

International
IR Rectifier

Features

- Low On-Resistance
 - Dynamic dV/dT Rating
 - 175°C Operating Temperature
 - Fast Switching
 - Fully Avalanche Rated
 - Repetitive Avalanche Allowed up to T_{jmax}
 - Lead-Free, RoHS Compliant
 - Automotive Qualified *

• **Automotive 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.

Absolute Maximum Ratings

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only; and functional operation of the device at these or any other condition beyond those indicated in the specifications is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability. The thermal resistance and power dissipation ratings are measured under board mounted and still air conditions. Ambient temperature (T_A) is 25°C, unless otherwise specified.

AUTOMOTIVE GRADE

PD - 97471A

AUIRF4104
AUIRF4104S

HEXFET® Power MOSFET

	V_{(BR)DSS}	40V
	R_{DS(on)} typ.	4.3mΩ
	max.	5.5mΩ
	I_D (Silicon Limited)	120A^⑨
	I_D (Package Limited)	75A



TO-220AB
AUIRF4104



D²Pak
AUIRF4104S

Electrical and Thermal Characteristics			
	Parameter	Max.	Units
I_D @ $T_C = 25^\circ\text{C}$	Continuous Drain Current, V_{GS} @ 10V	120 ⑨	A
I_D @ $T_C = 100^\circ\text{C}$	Continuous Drain Current, V_{GS} @ 10V	84 ⑨	
I_D @ $T_C = 25^\circ\text{C}$	Continuous Drain Current, V_{GS} @ 10V (Wire Bond Limited)	75	
I_{DM}	Pulsed Drain Current ①	470	
P_D @ $T_C = 25^\circ\text{C}$	Power Dissipation	140	W
	Linear Derating Factor	0.95	W/C
V_{GS}	Gate-to-Source Voltage	± 20	V
E_{AS}	Single Pulse Avalanche Energy (Thermally Limited) ②	120	mJ
E_{AS} (tested)	Single Pulse Avalanche Energy Tested Value ⑤	220	
I_{AR}	Avalanche Current ①	See Fig.12a, 12b, 15, 16	A
E_{AR}	Repetitive Avalanche Energy ⑤		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 ⑧	10 lbf•in (1.1N•m)	

Thermal Resistance

	Parameter	Typ.	Max.	Units
R_{0JC}	Junction-to-Case ⑦	—	1.05	°C/W
R_{0CS}	Case-to-Sink, Flat Greased Surface	0.50	—	
R_{0JA}	Junction-to-Ambient (PCB Mount)	—	40	

HEXFET® is a registered trademark of International Rectifier.

*Qualification standards can be found at <http://www.irf.com/>

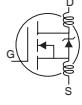
www.irf.com

Note ① to ⑨ are on page 3

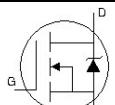
Static Electrical Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise stated)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(\text{BR})\text{DSS}}$	Drain-to-Source Breakdown Voltage	40	—	—	V	$V_{\text{GS}} = 0\text{V}$, $I_D = 250\mu\text{A}$
$\Delta V_{(\text{BR})\text{DSS}/\Delta T_J}$	Breakdown Voltage Temp. Coefficient	—	0.032	—	V/ $^\circ\text{C}$	Reference to 25°C , $I_D = 1\text{mA}$
$R_{\text{DS}(\text{on})}$	Static Drain-to-Source On-Resistance	—	4.3	5.5	$\text{m}\Omega$	$V_{\text{GS}} = 10\text{V}$, $I_D = 75\text{A}$ ③
$V_{\text{GS}(\text{th})}$	Gate Threshold Voltage	2.0	—	4.0	V	$V_{\text{DS}} = V_{\text{GS}}$, $I_D = 250\mu\text{A}$
g_{fs}	Forward Transconductance	63	—	—	V	$V_{\text{DS}} = 10\text{V}$, $I_D = 75\text{A}$
I_{DSS}	Drain-to-Source Leakage Current	—	—	20	μA	$V_{\text{DS}} = 40\text{V}$, $V_{\text{GS}} = 0\text{V}$
		—	—	250		$V_{\text{DS}} = 40\text{V}$, $V_{\text{GS}} = 0\text{V}$, $T_J = 125^\circ\text{C}$
I_{GSS}	Gate-to-Source Forward Leakage	—	—	200	nA	$V_{\text{GS}} = 20\text{V}$
		—	—	-200		$V_{\text{GS}} = -20\text{V}$

