

**SMPS MOSFET**

IRFB38N20DPbF  
IRFS38N20DPbF  
IRFSL38N20DPbF

HEXFET® Power MOSFET

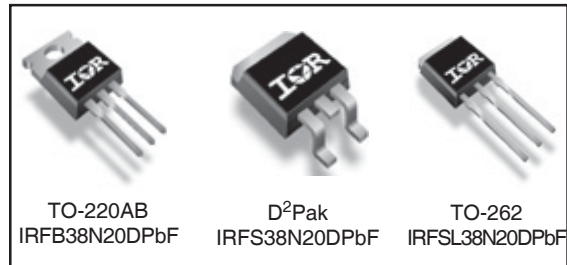
**Applications**

- High frequency DC-DC converters
- Plasma Display Panel
- Lead-Free

**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

| Key Parameters            |     |    |
|---------------------------|-----|----|
| $V_{DS}$                  | 200 | V  |
| $V_{DS}$ (Avalanche) min. | 260 | V  |
| $R_{DS(ON)}$ max @ 10V    | 54  | mΩ |
| $T_J$ max                 | 175 | °C |



**Absolute Maximum Ratings**

|                                   | Parameter                                  | Max.                   | Units |
|-----------------------------------|--|------------------------|-------|
| $I_D$ @ $T_C = 25^\circ\text{C}$  | Continuous Drain Current, $V_{GS}$ @ 10V ⑦ | 38*                    | A     |
| $I_D$ @ $T_C = 100^\circ\text{C}$ | Continuous Drain Current, $V_{GS}$ @ 10V ⑦ | 27*                    |       |
| $I_{DM}$                          | Pulsed Drain Current ①                     | 180                    |       |
| $P_D$ @ $T_A = 25^\circ\text{C}$  | Power Dissipation ⑦                        | 3.8                    | W     |
| $P_D$ @ $T_C = 25^\circ\text{C}$  | Power Dissipation ⑦                        | 230*                   |       |
|                                   | Linear Derating Factor ⑦                   | 1.5*                   | W/°C  |
| $V_{GS}$                          | Gate-to-Source Voltage                     | ± 30                   | V     |
| dv/dt                             | Peak Diode Recovery dv/dt ③                | 9.5                    | V/ns  |
| $T_J$                             | Operating Junction and                     | -55 to + 175           | °C    |
| $T_{STG}$                         | Storage Temperature Range                  |                        |       |
|                                   | Soldering Temperature, for 10 seconds      | 300 (1.6mm from case ) |       |
|                                   | Mounting torque, 6-32 or M3 screw⑥         | 10 lbf•in (1.1N•m)     |       |

**Thermal Resistance**

|                 | Parameter                             | Typ. | Max.  | Units |
|-----------------|---------------------------------------|------|-------|-------|
| $R_{\theta JC}$ | Junction-to-Case                      | —    | 0.47* | °C/W  |
| $R_{\theta CS}$ | Case-to-Sink, Flat, Greased Surface ⑧ | 0.50 | —     |       |
| $R_{\theta JA}$ | Junction-to-Ambient⑧                  | —    | 62    |       |
| $R_{\theta JA}$ | Junction-to-Ambient⑦                  | —    | 40    |       |

\*  $R_{\theta JC}$  (end of life) for D²Pak and TO-262 = 0.50°C/W. This is the maximum measured value after 1000 temperature cycles from -55 to 150°C and is accounted for by the physical wearout of the die attach medium.

Notes ① through ⑧ are on page 11

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**Static @ T<sub>J</sub> = 25°C (unless otherwise specified)**

|  | Parameter                            | Min. | Typ. | Max.  | Units | Conditions   |
|--|--------------------------------------|------|------|-------|-------|--|
| V <sub>(BR)DSS</sub>                   | Drain-to-Source Breakdown Voltage    | 200  | —    | —     | V     | V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA                         |
| ΔV <sub>(BR)DSS</sub> /ΔT <sub>J</sub> | Breakdown Voltage Temp. Coefficient  | —    | 0.22 | —     | V/°C  | Reference to 25°C, I <sub>D</sub> = 1mA                              |
| R <sub>DS(on)</sub>                    | Static Drain-to-Source On-Resistance | —    | —    | 0.054 | Ω     | V <sub>GS</sub> = 10V, I <sub>D</sub> = 26A ④                        |
| V <sub>GS(th)</sub>                    | Gate Threshold Voltage               | 3.0  | —    | 5.0   | V     | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250μA           |
| I <sub>DSS</sub>                       | Drain-to-Source Leakage Current      | —    | —    | 25    | μA    | V <sub>DS</sub> = 200V, V <sub>GS</sub> = 0V                         |
|  |                                      | —    | —    | 250   |       | V <sub>DS</sub> = 160V, V <sub>GS</sub> = 0V, T <sub>J</sub> = 150°C |
| I <sub>GSS</sub>                       | Gate-to-Source Forward Leakage       | —    | —    | 100   | nA    | V <sub>GS</sub> = 30V  |
|  | Gate-to-Source Reverse Leakage       | —    | —    | -100  |       | V <sub>GS</sub> = -30V   |

