PD - 97452A

International
IOR Rectifier

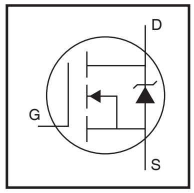
AUTOMOTIVE GRADE

AUIRFR4104
AUIRFU4104

HEXFET® Power MOSFET

Features

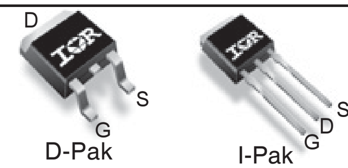
- Advanced Process Technology
- Ultra Low On-Resistance
- 175°C Operating Temperature
- Fast Switching
- Repetitive Avalanche Allowed up to Tjmax
- Lead-Free, RoHS Compliant
- Automotive Qualified *



$V_{(BR)DSS}$	**40V**
$R_{DS(on)}$ max.	**5.5mΩ**
$I_{D\ (Silicon\ Limited)}$	**119A**
$I_{D\ (Package\ Limited)}$	**42A**

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.



D-Pak
AUIRFR4104

I-Pak
AUIRFU4104

G	D	S
Gate	Drain	Source

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 (Silicon Limited)	119	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS} @ 10V	84	
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V (Package Limited)	42	
I_{DM}	Pulsed Drain Current ①	480	
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	145	mJ
E_{AS} (tested)	Single Pulse Avalanche Energy Tested Value ⑥	310	
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 (1.6mm from case)	300	
	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 ⑧	——	1.05	°C/W
$R_{\theta JA}$	Junction-to-Ambient (PCB mount) ⑦	——	40	
$R_{\theta JA}$	Junction-to-Ambient	——	110	

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

09/14/2010

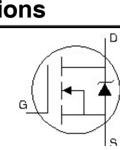
Static Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	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 = 42A ③
$V_{GS(th)}$	Gate Threshold Voltage	2.0	–––	4.0	V	V_{DS} = V_{GS}, I_D = 250µA
gfs	Forward Transconductance	58	–––	–––	S	V_{DS} = 10V, I_D = 42A
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 specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
Q_g	Total Gate Charge	–––	59	89	nC	I_D = 42A
Q_{gs}	Gate-to-Source Charge	–––	19	–––		V_{DS} = 32V
Q_{gd}	Gate-to-Drain ("Miller") Charge	–––	24	–––		V_{GS} = 10V ③
$t_{d(on)}$	Turn-On Delay Time	–––	17	–––	ns	V_{DD} = 20V
t_r	Rise Time	–––	69	–––		I_D = 42A
$t_{d(off)}$	Turn-Off Delay Time	–––	37	–––		R_G = 6.8 Ω
t_f	Fall Time	–––	36	–––		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	–––	2950	–––	pF	V_{GS} = 0V
C_{oss}	Output Capacitance	–––	660	–––		V_{DS} = 25V
C_{rss}	Reverse Transfer Capacitance	–––	370	–––		ƒ = 1.0MHz
C_{oss}	Output Capacitance	–––	2130	–––		V_{GS} = 0V, V_{DS} = 1.0V, ƒ = 1.0MHz
C_{oss}	Output Capacitance	–––	590	–––		V_{GS} = 0V, V_{DS} = 32V, ƒ = 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)	–––	–––	42	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ①	–––	–––	480		
V_{SD}	Diode Forward Voltage	–––	–––	1.3	V	T_J = 25°C, I_S = 42A, V_{GS} = 0V ③
t_{rr}	Reverse Recovery Time	–––	28	42	ns	T_J = 25°C, I_F = 42A, V_{DD} = 20V
Q_{rr}	Reverse Recovery Charge	–––	24	36	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†

<table>
<tr><td rowspan="2" colspan="2">Qualification Level</td><td colspan="2">Automotive
(per AEC-Q101) ††</td></tr>
<tr><td colspan="2">Comments: This part number(s) passed Automotive qualification. IR's Industrial and Consumer qualification level is granted by extension of the higher Automotive level.</td></tr>
<tr><td rowspan="2" colspan="2">Moisture Sensitivity Level</td><td>D-PAK</td><td>MSL1</td></tr>
<tr><td>I-PAK</td><td>MSL1</td></tr>
<tr><td rowspan="3">ESD</td><td>Machine Model</td><td colspan="2">Class M4 (425V)
AEC-Q101-002</td></tr>
<tr><td>Human Body Model</td><td colspan="2">Class H1C (1750V)
AEC-Q101-001</td></tr>
<tr><td>Charged Device Model</td><td colspan="2">Class C3 (625V)
AEC-Q101-005</td></tr>
<tr><td colspan="2">RoHS Compliant</td><td colspan="2">Yes</td></tr>
</table>

† 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.