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

Q_g	Total Gate Charge	—	68	100	nC	$I_D = 75\text{A}$ $V_{\text{DS}} = 32\text{V}$ $V_{\text{GS}} = 10\text{V}$ ③
Q_{gs}	Gate-to-Source Charge	—	21	—		
Q_{gd}	Gate-to-Drain ("Miller") Charge	—	27	—		
$t_{\text{d}(\text{on})}$	Turn-On Delay Time	—	16	—	ns	$V_{\text{DD}} = 20\text{V}$ $I_D = 75\text{A}$ $R_G = 6.8 \Omega$ $V_{\text{GS}} = 10\text{V}$ ③
t_r	Rise Time	—	130	—		
$t_{\text{d}(\text{off})}$	Turn-Off Delay Time	—	38	—		
t_f	Fall Time	—	77	—		
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	—	3000	—	pF	$V_{\text{GS}} = 0\text{V}$
C_{oss}	Output Capacitance	—	660	—		$V_{\text{DS}} = 25\text{V}$
C_{rss}	Reverse Transfer Capacitance	—	380	—		$f = 1.0\text{MHz}$
C_{oss}	Output Capacitance	—	2160	—		$V_{\text{GS}} = 0\text{V}$, $V_{\text{DS}} = 1.0\text{V}$, $f = 1.0\text{MHz}$
C_{oss}	Output Capacitance	—	560	—		$V_{\text{GS}} = 0\text{V}$, $V_{\text{DS}} = 32\text{V}$, $f = 1.0\text{MHz}$
$C_{\text{oss eff.}}$	Effective Output Capacitance	—	850	—		$V_{\text{GS}} = 0\text{V}$, $V_{\text{DS}} = 0\text{V}$ to 32V ④

Diode Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
I_S	Continuous Source Current (Body Diode)	—	—	75	A	MOSFET symbol showing the integral reverse p-n junction diode.
I_{SM}	Pulsed Source Current (Body Diode) ①	—	—	470		
V_{SD}	Diode Forward Voltage	—	—	1.3	V	$T_J = 25^\circ\text{C}$, $I_S = 75\text{A}$, $V_{\text{GS}} = 0\text{V}$ ③
t_{rr}	Reverse Recovery Time	—	23	35	ns	$T_J = 25^\circ\text{C}$, $I_F = 75\text{A}$, $V_{\text{DD}} = 20\text{V}$
Q_{rr}	Reverse Recovery Charge	—	6.8	10	nC	$\text{di}/\text{dt} = 100\text{A}/\mu\text{s}$ ③
t_{on}	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by L_S+L_D)				

Qualification Information[†]

Qualification Level		Automotive (per AEC-Q101) ^{††}	
		Comments: This part number(s) passed Automotive qualification. IR's Industrial and Consumer qualification level is granted by extension of the higher Automotive level.	
Moisture Sensitivity Level	TO-220AB	N/A	
	D ² PAK	MSL1	
ESD	Machine Model	Class M4 AEC-Q101-002	
	Human Body Model	Class H1C AEC-Q101-001	
	Charged Device Model	Class C3 AEC-Q101-005	
RoHS Compliant		Yes	

[†] Qualification standards can be found at International Rectifier's web site: <http://www.irf.com/>

^{††} Exceptions to AEC-Q101 requirements are noted in the qualification report.

Notes:

- ① Repetitive rating; pulse width limited by max. junction temperature. (See fig. 11).
- ② Limited by $T_{J\max}$, starting $T_J = 25^\circ\text{C}$, $L = 0.04\text{mH}$ $R_G = 25\Omega$, $I_{AS} = 75\text{A}$, $V_{GS} = 10\text{V}$. Part not recommended for use above this value.
- ③ Pulse width $\leq 1.0\text{ms}$; duty cycle $\leq 2\%$.
- ④ $C_{oss\ eff}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS} .
- ⑤ This value determined from sample failure population, starting $T_J = 25^\circ\text{C}$, $L = 0.04\text{mH}$, $R_G = 25\Omega$, $I_{AS} = 75\text{A}$, $V_{GS} = 10\text{V}$.
- ⑥ 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.
- ⑦ R_θ is measured at T_J approximately 90°C .
- ⑧ This is only applied to TO-220AB package.
- ⑨ Calculated continuous current based on maximum allowable junction temperature. Bond wire current limit is 75A. Note that current limitations arising from heating of the device leads may occur with some lead mounting arrangements.(Refer to AN-1140 <http://www.irf.com/technical-info/appnotes/an-1140.pdf>)

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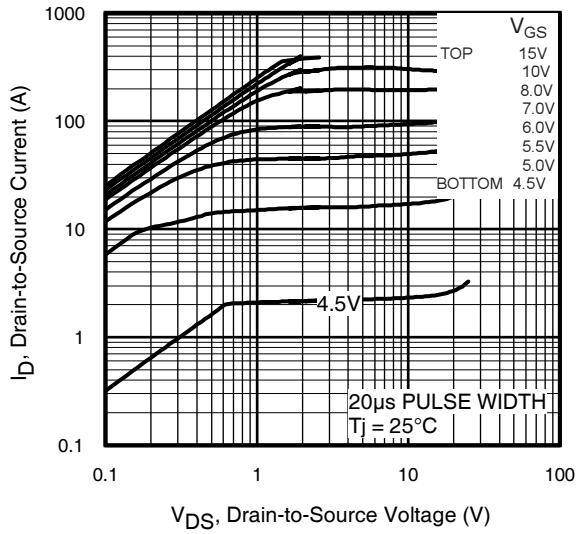


