International IOR Rectifier

AUTOMOTIVE MOSFET

IRFZ44Z
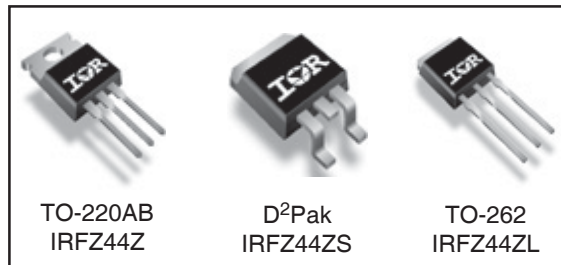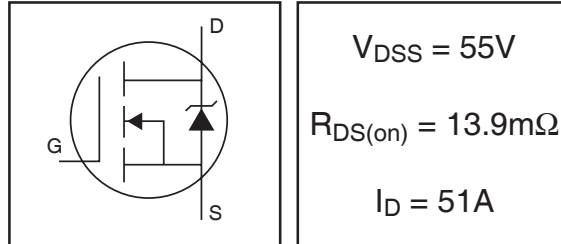# IRFZ44ZS
IRFZ44ZL

HEXFET® Power MOSFET

Features

- Advanced Process Technology
- Ultra Low On-Resistance
- Dynamic dv/dt Rating
- 175°C Operating Temperature
- Fast Switching
- Repetitive Avalanche Allowed up to Tjmax

Description

Specifically designed for Automotive applications, this HEXFET® Power MOSFET utilizes the latest processing techniques to achieve extremely low on-resistance per silicon area. Additional features of this design are a 175°C junction operating temperature, fast switching speed and improved repetitive avalanche rating . These features combine to make this design an extremely efficient and reliable device for use in Automotive applications and a wide variety of other applications.

$V_{DSS} = 55V$

$R_{DS(on)} = 13.9m\Omega$

$I_D = 51A$

| TO-220AB | D²Pak | TO-262 |
| IRFZ44Z | IRFZ44ZS | IRFZ44ZL |

Absolute Maximum Ratings

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V (Silicon Limited)	51	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS} @ 10V (See Fig. 9)	36	
I_{DM}	Pulsed Drain Current ①	200	
P_D @T_C = 25°C	Maximum Power Dissipation	80	W
	Linear Derating Factor	0.53	W/°C
V_{GS}	Gate-to-Source Voltage	± 20	V
E_{AS}	Single Pulse Avalanche Energy (Thermally Limited) ②	86	mJ
E_{AS} (tested)	Single Pulse Avalanche Energy Tested Value ⑦	105	
I_{AR}	Avalanche Current ①	See Fig.12a,12b,15,16	A
E_{AR}	Repetitive Avalanche Energy ⑥		mJ
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 screw	10 lbf•in (1.1N•m)	

Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	——	1.87	°C/W
$R_{\theta CS}$	Case-to-Sink, Flat, Greased Surface	0.50	——	
$R_{\theta JA}$	Junction-to-Ambient	——	62	
$R_{\theta JA}$	Junction-to-Ambient (PCB Mount, steady state)⑧	——	40	

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IRFZ44Z/S/L

Static @ T$_J$ = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
V$_{(BR)DSS}$	Drain-to-Source Breakdown Voltage	55	—	—	V	V$_{GS}$ = 0V, I$_D$ = 250µA
ΔBV$_{DSS}$/ΔT$_J$	Breakdown Voltage Temp. Coefficient	—	0.054	—	V/°C	Reference to 25°C, I$_D$ = 1mA
R$_{DS(on)}$	Static Drain-to-Source On-Resistance	—	11.1	13.9	mΩ	V$_{GS}$ = 10V, I$_D$ = 31A ④
V$_{GS(th)}$	Gate Threshold Voltage	2.0	—	4.0	V	V$_{DS}$ = V$_{GS}$, I$_D$ = 250µA
gfs	Forward Transconductance	22	—	—	S	V$_{DS}$ = 25V, I$_D$ = 31A
I$_{DSS}$	Drain-to-Source Leakage Current	—	—	20	µA	V$_{DS}$ = 55V, V$_{GS}$ = 0V
		—	—	250		V$_{DS}$ = 55V, V$_{GS}$ = 0V, T$_J$ = 125°C
I$_{GSS}$	Gate-to-Source Forward Leakage	—	—	200	nA	V$_{GS}$ = 20V
	Gate-to-Source Reverse Leakage	—	—	-200		V$_{GS}$ = -20V
Q$_g$	Total Gate Charge	—	29	43	nC	I$_D$ = 31A
Q$_{gs}$	Gate-to-Source Charge	—	7.2	11		V$_{DS}$ = 44V
Q$_{gd}$	Gate-to-Drain ("Miller") Charge	—	12	18		V$_{GS}$ = 10V ④
t$_{d(on)}$	Turn-On Delay Time	—	14	—	ns	V$_{DD}$ = 28V
t$_r$	Rise Time	—	68	—		I$_D$ = 31A
t$_{d(off)}$	Turn-Off Delay Time	—	33	—		R$_G$ = 15Ω
t$_f$	Fall Time	—	41	—		V$_{GS}$ = 10V ④
L$_D$	Internal Drain Inductance	—	4.5	—	nH	Between lead, 6mm (0.25in.) from package and center of die contact
L$_S$	Internal Source Inductance	—	7.5	—		
C$_{iss}$	Input Capacitance	—	1420	—	pF	V$_{GS}$ = 0V
C$_{oss}$	Output Capacitance	—	240	—		V$_{DS}$ = 25V
C$_{rss}$	Reverse Transfer Capacitance	—	130	—		f = 1.0MHz, See Fig. 5
C$_{oss}$	Output Capacitance	—	830	—		V$_{GS}$ = 0V, V$_{DS}$ = 1.0V, f = 1.0MHz
C$_{oss}$	Output Capacitance	—	190	—		V$_{GS}$ = 0V, V$_{DS}$ = 44V, f = 1.0MHz
C$_{oss}$ eff.	Effective Output Capacitance	—	300	—		V$_{GS}$ = 0V, V$_{DS}$ = 0V to 44V
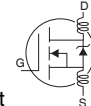
Diode Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
I$_S$	Continuous Source Current (Body Diode)	—	—	51	A	MOSFET symbol showing the integral reverse p-n junction diode.
I$_{SM}$	Pulsed Source Current (Body Diode) ①	—	—	200		
V$_{SD}$	Diode Forward Voltage	—	—	1.2	V	T$_J$ = 25°C, I$_S$ = 31A, V$_{GS}$ = 0V ④
t$_{rr}$	Reverse Recovery Time	—	23	35	ns	T$_J$ = 25°C, I$_F$ = 31A, V$_{DD}$ = 28V
Q$_{rr}$	Reverse Recovery Charge	—	17	26	nC	di/dt = 100A/µs ④
t$_{on}$	Forward Turn-On Time		Intrinsic turn-on time is negligible (turn-on is dominated by LS+LD)			
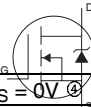
Notes:

① Repetitive rating; pulse width limited by max. junction temperature. (See fig. 11).

② Limited by T$_{Jmax}$, starting T$_J$ = 25°C, L =0.18mH, R$_G$ = 25Ω, I$_{AS}$ = 31A, V$_{GS}$ =10V. Part not recommended for use above this value.

③ I$_{SD}$ ≤ 31A, di/dt ≤ 840A/µs, V$_{DD}$ ≤ V$_{(BR)DSS}$, T$_J$ ≤ 175°C.

④ Pulse width ≤ 1.0ms; 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 Limited by T$_{Jmax}$, see Fig.12a, 12b, 15, 16 for typical repetitive avalanche performance.

⑦ This value determined from sample failure population. 100% tested to this value in production.

⑧ 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.

⑨ R$_\theta$ is rated at T$_J$ of approximately 90°C.

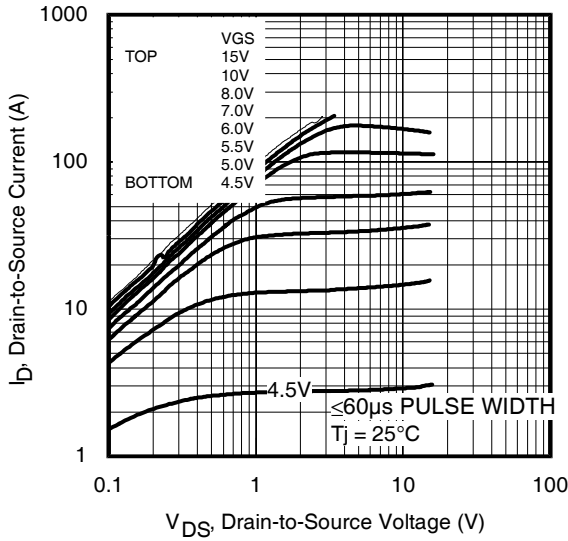# International IƏR Rectifier

IRFZ44Z/S/L

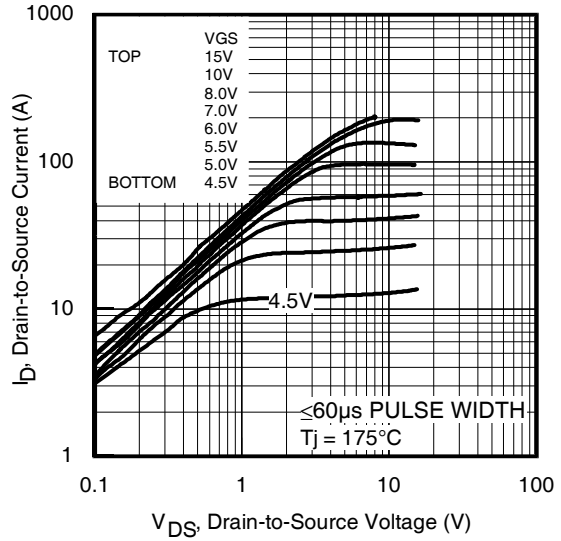**Fig 1.** Typical Output Characteristics

Fig 2. Typical Output Characteristics
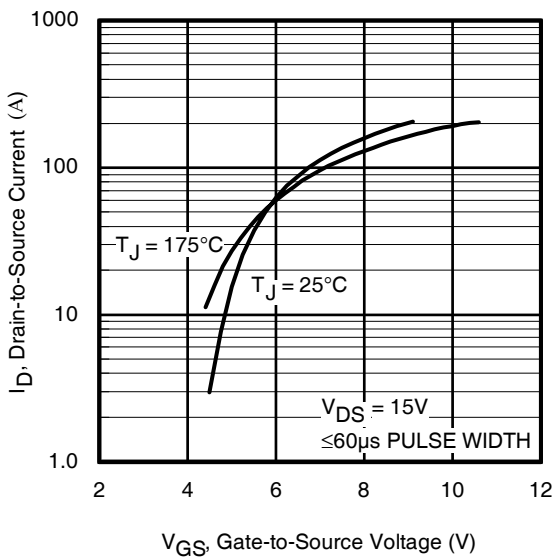
Fig 3. Typical Transfer Characteristics
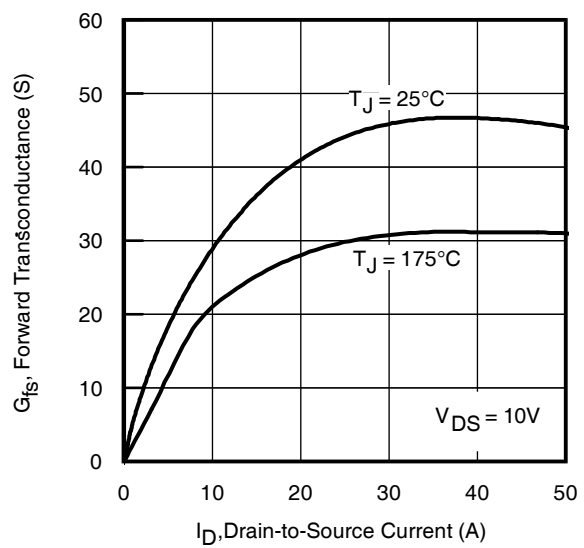
Fig 4. Typical Forward Transconductance vs. Drain Current