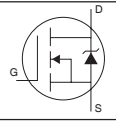
**Dynamic @ T<sub>J</sub> = 25°C (unless otherwise specified)**

|                       | Parameter                       | Min. | Typ. | Max. | Units | Conditions   |
|-----------------------|---------------------------------|------|------|------|-------|--|
| g <sub>fs</sub>       | Forward Transconductance        | 17   | —    | —    | S     | V <sub>DS</sub> = 50V, I <sub>D</sub> = 26A              |
| Q <sub>g</sub>        | Total Gate Charge               | —    | 60   | 91   | nC    | I <sub>D</sub> = 26A                                     |
| Q <sub>gs</sub>       | Gate-to-Source Charge           | —    | 17   | 25   |       | V <sub>DS</sub> = 100V                                   |
| Q <sub>gd</sub>       | Gate-to-Drain ("Miller") Charge | —    | 28   | 42   |       | V <sub>GS</sub> = 10V, ④                                 |
| t <sub>d(on)</sub>    | Turn-On Delay Time              | —    | 16   | —    | ns    | V <sub>DD</sub> = 100V                                   |
| t <sub>r</sub>        | Rise Time                       | —    | 95   | —    |       | I <sub>D</sub> = 26A                                     |
| t <sub>d(off)</sub>   | Turn-Off Delay Time             | —    | 29   | —    |       | R <sub>G</sub> = 2.5Ω                                    |
| t <sub>f</sub>        | Fall Time                       | —    | 47   | —    |       | V <sub>GS</sub> = 10V ④                                  |
| C <sub>iss</sub>      | Input Capacitance               | —    | 2900 | —    | pF    | V <sub>GS</sub> = 0V                                     |
| C <sub>oss</sub>      | Output Capacitance              | —    | 450  | —    |       | V <sub>DS</sub> = 25V                                    |
| C <sub>rss</sub>      | Reverse Transfer Capacitance    | —    | 73   | —    |       | f = 1.0MHz   |
| C <sub>oss</sub>      | Output Capacitance              | —    | 3550 | —    |       | V <sub>GS</sub> = 0V, V <sub>DS</sub> = 1.0V, f = 1.0MHz |
| C <sub>oss</sub>      | Output Capacitance              | —    | 180  | —    |       | V <sub>GS</sub> = 0V, V <sub>DS</sub> = 160V, f = 1.0MHz |
| C <sub>oss eff.</sub> | Effective Output Capacitance    | —    | 380  | —    |       | V <sub>GS</sub> = 0V, V <sub>DS</sub> = 0V to 160V ⑤     |
|                       |                                 | —    | —    | —    |       |  |

**Avalanche Characteristics**

|                             | Parameter                        | Min. | Typ. | Max. | Units |
|-----------------------------|----------------------------------|------|------|------|-------|
| E <sub>AS</sub>             | Single Pulse Avalanche Energy ②⑥ | —    | —    | 460  | mJ    |
| I <sub>AR</sub>             | Avalanche Current ①              | —    | —    | 26   | A     |
| E <sub>AR</sub>             | Repetitive Avalanche Energy ①    | —    | 390  | —    | mJ    |
| V <sub>DS (Avalanche)</sub> | Repetitive Avalanche Voltage ①   | 260  | —    | —    | V     |

**Diode Characteristics**

|                 | Parameter                              | Min.   | Typ. | Max. | Units | Conditions   |
|-----------------|--|--|------|------|-------|--|
| I <sub>S</sub>  | Continuous Source Current (Body Diode) | —  | —    | 44   | A     | MOSFET symbol showing the integral reverse p-n junction diode.  |
| I <sub>SM</sub> | Pulsed Source Current (Body Diode) ①⑥  | —  | —    | 180  |       |  |
| V <sub>SD</sub> | Diode Forward Voltage                  | —  | —    | 1.5  | V     | T <sub>J</sub> = 25°C, I <sub>S</sub> = 26A, V <sub>GS</sub> = 0V ④  |
| t <sub>rr</sub> | Reverse Recovery Time                  | —  | 160  | 240  | nS    | T <sub>J</sub> = 25°C, I <sub>F</sub> = 26A  |
| Q <sub>rr</sub> | Reverse Recovery Charge                | —  | 1.3  | 2.0  | μC    | di/dt = 100A/μs ④  |
| 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> ) |      |      |       |  |