Fig 1. Typical Output Characteristics

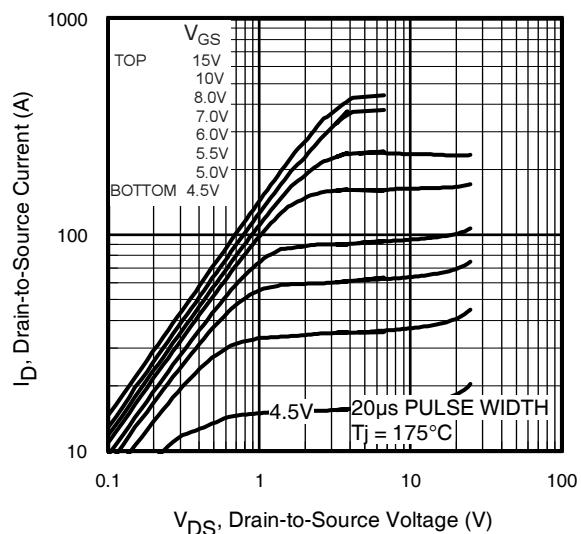


Fig 2. Typical Output Characteristics

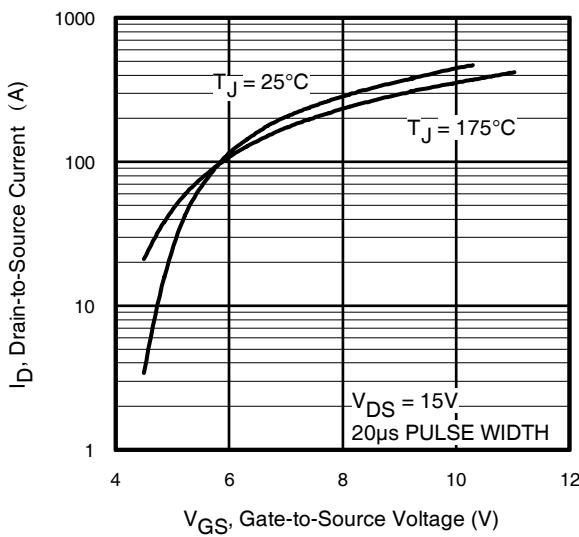


Fig 3. Typical Transfer Characteristics

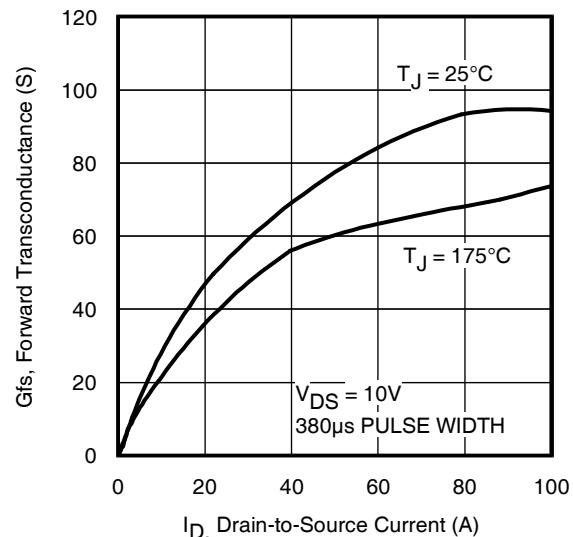


Fig 4. Typical Forward Transconductance Vs. Drain Current

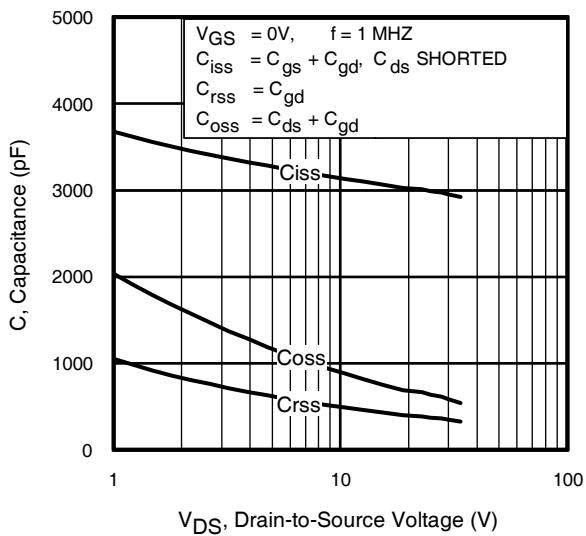


Fig 5. Typical Capacitance Vs.