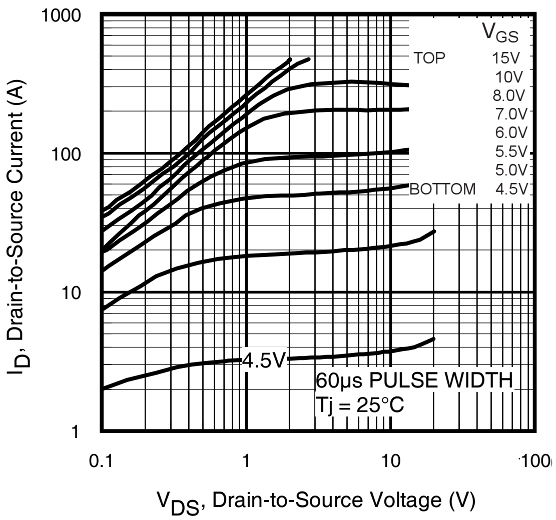


Fig 1. Typical Output Characteristics

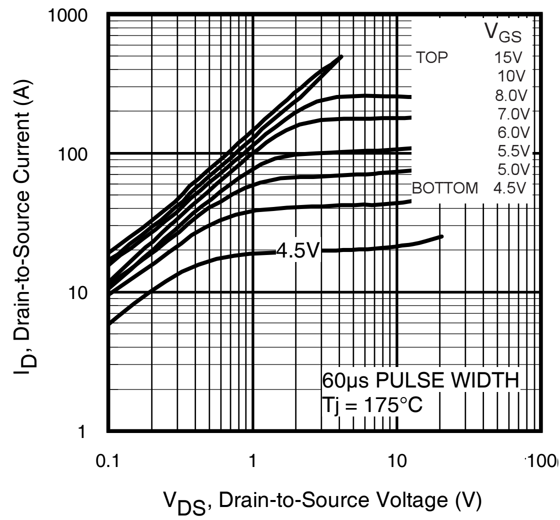


Fig 2. Typical Output Characteristics

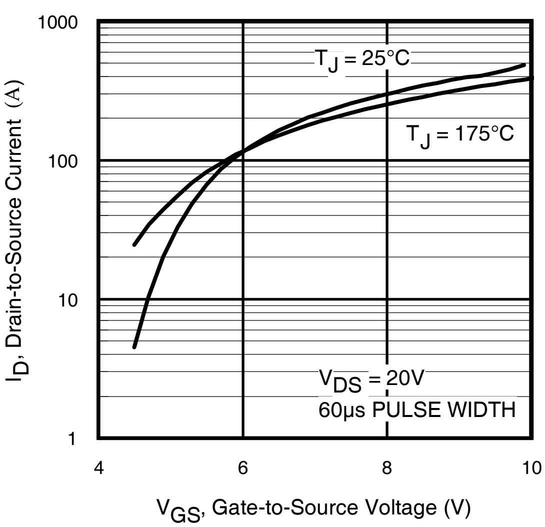


Fig 3. Typical Transfer Characteristics

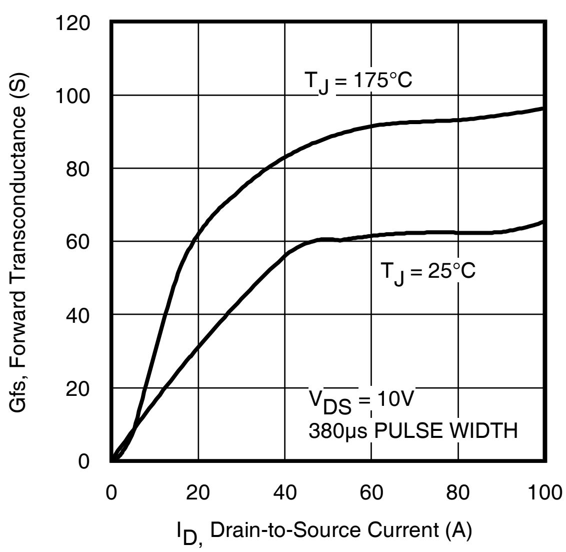


Fig 4. Typical Forward Transconductance Vs. Drain Current

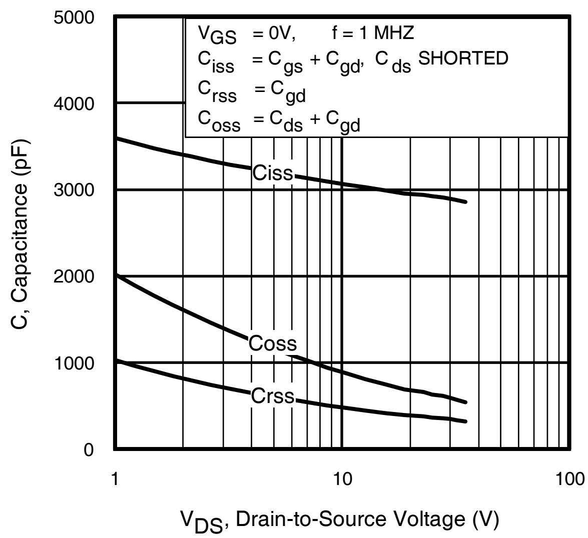


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