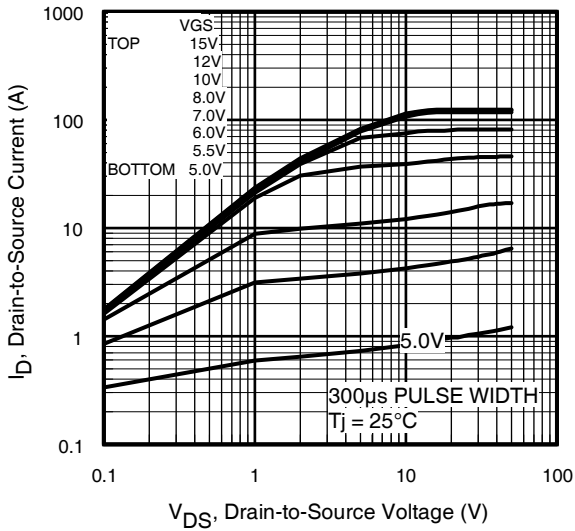


Fig 1. Typical Output Characteristics

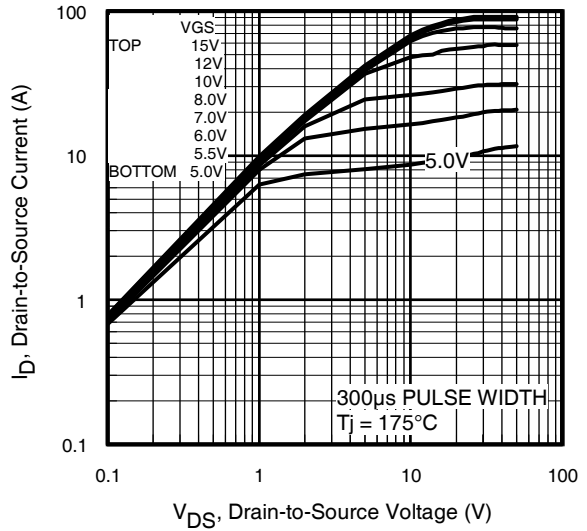


Fig 2. Typical Output Characteristics

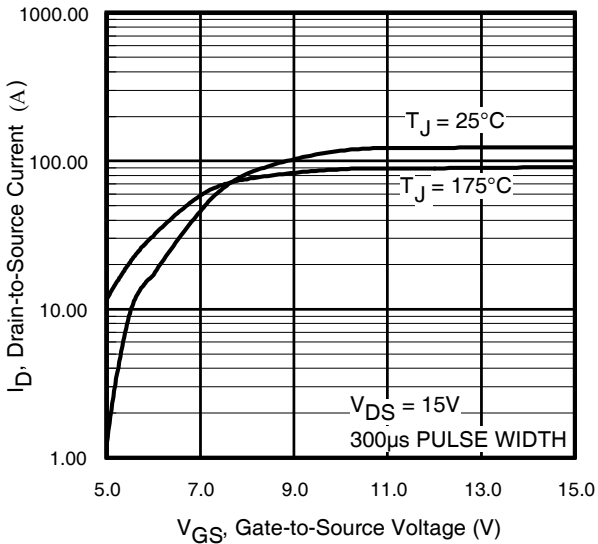


Fig 3. Typical Transfer Characteristics

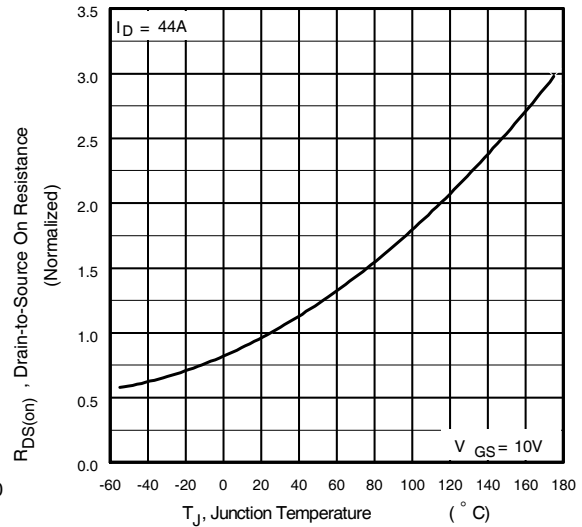
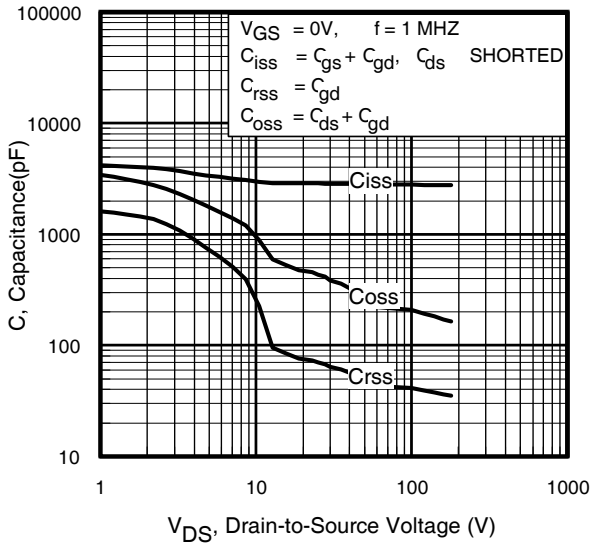
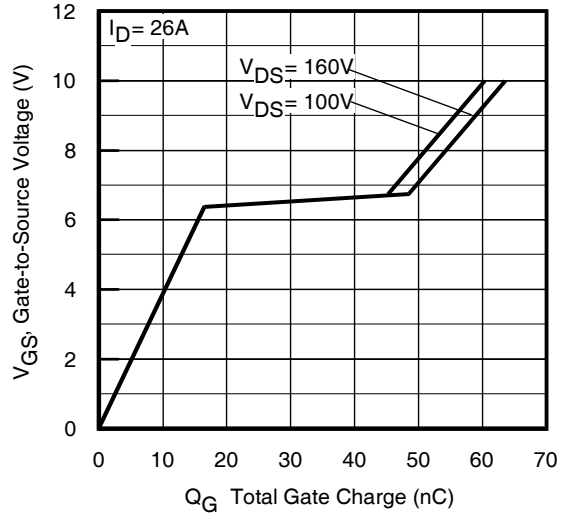


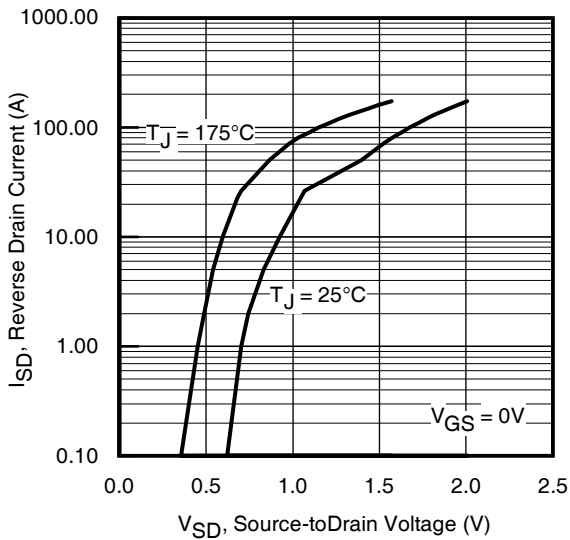
Fig 4. Normalized On-Resistance Vs. Temperature



