PD - 97001C

International
IOR Rectifier

# IRFB38N20DPbF
# IRFS38N20DPbF
# IRFSL38N20DPbF

HEXFET® Power MOSFET

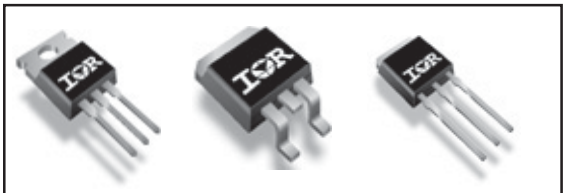
### Applications

- High frequency DC-DC converters
- Plasma Display Panel

### 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
- Lead-Free

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



TO-220AB IRFB38N20DPbF | D²Pak IRFS38N20DPbF | TO-262 IRFSL38N20DPbF

### Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---|---|---|---|
| $I_D$ @ $T_C$ = 25°C | Continuous Drain Current, $V_{GS}$ @ 10V ⑦ | 43* | A |
| $I_D$ @ $T_C$ = 100°C | Continuous Drain Current, $V_{GS}$ @ 10V ⑦ | 30* | |
| $I_{DM}$ | Pulsed Drain Current ① | 180 | |
| $P_D$ @$T_A$ = 25°C | Power Dissipation ⑦ | 3.8 | W |
| $P_D$ @$T_C$ = 25°C | Power Dissipation ⑦ | 300* | |
| | Linear Derating Factor ⑦ | 2.0* | 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 torqe, 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 ⑥ | 0.50 | — | |
| $R_{\theta JA}$ | Junction-to-Ambient⑥ | — | 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 ⑦ are on page 11

## Static @ $T_J$ = 25°C (unless otherwise specified)

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-to-Source Breakdown Voltage | 200 | — | — | V | $V_{GS}$ = 0V, $I_D$ = 250µA |
| $\Delta V_{(BR)DSS}/\Delta T_J$ | Breakdown Voltage Temp. Coefficient | — | 0.22 | — | V/°C | Reference to 25°C, $I_D$ = 1mA |
| $R_{DS(on)}$ | Static Drain-to-Source On-Resistance | — | — | 0.054 | Ω | $V_{GS}$ = 10V, $I_D$ = 26A ④ |
| $V_{GS(th)}$ | Gate Threshold Voltage | 3.0 | — | 5.0 | V | $V_{DS}$ = $V_{GS}$, $I_D$ = 250µA |
| $I_{DSS}$ | Drain-to-Source Leakage Current | — | — | 25 | µA | $V_{DS}$ = 200V, $V_{GS}$ = 0V |
| | | — | — | 250 | | $V_{DS}$ = 160V, $V_{GS}$ = 0V, $T_J$ = 150°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°C (unless otherwise specified)

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| $g_{fs}$ | Forward Transconductance | 17 | — | — | S | $V_{DS}$ = 50V, $I_D$ = 26A |
| $Q_g$ | Total Gate Charge | — | 60 | 91 | nC | $I_D$ = 26A |
| $Q_{gs}$ | Gate-to-Source Charge | — | 17 | 25 | | $V_{DS}$ = 100V |
| $Q_{gd}$ | Gate-to-Drain ("Miller") Charge | — | 28 | 42 | | $V_{GS}$ = 10V, ④ |
| $t_{d(on)}$ | Turn-On Delay Time | — | 16 | — | ns | $V_{DD}$ = 100V |
| $t_r$ | Rise Time | — | 95 | — | | $I_D$ = 26A |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 29 | — | | $R_G$ = 2.5Ω |
| $t_f$ | Fall Time | — | 47 | — | | $V_{GS}$ = 10V ④ |
| $C_{iss}$ | Input Capacitance | — | 2900 | — | pF | $V_{GS}$ = 0V |
| $C_{oss}$ | Output Capacitance | — | 450 | — | | $V_{DS}$ = 25V |
| $C_{rss}$ | Reverse Transfer Capacitance | — | 73 | — | | $f$ = 1.0MHz |
| $C_{oss}$ | Output Capacitance | — | 3550 | — | | $V_{GS}$ = 0V, $V_{DS}$ = 1.0V, $f$ = 1.0MHz |
| $C_{oss}$ | Output Capacitance | — | 180 | — | | $V_{GS}$ = 0V, $V_{DS}$ = 160V, $f$ = 1.0MHz |
| $C_{oss}$ eff. | Effective Output Capacitance | — | 380 | — | | $V_{GS}$ = 0V, $V_{DS}$ = 0V to 160V ⑤ |

## Avalanche Characteristics

| | Parameter | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $E_{AS}$ | Single Pulse Avalanche Energy②⑥ | — | — | 460 | mJ |
| $I_{AR}$ | Avalanche Current ① | — | — | 26 | A |
| $E_{AR}$ | Repetitive Avalanche Energy ① | — | 390 | — | mJ |
| $V_{DS\ (Avalanche)}$ | Repetitive Avalanche Voltage ① | 260 | — | — | V |