 Drain-to-Source Voltage

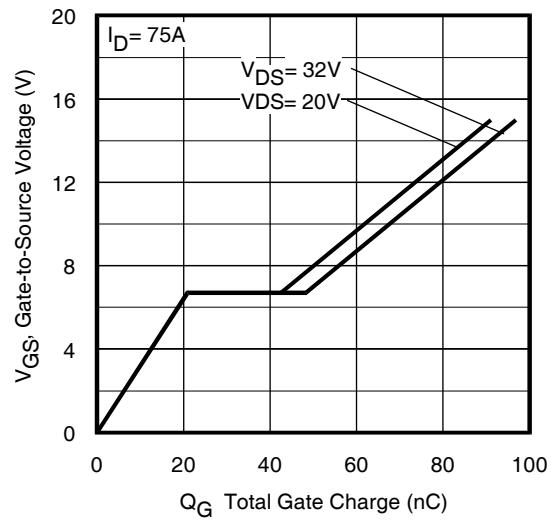


Fig 6. Typical Gate Charge Vs.
 Gate-to-Source Voltage

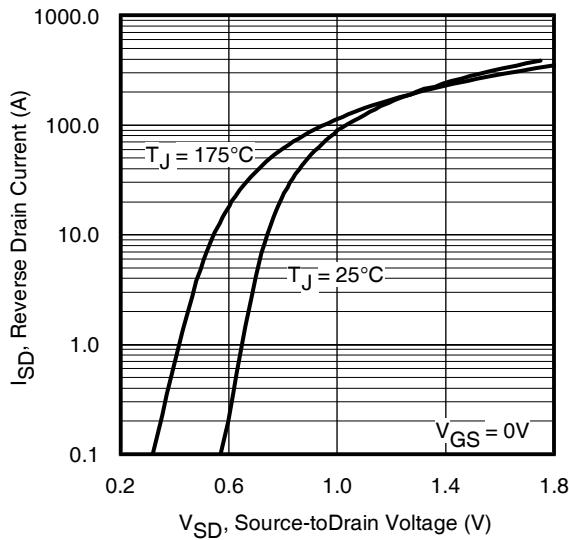


Fig 7. Typical Source-Drain Diode
 Forward Voltage

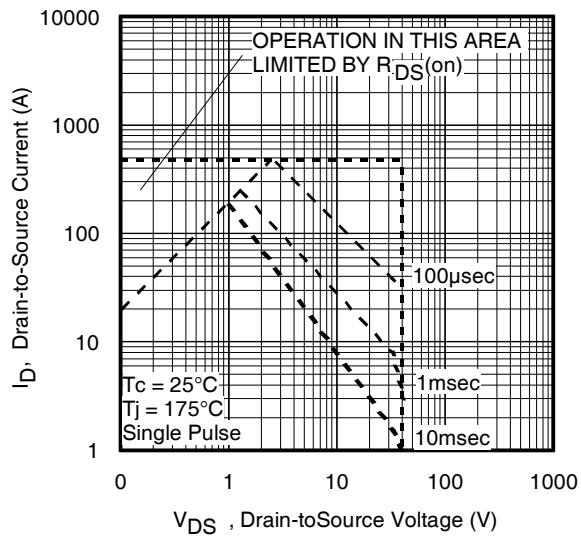


Fig 8. Maximum Safe Operating Area

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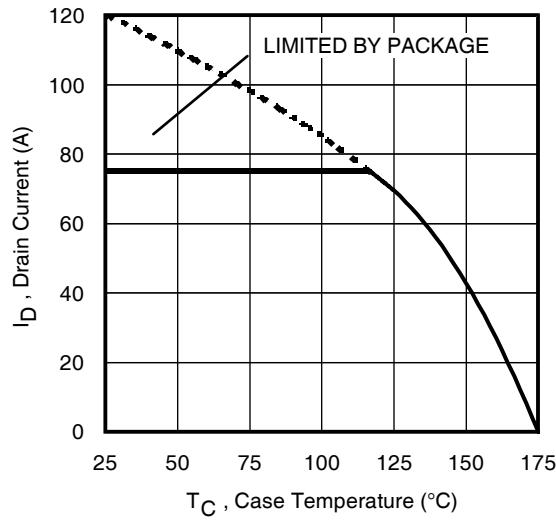


