

SMPS MOSFET

IRFB38N20DPbF

IRFS38N20DPbF

IRFSL38N20DPbF

HEXFET® Power MOSFET

Applications

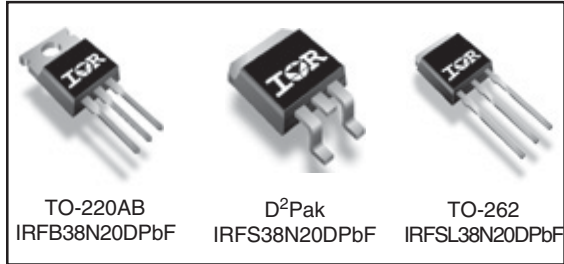
- High frequency DC-DC converters
- Plasma Display Panel
- Lead-Free

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	m Ω
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	43*	A
I_D @ $T_C = 100^\circ\text{C}$	Continuous Drain Current, V_{GS} @ 10V ⑦	30*	
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	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 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 @ $T_J = 25^\circ\text{C}$ (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	—	0.22	—	V/ $^\circ\text{C}$	Reference to 25°C , $I_D = 1\text{mA}$
$R_{DS(on)}$	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	$V_{DS} = V_{GS}, I_D = 250\mu A$
I_{DSS}	Drain-to-Source Leakage Current	—	—	25	μA	$V_{DS} = 200V, V_{GS} = 0V$
		—	—	250		$V_{DS} = 160V, V_{GS} = 0V, T_J = 150^\circ\text{C}$
I_{GSS}	Gate-to-Source Forward Leakage	—	—	100	nA	$V_{GS} = 30V$
	Gate-to-Source Reverse Leakage	—	—	-100		$V_{GS} = -30V$

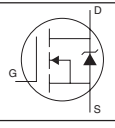
Dynamic @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
g_{fs}	Forward Transconductance	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	—		$R_G = 2.5\Omega$
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	—		$f = 1.0\text{MHz}$
C_{oss}	Output Capacitance	—	3550	—		$V_{GS} = 0V, V_{DS} = 1.0V, f = 1.0\text{MHz}$
C_{oss}	Output Capacitance	—	180	—		$V_{GS} = 0V, V_{DS} = 160V, f = 1.0\text{MHz}$
$C_{oss \text{ eff.}}$	Effective Output Capacitance	—	380	—		$V_{GS} = 0V, V_{DS} = 0V \text{ to } 160V$ ⑤

Avalanche Characteristics

	Parameter	Min.	Typ.	Max.	Units
E_{AS}	Single Pulse Avalanche Energy ②⑥	—	—	460	mJ
I_{AR}	Avalanche Current ①	—	—	26	A
E_{AR}	Repetitive Avalanche Energy ①	—	390	—	mJ
$V_{DS} \text{ (Avalanche)}$	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	$T_J = 25^\circ\text{C}, I_S = 26A, V_{GS} = 0V$ ④
t_{rr}	Reverse Recovery Time	—	160	240	nS	$T_J = 25^\circ\text{C}, I_F = 26A$
Q_{rr}	Reverse Recovery Charge	—	1.3	2.0	μC	$di/dt = 100A/\mu s$ ④
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by $L_S + L_D$)				