## Diode Characteristics

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| $I_S$ | Continuous Source Current (Body Diode) | — | — | 44 | A | MOSFET symbol showing the integral reverse p-n junction diode. |
| $I_{SM}$ | Pulsed Source Current (Body Diode) ①⑥ | — | — | 180 | | |
| $V_{SD}$ | Diode Forward Voltage | — | — | 1.5 | V | $T_J$ = 25°C, $I_S$ = 26A, $V_{GS}$ = 0V ④ |
| $t_{rr}$ | Reverse Recovery Time | — | 160 | 240 | nS | $T_J$ = 25°C, $I_F$ = 26A |
| $Q_{rr}$ | Reverse RecoveryCharge | — | 1.3 | 2.0 | µC | di/dt = 100A/µs ④ |
| $t_{on}$ | Forward Turn-On Time | Intrinsic turn-on time is negligible (turn-on is dominated by $L_S$+$L_D$) | | | | |

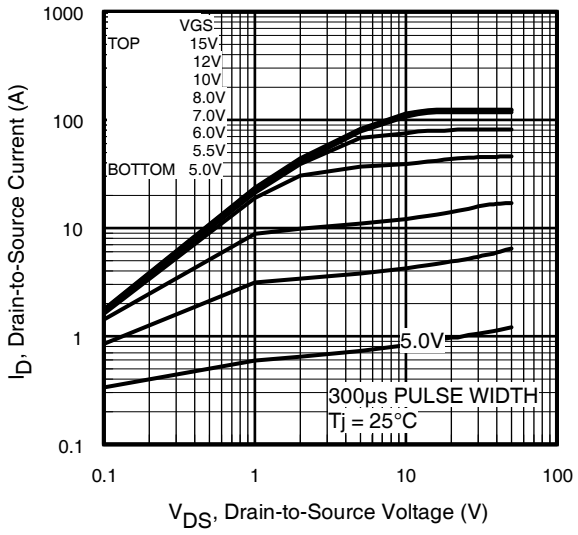



**Fig 1.** Typical Output Characteristics

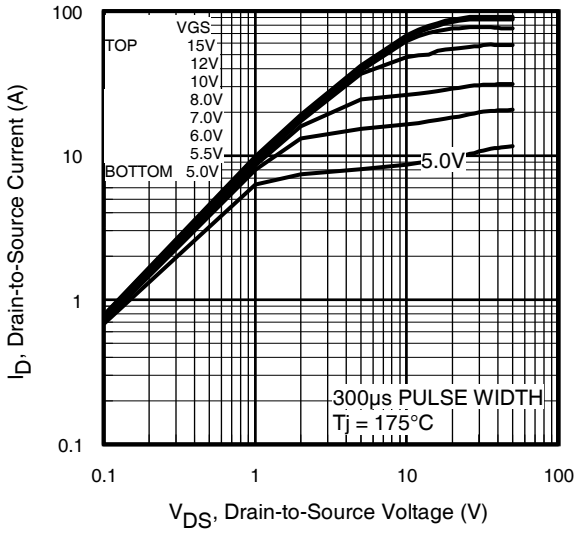



**Fig 2.** Typical Output Characteristics

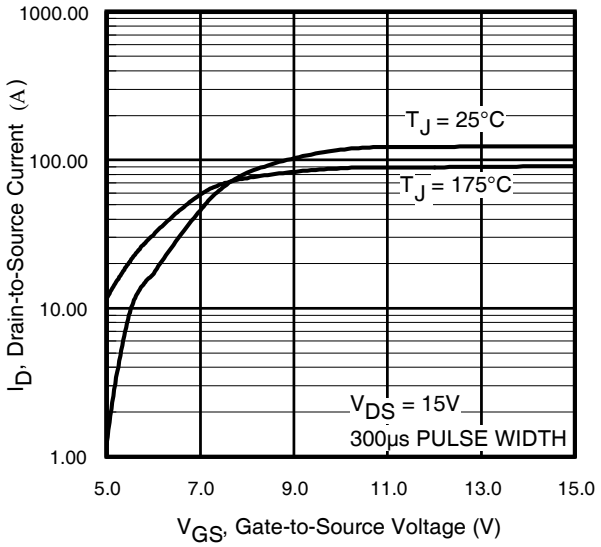



**Fig 3.** Typical Transfer Characteristics

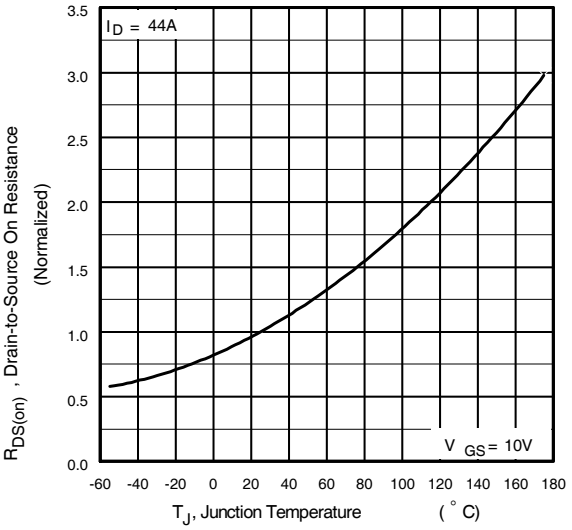



**Fig 4.** Normalized On-Resistance Vs. Temperature

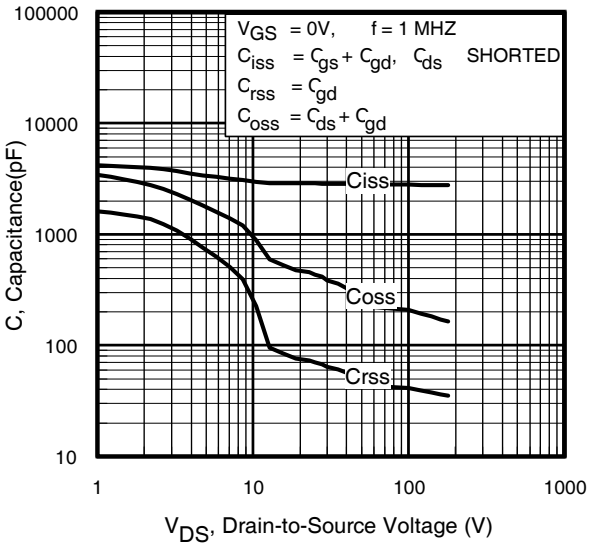



**Fig 5.** Typical Capacitance Vs. Drain-to-Source Voltage

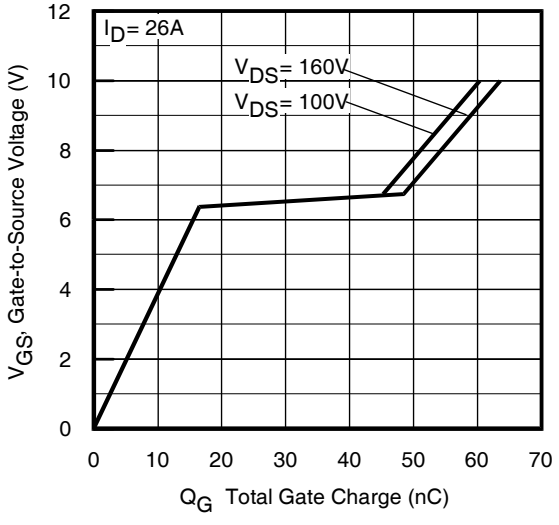