Fig 9. Maximum Drain Current Vs.
Case Temperature

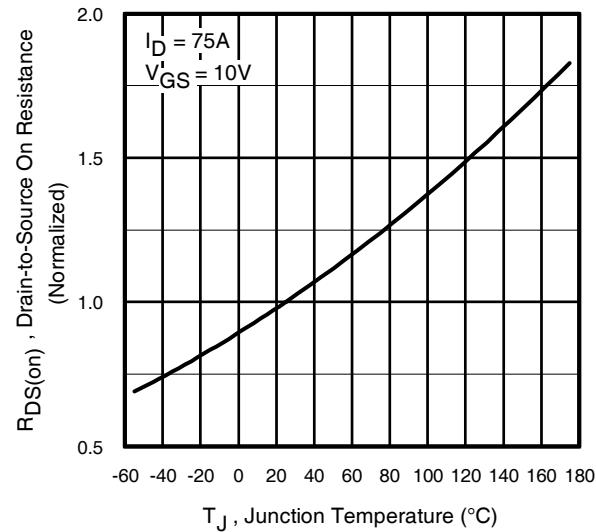


Fig 10. Normalized On-Resistance
Vs. Temperature

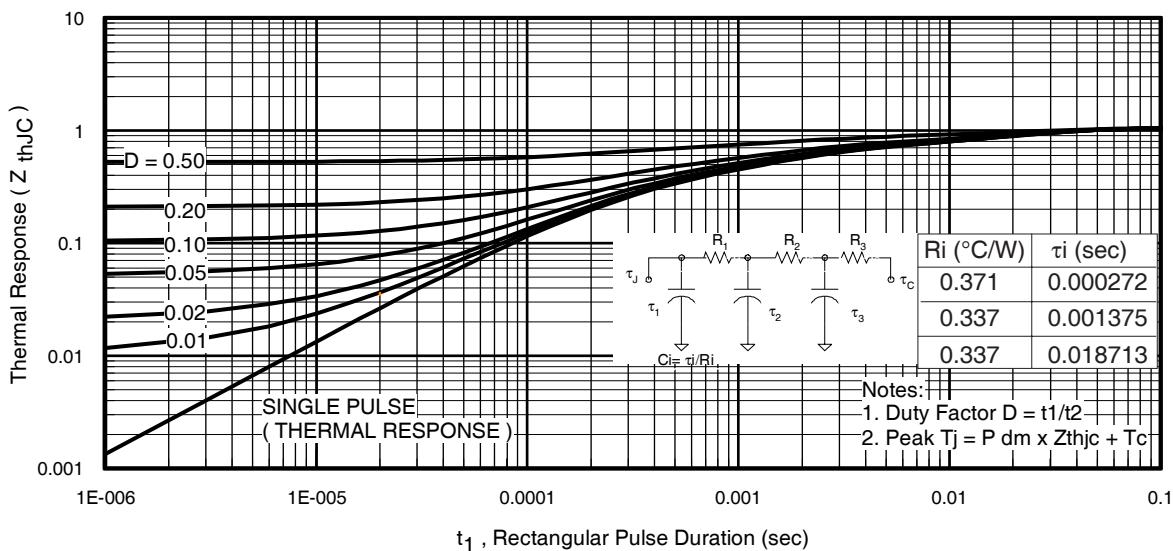


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

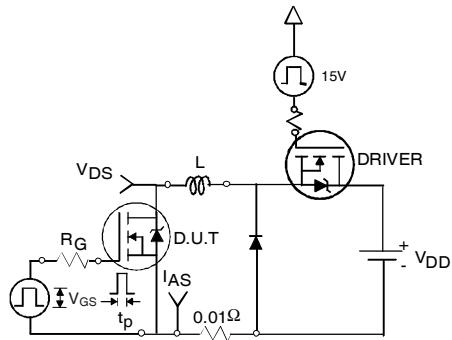


Fig 12a. Unclamped Inductive Test Circuit

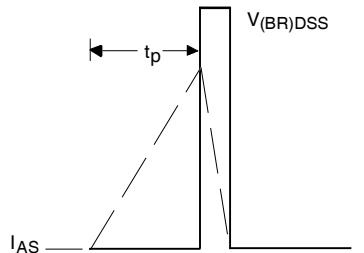


Fig 12b. Unclamped Inductive Waveforms

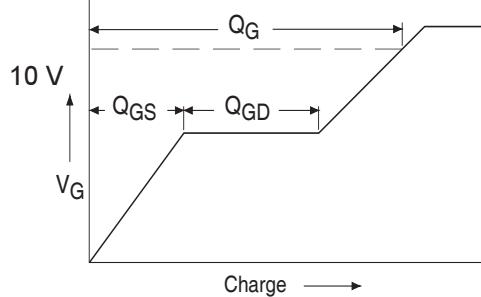


Fig 13a. Basic Gate Charge Waveform

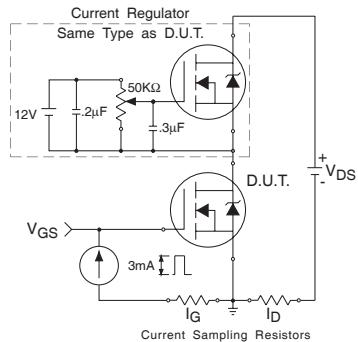


Fig 13b. Gate Charge Test Circuit