IRFZ44Z/S/L

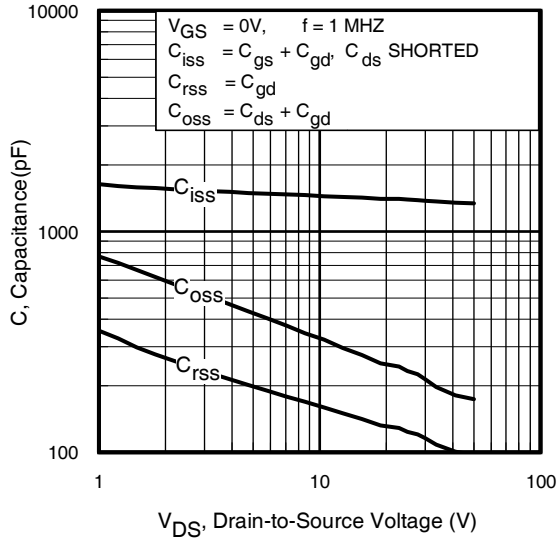International
IGR Rectifier

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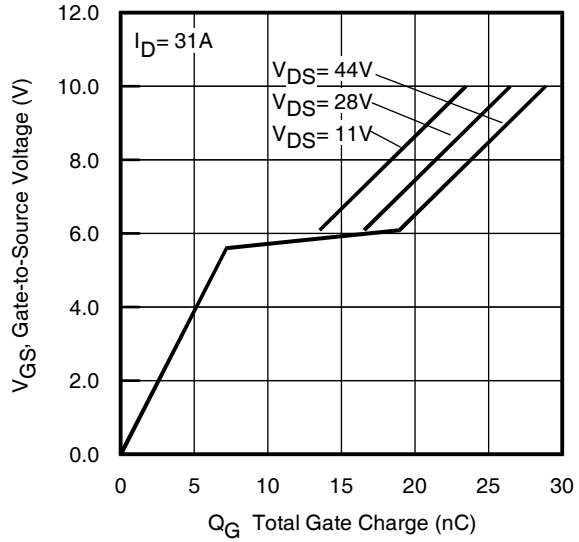Drain-to-Source Voltage

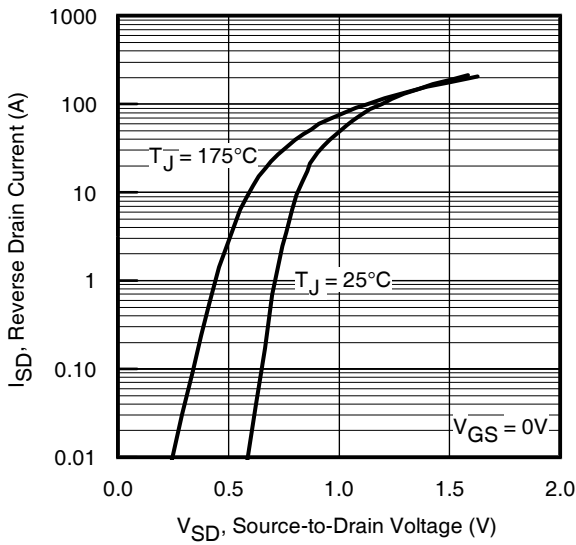**Fig 6.** Typical Gate Charge vs.
Gate-to-Source Voltage

Fig 7. Typical Source-Drain Diode
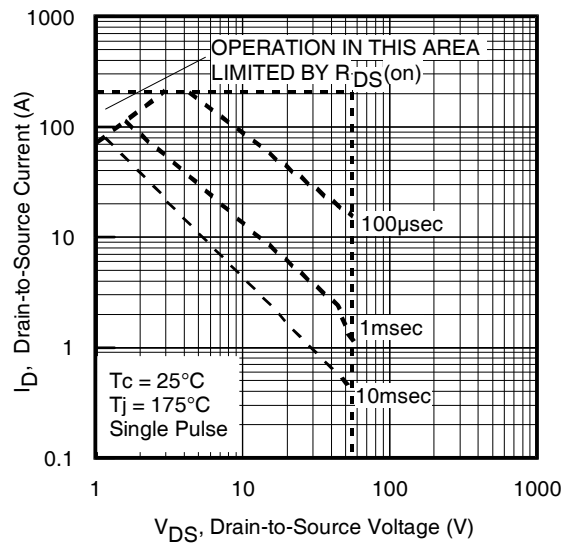Forward Voltage