**Fig 6.** Typical Gate Charge Vs. Gate-to-Source Voltage

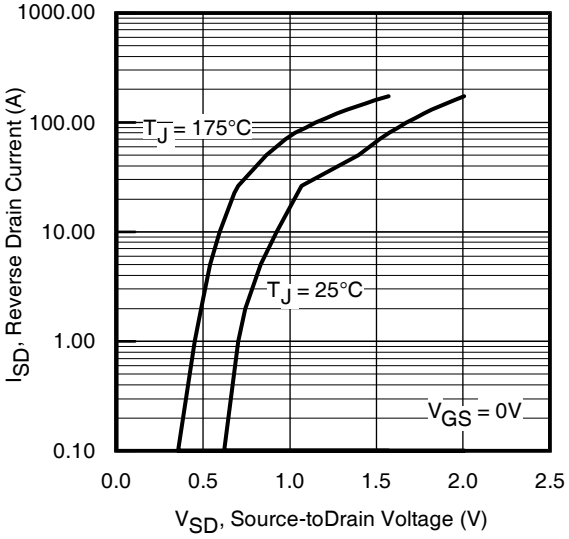



**Fig 7.** Typical Source-Drain Diode Forward Voltage

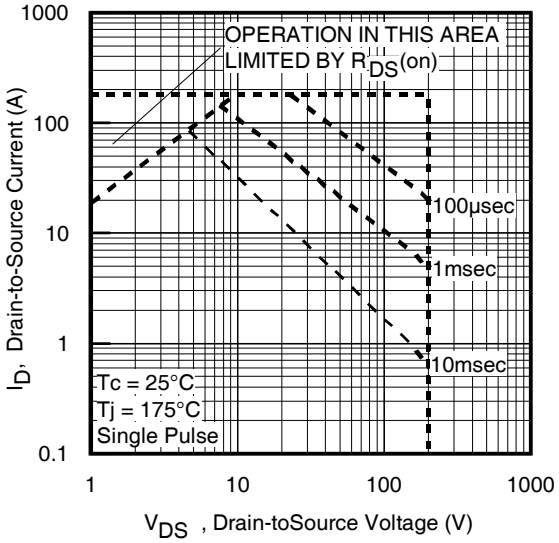



**Fig 8.** Maximum Safe Operating Area

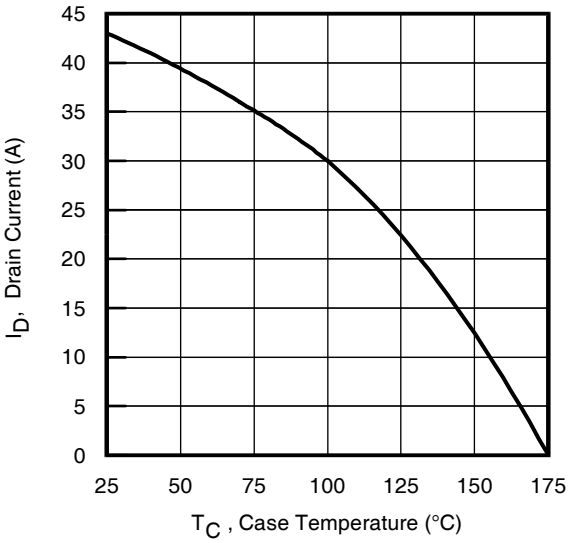



**Fig 9.** Maximum Drain Current Vs. Case Temperature

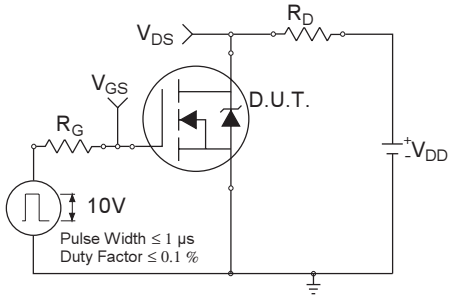



**Fig 10a.** Switching Time Test Circuit

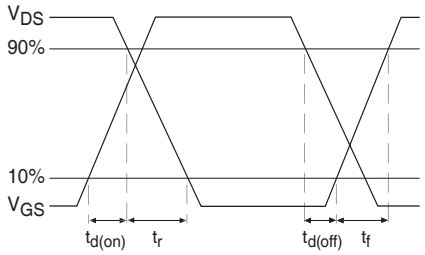



**Fig 10b.** Switching Time Waveforms

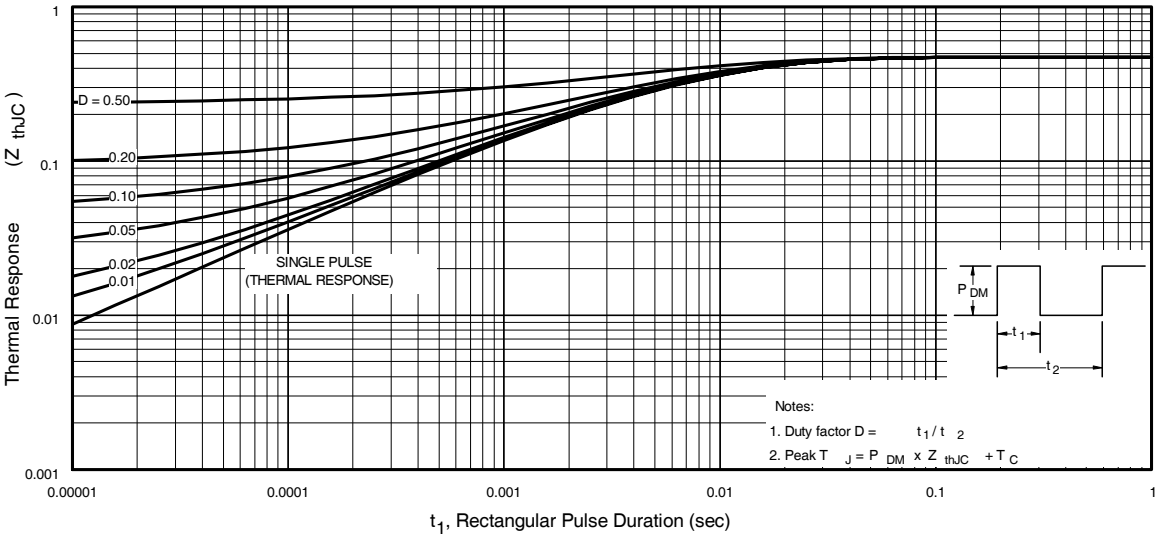



