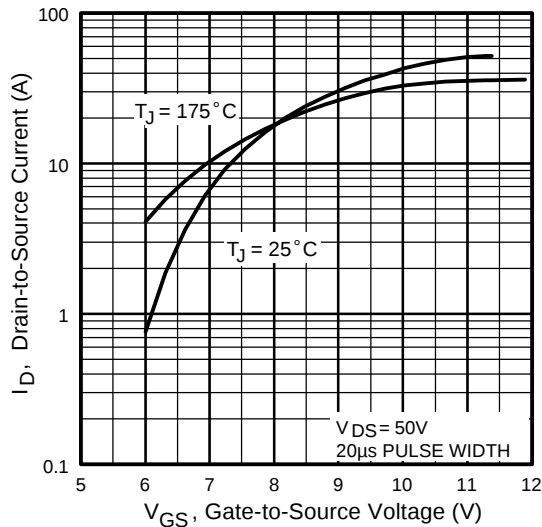


Fig 3. Typical Transfer Characteristics

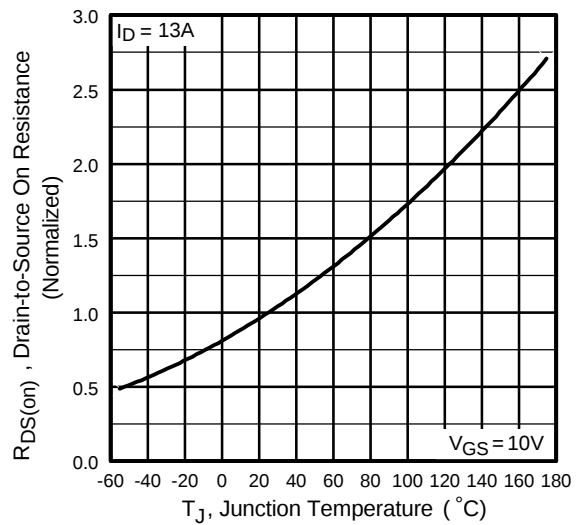
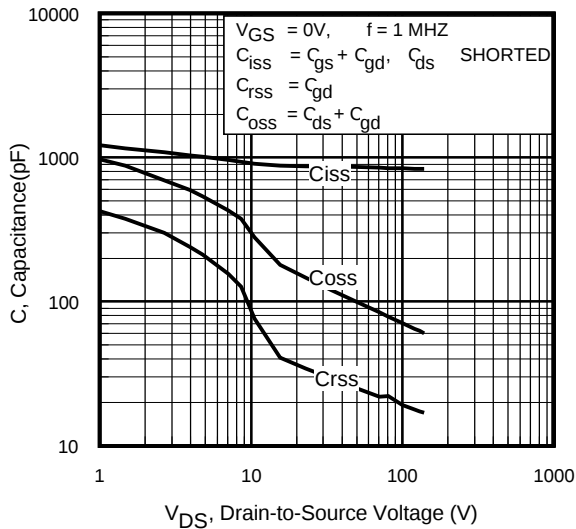


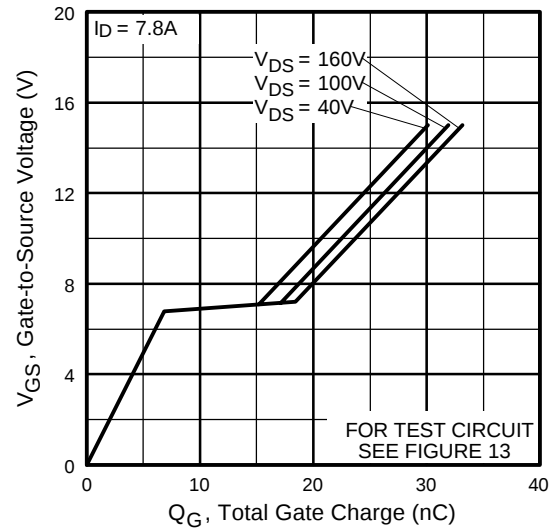
Fig 4. Normalized On-Resistance Vs. Temperature