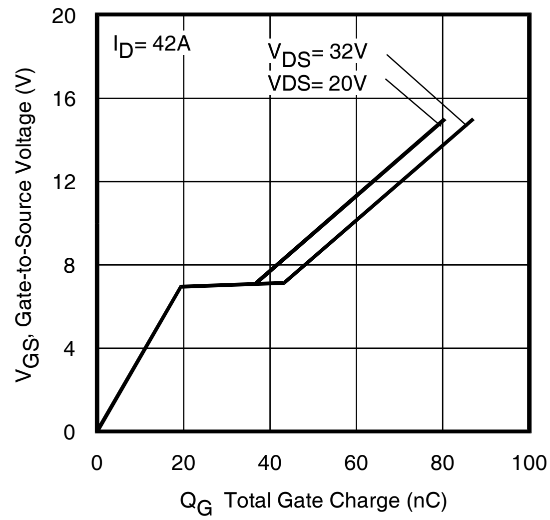


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

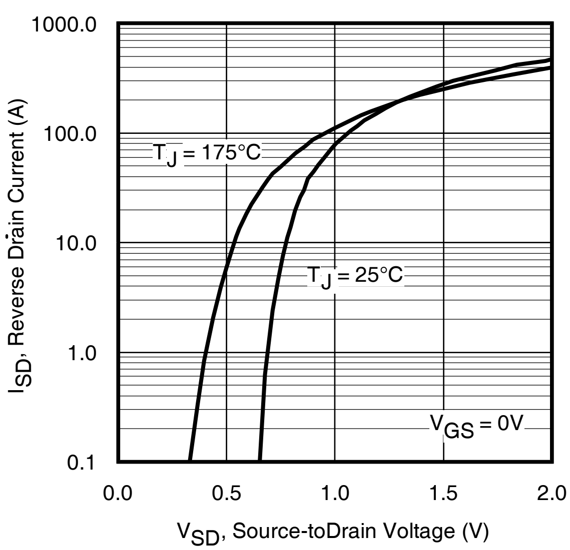


Fig 7. Typical Source-Drain Diode Forward Voltage

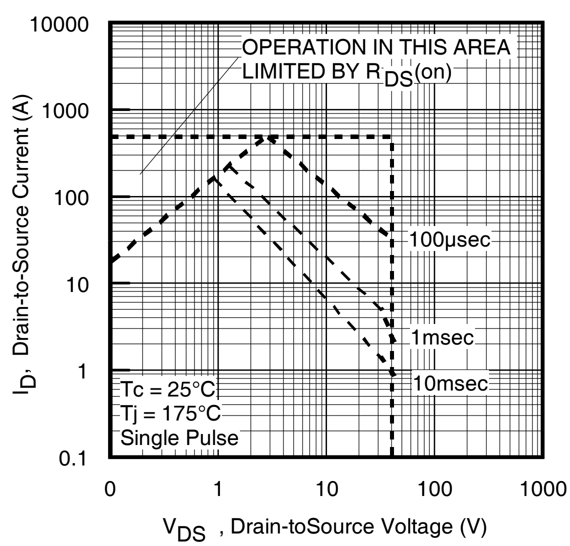


Fig 8. Maximum Safe Operating Area

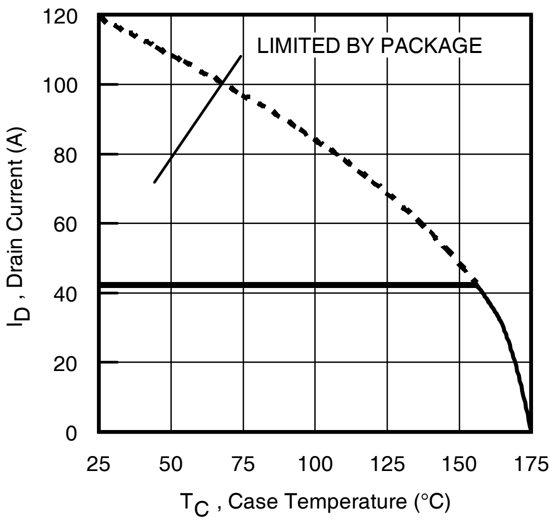


Fig 9. Maximum Drain Current Vs. Case Temperature

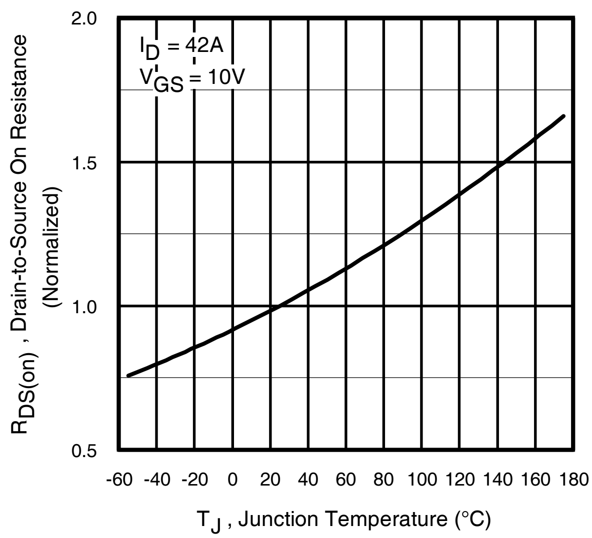


Fig 10. Normalized On-Resistance Vs. Temperature