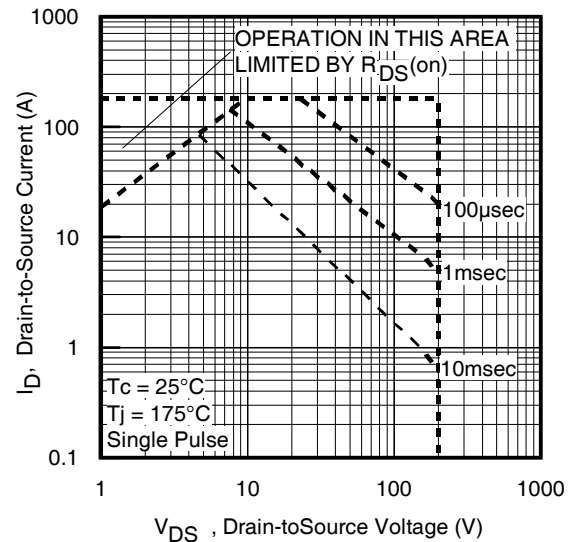
**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage



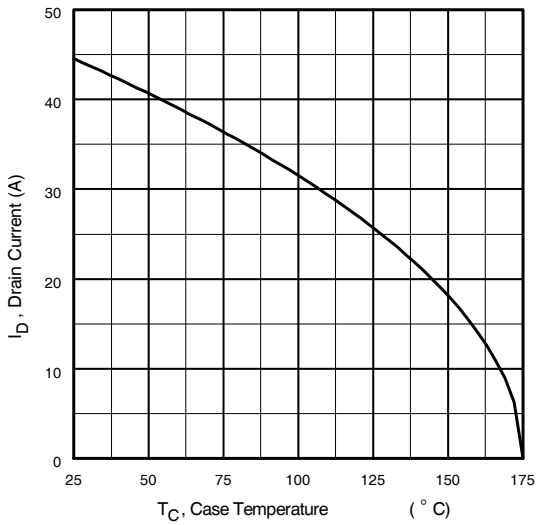
**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage



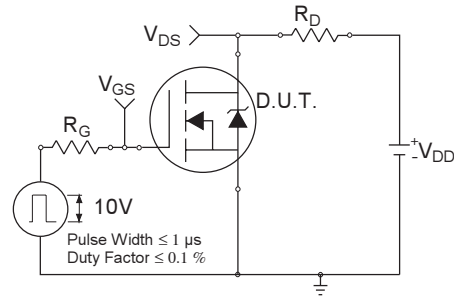
**Fig 7.** Typical Source-Drain Diode Forward Voltage



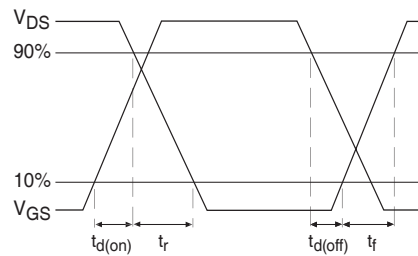
**Fig 8.** Maximum Safe Operating Area



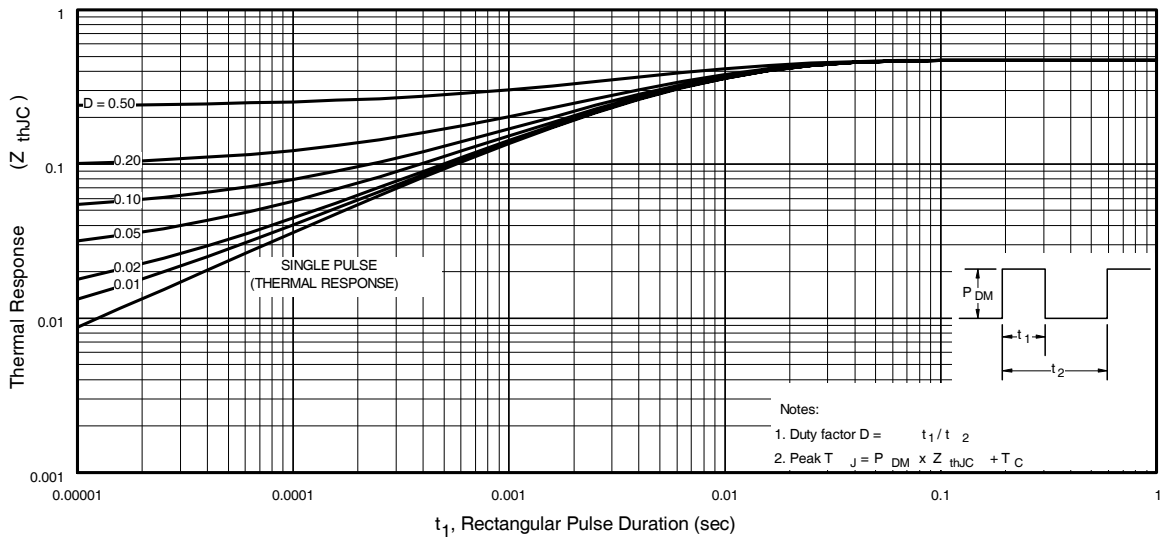
**Fig 9.** Maximum Drain Current Vs. Case Temperature