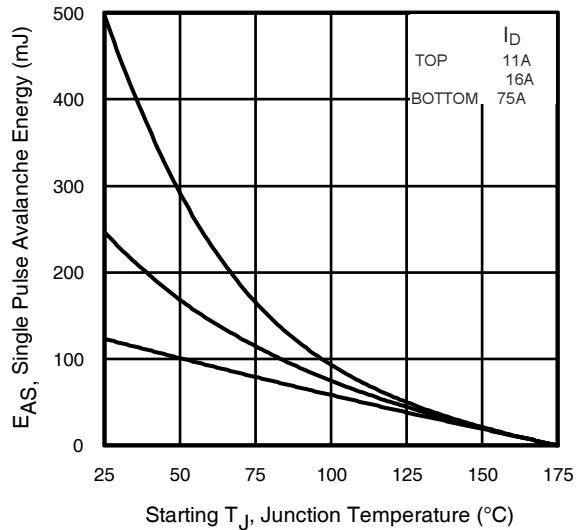


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

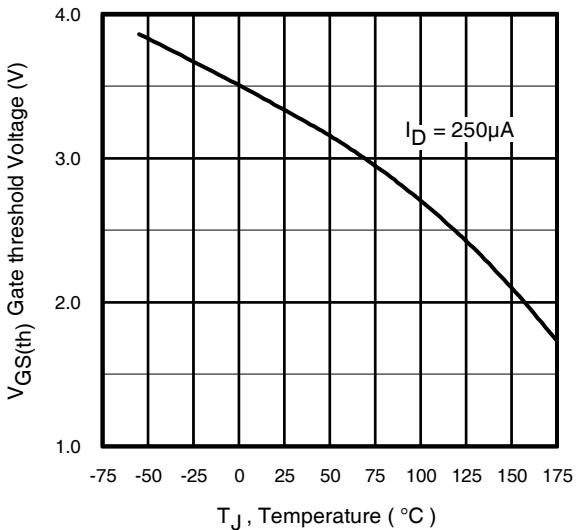


Fig 14. Threshold Voltage Vs. Temperature

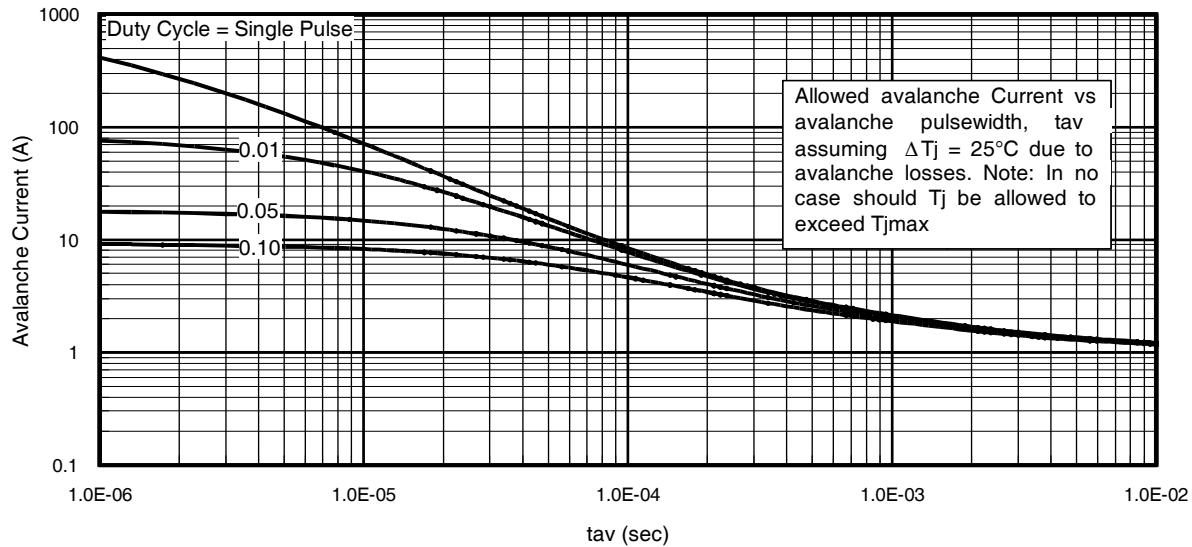


Fig 15. Typical Avalanche Current Vs.Pulsewidth

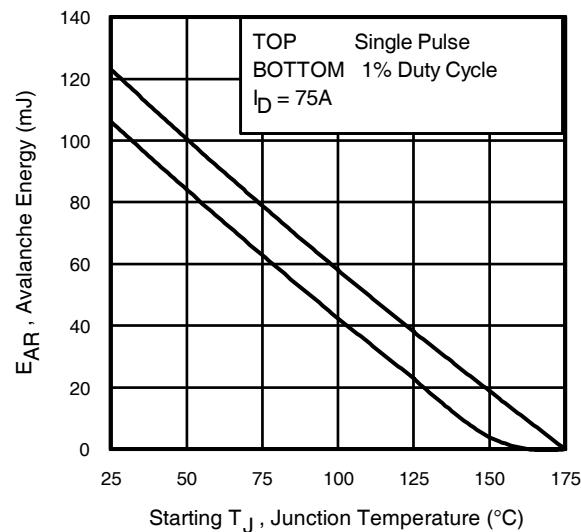


Fig 16. Maximum Avalanche Energy Vs. Temperature

**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

$$P_{D(ave)} = 1/2 (1.3 \cdot BV \cdot I_{av}) = \Delta T / Z_{thJC}$$

$$I_{av} = 2\Delta T / [1.3 \cdot BV \cdot Z_{th}]$$

$$E_{AS(AR)} = P_{D(ave)} \cdot t_{av}$$