**Fig 11.** Maximum Effective Transient Thermal Impedance, Junction-to-Case

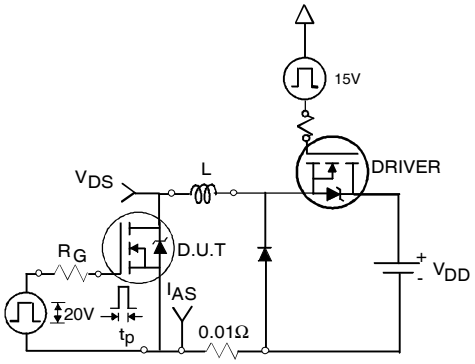



**Fig 12a.** Unclamped Inductive Test Circuit

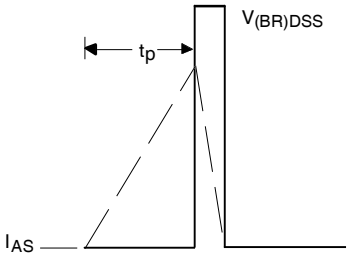



**Fig 12b.** Unclamped Inductive Waveforms

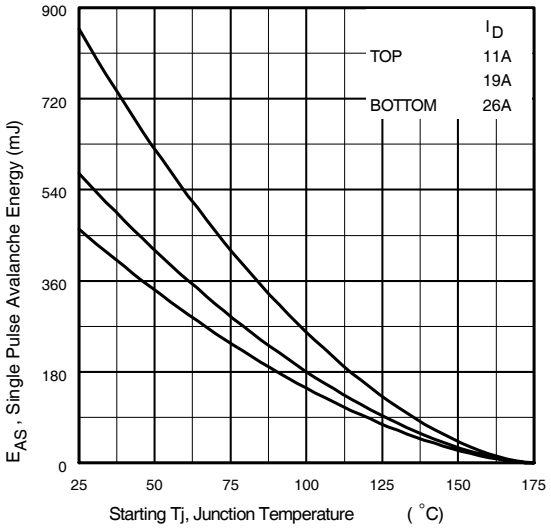



**Fig 12c.** Maximum Avalanche Energy Vs. Drain Current

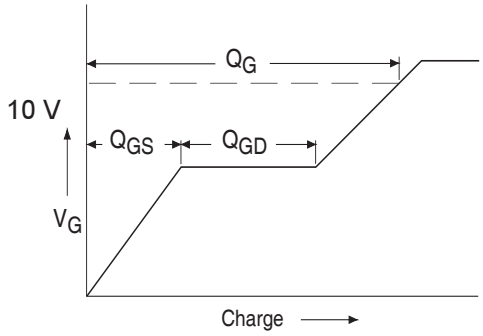



**Fig 13a.** Basic Gate Charge Waveform

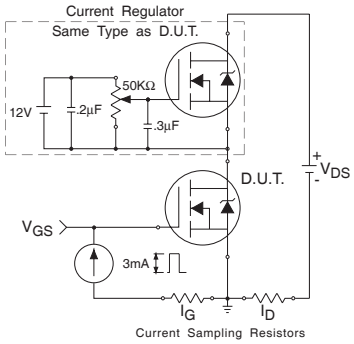
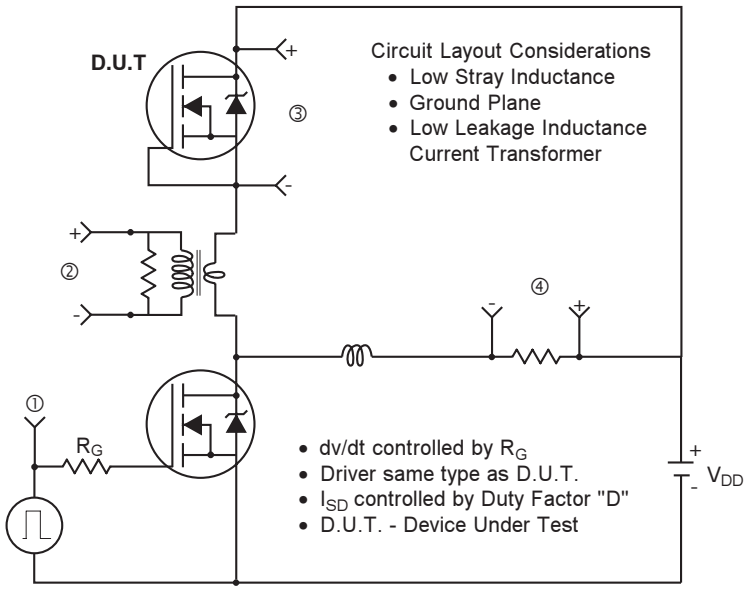
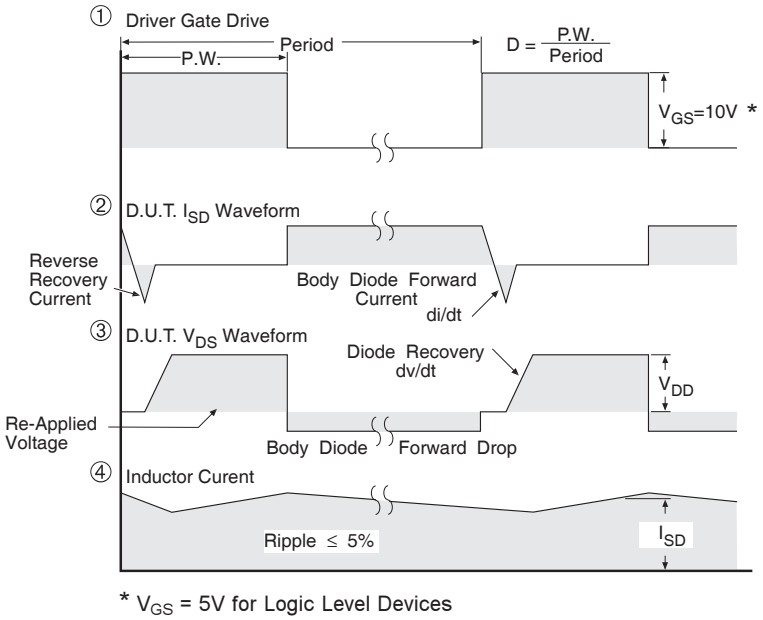



