International IΩR Rectifier

SMPS MOSFET

IRL3716
IRL3716S
IRL3716L

HEXFET® Power MOSFET

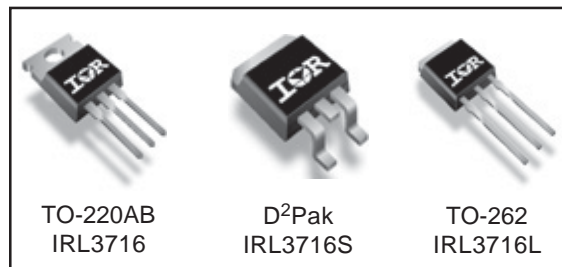| V$_{DSS}$	R$_{DS(on)}$ max	I$_D$
20V	**4.0mΩ**	**180A**[6]

Applications
- High Frequency Isolated DC-DC Converters with Synchronous Rectification for Telecom and Industrial Use
- High Frequency Buck Converters for Computer Processor Power
- Active Oring

Benefits
- Ultra-Low Gate Impedance
- Very Low R$_{DS(on)}$ at 4.5V V$_{GS}$
- Fully Characterized Avalanche Voltage and Current

| TO-220AB | D^{2}Pak | TO-262 |
| IRL3716 | IRL3716S | IRL3716L |

Absolute Maximum Ratings

Symbol	Parameter	Max.	Units
V$_{DS}$	Drain-Source Voltage	20	V
V$_{GS}$	Gate-to-Source Voltage	± 20	V
I$_D$ @ T$_C$ = 25°C	Continuous Drain Current, V$_{GS}$ @ 10V	180[6]	
I$_D$ @ T$_C$ = 100°C	Continuous Drain Current, V$_{GS}$ @ 10V	130	A
I$_{DM}$	Pulsed Drain Current[1]	720	
P$_D$ @T$_C$ = 25°C	Maximum Power Dissipation[3]	210	W
P$_D$ @T$_C$ = 100°C	Maximum Power Dissipation[3]	100	W
	Linear Derating Factor	1.4	W/°C
T$_J$, T$_{STG}$	Junction and Storage Temperature Range	-55 to + 175	°C

Thermal Resistance

	Parameter	Typ.	Max.	Units
R$_{\theta JC}$	Junction-to-Case[7]	——	0.72	
R$_{\theta CS}$	Case-to-Sink, Flat, Greased Surface [4]	0.50	——	°C/W
R$_{\theta JA}$	Junction-to-Ambient[4]	——	62	
R$_{\theta JA}$	Junction-to-Ambient (PCB mount)[5]	——	40	

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	20	——	——	V	V_{GS} = 0V, I_D = 250µA
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	——	0.021	——	V/°C	Reference to 25°C, I_D = 1mA
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	——	3.0	4.0	mΩ	V_{GS} = 10V, I_D = 90A ③
		——	4.0	4.8		V_{GS} = 4.5V, I_D = 72A ③
$V_{GS(th)}$	Gate Threshold Voltage	1.0	——	3.0	V	V_{DS} = V_{GS}, I_D = 250µA
I_{DSS}	Drain-to-Source Leakage Current	——	——	20	µA	V_{DS} = 16V, V_{GS} = 0V
		——	——	250		V_{DS} = 16V, V_{GS} = 0V, T_J = 125°C
I_{GSS}	Gate-to-Source Forward Leakage	——	——	200	nA	V_{GS} = 16V
	Gate-to-Source Reverse Leakage	——	——	-200		V_{GS} = -16V

Dynamic @ T_J = 25°C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
g_{fs}	Forward Transconductance	100	——	——	S	V_{DS} = 10V, I_D = 72A
Q_g	Total Gate Charge	——	53	79	nC	I_D = 72A
Q_{gs}	Gate-to-Source Charge	——	17	26		V_{DS} = 16V
Q_{gd}	Gate-to-Drain ("Miller") Charge	——	24	35		V_{GS} = 4.5V
Q_{oss}	Output Gate Charge	——	50	75		V_{GS} = 0V, V_{DS} = 10V
R_g	Gate Resistance		1.5		Ω	
$t_{d(on)}$	Turn-On Delay Time	——	18	——	ns	V_{DD} = 10V
t_r	Rise Time	——	140	——		I_D = 72A
$t_{d(off)}$	Turn-Off Delay Time	——	38	——		R_G = 3.9Ω
t_f	Fall Time	——	36	——		V_{GS} = 4.5V ③
C_{iss}	Input Capacitance	——	5090	——	pF	V_{GS} = 0V
C_{oss}	Output Capacitance	——	3440	——		V_{DS} = 10V
C_{rss}	Reverse Transfer Capacitance	——	560	——		f = 1.0MHz