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



**Fig 10b.** Switching Time Waveforms



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

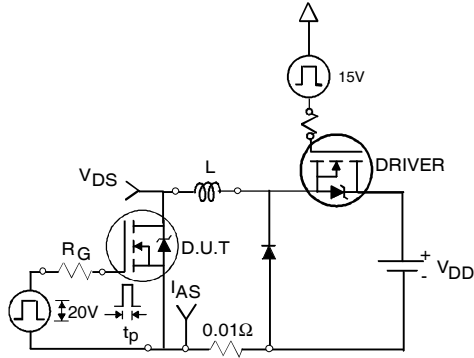


Fig 12a. Unclamped Inductive Test Circuit

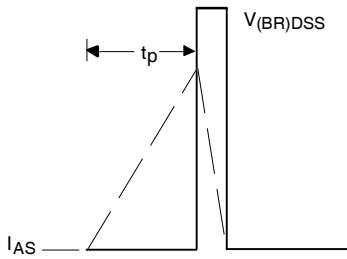


Fig 12b. Unclamped Inductive Waveforms

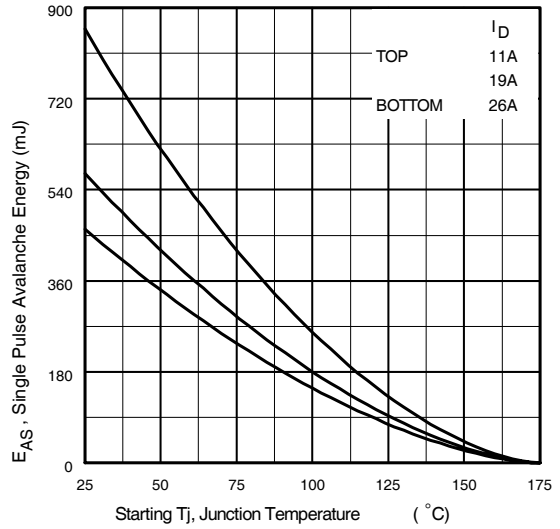


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

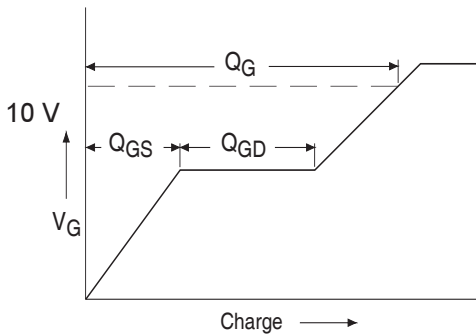


Fig 13a. Basic Gate Charge Waveform

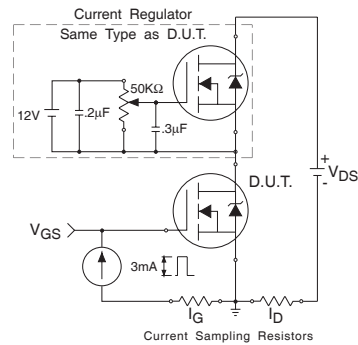
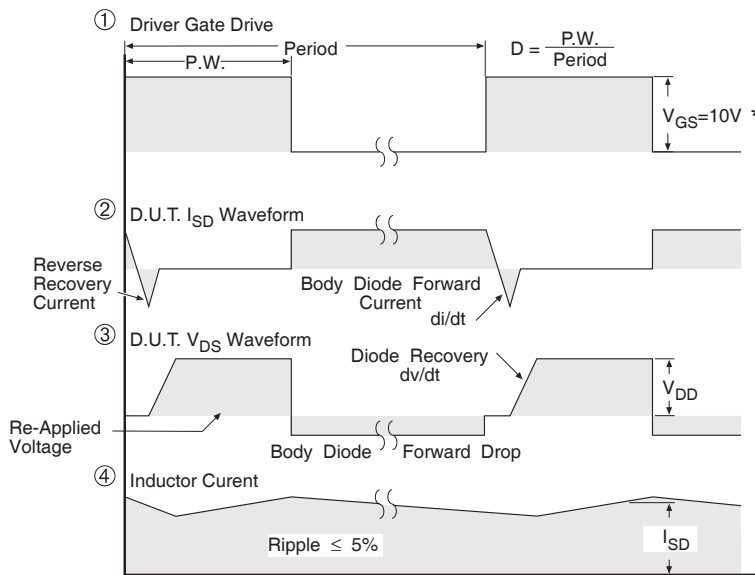
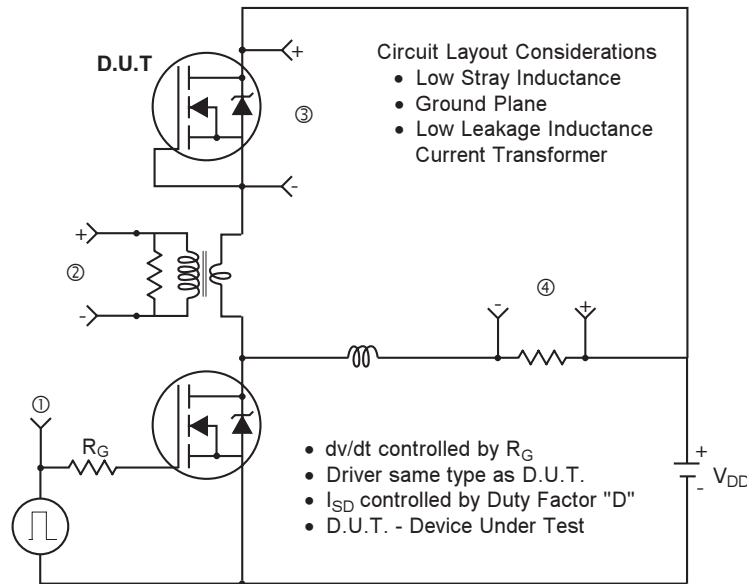


