PD - 97471A

International **IOR** Rectifier

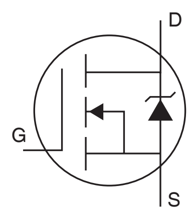
AUTOMOTIVE GRADE

AUIRF4104
AUIRF4104S

HEXFET® Power MOSFET

Features

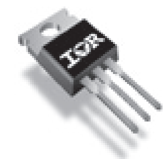
- Low On-Resistance
- Dynamic dV/dT Rating
- 175°C Operating Temperature
- Fast Switching
- Fully Avalanche Rated
- Repetitive Avalanche Allowed up to Tjmax
- Lead-Free, RoHS Compliant
- Automotive Qualified *



$V_{(BR)DSS}$		40V
$R_{DS(on)}$	typ.	4.3mΩ
	max.	5.5mΩ
$I_{D\ (Silicon\ Limited)}$		120A⑨
$I_{D\ (Package\ Limited)}$		75A

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.



TO-220AB
AUIRF4104

D²Pak
AUIRF4104S

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.

	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V	120 ⑨	A
I_D @ T_C = 100°C	Continuous Drain Current, VGS @ 10V	84⑨	
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V (Wire Bond Limited)	75	
I_{DM}	Pulsed Drain Current ①	470	
P_D @T_C = 25°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 T_{STG}	Operating Junction and Storage Temperature Range	-55 to + 175	°C
	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
$R_{\theta JC}$	Junction-to-Case ⑦	——	1.05	°C/W
$R_{\theta CS}$	Case-to-Sink, Flat Greased Surface	0.50	——	
$R_{\theta JA}$	Junction-to-Ambient (PCB Mount)	——	40	

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

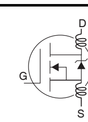
Note ① to ⑨ are on page 3

3/29/10

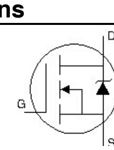
Static Electrical Characteristics @ T_J = 25°C (unless otherwise stated)

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

Dynamic Electrical Characteristics @ T_J = 25°C (unless otherwise stated)

Q_g	Total Gate Charge	–––	68	100		I_D = 75A
Q_{gs}	Gate-to-Source Charge	–––	21	–––	nC	V_{DS} = 32V
Q_{gd}	Gate-to-Drain ("Miller") Charge	–––	27	–––		V_{GS} = 10V ③
$t_{d(on)}$	Turn-On Delay Time	–––	16	–––		V_{DD} = 20V
t_r	Rise Time	–––	130	–––		I_D = 75A
$t_{d(off)}$	Turn-Off Delay Time	–––	38	–––	ns	R_G = 6.8 Ω
t_f	Fall Time	–––	77	–––		V_{GS} = 10V ③
L_D	Internal Drain Inductance	–––	4.5	–––	nH	Between lead, 6mm (0.25in.) 
L_S	Internal Source Inductance	–––	7.5	–––		from package and center of die contact
C_{iss}	Input Capacitance	–––	3000	–––		V_{GS} = 0V
C_{oss}	Output Capacitance	–––	660	–––		V_{DS} = 25V
C_{rss}	Reverse Transfer Capacitance	–––	380	–––	pF	f = 1.0MHz
C_{oss}	Output Capacitance	–––	2160	–––		V_{GS} = 0V, V_{DS} = 1.0V, f = 1.0MHz
C_{oss}	Output Capacitance	–––	560	–––		V_{GS} = 0V, V_{DS} = 32V, f = 1.0MHz
C_{oss} eff.	Effective Output Capacitance	–––	850	–––		V_{GS} = 0V, V_{DS} = 0V to 32V ④

Diode Characteristics

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

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_{Jmax}, starting T_J = 25°C, L = 0.04mH R_G = 25Ω, I_{AS} = 75A, V_{GS} =10V. Part not recommended for use above this value.

③ Pulse width ≤ 1.0ms; duty cycle ≤ 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°C, L = 0.04mH, R_G = 25Ω, I_{AS} = 75A, V_{GS} =10V

⑥ This is applied to D^2Pak, 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 pakcage.