Fig 8. Maximum Safe Operating Area
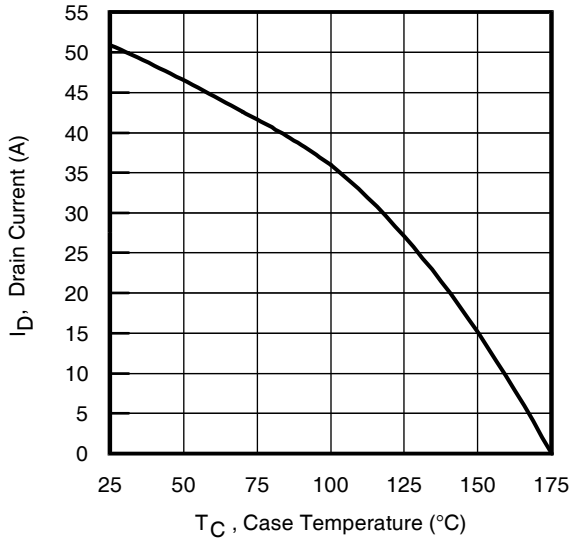
Fig 9. Maximum Drain Current vs.
Case Temperature
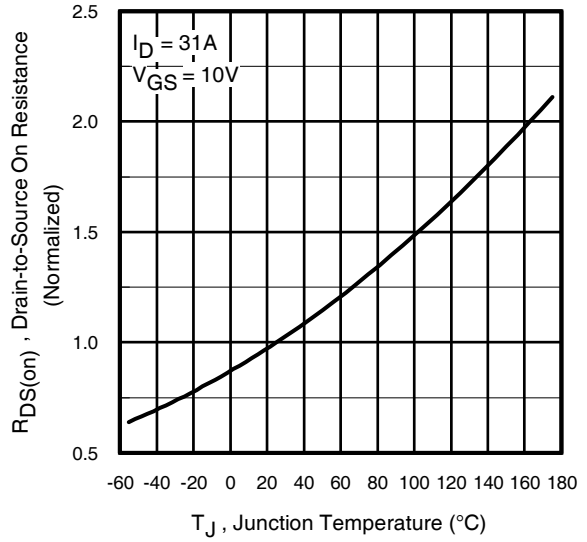
Fig 10. Normalized On-Resistance
vs. Temperature

Ri (°C/W)	τi (sec)
0.8487	0.00044
0.6254	0.00221
0.3974	0.01173

$C_i = \tau_i / R_i$

SINGLE PULSE
(THERMAL RESPONSE)

Notes:
1. Duty Factor D = t1/t2
2. Peak Tj = P dm x Zthjc + Tc
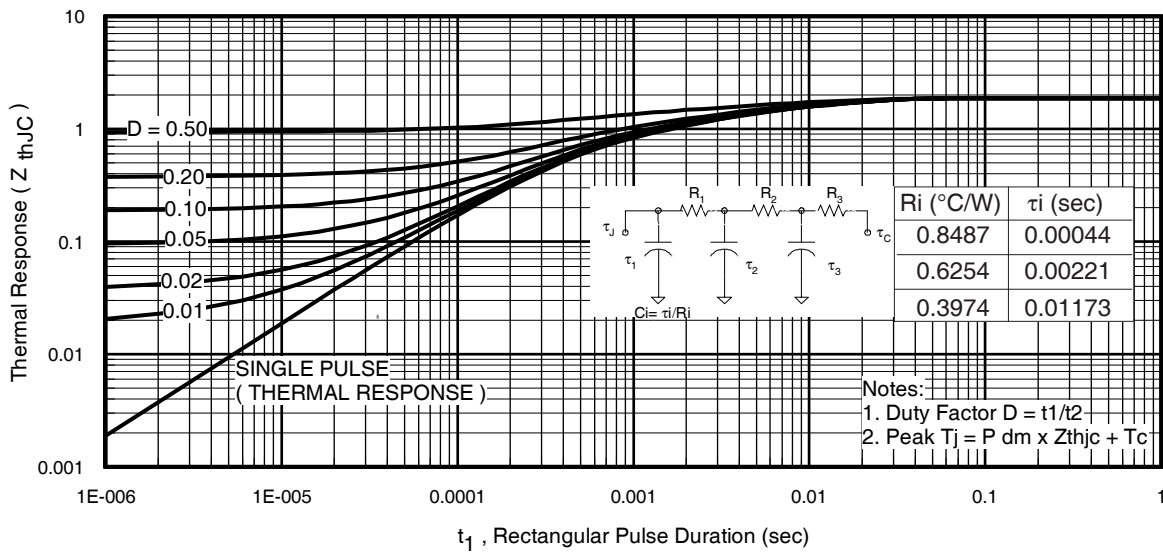
Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case
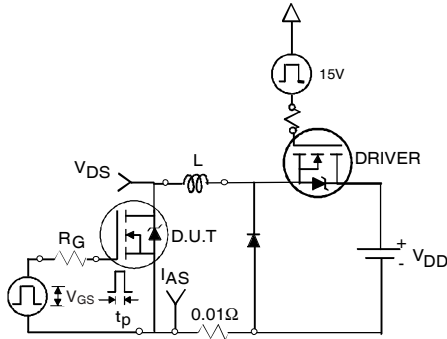
Fig 12a. Unclamped Inductive Test Circuit

Fig 12b. Unclamped Inductive Waveforms

E_{AS}, Single Pulse Avalanche Energy (mJ)

Starting T_J, Junction Temperature (°C)