Fig 13b. Gate Charge Test Circuit

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



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

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

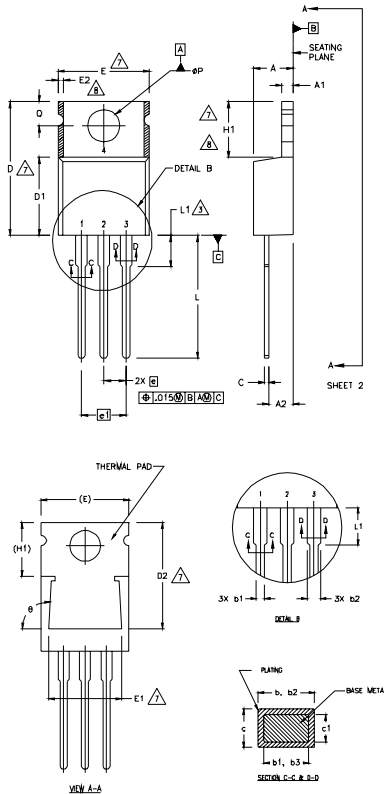
PROVISIONAL

IRFB38N20DPbF/IRFS38N20DPbF/IRFSL38N20DPbF



TO-220AB Package Outline

Dimensions are shown in millimeters (inches)



- NOTES:
- 1 DIMENSIONING AND TOLERANCING PER ASME Y14.5 M- 1994.
  - 2 DIMENSIONS ARE SHOWN IN INCHES (MILLIMETERS).
  - 3 LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
  - 4 DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .025" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
  - 5 DIMENSION b1 & c1 APPLY TO BASE METAL ONLY.
  - 6 CONTROLLING DIMENSION : INCHES.
  - 7 THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS E,H1,D2 & E1 AND SINGULATION IRREGULARITIES ARE ALLOWED.

LEAD ASSIGNMENTS

DIODES

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

IGBTs, CoPACK

- 1- GATE
- 2- COLLECTOR
- 3- EMITTER

DIODES

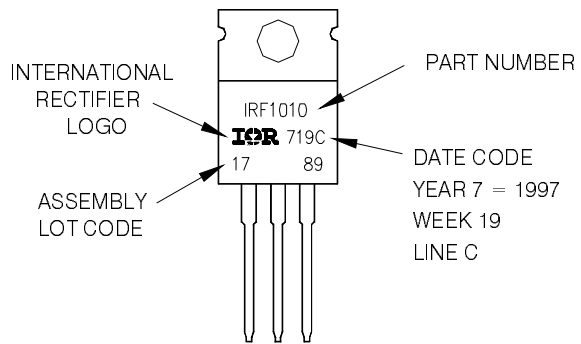
- 1- ANODE/OPEN
- 2- CATHODE
- 3- ANODE

| SYMBOL | DIMENSIONS  |       |          |      | NOTES |
|--------|-------------|-------|----------|------|-------|
|        | MILLIMETERS |       | INCHES   |      |       |
|        | MIN.        | MAX.  | MIN.     | MAX. |       |
| A      | 3.56        | 4.82  | .140     | .190 |       |
| A1     | 0.51        | 1.40  | .020     | .055 |       |
| A2     | 2.04        | 2.92  | .080     | .115 |       |
| b      | 0.38        | 1.01  | .015     | .040 |       |
| b1     | 0.38        | 0.96  | .015     | .038 | 5     |
| b2     | 1.15        | 1.77  | .045     | .070 |       |
| b3     | 1.15        | 1.73  | .045     | .068 |       |
| c      | 0.36        | 0.61  | .014     | .024 |       |
| c1     | 0.36        | 0.56  | .014     | .022 | 5     |
| D      | 14.22       | 16.51 | .560     | .650 | 4     |
| D1     | 8.38        | 9.02  | .330     | .355 |       |
| D2     | 12.19       | 12.88 | .480     | .507 | 7     |
| E      | 9.66        | 10.66 | .380     | .420 | 4,7   |
| E1     | 8.38        | 8.89  | .330     | .350 | 7     |
| e      | 2.54 BSC    |       | .100 BSC |      |       |
| e1     | 5.08        |       | .200 BSC |      |       |
| H1     | 5.85        | 6.55  | .230     | .270 | 7,8   |
| L      | 12.70       | 14.73 | .500     | .580 |       |
| L1     | -           | 6.35  | -        | .250 | 3     |
| phi P  | 3.54        | 4.08  | .139     | .161 |       |
| Q      | 2.54        | 3.42  | .100     | .135 |       |
| phi    | 90°-93°     |       | 90°-93°  |      |       |

TO-220AB Part Marking Information

EXAMPLE: THIS IS AN IRF1010  
 LOT CODE 1789  
 ASSEMBLED ON WW 19, 1997  
 IN THE ASSEMBLY LINE "C"

Note: "P" in assembly line position indicates "Lead - Free"