Avalanche Characteristics

Symbol	Parameter	Typ.	Max.	Units
E_{AS}	Single Pulse Avalanche Energy②	——	640	mJ
I_{AR}	Avalanche Current①	——	72	A

Diode Characteristics

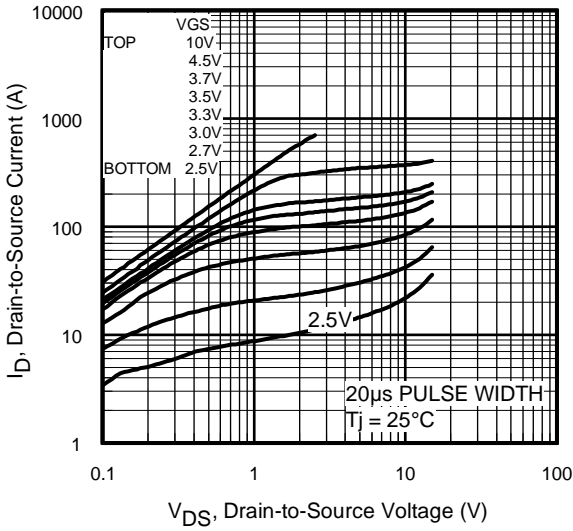| Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
I_S	Continuous Source Current (Body Diode)	——	——	180⑥	A	MOSFET symbol showing the integral reverse p-n junction diode.
I_{SM}	Pulsed Source Current (Body Diode) ①	——	——	720		
V_{SD}	Diode Forward Voltage	——	0.93	1.3	V	T_J = 25°C, I_S = 72A, V_{GS} = 0V ③
		——	0.80	——		T_J = 125°C, I_S = 72A, V_{GS} = 0V ③
t_{rr}	Reverse Recovery Time	——	180	280	ns	T_J = 25°C, I_F = 72A, V_R=20V
Q_{rr}	Reverse Recovery Charge	——	87	130	nC	di/dt = 100A/µs ③
t_{rr}	Reverse Recovery Time	——	190	280	ns	T_J = 125°C, I_F = 72A, V_R=20V
Q_{rr}	Reverse Recovery Charge	——	85	130	nC	di/dt = 100A/µs ③

IRL3716/3716S/3716L

Fig 1. Typical Output Characteristics
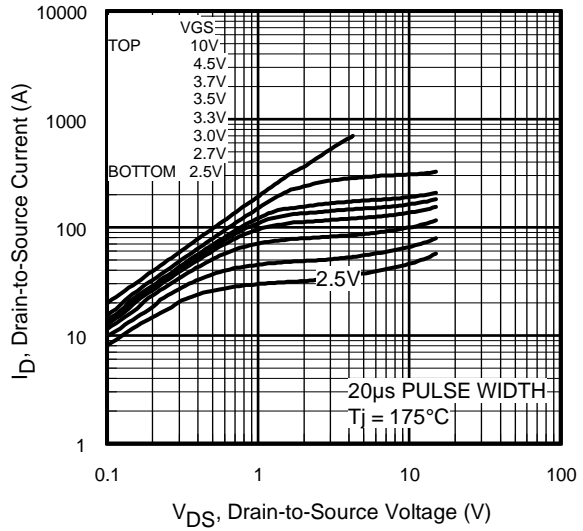

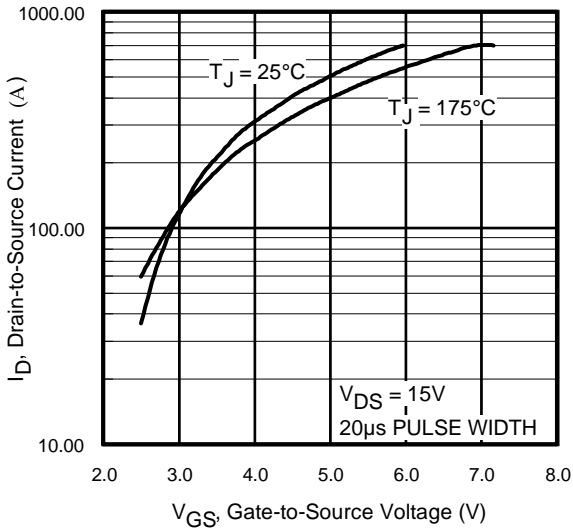**Fig 2.** Typical Output Characteristics