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)

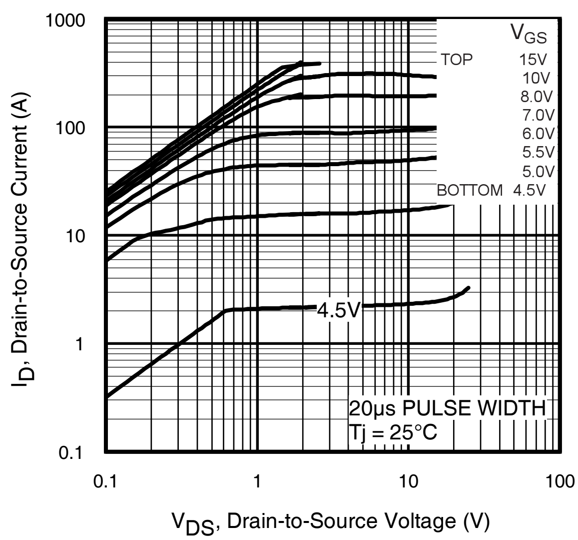


Fig 1. Typical Output Characteristics

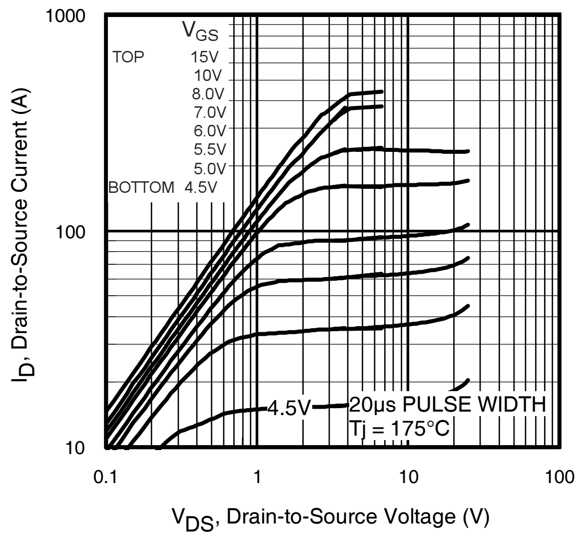


Fig 2. Typical Output Characteristics

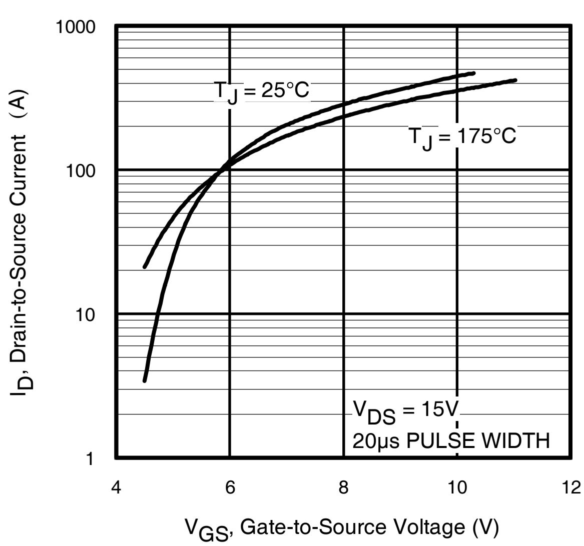


Fig 3. Typical Transfer Characteristics

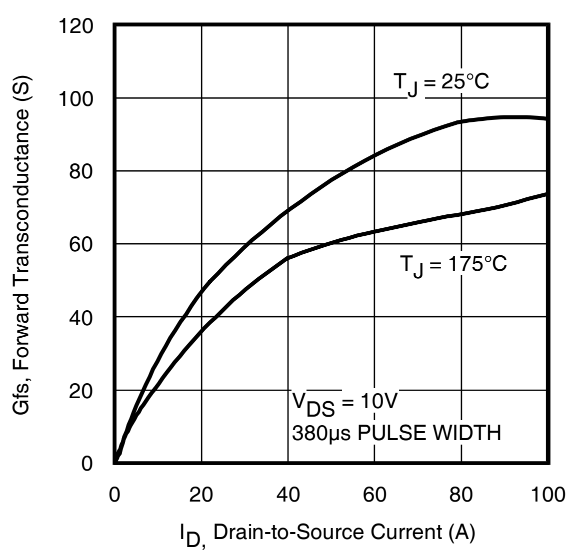


Fig 4. Typical Forward Transconductance Vs. Drain Current

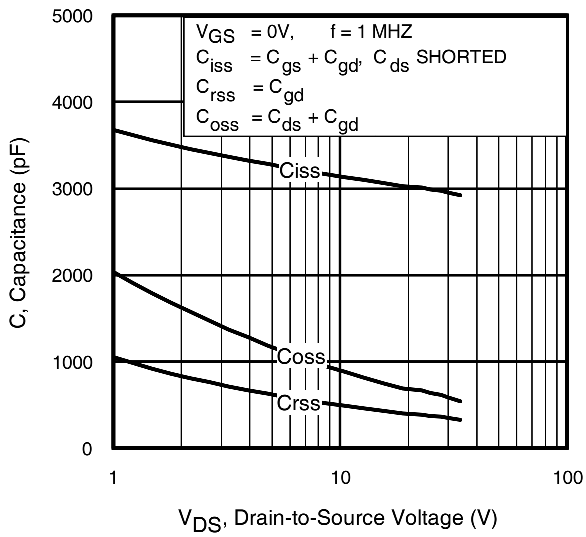