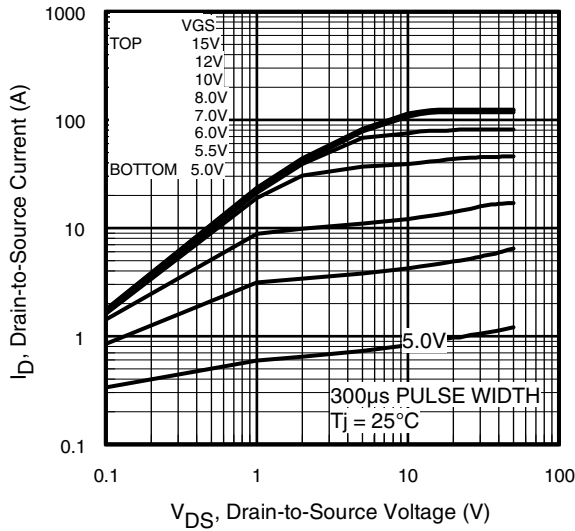


Fig 1. Typical Output Characteristics

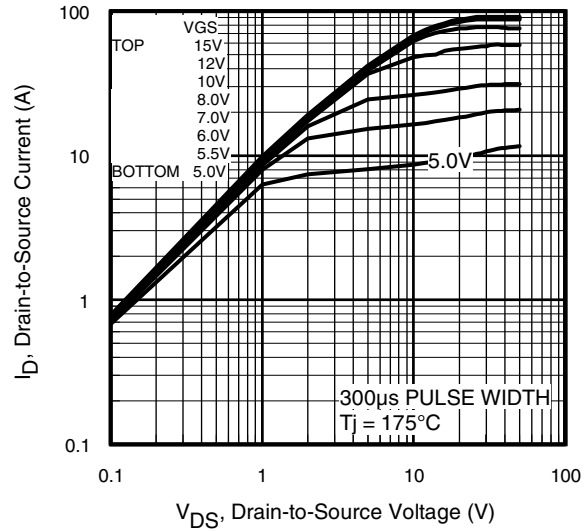


Fig 2. Typical Output Characteristics

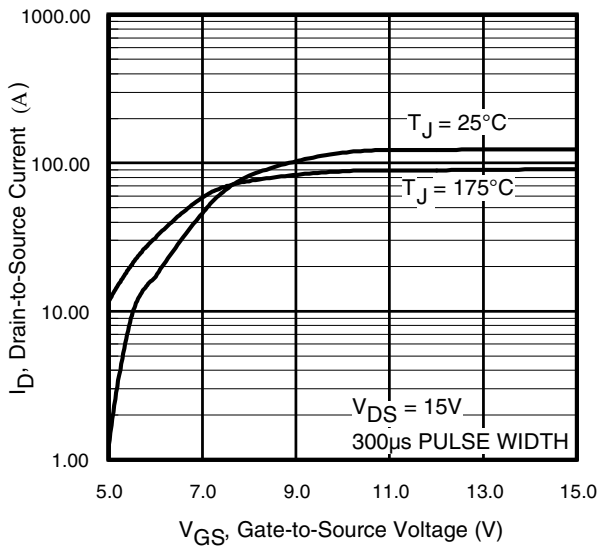


Fig 3. Typical Transfer Characteristics

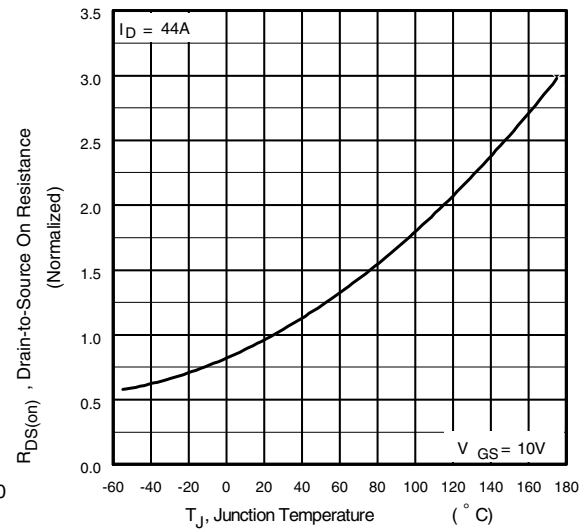


Fig 4. Normalized On-Resistance Vs. Temperature

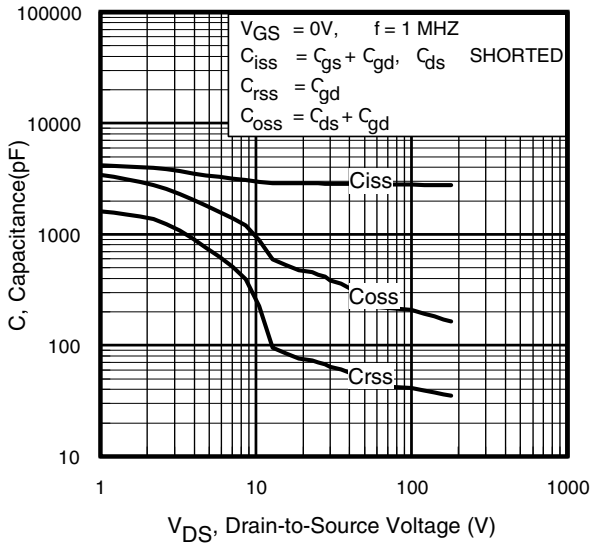