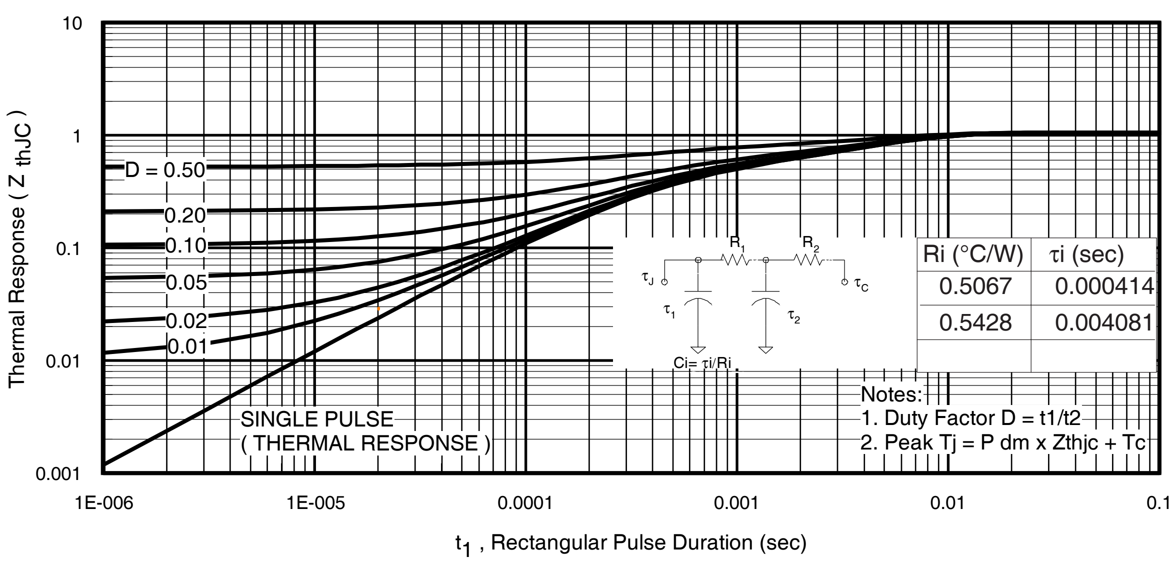


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

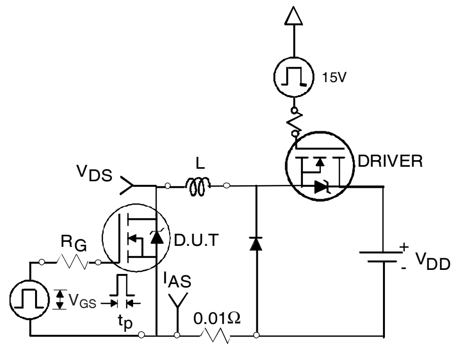


Fig 12a. Unclamped Inductive Test Circuit

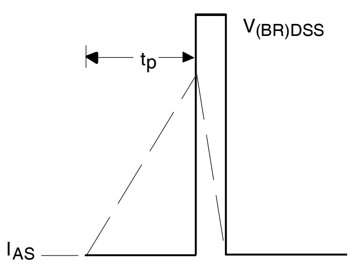


Fig 12b. Unclamped Inductive Waveforms

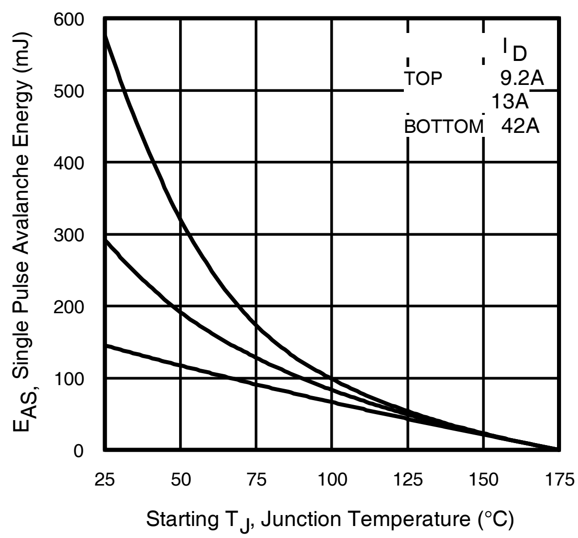


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

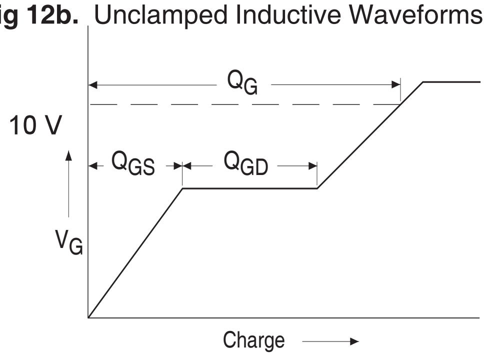


Fig 13a. Basic Gate Charge Waveform