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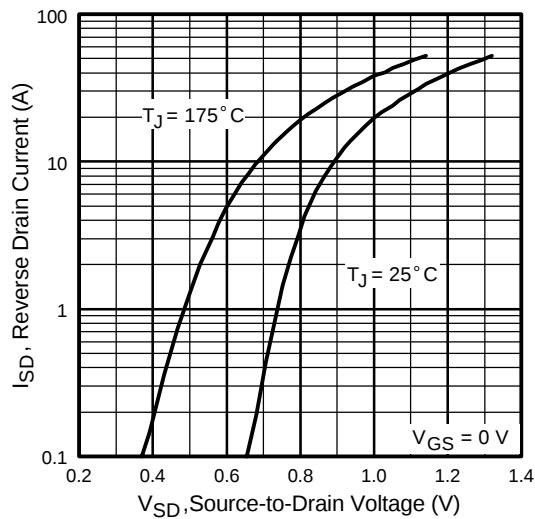
International  
**IR** Rectifier



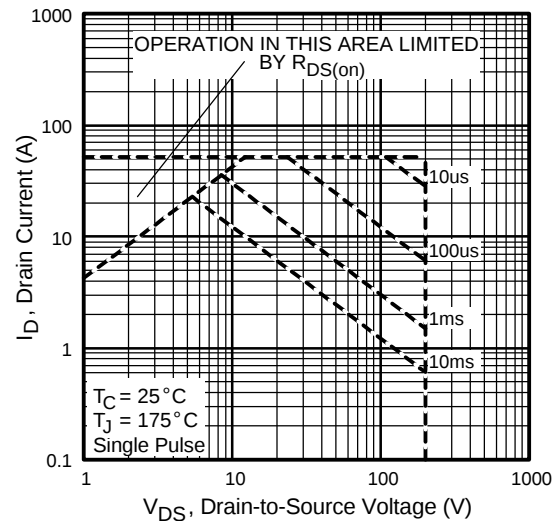
**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage



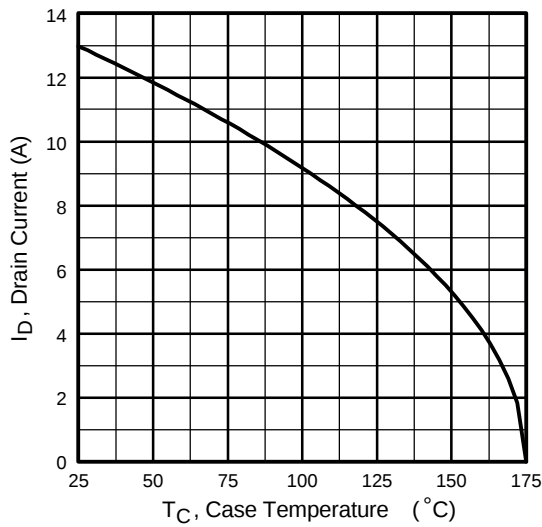
**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage



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



**Fig 8.** Maximum Safe Operating Area



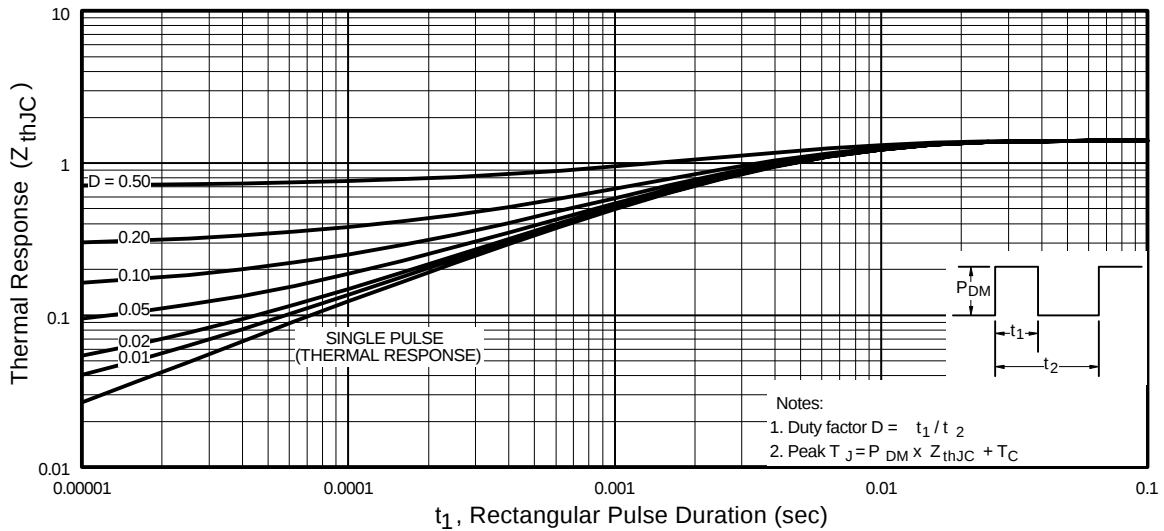
**Fig 9.** Maximum Drain Current Vs. Case Temperature