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

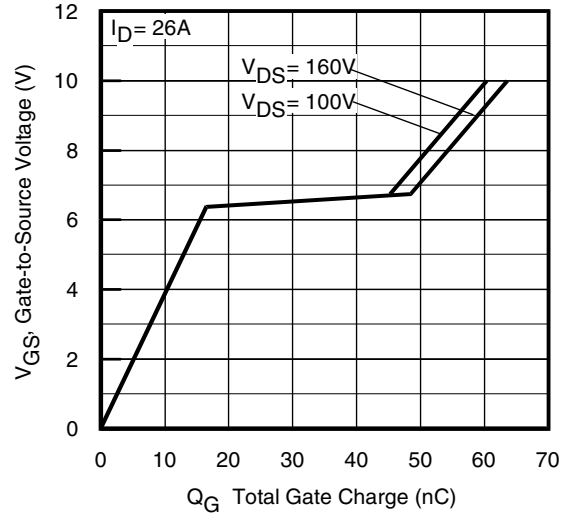


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

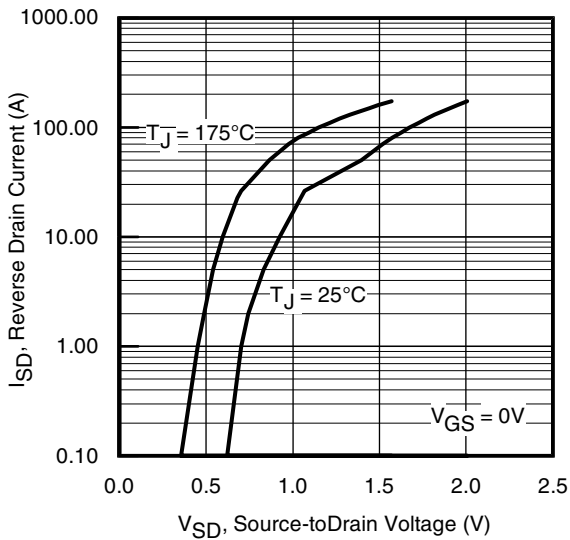


Fig 7. Typical Source-Drain Diode Forward Voltage

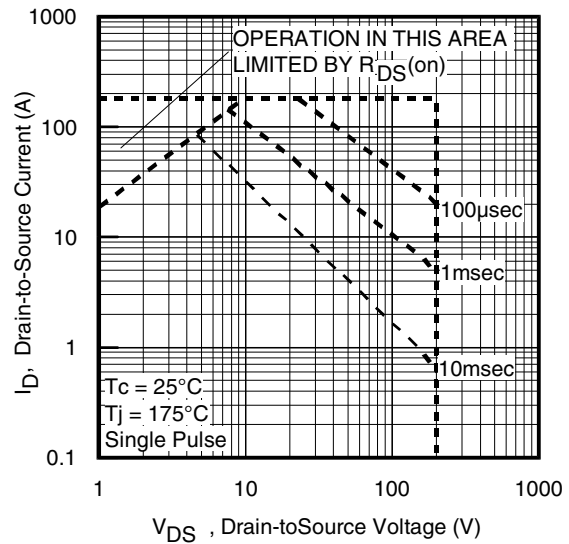


Fig 8. Maximum Safe Operating Area

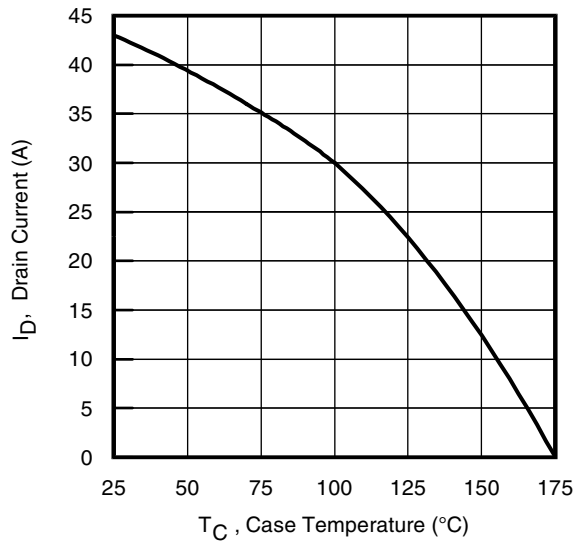