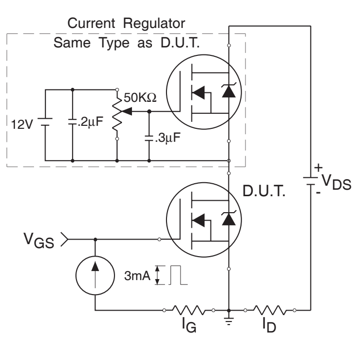


Fig 13b. Gate Charge Test Circuit

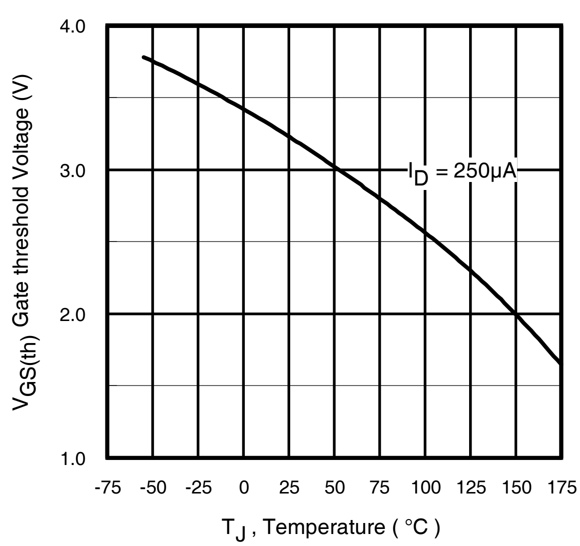


Fig 14. Threshold Voltage Vs. Temperature

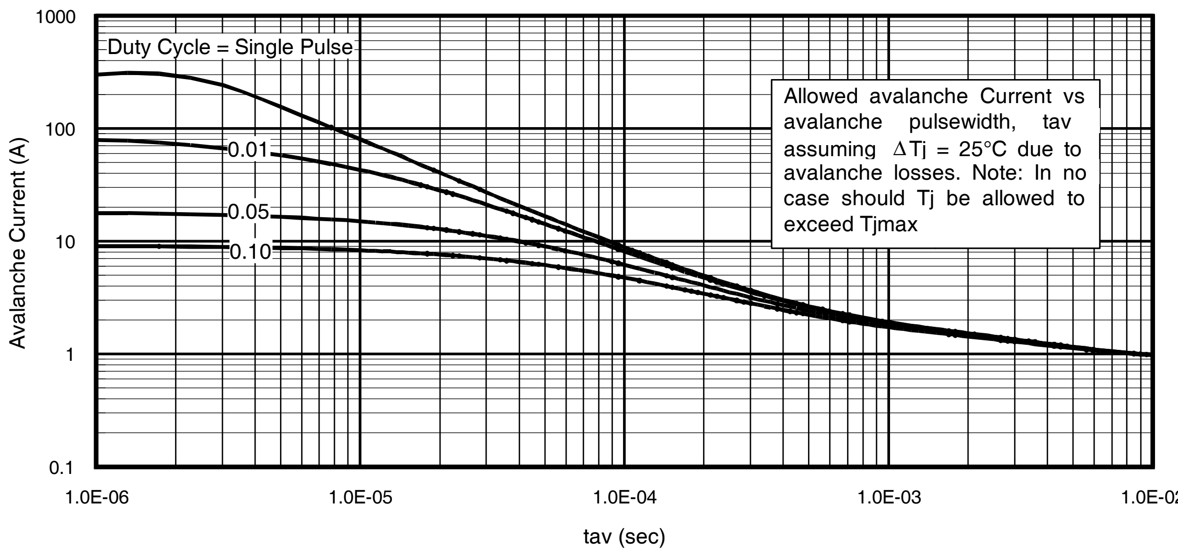


Fig 15. Typical Avalanche Current Vs.Pulsewidth

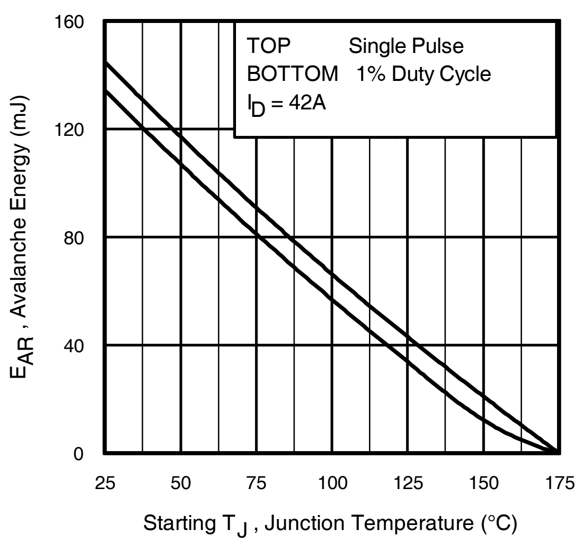


Fig 16. Maximum Avalanche Energy Vs. Temperature

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 asT_{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)