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



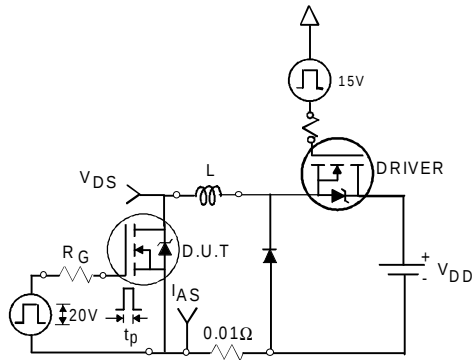
**Fig 10b.** Switching Time Waveforms



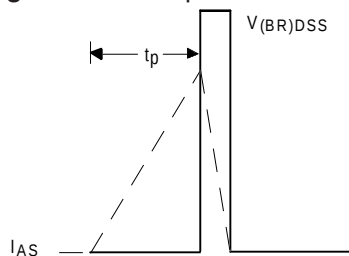
**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

# IRFR13N20D/IRFU13N20D

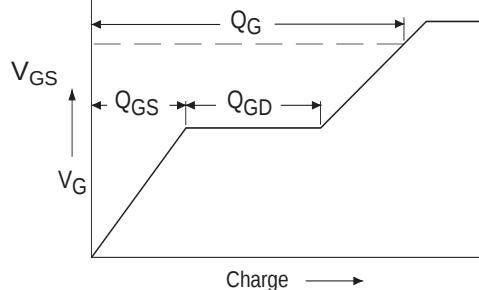
International  
**IR** Rectifier



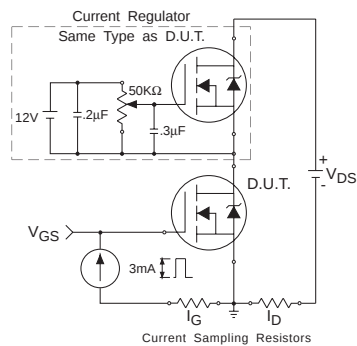
**Fig 12a.** Unclamped Inductive Test Circuit



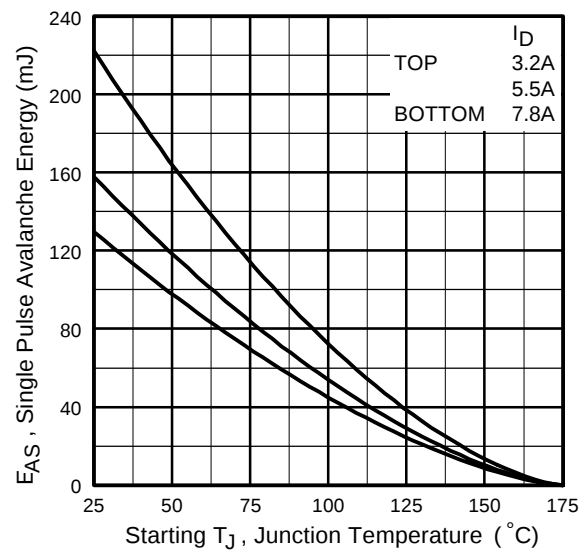
**Fig 12b.** Unclamped Inductive Waveforms