Fig 9. Maximum Drain Current Vs. Case Temperature

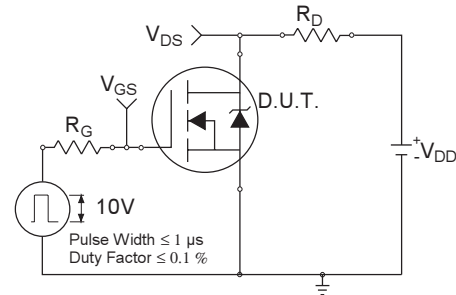


Fig 10a. Switching Time Test Circuit

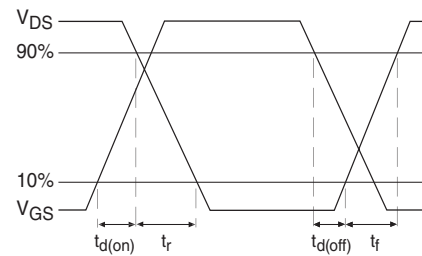


Fig 10b. Switching Time Waveforms

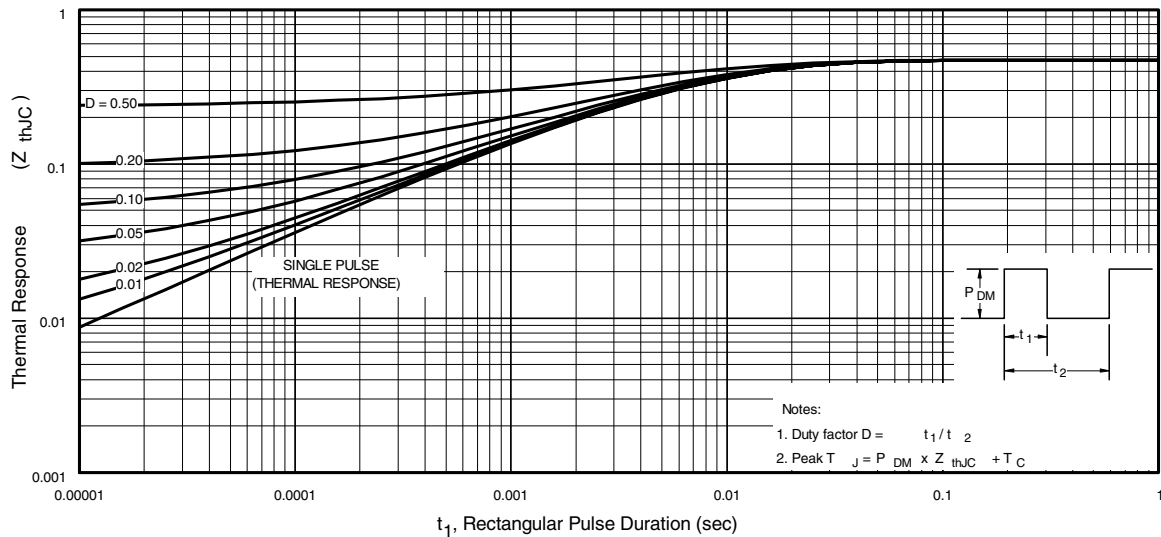


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

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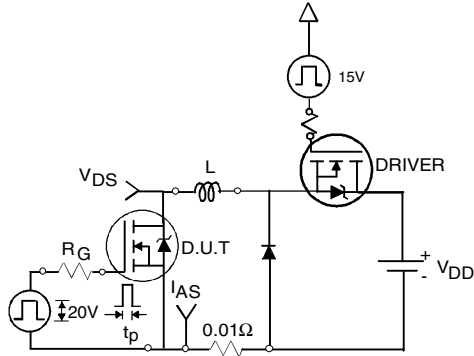