Fig 3. Typical Transfer Characteristics
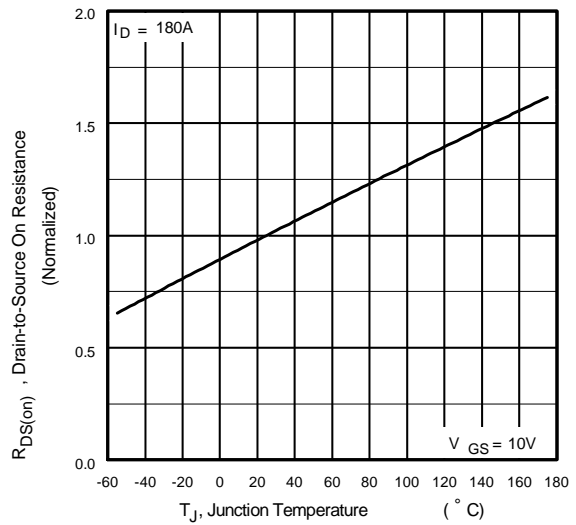

Fig 4. Normalized On-Resistance
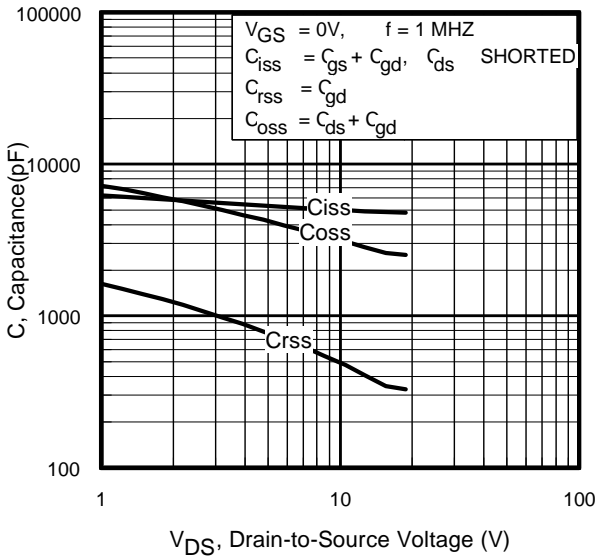Vs. Temperature