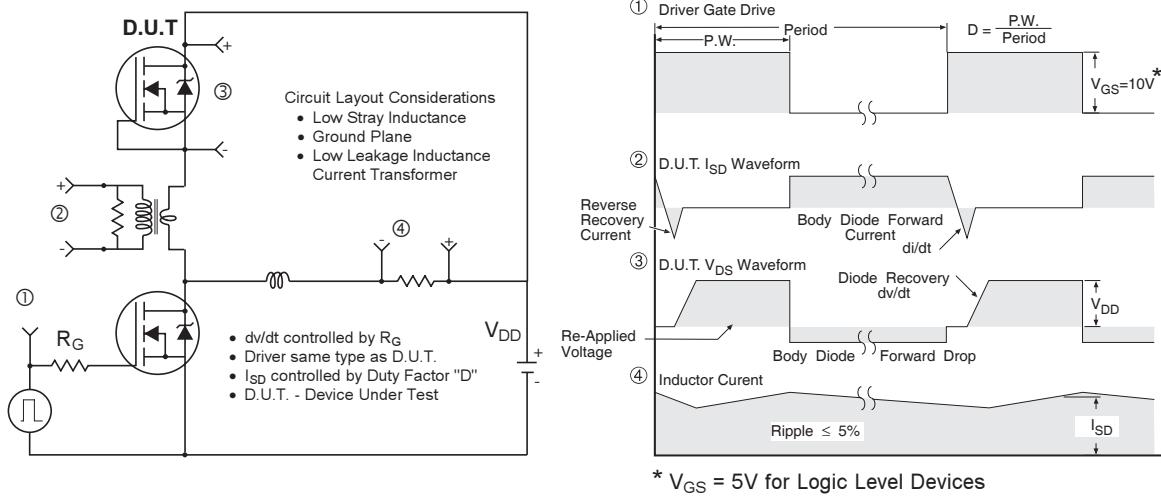


Fig 17. Peak Diode Recovery dv/dt Test Circuit for N-Channel HEXFET® Power MOSFETs

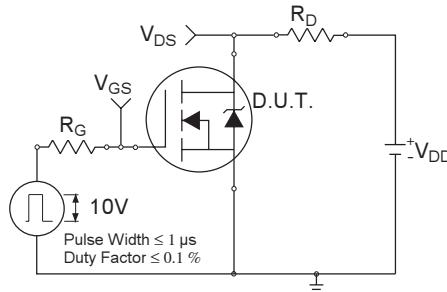


Fig 18a. Switching Time Test Circuit

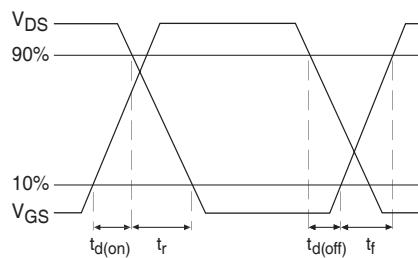
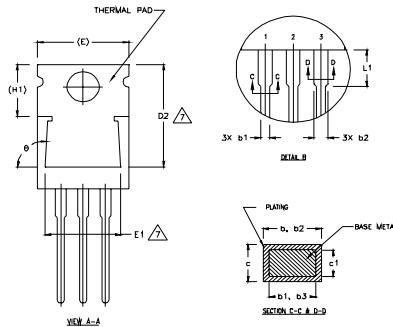
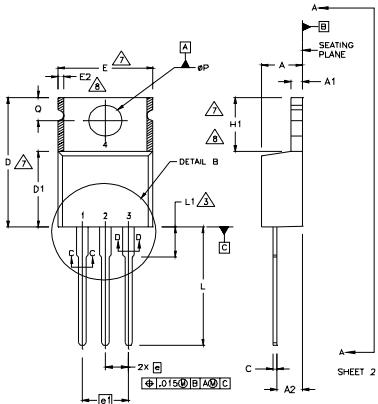


Fig 18b. Switching Time Waveforms

AUIRF4104/S

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 1.1.
4. DIMENSION D & 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 & 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.