**Fig 13b.** Gate Charge Test Circuit

## Peak Diode Recovery dv/dt Test Circuit



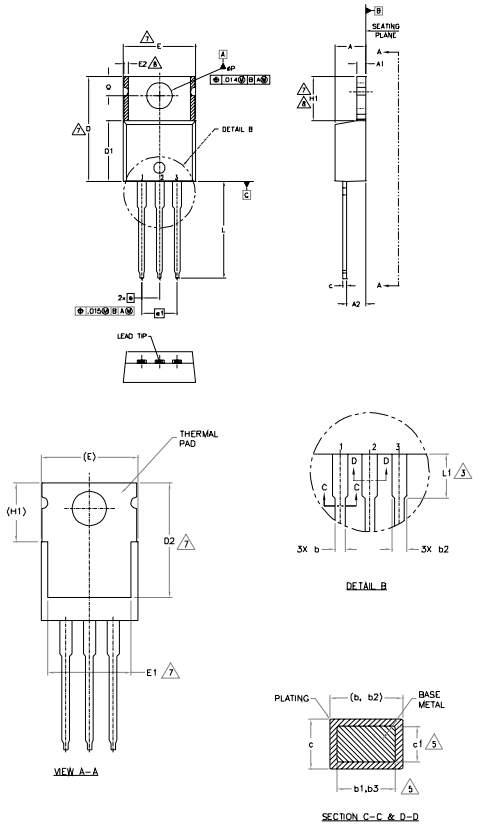

* $V_{GS}$ = 5V for Logic Level Devices

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

International
IOR Rectifier

# TO-220AB Package Outline

Dimensions are shown in millimeters (inches)




NOTES:

1.– DIMENSIONING AND TOLERANCING AS PER ASME Y14.5 M– 1994.
2.– DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
3.– LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
4.– DIMENSION D, D1 & 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.
5.– DIMENSION b1, b3 & c1 APPLY TO BASE METAL ONLY.
6.– CONTROLLING DIMENSION : INCHES.
7.– THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS E,H1,D2 & E1
8.– DIMENSION E2 X H1 DEFINE A ZONE WHERE STAMPING AND SINGULATION IRREGULARITIES ARE ALLOWED.
9.– OUTLINE CONFORMS TO JEDEC TO-220, EXCEPT A2 (max.) AND D2 (min.) WHERE DIMENSIONS ARE DERIVED FROM THE ACTUAL PACKAGE OUTLINE.

| SYMBOL | DIMENSIONS | | | | NOTES |
|---|---|---|---|---|---|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 3.56 | 4.83 | .140 | .190 | |
| A1 | 0.51 | 1.40 | .020 | .055 | |
| A2 | 2.03 | 2.92 | .080 | .115 | |
| b | 0.38 | 1.01 | .015 | .040 | |
| b1 | 0.38 | 0.97 | .015 | .038 | 5 |
| b2 | 1.14 | 1.78 | .045 | .070 | |
| b3 | 1.14 | 1.73 | .045 | .068 | 5 |
| 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 | 11.68 | 12.88 | .460 | .507 | 7 |
| E | 9.65 | 10.67 | .380 | .420 | 4,7 |
| E1 | 6.86 | 8.89 | .270 | .350 | 7 |
| E2 | – | 0.76 | – | .030 | 8 |
| e | 2.54 BSC | | .100 BSC | | |
| e1 | 5.08 BSC | | .200 BSC | | |
| H1 | 5.84 | 6.86 | .230 | .270 | 7,8 |
| L | 12.70 | 14.73 | .500 | .580 | |
| L1 | 3.56 | 4.06 | .140 | .160 | 3 |
| øP | 3.54 | 4.08 | .139 | .161 | |
| Q | 2.54 | 3.42 | .100 | .135 | |

LEAD ASSIGNMENTS

HEXFET
1.– GATE
2.– DRAIN
3.– SOURCE

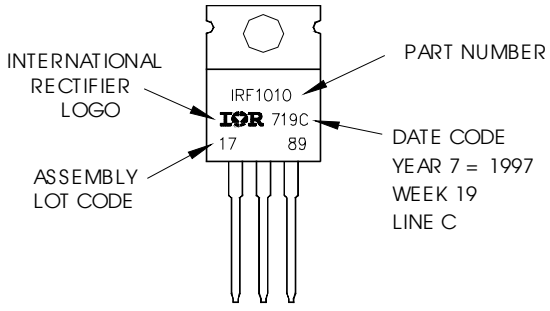
IGBTs, CoPACK
1.– GATE
2.– COLLECTOR
3.– EMITTER

DIODES
1.– ANODE
2.– CATHODE
3.– ANODE

# 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"




TO-220AB packages are not recommended for Surface Mount Application.