I_D
TOP   3.8A
         5.5A
BOTTOM 31A

Fig 12c. Maximum Avalanche Energy
vs. Drain Current
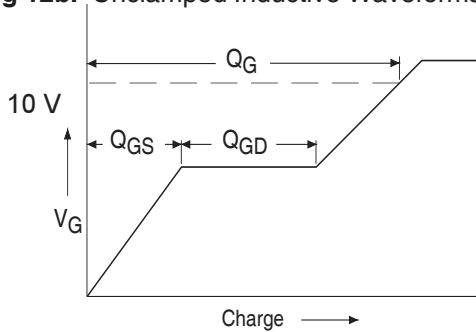
Fig 13a. Basic Gate Charge Waveform
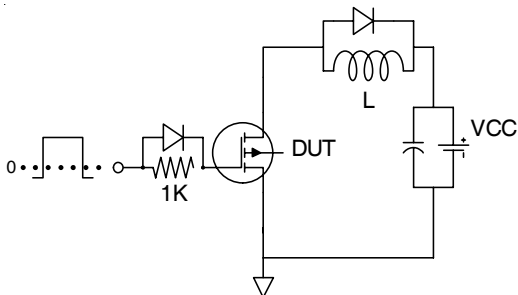
Fig 13b. Gate Charge Test Circuit

$V_{GS(th)}$ Gate threshold Voltage (V)

$I_D = 250\mu A$
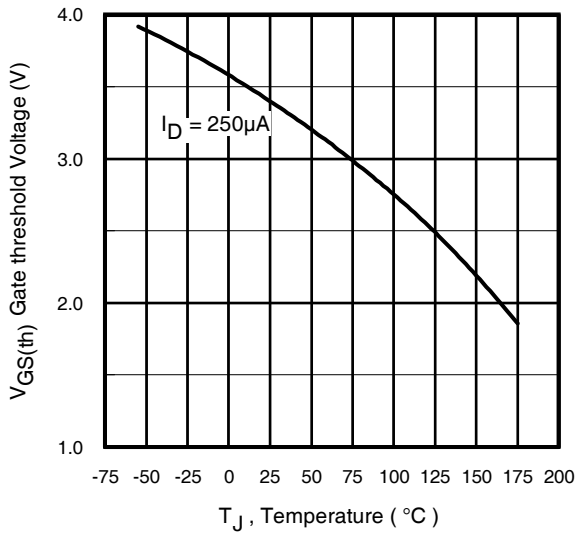
T_J, Temperature (°C)

Fig 14. Threshold Voltage vs. Temperature
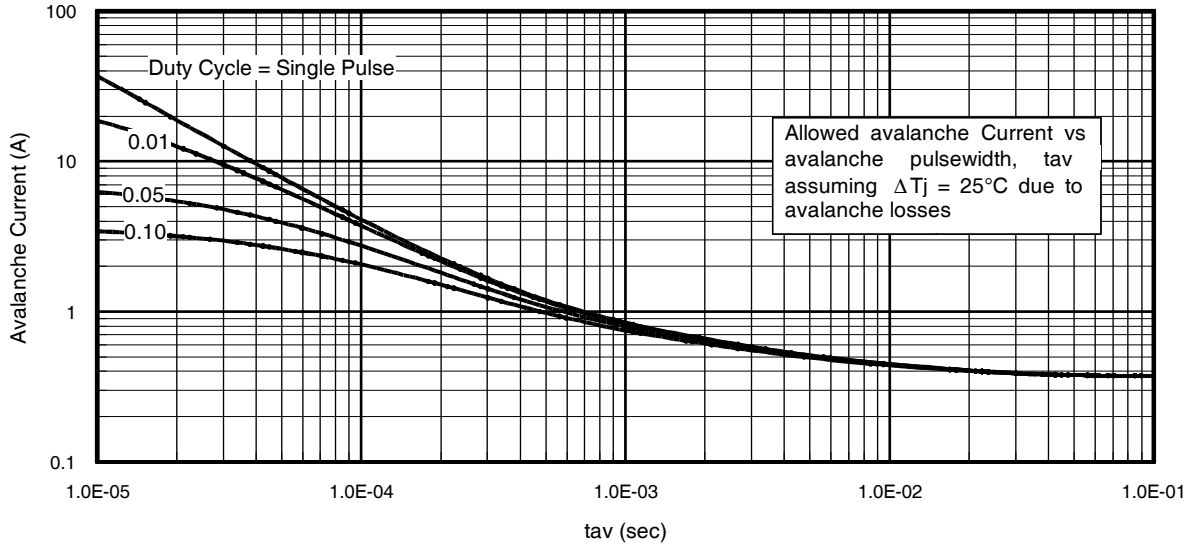
www.irf.com

Fig 15. Typical Avalanche Current vs.Pulsewidth

The graph shows Avalanche Current (A) on the y-axis vs tav (sec) on the x-axis with curves labeled: Duty Cycle = Single Pulse, 0.01, 0.05, 0.10. Text box: "Allowed avalanche Current vs avalanche pulsewidth, tav assuming $\Delta Tj = 25°C$ due to avalanche losses"
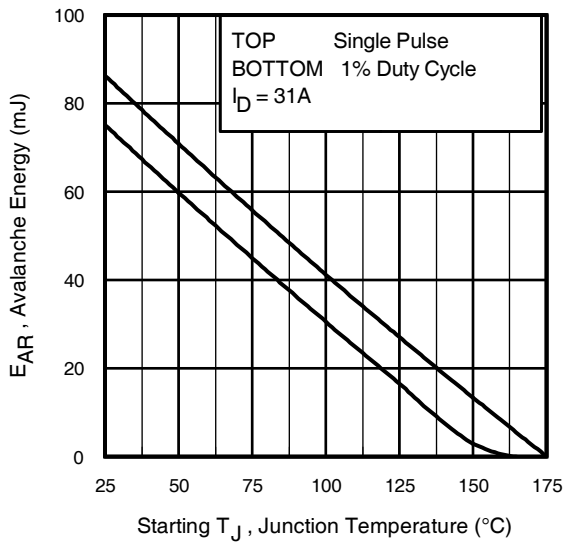
Fig 16. Maximum Avalanche Energy
vs. Temperature