IRL3716/3716S/3716L

Fig 5. Typical Capacitance Vs.
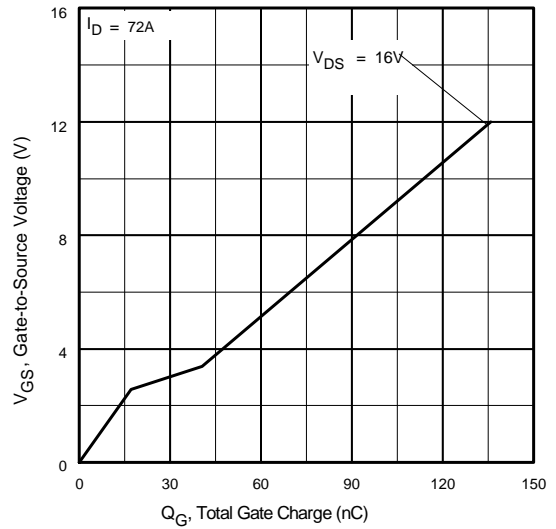Drain-to-Source Voltage
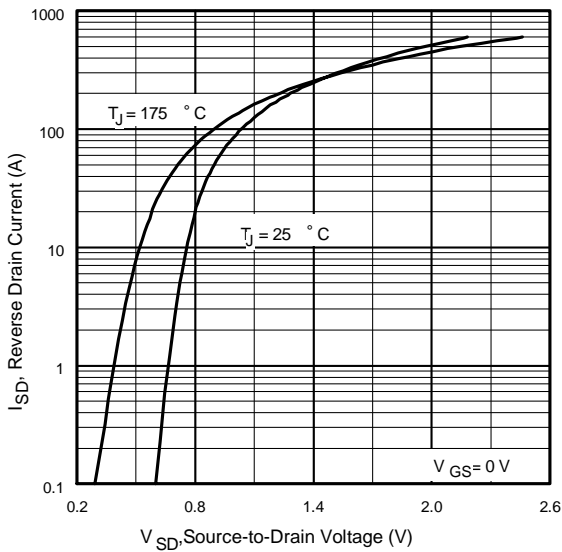
Fig 6. Typical Gate Charge Vs.
Gate-to-Source Voltage
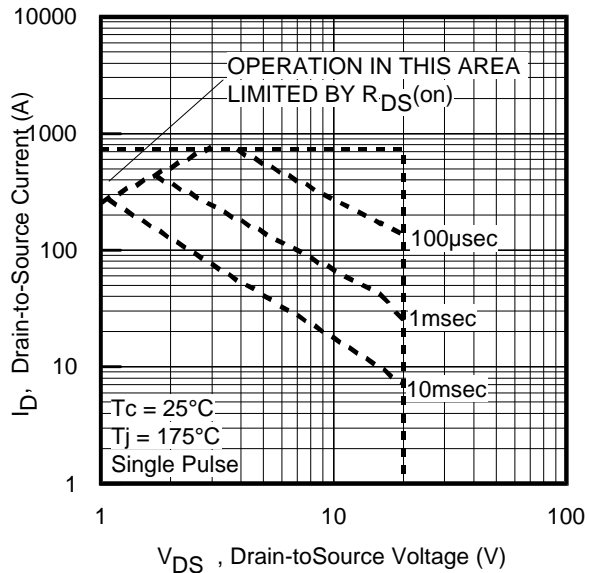
Fig 7. Typical Source-Drain Diode
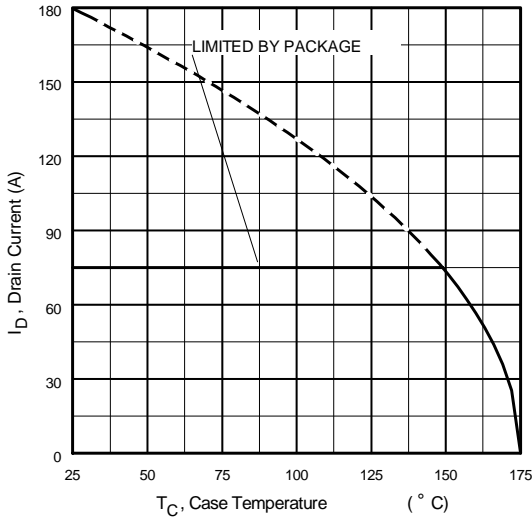Forward Voltage

Fig 8. Maximum Safe Operating Area

4

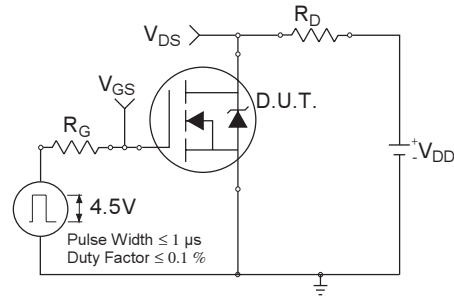**Fig 9.** Maximum Drain Current Vs. Case Temperature