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

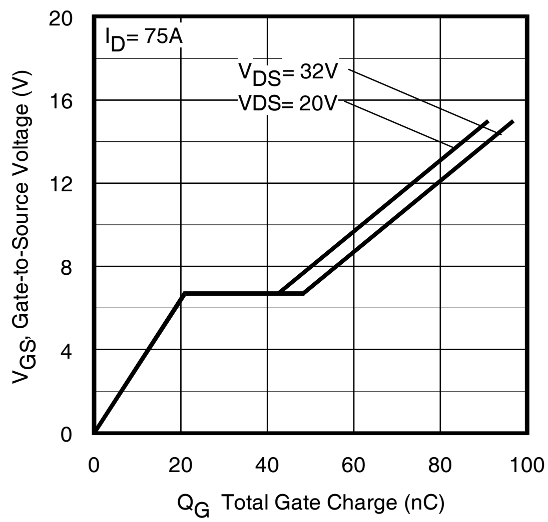


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

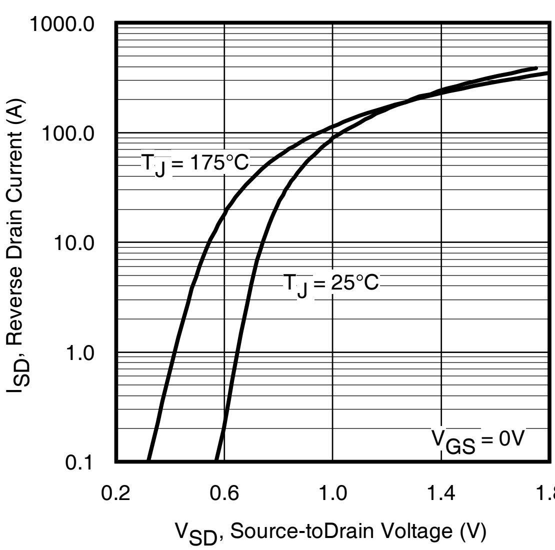


Fig 7. Typical Source-Drain Diode Forward Voltage

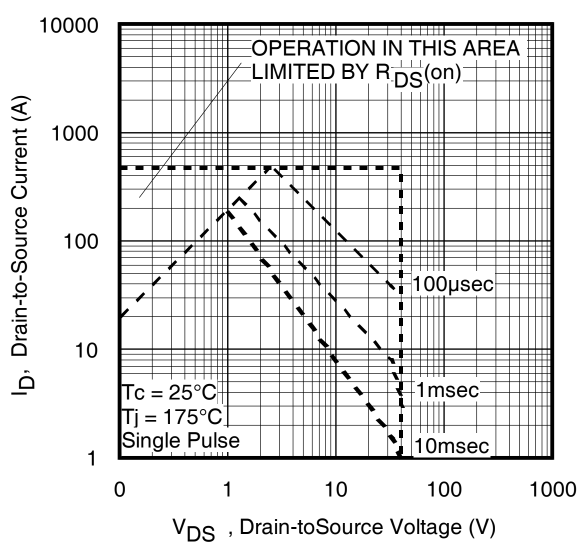


Fig 8. Maximum Safe Operating Area

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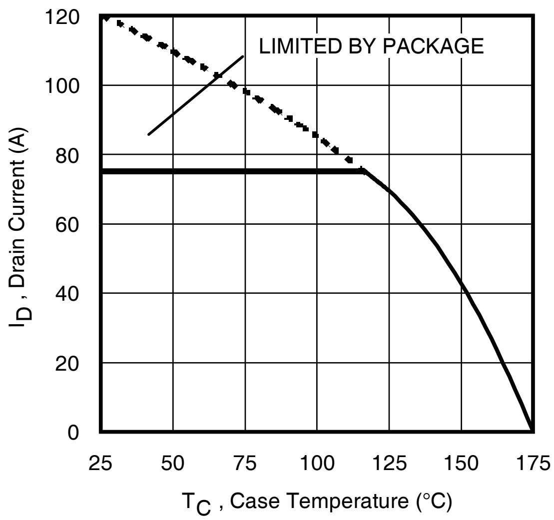