Fig 12a. Unclamped Inductive Test Circuit

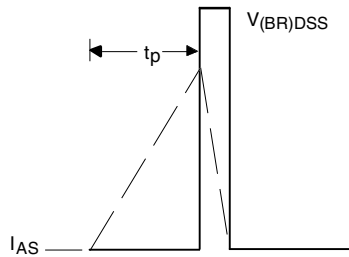


Fig 12b. Unclamped Inductive Waveforms

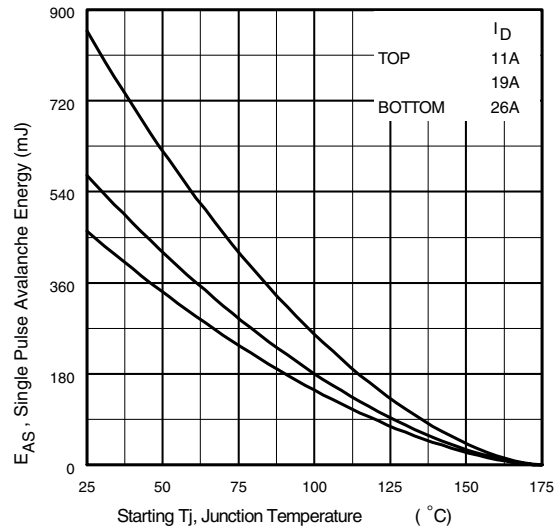


Fig 12c. Maximum Avalanche Energy
Vs. Drain Current

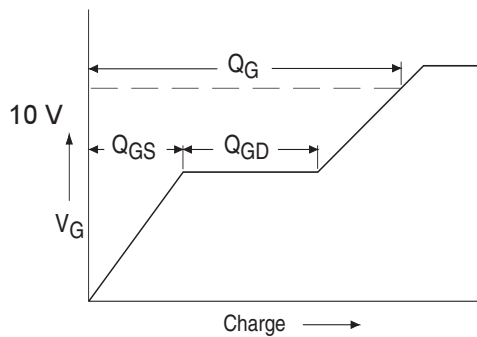


Fig 13a. Basic Gate Charge Waveform

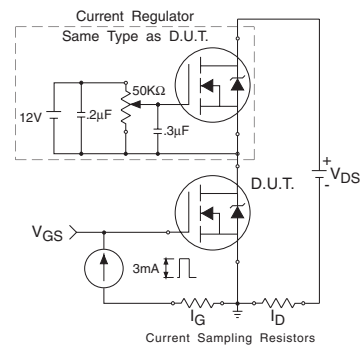
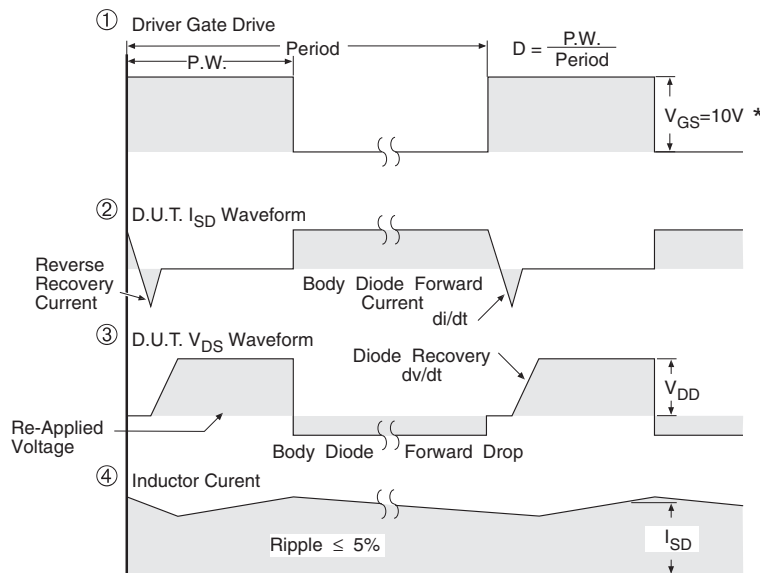
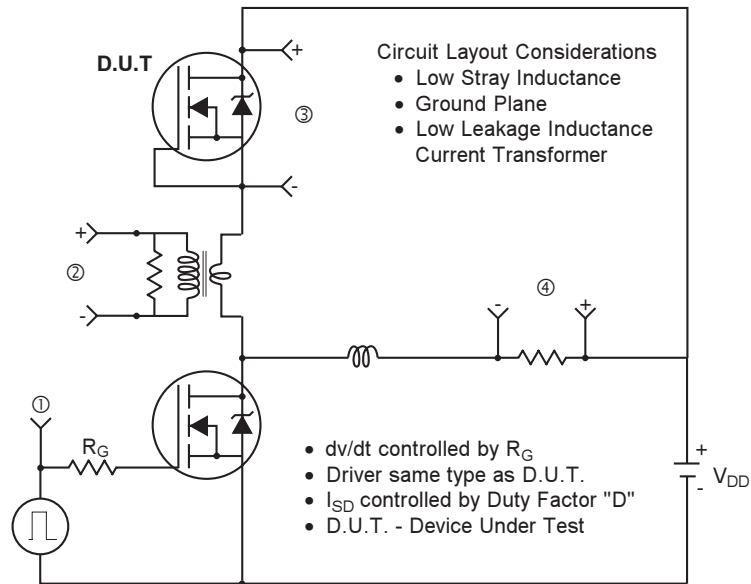


Fig 13b. Gate Charge Test Circuit

Peak Diode Recovery dv/dt Test Circuit

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

Fig 14. For N-Channel HEXFET® Power MOSFETs

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TO-220AB Package Outline

Figure 1 consists of four detailed drawings of the lead tip assembly:

- (A) Top View:** Shows a circular lead tip with four pins. Dimensions include $D1$ (overall diameter), $D2$ (inner diameter), and $E1$ (pin diameter). A callout for **DETAIL B** is shown.
- (B) Side View:** Shows the profile of the lead tip. Dimensions include A (total height), $A1$ (height of the upper section), $A2$ (height of the lower section), and C (width of the base).
- (C) Cross-section:** Shows a cross-section of the lead tip. Dimensions include $L1$, $L2$, and $L3$ (heights of different layers), and C (width of the base).
- (D) Section C-C & D-D:** Shows a cross-section of the lead tip. Dimensions include $b1$, $b2$, and $b3$ (widths of different layers), $c1$, and $c2$ (heights of different layers).