The graph shows E_{AR}, Avalanche Energy (mJ) vs Starting T_J, Junction Temperature (°C). Legend: TOP Single Pulse, BOTTOM 1% Duty Cycle, $I_D = 31A$

Notes on Repetitive Avalanche Curves , Figures 15, 16:
(For further info, see AN-1005 at www.irf.com)
1. Avalanche failures assumption:
   Purely a thermal phenomenon and failure occurs at a temperature far in excess of T_{jmax}. This is validated for every part type.
2. Safe operation in Avalanche is allowed as long as T_{jmax} is not exceeded.
3. Equation below based on circuit and waveforms shown in Figures 12a, 12b.
4. $P_{D (ave)}$ = Average power dissipation per single avalanche pulse.
5. BV = Rated breakdown voltage (1.3 factor accounts for voltage increase during avalanche).
6. I_{av} = Allowable avalanche current.
7. ΔT = Allowable rise in junction temperature, not to exceed T_{jmax} (assumed as 25°C in Figure 15, 16).
   t_{av} = Average time in avalanche.
   D = Duty cycle in avalanche = $t_{av} \cdot f$
   $Z_{thJC}(D, t_{av})$ = Transient thermal resistance, see figure 11)

$$P_{D (ave)} = 1/2 (1.3 \cdot BV \cdot I_{av}) = \Delta T / Z_{thJC}$$
$$I_{av} = 2\Delta T / [1.3 \cdot BV \cdot Z_{th}]$$
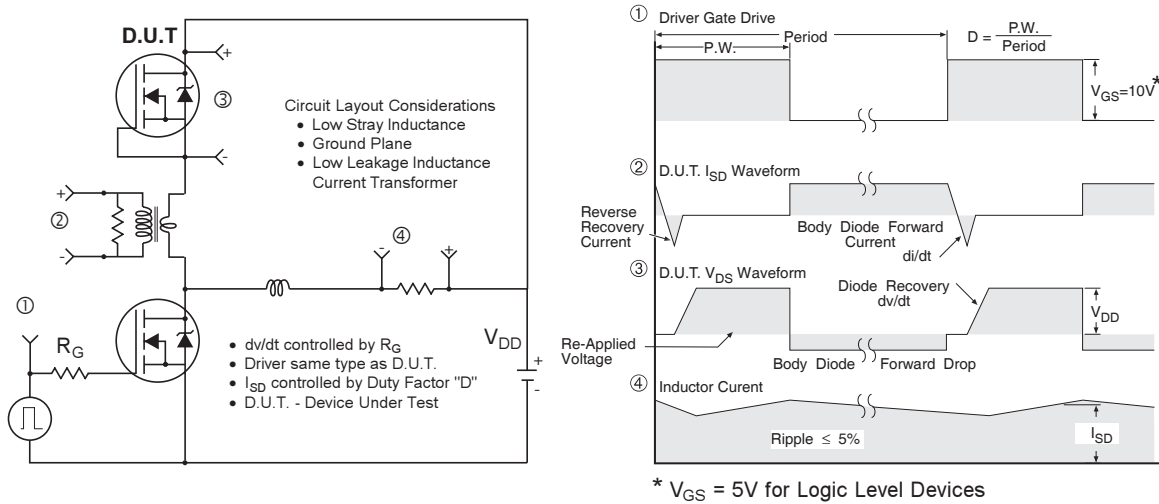$$E_{AS (AR)} = P_{D (ave)} \cdot t_{av}$$

Fig 17. Peak Diode Recovery dv/dt Test Circuit for N-Channel
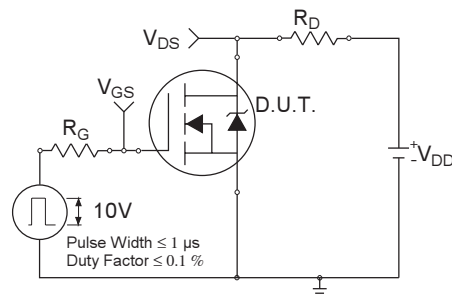HEXFET® Power MOSFETs
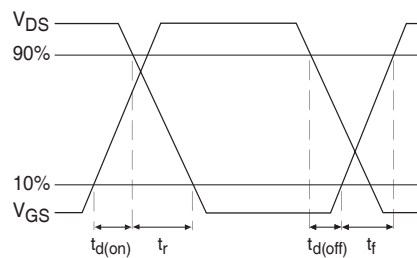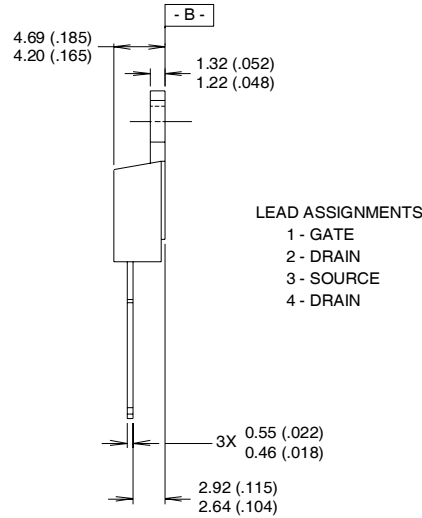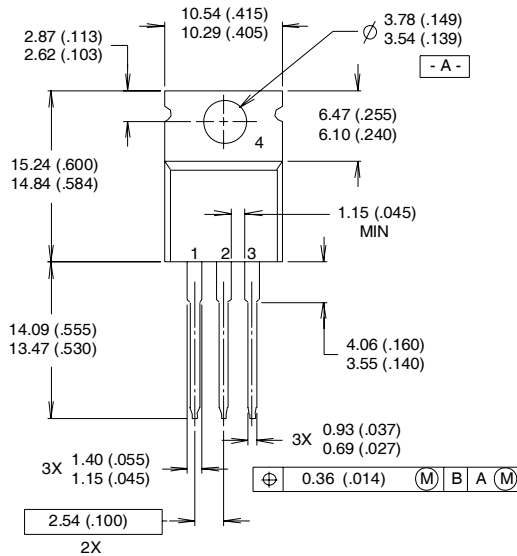