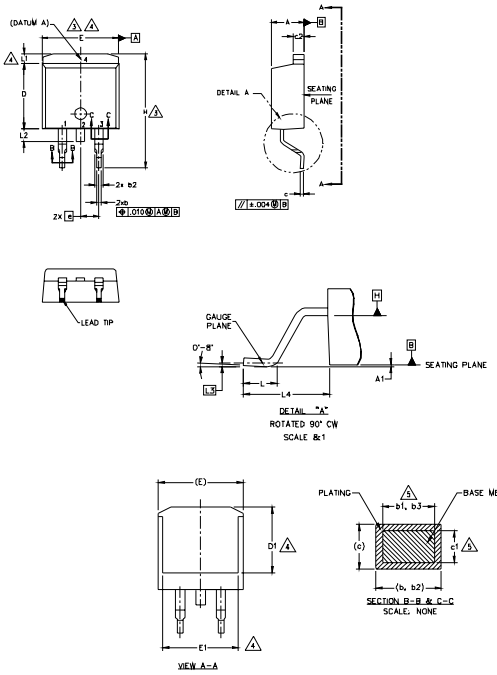
**Notes:**

**1. For an Automotive Qualified version of this part please see http://www.irf.com/product-info/auto/**

**2. For the most current drawing please refer to IR website at http://www.irf.com/package/**

# D²Pak 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 | 0.00 | 0.254 | .000 | .010 | |
| b | 0.51 | 0.99 | .020 | .039 | |
| b1 | 0.51 | 0.89 | .020 | .035 | 5 |
| b2 | 1.14 | 1.78 | .045 | .070 | |
| b3 | 1.14 | 1.73 | .045 | .068 | 5 |
| c | 0.38 | 0.74 | .015 | .029 | |
| c1 | 0.38 | 0.58 | .015 | .023 | 5 |
| c2 | 1.14 | 1.65 | .045 | .065 | |
| D | 8.38 | 9.65 | .330 | .380 | 3 |
| D1 | 6.86 | – | .270 | | 4 |
| E | 9.65 | 10.67 | .380 | .420 | 3,4 |
| E1 | 6.22 | – | .245 | | 4 |
| e | 2.54 BSC | | .100 BSC | | |
| H | 14.61 | 15.88 | .575 | .625 | |
| L | 1.78 | 2.79 | .070 | .110 | |
| L1 | – | 1.65 | – | .066 | 4 |
| L2 | – | 1.78 | – | .070 | |
| L3 | 0.25 BSC | | .010 BSC | | |
| L4 | 4.78 | 5.28 | .188 | .208 | |

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 AT DATUM H.
4. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.
5. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
6. DATUM A & B TO BE DETERMINED AT DATUM PLANE H.
7. CONTROLLING DIMENSION: INCH.
8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-263AB.

LEAD ASSIGNMENTS

DIODES

1.- ANODE (TWO DIE) / OPEN (ONE DIE)
2, 4.- CATHODE
3.- ANODE

HEXFET

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

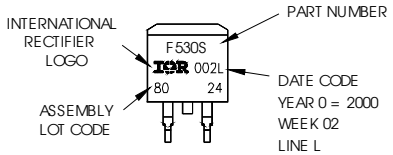
IGBTs, CoPACK

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

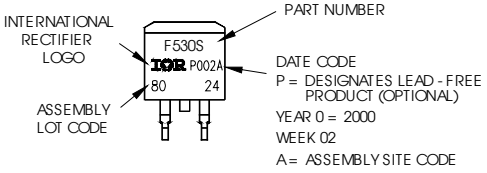
# D²Pak Part Marking Information

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




**Notes:**

**1. For an Automotive Qualified version of this part please see http://www.irf.com/product-info/auto/**

**2. For the most current drawing please refer to IR website at http://www.irf.com/package/**

# TO-262 Package Outline

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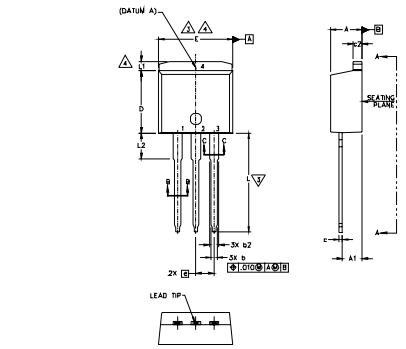


| SYMBOL | DIMENSIONS | | | | NOTES |
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| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 4.06 | 4.83 | .160 | .190 | |
| A1 | 2.03 | 3.02 | .080 | .119 | |
| b | 0.51 | 0.99 | .020 | .039 | |
| b1 | 0.51 | 0.89 | .020 | .035 | 5 |
| b2 | 1.14 | 1.78 | .045 | .070 | |
| b3 | 1.14 | 1.73 | .045 | .068 | 5 |
| c | 0.38 | 0.74 | .015 | .029 | |
| c1 | 0.38 | 0.58 | .015 | .023 | 5 |
| c2 | 1.14 | 1.65 | .045 | .065 | |
| D | 8.38 | 9.65 | .330 | .380 | 3 |
| D1 | 6.86 | – | .270 | – | 4 |
| E | 9.65 | 10.67 | .380 | .420 | 3,4 |
| E1 | 6.22 | – | .245 | | 4 |
| e | 2.54 BSC | | .100 BSC | | |
| L | 13.46 | 14.10 | .530 | .555 | |
| L1 | – | 1.65 | – | .065 | 4 |
| L2 | 3.56 | 3.71 | .140 | .146 | |