Fig 9. Maximum Drain Current Vs. Case Temperature

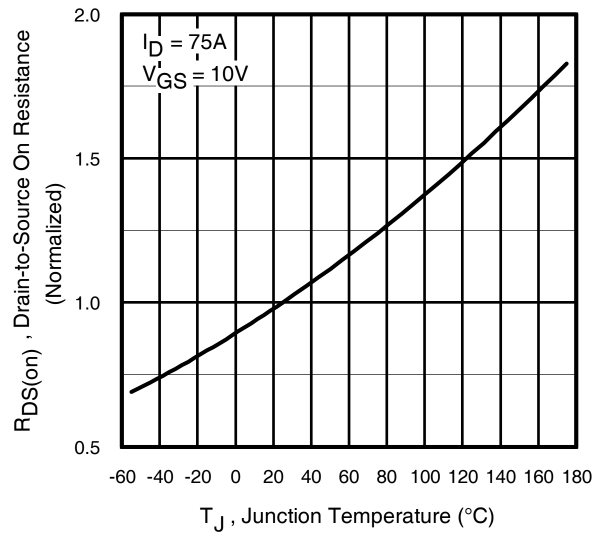


Fig 10. Normalized On-Resistance Vs. Temperature

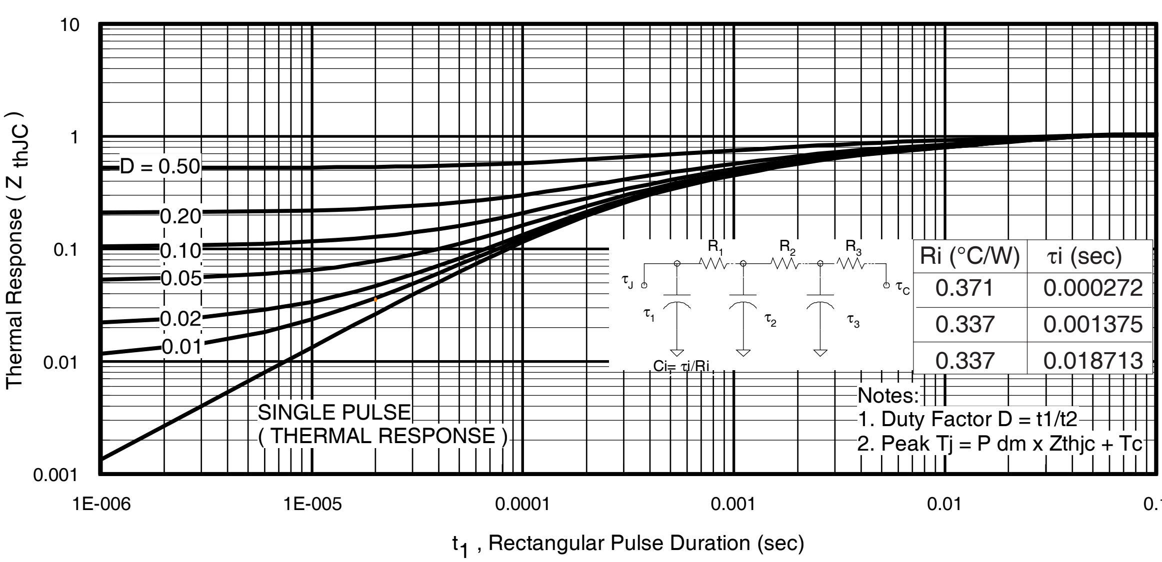


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

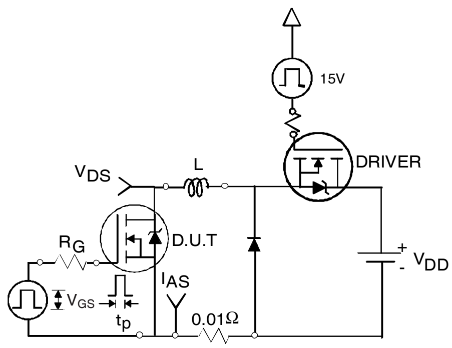


Fig 12a. Unclamped Inductive Test Circuit

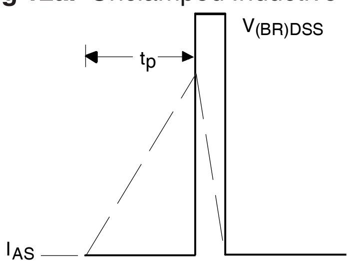


Fig 12b. Unclamped Inductive Waveforms