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

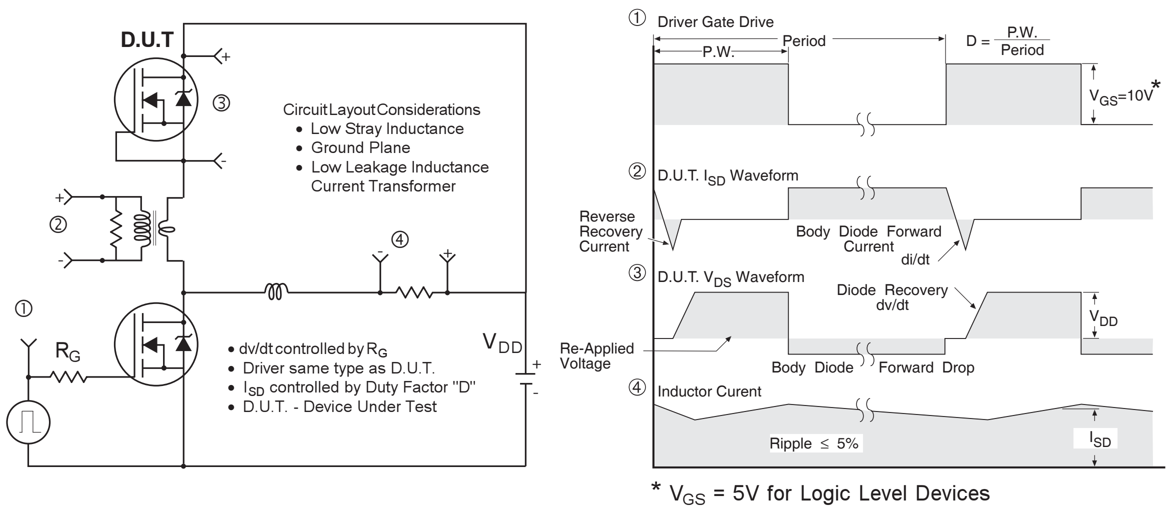


Fig 17. Peak Diode Recovery dv/dt Test Circuit for N-Channel HEXFET® Power MOSFETs

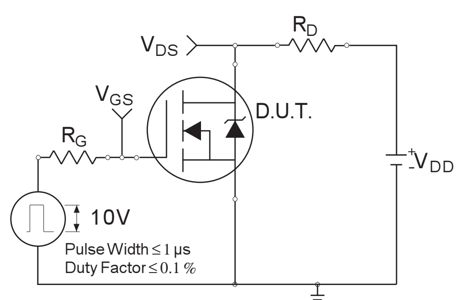


Fig 18a. Switching Time Test Circuit

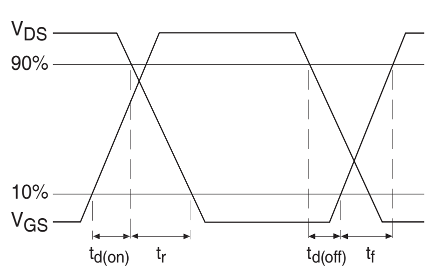
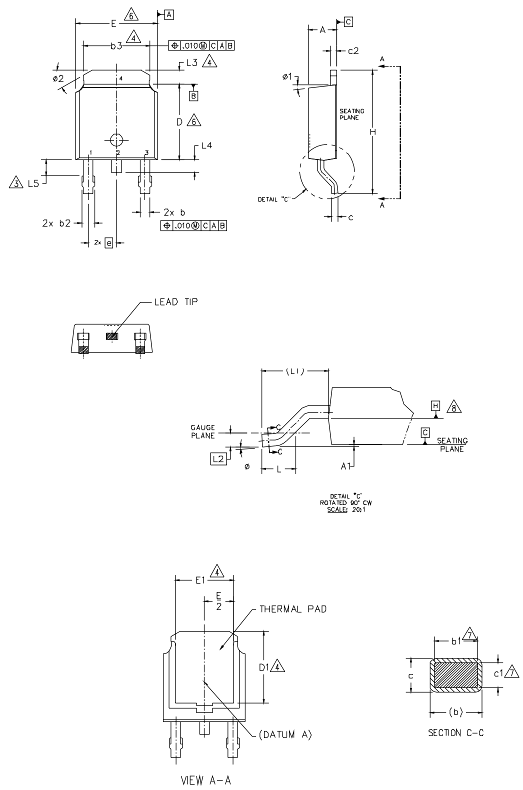


Fig 18b. Switching Time Waveforms

D-Pak (TO-252AA) Package Outline

Dimensions are shown in millimeters (inches)



NOTES:

1.- DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2.- DIMENSION ARE SHOWN IN INCHES [MILLIMETERS].
3.- LEAD DIMENSION UNCONTROLLED IN L5.
4.- DIMENSION D1, E1, L3 & b3 ESTABLISH A MINIMUM MOUNTING SURFACE FOR THERMAL PAD.
5.- SECTION C-C DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN .005 AND 0.10 [0.13 AND 0.25] FROM THE LEAD TIP.
6.- DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005 [0.13] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
7.- DIMENSION b1 & c1 APPLIED TO BASE METAL ONLY.
8.- DATUM A & B TO BE DETERMINED AT DATUM PLANE H.
9.- OUTLINE CONFORMS TO JEDEC OUTLINE TO-252AA.

SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	2.18	2.39	.086	.094	
A1	–	0.13	–	.005	
b	0.64	0.89	.025	.035	
b1	0.65	0.79	.025	.031	7
b2	0.76	1.14	.030	.045	
b3	4.95	5.46	.195	.215	4
c	0.46	0.61	.018	.024	
c1	0.41	0.56	.016	.022	7
c2	0.46	0.89	.018	.035	
D	5.97	6.22	.235	.245	6
D1	5.21	–	.205	–	4
E	6.35	6.73	.250	.265	6
E1	4.32	–	.170	–	4
e	2.29 BSC		.090 BSC		
H	9.40	10.41	.370	.410	
L	1.40	1.78	.055	.070	
L1	2.74 BSC		.108 REF.		
L2	0.51 BSC		.020 BSC		
L3	0.89	1.27	.035	.050	4
L4	–	1.02	–	.040	
L5	1.14	1.52	.045	.060	3
ø	0°	10°	0°	10°	
ø1	0°	15°	0°	15°	
ø2	25°	35°	25°	35°	

LEAD ASSIGNMENTS

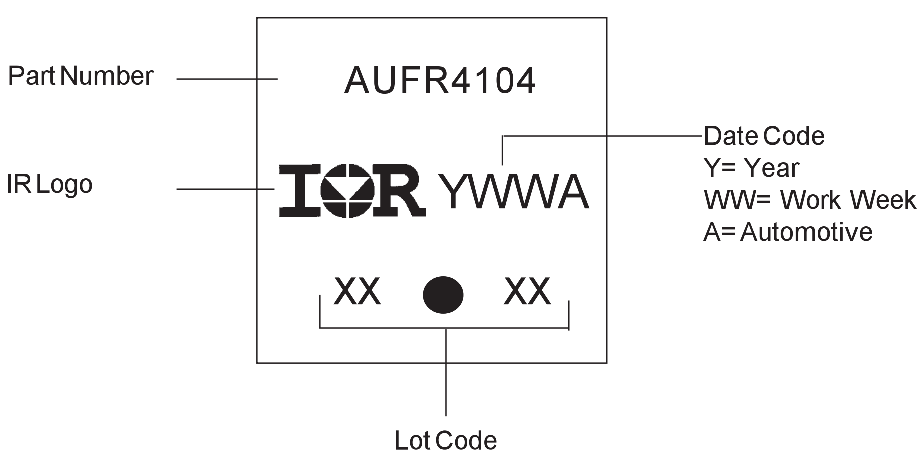
HEXFET

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

IGBT & CoPAK

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

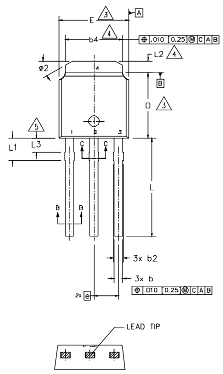
D-Pak Part Marking Information

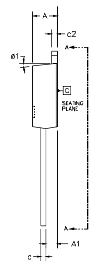


Note: For the most current drawing please refer to IR website at http://www.irf.com/package/

I-Pak (TO-251AA) Package Outline

Dimensions are shown in millimeters (inches)





NOTES:

1.– DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994

2.– DIMENSION ARE SHOWN IN INCHES [MILLIMETERS].

3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005 [0.13] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.

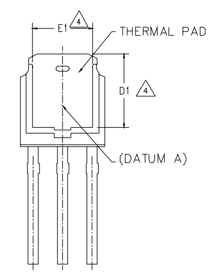
4.– THERMAL PAD CONTOUR OPTION WITHIN DIMENSION b4, L2, E1 & D1.

5.– LEAD DIMENSION UNCONTROLLED IN L3.

6.– DIMENSION b1, b3 & c1 APPLY TO BASE METAL ONLY.

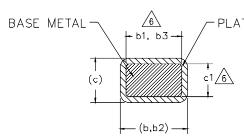
7.– OUTLINE CONFORMS TO JEDEC OUTLINE TO–251AA (Date 06/02).

8.– CONTROLLING DIMENSION : INCHES.



VIEW A–A

SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	2.18	2.39	.086	.094	
A1	0.89	1.14	.035	.045	
b	0.64	0.89	.025	.035	
b1	0.65	0.79	.025	.031	6
b2	0.76	1.14	.030	.045	
b3	0.76	1.04	.030	.041	6
b4	4.95	5.46	.195	.215	4
c	0.46	0.61	.018	.024	
c1	0.41	0.56	.016	.022	6
c2	0.46	0.89	.018	.035	
D	5.97	6.22	.235	.245	3
D1	5.21	–	.205	–	4
E	6.35	6.73	.250	.265	3
E1	4.32	–	.170	–	4
e	2.29 BSC		.090 BSC		
L	8.89	9.65	.350	.380	
L1	1.91	2.29	.045	.090	
L2	0.89	1.27	.035	.050	4
L3	1.14	1.52	.045	.060	5
ø1	0°	15°	0°	15°	
ø2	25°	35°	25°	35°	