- 1- DIMENSIONING AND TOLERANCING AS PER ASME Y14.5 M- 1994.
- 2- DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
- 3- LEAD DIMENSION AND FINISH UNINCLUDED 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, B5 & C1 ARE OF THE BASE METAL ONLY.
- 6- CONTROLLING DIMENSION: INCHES.
- 7- THERMAL PAD CONTOUR OUTLINE WITHIN DIMENSIONS E1,D2 & E1
- 8- DIMENSION E2 X H1 DEFINE A ZONE WHERE STAMPING AND SINGULATION IRREGULARITIES ARE ALLOWED.
- 9- OUTLINE CONFORMS TO JEDEC 10-220, EXCEPT A2 (max.) AND D2 (min). WHERE DIMENSIONS ARE DERIVED FROM THE ACTUAL PACKAGE DIMENSIONS.

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	
d	14.22	16.51	.560	.650	
D1	8.38	9.02	.330	.355	
D2	11.68	12.88	.460	.507	
E	9.65	10.67	.380	.420	7, 8
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	

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

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

DIODES

- 1.- ANODE
- 2.- CATHODE
- 3.- ANODE

Diagram illustrating the markings on an IRF1010 MOSFET package:

- INTERNATIONAL RECTIFIER LOGO**: Points to the IR logo.
- PART NUMBER**: Points to the text IRF1010.
- DATE CODE**: Points to the text 719C.
- YEAR 7 = 1997**: Points to the first digit of the date code (7).
- WEEK 19**: Points to the second digit of the date code (19).
- LINE C**: Points to the third digit of the date code (C).
- ASSEMBLY LOT CODE**: Points to the text 17.
- 89**: Points to the text 89.

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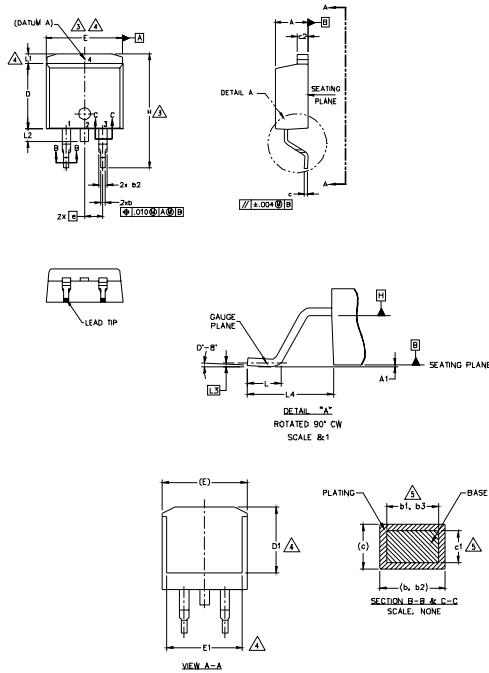
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D²Pak Package Outline

Dimensions are shown in millimeters (inches)



SYMBOL	DIMENSIONS				ZC-UB
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	5
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	
c	0.38	0.74	.015	.029	5
c1	0.38	0.58	.015	.023	
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		4
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 [0.005] 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 10-263AB.