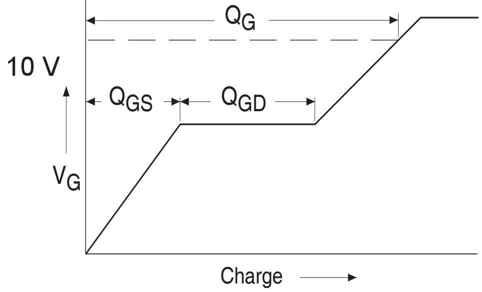


Fig 13a. Basic Gate Charge Waveform

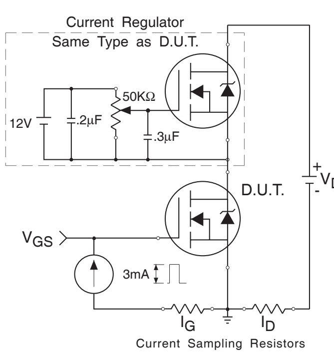


Fig 13b. Gate Charge Test Circuit

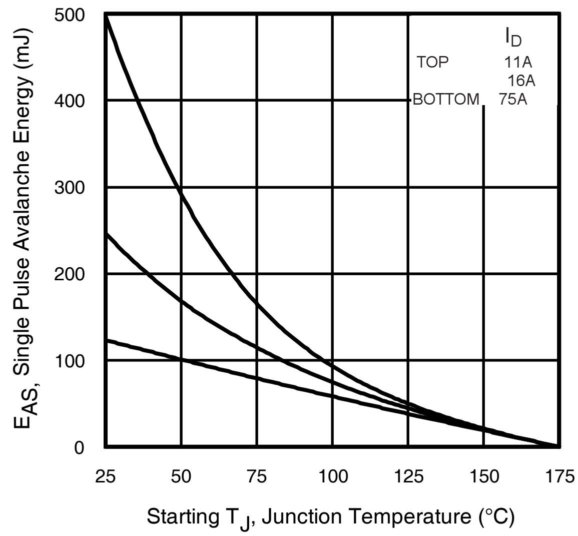


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

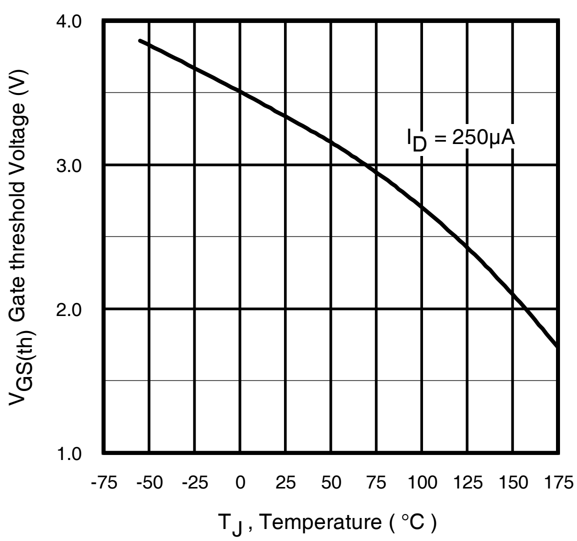


Fig 14. Threshold Voltage Vs. Temperature

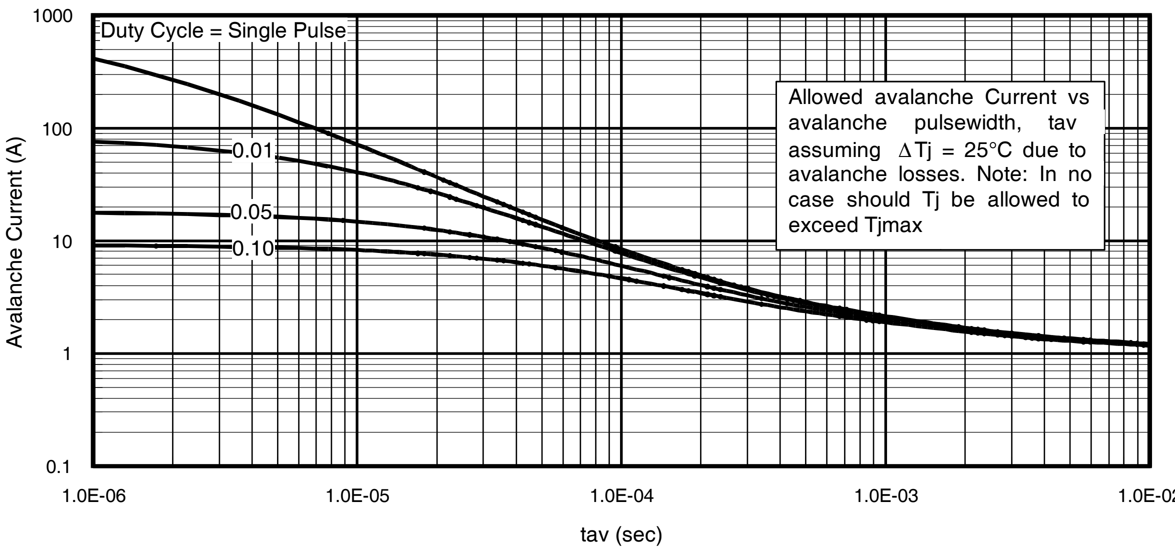