Fig 10a. Switching Time Test Circuit
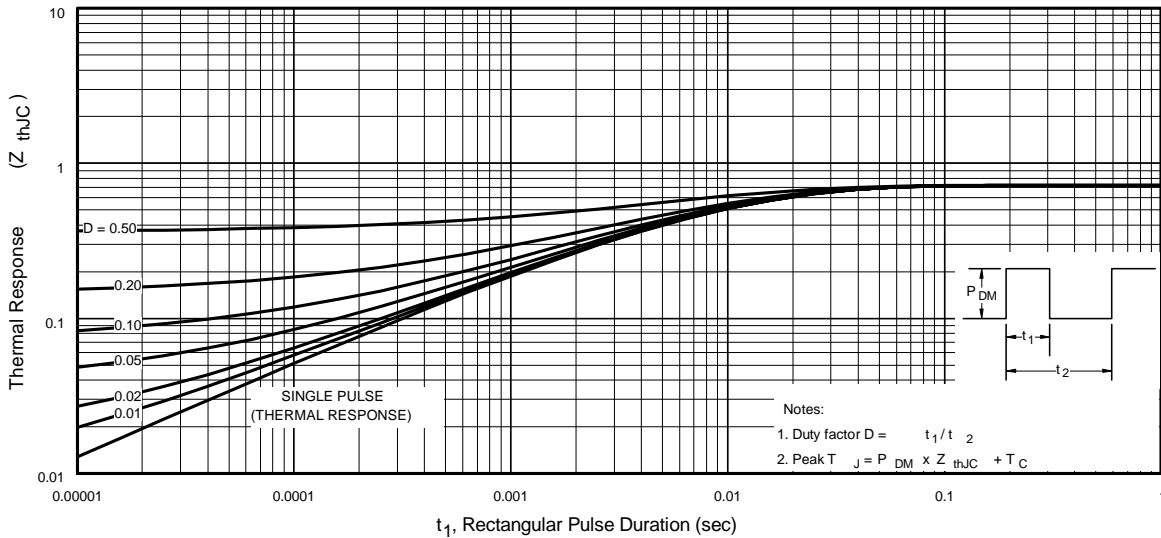

Fig 10b. Switching Time Waveforms

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

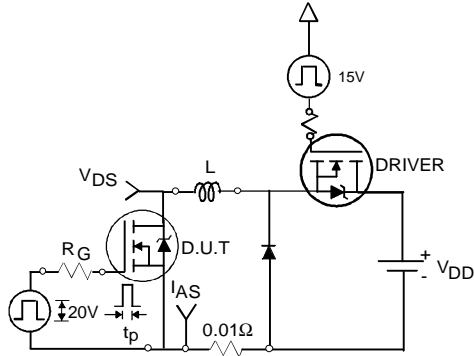# IRL3716/3716S/3716L

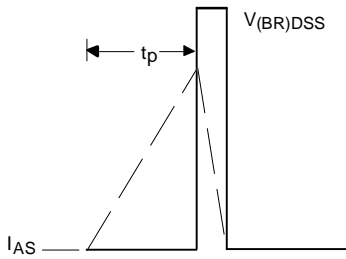**Fig 12a.** Unclamped Inductive Test Circuit

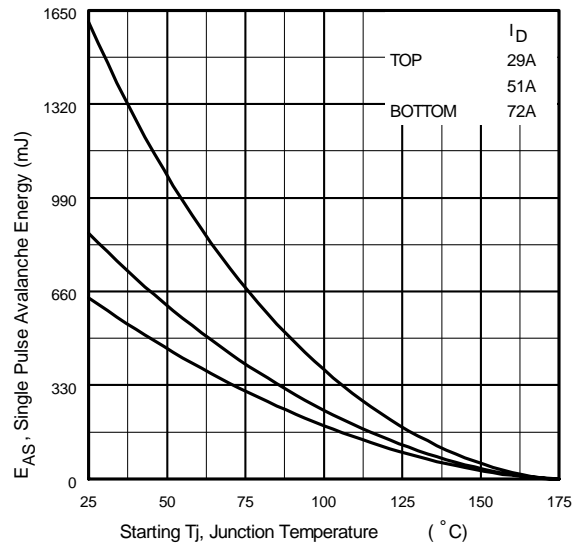

Fig 12b. Unclamped Inductive Waveforms
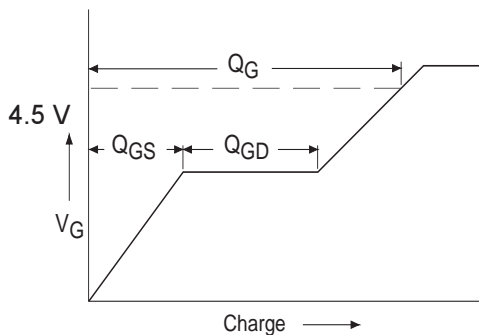

Fig 12c. Maximum Avalanche Energy
Vs. Drain Current

Fig 13a. Basic Gate Charge Waveform

Fig 13b. Gate Charge Test Circuit

Peak Diode Recovery dv/dt Test Circuit

D.U.T

③

Circuit Layout Considerations
- Low Stray Inductance
- Ground Plane
- Low Leakage Inductance Current Transformer

④

R_G

- dv/dt controlled by R_G
- Driver same type as D.U.T.
- I_{SD} controlled by Duty Factor "D"
- D.U.T. - Device Under Test