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

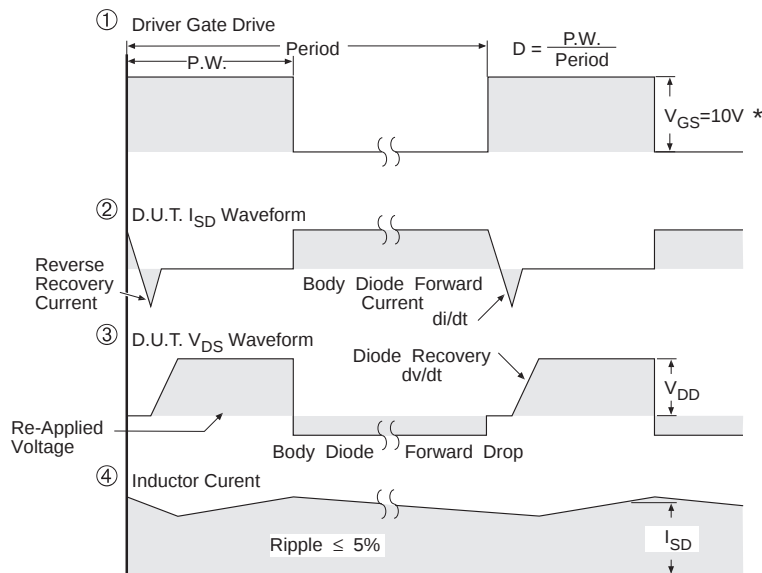
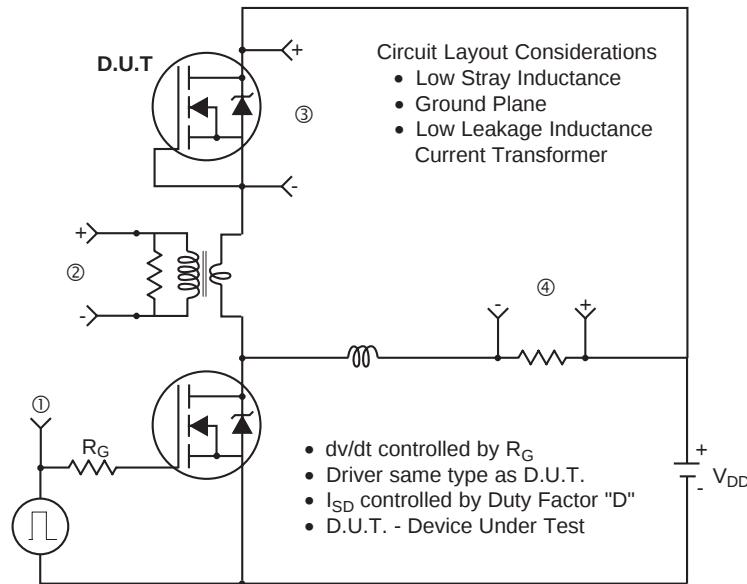


**Fig 13b.** Gate Charge Test Circuit



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

### Peak Diode Recovery dv/dt Test Circuit



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

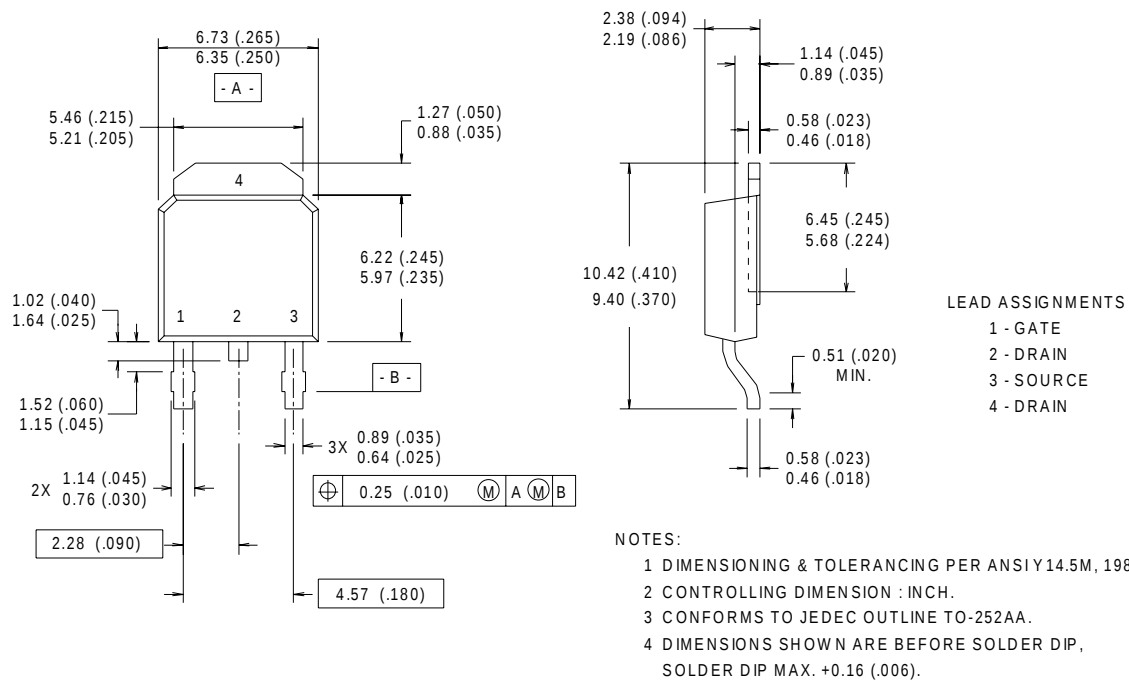
**Fig 14.** For N-Channel HEXFET® Power MOSFETs