Fig 15. Typical Avalanche Current Vs.Pulsewidth

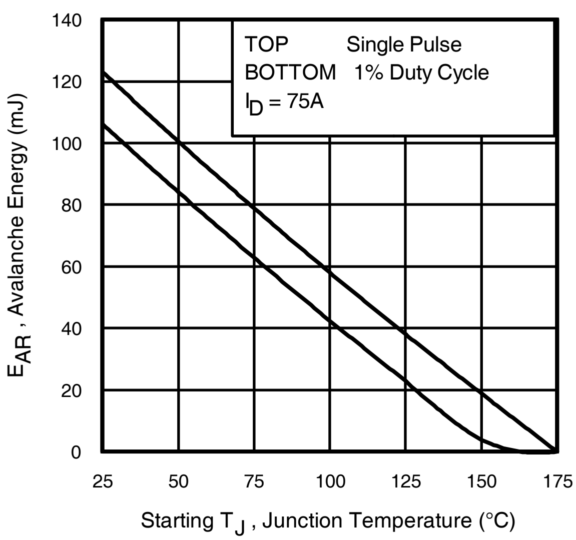


Fig 16. Maximum Avalanche Energy Vs. Temperature

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)

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

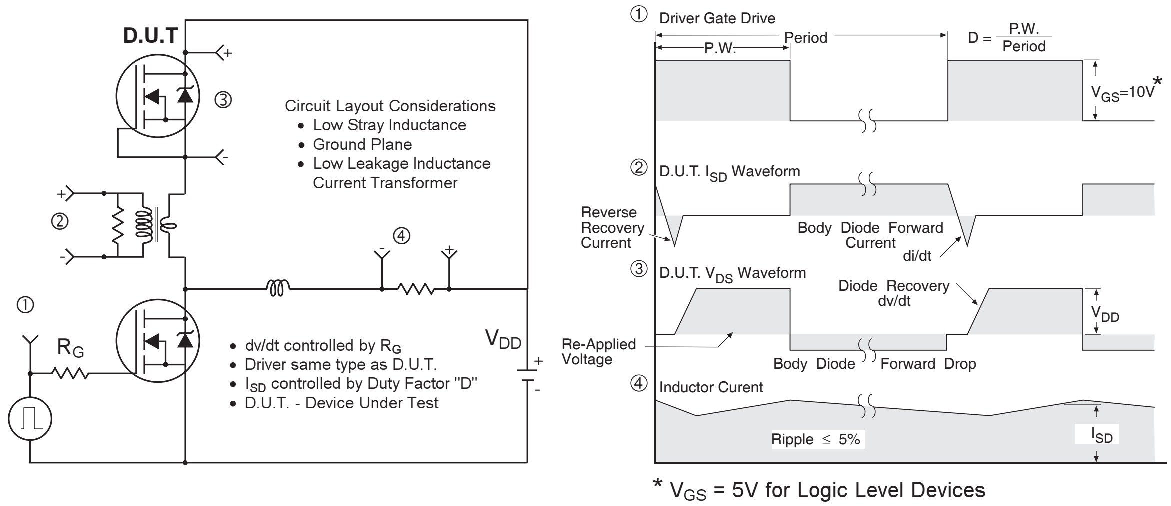


Fig 17. Peak Diode Recovery dv/dt Test Circuit for N-Channel HEXFET® Power MOSFETs