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. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.
5. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
6. CONTROLLING DIMENSION: INCH.
7 – OUTLINE CONFORM TO JEDEC TO-262 EXCEPT A1(max.), b(min.) AND D1(min.) WHERE DIMENSIONS DERIVED THE ACTUAL PACKAGE OUTLINE

LEAD ASSIGNMENTS

IGBTs, CoPACK
1.– GATE
2.– COLLECTOR
3.– EMITTER
4.– COLLECTOR

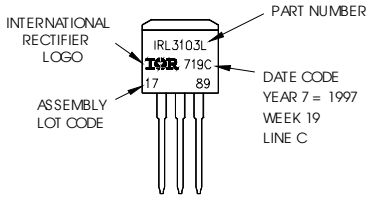
HEXFET
1.– GATE
2.– DRAIN
3.– SOURCE
4.– DRAIN

DIODES
1.– ANODE (TWO DIE) / OPEN (ONE DIE)
2, 4.– CATHODE
3.– ANODE

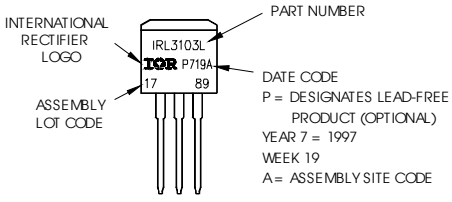
# TO-262 Part Marking Information

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

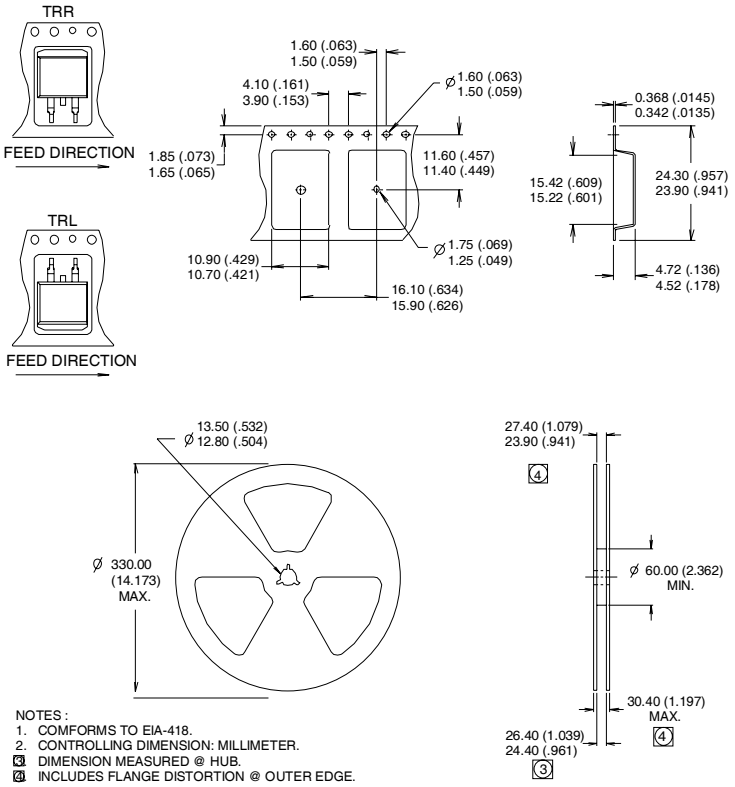



**Notes:**

**1. For an Automotive Qualified version of this part please see http://www.irf.com/product-info/auto/**

**2. For the most current drawing please refer to IR website at http://www.irf.com/package/**

# D²Pak Tape & Reel Information




**Notes:**

① Repetitive rating; pulse width limited by max. junction temperature.

② Starting $T_J$ = 25°C, L = 1.3mH $R_G$ = 25Ω, $I_{AS}$ = 26A.

③ $I_{SD} \leq$ 26A, di/dt ≤ 390A/µs, $V_{DD} \leq V_{(BR)DSS}$, $T_J \leq$ 175°C.

④ Pulse width ≤ 300µs; duty cycle ≤ 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 D²Pak, when mounted on 1" square PCB (FR-4 or G-10 Material ). For recommended footprint and soldering techniques refer to application note #AN-994.

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
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**IR WORLD HEADQUARTERS:** 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105
TAC Fax: (310) 252-7903
Visit us at www.irf.com for sales contact information.09/2010