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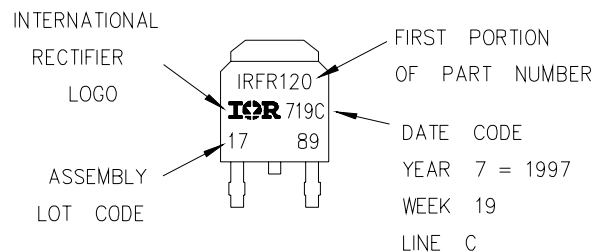
## D-Pak (TO-252AA) Package Outline

Dimensions are shown in millimeters (inches)

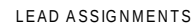


## D-Pak (TO-252AA) Part Marking Information

EXAMPLE: THIS IS AN IRFR120  
LOT CODE 1789  
ASSEMBLED ON WW 19, 1997  
IN THE ASSEMBLY LINE "C"

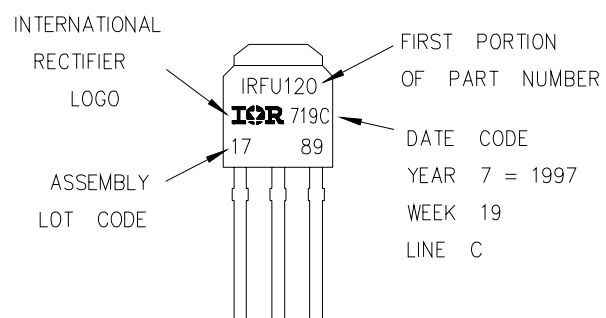


Dimensions are shown in millimeters (inches)



- 1 - GATE  
2 - DRAIN  
3 - SOURCE  
4 - DRAIN

EXAMPLE: THIS IS AN IRFU120  
LOT CODE 1789  
ASSEMBLED ON WW 19, 1997  
IN THE ASSEMBLY LINE "C"

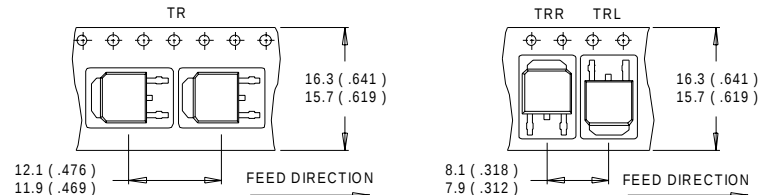


# IRFR13N20D/IRFU13N20D

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**IR** Rectifier

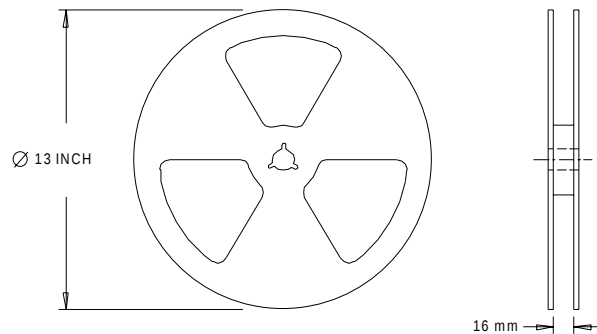
## D-Pak (TO-252AA) Tape & Reel Information

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. OUTLINE CONFORMS TO EIA-481.

### Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature.
  - ② Starting  $T_J = 25^\circ\text{C}$ ,  $L = 4.3\text{mH}$ ,  $R_G = 25\Omega$ ,  $I_{AS} = 7.8\text{A}$ .
  - ③  $I_{SD} \leq 7.8\text{A}$ ,  $di/dt \leq 81\text{A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_J \leq 175^\circ\text{C}$ .
  - 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%  $V_{DSS}$ .
- \* When mounted on 1" square PCB (FR-4 or G-10 Material).  
For recommended footprint and soldering techniques refer to application note #AN-994.

International  
**IR** Rectifier

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*Data and specifications subject to change without notice. 2/2000*

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