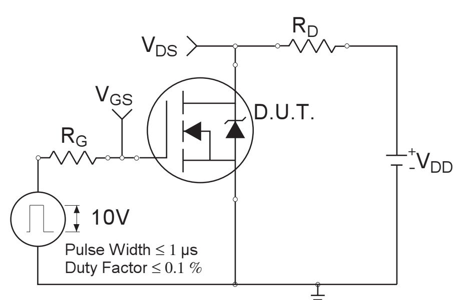


Fig 18a. Switching Time Test Circuit

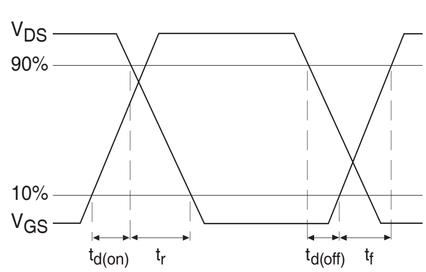
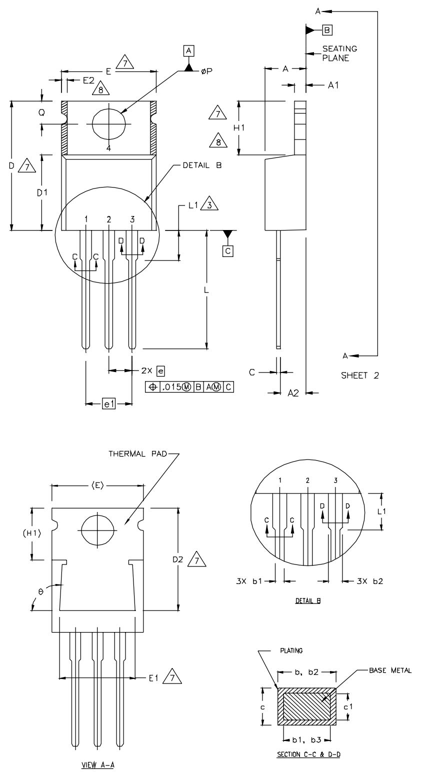


Fig 18b. Switching Time Waveforms

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 L1.
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