Fig 18a. Switching Time Test Circuit

Fig 18b. Switching Time Waveforms

8

TO-220AB Package Outline

Dimensions are shown in millimeters (inches)


```
2.87 (.113)        10.54 (.415)         ∅  3.78 (.149)
2.62 (.103)        10.29 (.405)            3.54 (.139)
                                                    - A -
                                         6.47 (.255)
                                         6.10 (.240)
15.24 (.600)
14.84 (.584)
                            1.15 (.045)
                            MIN

14.09 (.555)
13.47 (.530)
                            4.06 (.160)
                            3.55 (.140)

            3X  0.93 (.037)
                0.69 (.027)
   3X  1.40 (.055)
       1.15 (.045)
        ⊕  0.36 (.014)  Ⓜ B A Ⓜ
   2.54 (.100)
   2X
```

```
         - B -
4.69 (.185)
4.20 (.165)        1.32 (.052)
                   1.22 (.048)

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

                   3X  0.55 (.022)
                       0.46 (.018)
                   2.92 (.115)
                   2.64 (.104)
```

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"

INTERNATIONAL RECTIFIER LOGO

PART NUMBER

DATE CODE
YEAR 7 = 1997
WEEK 19
LINE C

ASSEMBLY LOT CODE

For GB Production

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

INTERNATIONAL RECTIFIER LOGO

PART NUMBER

DATE CODE

LOT CODE

International
IQR Rectifier
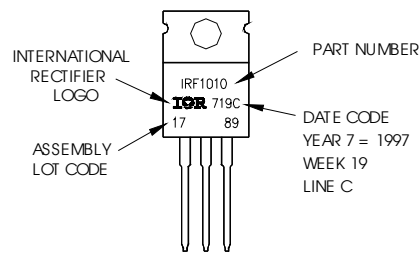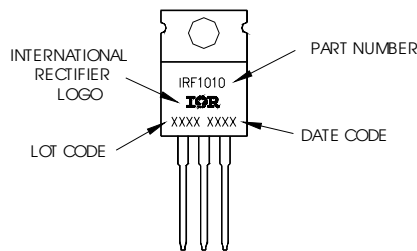
D²Pak Package Outline

Dimensions are shown in millimeters (inches)
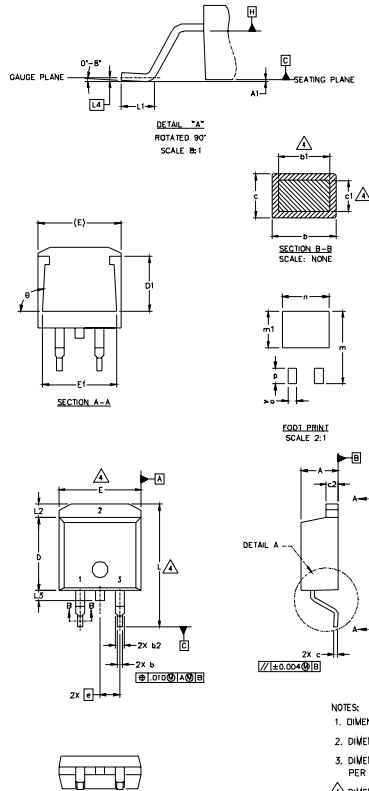
S Y M B O L	DIMENSIONS				N O T E S
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	
A1		0.127		.005	
b	0.51	0.99	.020	.039	
b1	0.51	0.89	.020	.035	4
b2	1.14	1.40	.045	.055	
c	0.43	0.63	.017	.025	
c1	0.38	0.74	.015	.029	4
c2	1.14	1.40	.045	.055	
D	8.51	9.65	.335	.380	3
D1	5.33		.210		
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"

INTERNATIONAL RECTIFIER LOGO

PART NUMBER

DATE CODE
YEAR 0 = 2000
WEEK 02
LINE L

ASSEMBLY LOT CODE

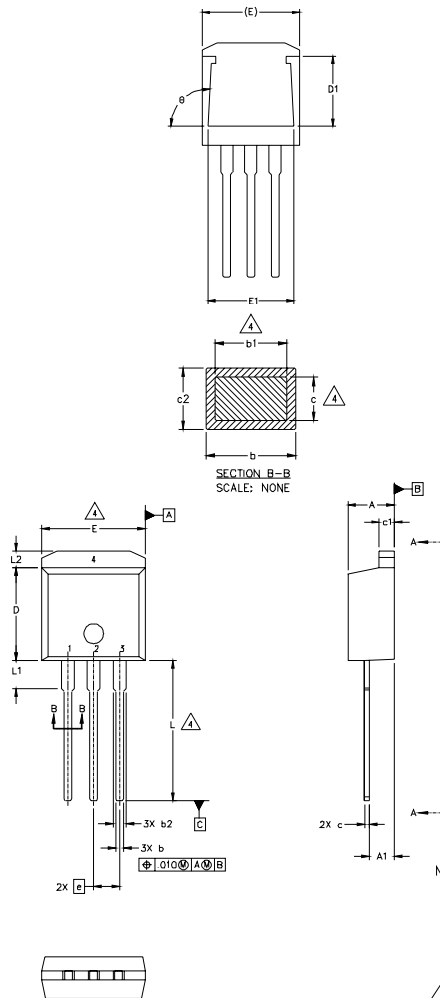**For GB Production**
EXAMPLE: THIS IS AN IRF530S WITH LOT CODE 8024 ASSEMBLED ON WW 02, 2000 IN THE ASSEMBLY LINE "L"