V_{DD}

① Driver Gate Drive

$D = \dfrac{P.W.}{Period}$

P.W. Period

$V_{GS}=10V$ *

② D.U.T. I_{SD} Waveform

Reverse Recovery Current

Body Diode Forward Current

di/dt

③ D.U.T. V_{DS} Waveform

Diode Recovery dv/dt

V_{DD}

Re-Applied Voltage

Body Diode Forward Drop

④ Inductor Curent

Ripple ≤ 5%

I_{SD}

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

Fig 14. For N-Channel HEXFET® Power MOSFETs

IRL3716/3716S/3716L

TO-220AB Package Outline

Dimensions are shown in millimeters (inches)

LEAD ASSIGNMENTS

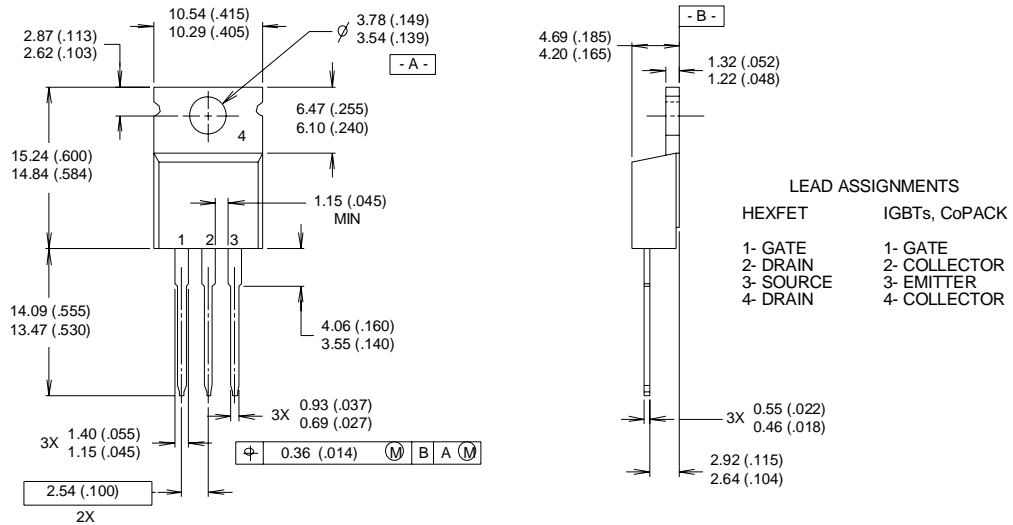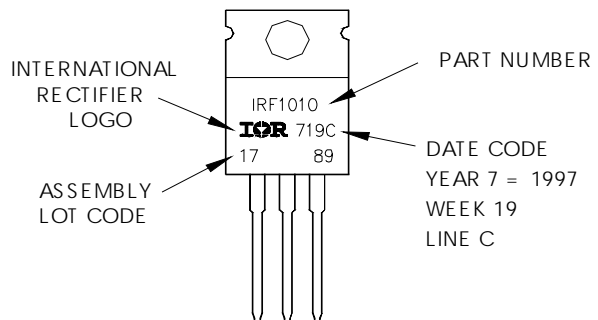| HEXFET	IGBTs, CoPACK
1- GATE	1- GATE
2- DRAIN	2- COLLECTOR
3- SOURCE	3- EMITTER
4- DRAIN	4- COLLECTOR

NOTES:

1 DIMENSIONING & TOLERANCING PER ANSI Y14.5M, 1982.
2 CONTROLLING DIMENSION : INCH

3 OUTLINE CONFORMS TO JEDEC OUTLINE TO-220AB.
4 HEATSINK & LEAD MEASUREMENTS DO NOT INCLUDE BURRS.

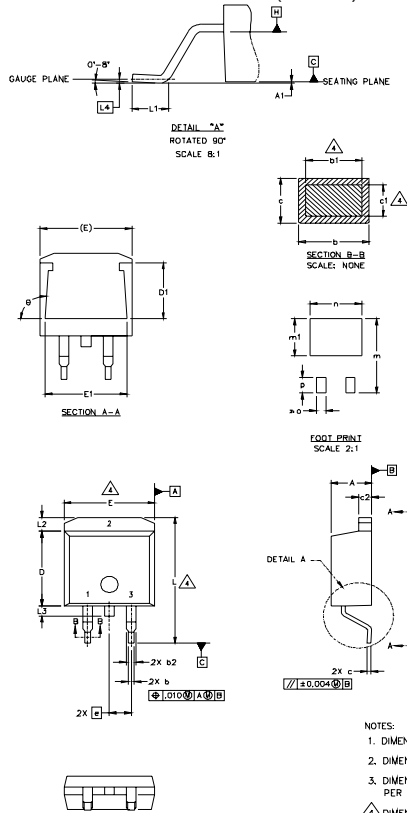## TO-220AB Part Marking Information

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"