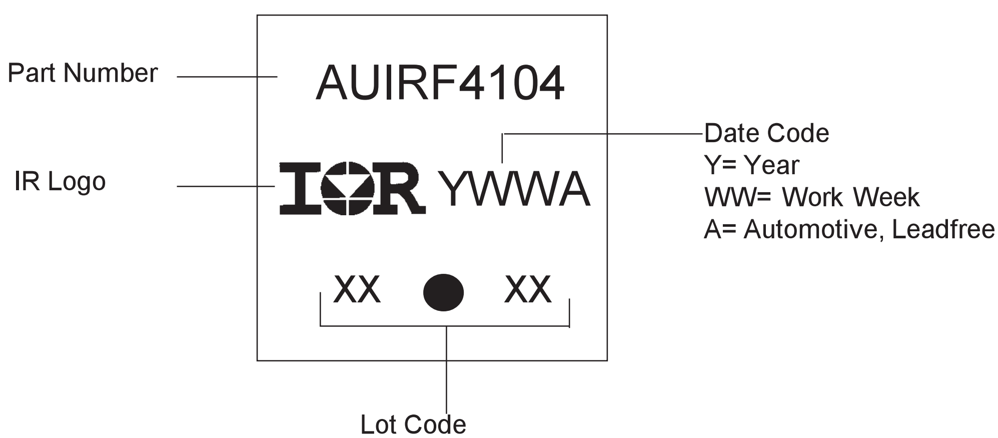
HEXFET
1.- GATE
2.- DRAIN
3.- SOURCE

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

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

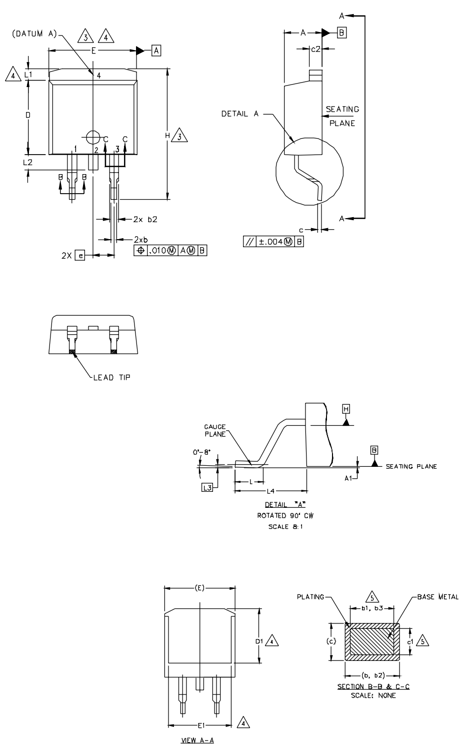
SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	3.56	4.82	.140	.190	
A1	0.51	1.40	.020	.055	
A2	2.04	2.92	.080	.115	
b	0.38	1.01	.015	.040	
b1	0.38	0.96	.015	.038	5
b2	1.15	1.77	.045	.070	
b3	1.15	1.73	.045	.068	
c	0.36	0.61	.014	.024	
c1	0.36	0.56	.014	.022	5
D	14.22	16.51	.560	.650	4
D1	8.38	9.02	.330	.355	
D2	12.19	12.88	.480	.507	7
E	9.66	10.66	.380	.420	4,7
E1	8.38	8.89	.330	.350	7
e	2.54 BSC		.100 BSC		
e1	5.08		.200 BSC		
H1	5.85	6.55	.230	.270	7,8
L	12.70	14.73	.500	.580	
L1	–	6.35	–	.250	3
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/

D²Pak Package Outline (Dimensions are shown in millimeters (inches))



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

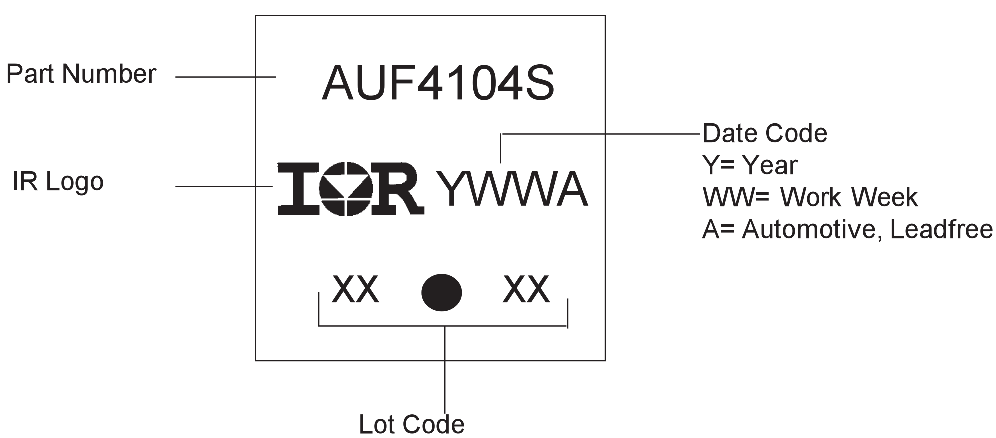
HEXFET
1.– GATE
2, 4.– DRAIN
3.– SOURCE

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

DIODES
1.– ANODE *
2, 4.– CATHODE
3.– ANODE

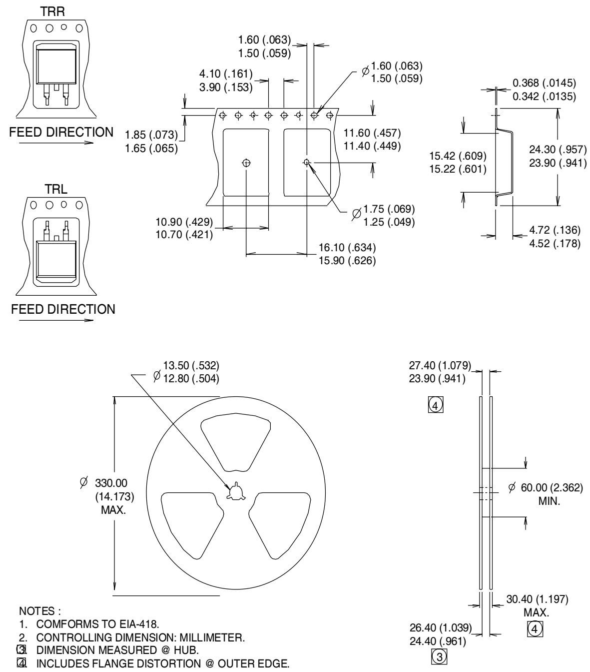
* PART DEPENDENT.

D²Pak Part Marking Information



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

D^2Pak 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

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For technical support, please contact IR's Technical Assistance Center
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Revision History

Date	Comments
2/5/2010	Revised with new AU template:
	1)Add sentence below Absolute Max Rating
	2)Update ESD by using ESD data and table from Anika
	3)Update Part Marking drawing
	4) Add Order Info table
	5) Add Revision History