LEAD ASSIGNMENTS

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

IGBTs, CoPak

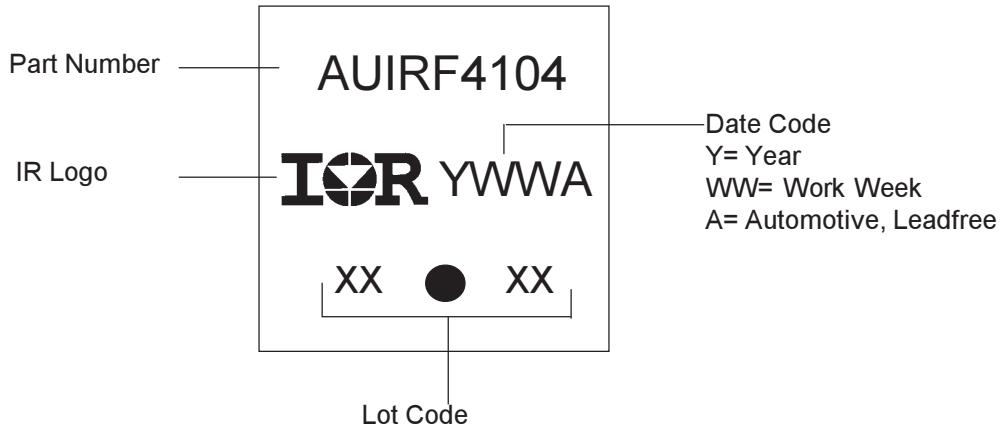
- 1.- GATE
 2.- COLLECTOR
 3.- Emitter

Diodes

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

SYMBOL	DIMENSIONS		NOTES
	MILLIMETERS	INCHES	
	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
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
D	14.22	16.51	.560 .650
D1	8.38	9.02	.330 .355
D2	12.19	12.88	.480 .507
E	9.66	10.66	.380 .420
E1	8.38	8.89	.330 .350
e	2.54 BSC 5.08	.100 BSC .200 BSC	
e1			
H1	5.85	6.55	.230 .270
L	12.70	14.73	.500 .580
L1	—	6.35	— .250
øP	3.54	4.08	.139 .161
Q	2.54	3.42	.100 .135
ø	90°-93°	90°-93°	

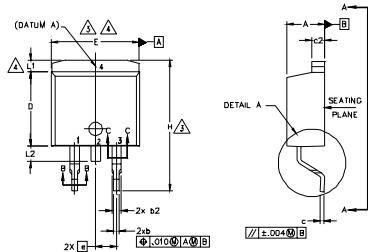
TO-220AB Part Marking Information



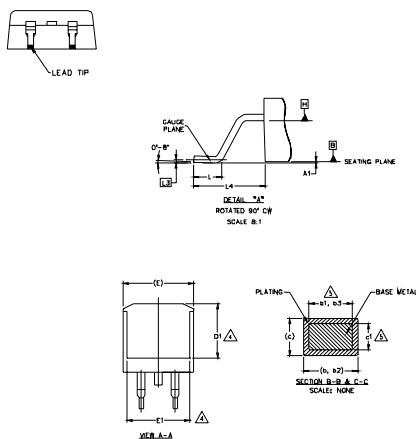
Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>

International
IR Rectifier
D²Pak Package Outline (Dimensions are shown in millimeters (inches))

AUIRF4104/S



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.



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	1.27	1.78	—	.070		
L3	0.25	BSC	.010	BSC		
L4	4.78	5.28	.188	.208		

LEAD ASSIGNMENTS

HEXFET

1. GATE
2. 4. DRAIN
3. SOURCE

IGBT_s, CoPACK

1. GATE
2. 4. COLLECTOR
3. Emitter

DIODES

1. ANODE *
2. 4. CATHODE
3. ANODE

* PART DEPENDENT.

D²Pak Part Marking Information

Part Number

AUF4104S

Date Code

Y= Year

WW= Work Week

A= Automotive, Leadfree

IR Logo

IR YWVA

XX ● XX

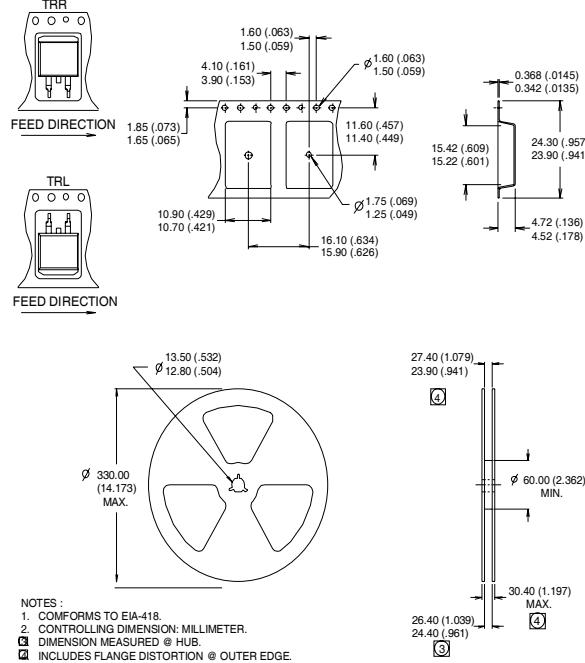
Lot Code

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

AUIRF4104/S

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IR Rectifier

D²Pak Tape & Reel Infomation



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

Ordering Information

Base part number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIRF4104	TO-220	Tube	50	AUIRF4104
AUIRF4104S	D2Pak	Tube	50	AUIRF4104S
AUIRF4104S		Tape and Reel Left	800	AUIRF4104STRL
AUIRF4104S		Tape and Reel Right	800	AUIRF4104STRR

IMPORTANT NOTICE

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WORLD HEADQUARTERS:

233 Kansas St., El Segundo, California 90245

Tel: (310) 252-7105

www.irf.com

Revision History

Date	Comments
2/5/2010	<p>Revised with new AU template:</p> <ul style="list-style-type: none">1)Add sentence below Absolute Max Rating2)Update ESD by using ESD data and table from Anika3)Update Part Marking drawing4) Add Order Info table5) Add Revision History