INTERNATIONAL RECTIFIER LOGO

PART NUMBER

DATE CODE
YEAR 7 = 1997
WEEK 19
LINE C

ASSEMBLY LOT CODE

www.irf.com

D²Pak Package Outline

Dimensions are shown in millimeters (inches)

GAUGE PLANE — 0°-8°

SEATING PLANE

DETAIL "A"
ROTATED 90°
SCALE 8:1

SECTION B–B
SCALE: NONE

SECTION A–A

FOOT PRINT
SCALE 2:1

DETAIL A

S Y M B O L	DIMENSIONS				N O T E S
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	
A1		0.127		.005	
b	0.51	0.99	.020	.039	
b1	0.51	0.89	.020	.035	4
b2	1.14	1.40	.045	.055	
c	0.43	0.63	.017	.025	
c1	0.38	0.74	.015	.029	4
c2	1.14	1.40	.045	.055	
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	14.61	15.88	.575	.625	
L1	1.78	2.79	.070	.110	
L2		1.65		.065	
L3	1.27	1.78	.050	.070	
L4	0.25 BSC		.010 BSC		
m	17.78		.700		
m1	8.89		.350		
n	11.43		.450		
o	2.08		.082		
p	3.81		.150		
θ	90°	93°	90°	93°	

LEAD ASSIGNMENTS

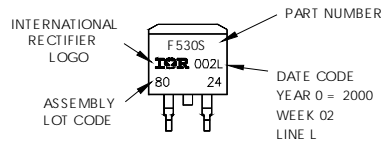| HEXFET	IGBTs, CoPACK	DIODES
1.– GATE	1.– GATE	1.– ANODE *
2.– DRAIN	2.– COLLECTOR	2.– CATHODE
3.– SOURCE	3.– EMITTER	3.– ANODE

* PART DEPENDENT.

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.
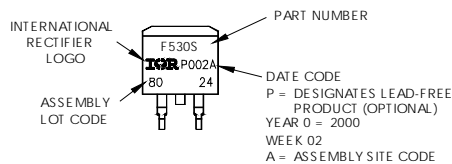5. CONTROLLING DIMENSION: INCH.

D²Pak Part Marking Information

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

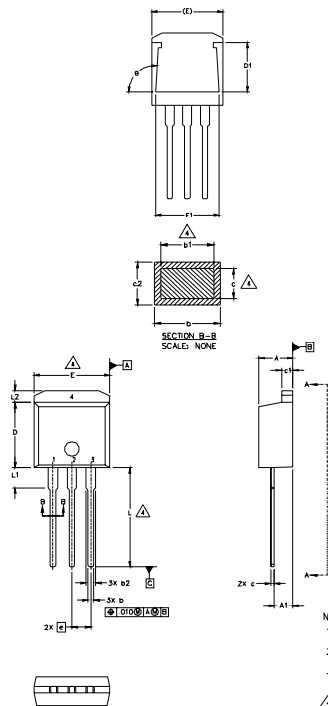Note: "P" in assembly line
position indicates "Lead-Free"

PART NUMBER

INTERNATIONAL
RECTIFIER
LOGO

F530S
IGR 002L
80   24

ASSEMBLY
LOT CODE

DATE CODE
YEAR 0 = 2000
WEEK 02
LINE L

OR

INTERNATIONAL
RECTIFIER
LOGO

PART NUMBER

F530S
IGR P002A
80   24

ASSEMBLY
LOT CODE

DATE CODE
P = DESIGNATES LEAD-FREE
PRODUCT (OPTIONAL)
YEAR 0 = 2000
WEEK 02
A = ASSEMBLY SITE CODE

International
IOR Rectifier

TO-262 Package Outline

Dimensions are shown in millimeters (inches)

S Y M B O L	DIMENSIONS				N O T E S
	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	

SECTION B-B
SCALE: NONE

LEAD ASSIGNMENTS

HEXFET

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

IGBT

1 - GATE
2 - COLLECTOR
3 - EMITTER

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.
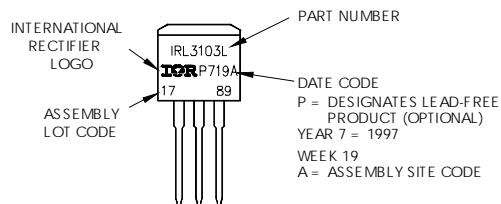5. CONTROLLING DIMENSION: INCH.