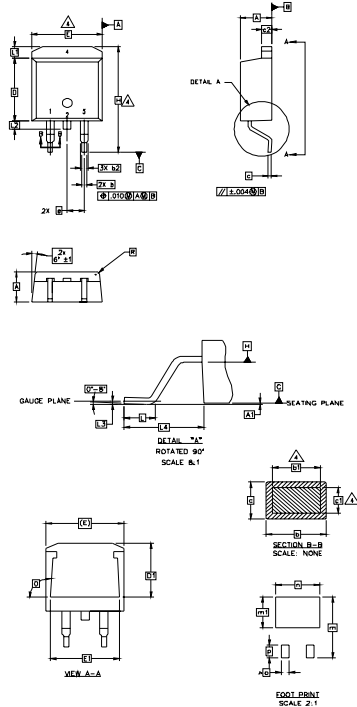
PROVISIONAL

International  
**IR** Rectifier

# IRFB38N20DPbF/IRFS38N20DPbF/IRFSL38N20DPbF

## D<sup>2</sup>Pak Package Outline

Dimensions are shown in millimeters (inches)



**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS (INCHES).
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
4. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
5. CONTROLLING DIMENSION: INCH.

| SYMBOL | DIMENSIONS  |       |        |      | NOTES |
|--------|-------------|-------|--------|------|-------|
|        | MILLIMETERS |       | INCHES |      |       |
|        | MIN.        | MAX.  | MIN.   | MAX. |       |
| A      | 4.06        | 4.83  | .160   | .190 | 4     |
| A1     | 0.00        | 0.254 | .000   | .010 |       |
| b      | 0.51        | 0.99  | .020   | .039 |       |
| b1     | 0.51        | 0.89  | .020   | .035 |       |
| b2     | 1.14        | 1.78  | .045   | .070 |       |
| c      | 0.38        | 0.74  | .015   | .029 |       |
| c1     | 0.38        | 0.58  | .015   | .023 |       |
| c2     | 1.14        | 1.65  | .045   | .065 |       |
| D      | 8.51        | 9.65  | .335   | .380 |       |
| D1     | 6.86        |       | .270   |      |       |
| E      | 9.65        | 10.67 | .380   | .420 |       |
| E1     | 6.22        |       | .245   |      |       |
| e      | 2.54        | BSC   | .100   | BSC  |       |
| H      | 14.61       | 15.88 | .575   | .625 | 3     |
| L      | 1.78        | 2.79  | .070   | .110 |       |
| L1     |             | 1.65  | .065   | .070 |       |
| L2     | 1.27        | 1.78  | .050   | .070 | 4     |
| L3     | 0.25        | BSC   | .010   | BSC  |       |
| L4     | 4.78        | 5.28  | .188   | .208 |       |
| m      | 17.78       |       | .700   |      | 3     |
| m1     | 8.89        |       | .350   |      |       |
| n      | 11.43       |       | .450   |      | 3     |
| o      | 2.08        |       | .082   |      |       |
| p      | 3.81        |       | .150   |      | 3     |
| R      | 0.51        | 0.71  | .020   | .028 |       |
| θ      | 90°         | 93°   | 90°    | 93°  |       |

**LEAD ASSIGNMENTS**

**HEXFET**

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

**IGBTs, CoPACK**

- 1.- GATE
- 2, 4.- COLLECTOR
- 3.- EMITTER

**DIODES**

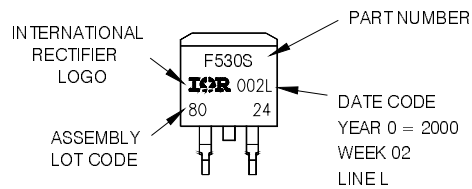
- 1.- ANODE \*
- 2, 4.- CATHODE
- 3.- ANODE

\* PART DEPENDENT.

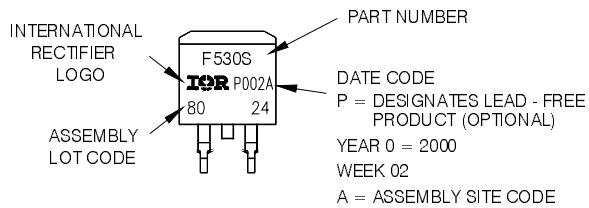
## D<sup>2</sup>Pak Part Marking Information

EXAMPLE: THIS IS AN IRF530S WITH  
LOT CODE 8024  
ASSEMBLED ON WW 02, 2000  
IN THE ASSEMBLY LINE 'L'

Note: "P" in assembly line position  
indicates "Lead - Free"



OR



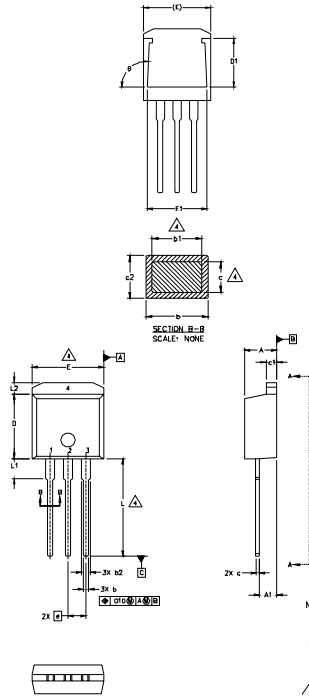
PROVISIONAL

IRFB38N20DPbF/IRFS38N20DPbF/IRFSL38N20DPbF

International  
**IR** Rectifier

TO-262 Package Outline

Dimensions are shown in millimeters (inches)