INTERNATIONAL RECTIFIER LOGO

PART NUMBER

DATE CODE
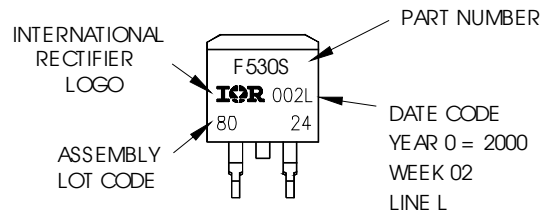
LOT CODE
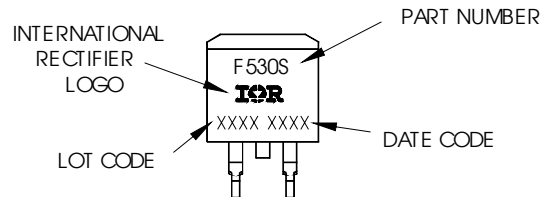
TO-262 Package Outline

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	

LEAD ASSIGNMENTS
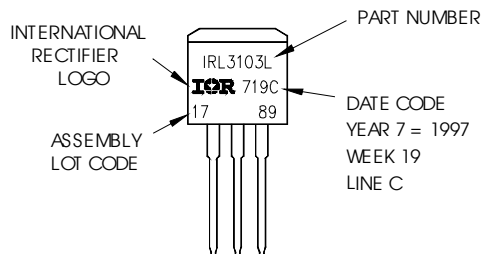
HEXFET
1.— GATE
2.— DRAIN
3.— SOURCE
4.— DRAIN

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 Information

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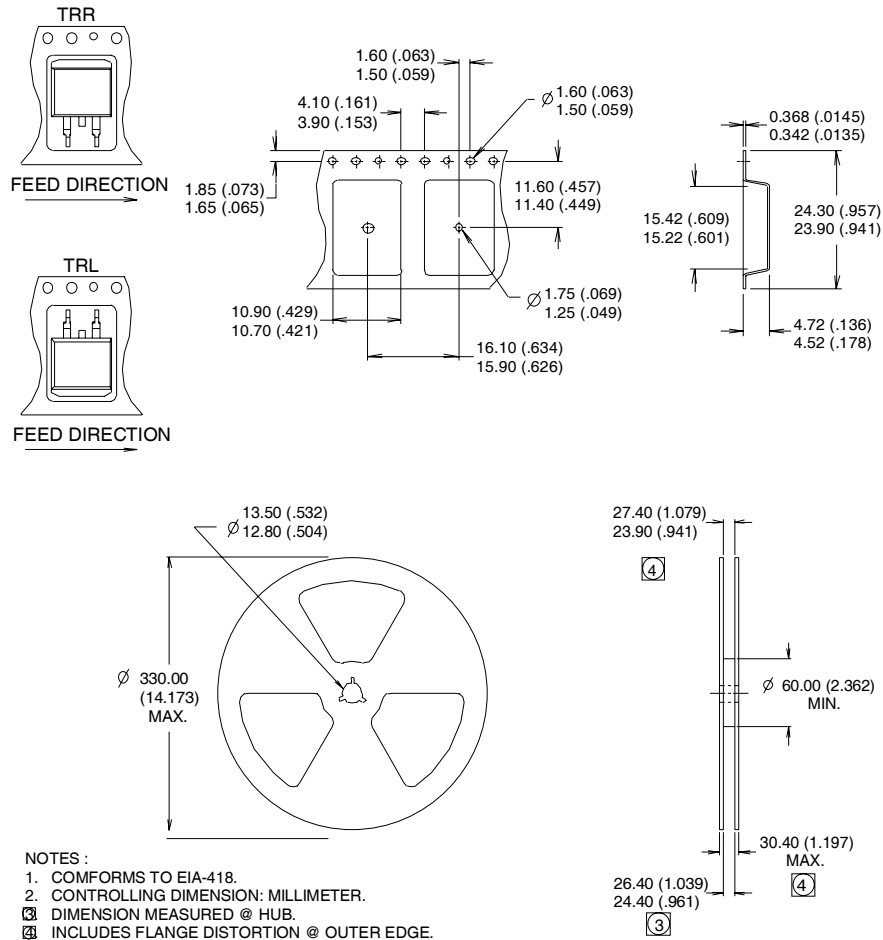ASSEMBLED ON WW 19, 1997
IN THE ASSEMBLY LINE "C"

INTERNATIONAL RECTIFIER LOGO

PART NUMBER

IRL3103L
IΩR 719C
17   89

ASSEMBLY LOT CODE

DATE CODE
YEAR 7 = 1997
WEEK 19
LINE C

IRFZ44Z/S/L

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)

1.85 (.073)
1.65 (.065)

10.90 (.429)
10.70 (.421)

Ø 1.60 (.063)
1.50 (.059)

11.60 (.457)
11.40 (.449)

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.

TO-220AB 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] market.
Qualification Standards can be found on IR's Web site.

International
IФR Rectifier

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Visit us at www.irf.com for sales contact information**.** 10/03