TO-262 Part Marking Informa-

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

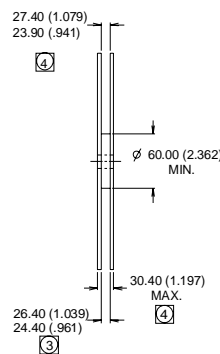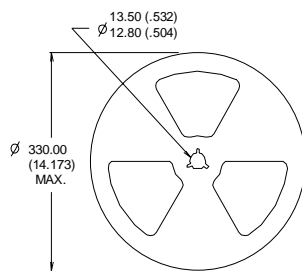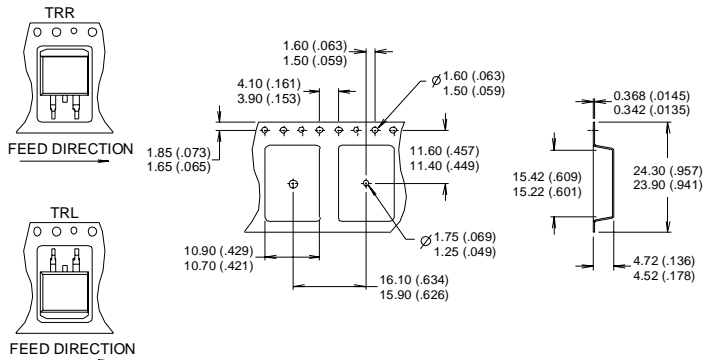Note: "P" in assembly line position indicates "Lead-Free"

INTERNATIONAL RECTIFIER LOGO

PART NUMBER

IRL3103L
IOR 719C
17   89

DATE CODE
YEAR 7 = 1997
WEEK 19
LINE C

ASSEMBLY LOT CODE

OR

INTERNATIONAL RECTIFIER LOGO

PART NUMBER

IRL3103L
IOR P719A
17   89

DATE CODE
P = DESIGNATES LEAD-FREE PRODUCT (OPTIONAL)
YEAR 7 = 1997
WEEK 19
A = ASSEMBLY SITE CODE

ASSEMBLY LOT CODE

D²Pak Tape & Reel Information

Dimensions are shown in millimeters (inches)

TRR

FEED DIRECTION

TRL

FEED DIRECTION

1.60 (.063)
1.50 (.059)

4.10 (.161)
3.90 (.153)

Ø 1.60 (.063)
1.50 (.059)

1.85 (.073)
1.65 (.065)

11.60 (.457)
11.40 (.449)

10.90 (.429)
10.70 (.421)

Ø 1.75 (.069)
1.25 (.049)

16.10 (.634)
15.90 (.626)

0.368 (.0145)
0.342 (.0135)

15.42 (.609)
15.22 (.601)

24.30 (.957)
23.90 (.941)

4.72 (.136)
4.52 (.178)

13.50 (.532)
Ø 12.80 (.504)

Ø 330.00
(14.173)
MAX.

27.40 (1.079)
23.90 (.941)

④

Ø 60.00 (2.362)
MIN.

30.40 (1.197)
MAX.

④

26.40 (1.039)
24.40 (.961)

③

NOTES :
1. COMFORMS TO EIA-418.
2. CONTROLLING DIMENSION: MILLIMETER.
③ DIMENSION MEASURED @ HUB.
④ INCLUDES FLANGE DISTORTION @ OUTER EDGE.

Notes:

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

② Starting T_J = 25°C, L = 0.25mH
R_G = 25Ω, I_{AS} = 72A.

③ Pulse width ≤ 400μs; duty cycle ≤ 2%.

④ This is only applied to TO-220AB package

⑤ 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.

⑥ Calculated continuous current based on maximum allowable
junction temperature. Package limitation current is 75A.

⑦ R_θ is measured at T_J approximately 90°C

International
I⚡R Rectifier

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

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