| SYMBOL | DIMENSIONS  |       |          |      | NOTES |
|--------|-------------|-------|----------|------|-------|
|        | MILLIMETERS |       | INCHES   |      |       |
|        | MIN.        | MAX.  | MIN.     | MAX. |       |
| A      | 4.06        | 4.83  | .160     | .190 |       |
| A1     | 2.03        | 2.92  | .080     | .115 |       |
| b      | 0.51        | 0.99  | .020     | .039 |       |
| b1     | 0.51        | 0.89  | .020     | .035 | 4     |
| b2     | 1.14        | 1.40  | .045     | .055 |       |
| c      | 0.38        | 0.63  | .015     | .025 | 4     |
| c1     | 1.14        | 1.40  | .045     | .055 |       |
| c2     | 0.43        | .063  | .017     | .029 |       |
| D      | 8.51        | 9.65  | .335     | .380 | 3     |
| D1     | 5.33        |       | .210     |      |       |
| E      | 9.65        | 10.67 | .380     | .420 | 3     |
| E1     | 6.22        |       | .245     |      |       |
| e      | 2.54 BSC    |       | .100 BSC |      |       |
| L      | 13.46       | 14.09 | .530     | .555 |       |
| L1     | 3.56        | 3.71  | .140     | .146 |       |
| L2     |             | 1.65  |          | .065 |       |

LEAD ASSIGNMENTS

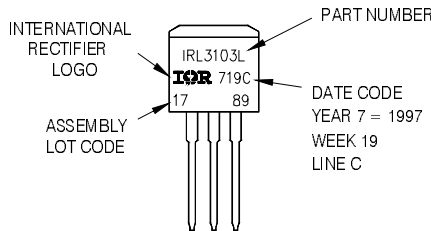
HEXFET — IGBT  
 1. — GATE  
 2. — DRAIN  
 3. — SOURCE  
 4. — DRAIN  
 1- GATE

- NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
  2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES]
  3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [0.005] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
  4. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
  5. CONTROLLING DIMENSION: INCH.

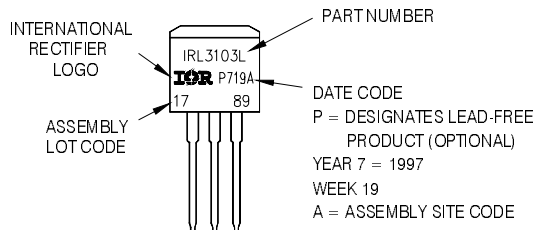
TO-262 Part Marking Information

EXAMPLE: THIS IS AN IRL3103L  
 LOT CODE 1789  
 ASSEMBLED ON WW 19, 1997  
 IN THE ASSEMBLY LINE 'C'

Note: "P" in assembly line position indicates "Lead - Free"



OR

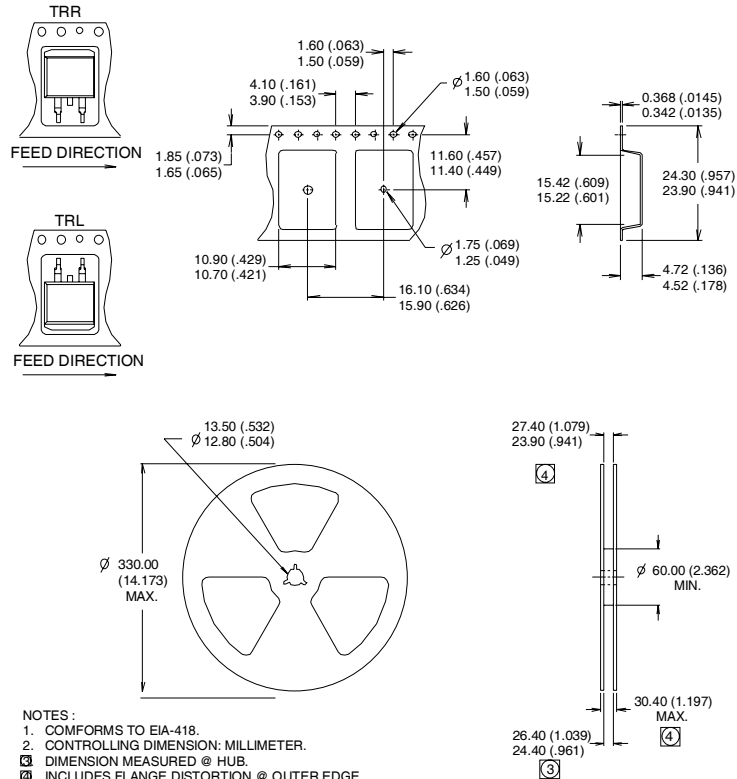


PROVISIONAL

International  
**IR** Rectifier

IRFB38N20DPbF/IRFS38N20DPbF/IRFSL38N20DPbF

## D<sup>2</sup>Pak Tape & Reel Information



### Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature.
- ② Starting  $T_J = 25^\circ\text{C}$ ,  $L = 1.3\text{mH}$   
 $R_G = 25\Omega$ ,  $I_{AS} = 26\text{A}$ .
- ③  $I_{SD} \leq 26\text{A}$ ,  $di/dt \leq 390\text{A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  
 $T_J \leq 175^\circ\text{C}$ .
- 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 This is only applied to TO-220AB package.
- ⑦ This is applied to D<sup>2</sup>Pak, when mounted on 1" square PCB (FR-4 or G-10 Material). For recommended footprint and soldering techniques refer to application note #AN-994.

**TO-220 package is not recommended for Surface Mount Application.**

Data and specifications subject to change without notice.  
 This product has been designed and qualified for the Automotive [Q101] (IRFB38N20DPbF),  
 & Industrial (IRFS38N20DPbF/IRFSL38N20D) market.  
 Qualification Standards can be found on IR's Web site.

International  
**IR** Rectifier

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