LEAD ASSIGNMENTS

DIODES

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

HEXFET

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

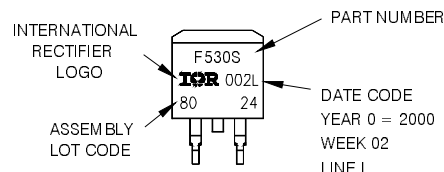
IGBTs, CoPACK

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

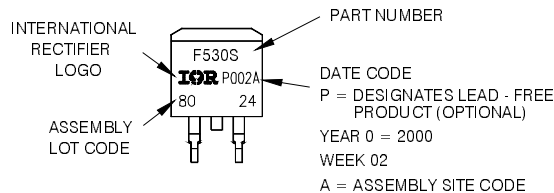
D²Pak Part Marking Information

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



Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>

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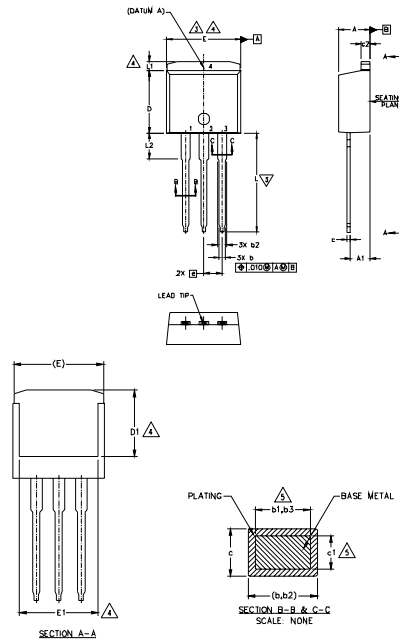
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IRFB/S/SL38N20DPbF

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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	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 .0127 (.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(max.) AND D1(max.) WHERE DIMENSIONS DERIVED THE ACTUAL PACKAGE OUTLINE.

LEAD ASSIGNMENTS

SMALL CAPACITOR

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

HERFET

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

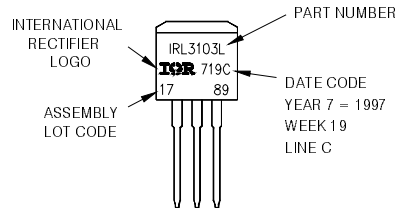
DIGGES

1. ANODE (TWO DI) / OPEN (ONE DI)
2. A - CATHODE
3. ANODE

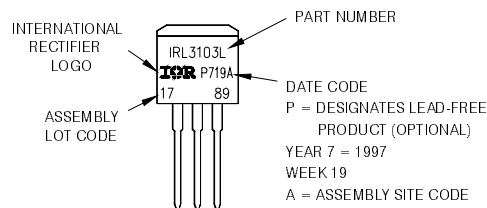
TO-262 Part Marking Information

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



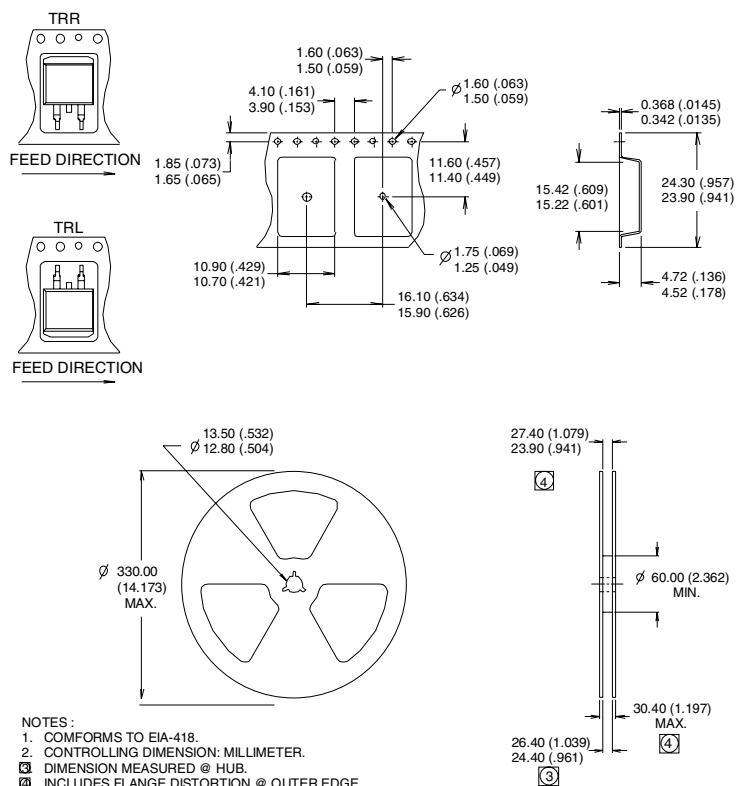
Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>

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D²Pak 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 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.

Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>

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.

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