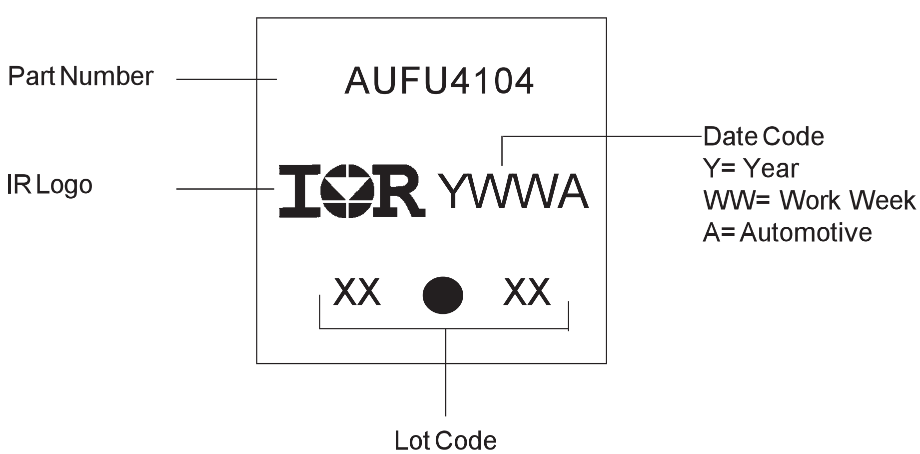
SECTION B–B & C–C

LEAD ASSIGNMENTS

HEXFET

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

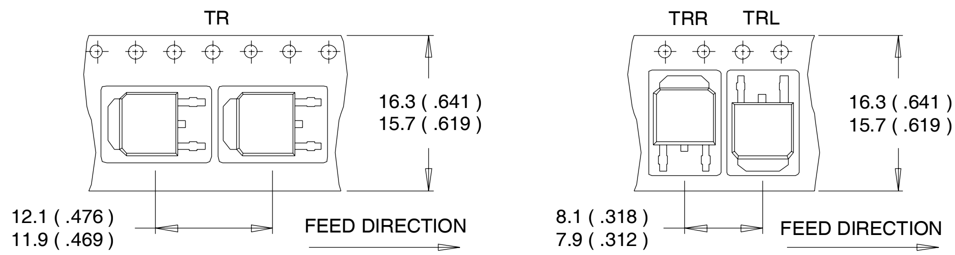
I-Pak Part Marking Information



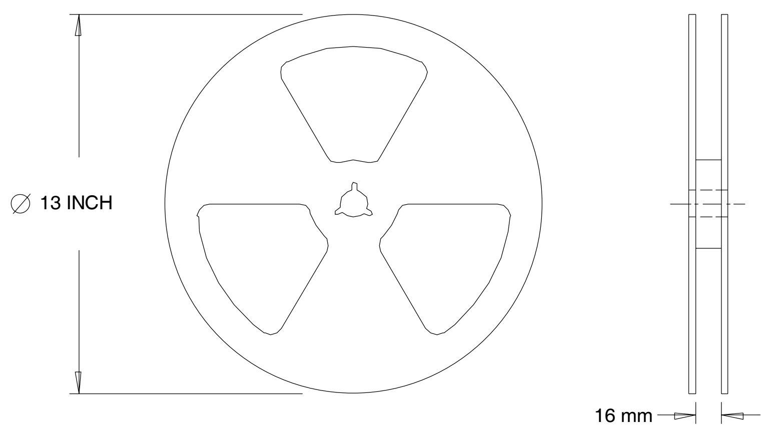
Note: For the most current drawing please refer to IR website at http://www.irf.com/package/

D-Pak (TO-252AA) Tape & Reel Information

Dimensions are shown in millimeters (inches)



NOTES :
1. CONTROLLING DIMENSION : MILLIMETER.
2. ALL DIMENSIONS ARE SHOWN IN MILLIMETERS (INCHES).
3. OUTLINE CONFORMS TO EIA-481 & EIA-541.



NOTES :
1. OUTLINE CONFORMS TO EIA-481.

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 = 0.16mH R_G = 25Ω, I_{AS} = 42A, 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 Limited by T_{Jmax} , see Fig.12a, 12b, 15, 16 for typical repetitive avalanche performance.

⑥ This value determined from sample failure population, starting T_J = 25°C, L = 0.16mH, R_G = 25Ω, I_{AS} = 42A, V_{GS} =10V.

⑦ When mounted on 1" square PCB (FR-4 or G-10 Material) . For recommended footprint and soldering techniques refer to application note #AN-994.

⑧ R_θ is measured at TJ approximately 90°C.

Ordering Information

Base part number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIRFR4104	Dpak	Tube	75	AUIRFR4104
		Tape and Reel	2000	AUIRFR4104TR
		Tape and Reel Left	3000	AUIRFR4104TRL
		Tape and Reel Right	3000	AUIRFR4104TRR
AUIRFU4104	Ipak	Tube	75	AUIRFU4104

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