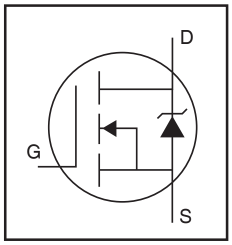
International
IOR Rectifier

AUTOMOTIVE GRADE

AUIRF1404S
AUIRF1404L

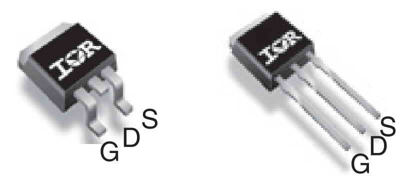
HEXFET® Power MOSFET

Features
- Advanced Planar Technology
- 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_{DSS}		40V
$R_{DS(on)}$	typ.	3.5mΩ
	max.	4.0mΩ
I_{D} (Silicon Limited)		162A⑥
I_{D} (Package Limited)		75A

Description
Specifically designed for Automotive applications, this Stripe Planar design of HEXFET® Power MOSFETs utilizes the latest processing techniques to achieve low on-resistance per silicon area. This benefit combined with the fast switching speed and ruggedized device design that HEXFET power MOSFETs are well known for, provides the designer with an extremely efficient and reliable device for use in Automotive and a wide variety of other applications.



D^2Pak AUIRF1404S   TO-262 AUIRF1404L

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.

Symbol	Parameter	Max.	Units
I_D @ T_C = 25°C	Continuous Drain Current, VGS @ 10V (Silicon Limited) ⑦	162⑥	A
I_D @ T_C = 100°C	Continuous Drain Current, VGS @ 10V (Silicon Limited) ⑦	115⑥	
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V (Package Limited)	75	
I_{DM}	Pulsed Drain Current ①⑦	650	
P_D @T_A = 25°C	Maximum Power Dissipation	3.8	W
P_D @T_C = 25°C	Maximum Power Dissipation	200	
	Linear Derating Factor	1.3	W/°C
V_{GS}	Gate-to-Source Voltage	± 20	V
E_{AS}	Single Pulse Avalanche Energy (Thermally Limited) ②⑦	519	mJ
I_{AR}	Avalanche Current ①	95	A
E_{AR}	Repetitive Avalanche Energy ①	20	mJ
dv/dt	Peak Diode Recovery ③⑦	5.0	V/ns
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to + 175	°C
	Soldering Temperature, for 10 seconds (1.6mm from case)	300	

Thermal Resistance

Symbol	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case ⑨	——	0.75	°C/W
$R_{\theta JA}$	Junction-to-Ambient (PCB Mounted, steady-state) ⑧	——	40	

HEXFET® is a registered trademark of International Rectifier.
*Qualification standards can be found at http://www.irf.com/

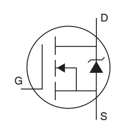
Static Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

Symbol	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	–––	0.036	–––	V/°C	Reference to 25°C, I_D = 1.0mA
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	–––	3.5	4.0	mΩ	V_{GS} = 10V, I_D = 95A ④
$V_{GS(th)}$	Gate Threshold Voltage	2.0	–––	4.0	V	V_{DS} = V_{GS}, I_D = 250µA
gfs	Forward Transconductance	106	–––	–––	S	V_{DS} = 25V, I_D = 60A ⑦
I_{DSS}	Drain-to-Source Leakage Current	–––	–––	20	µA	V_{DS} = 40V, V_{GS} = 0V
		–––	–––	250		V_{DS} = 32V, 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)

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
Q_g	Total Gate Charge	–––	160	200	nC	I_D = 95A
Q_{gs}	Gate-to-Source Charge	–––	35	–––		V_{DS} = 32V
Q_{gd}	Gate-to-Drain ("Miller") Charge	–––	42	60		V_{GS} = 10V ④⑦
$t_{d(on)}$	Turn-On Delay Time	–––	17	–––	ns	V_{DD} = 20V
t_r	Rise Time	–––	140	–––		I_D = 95A
$t_{d(off)}$	Turn-Off Delay Time	–––	72	–––		R_G = 2.5Ω
t_f	Fall Time	–––	26	–––		R_D = 0.21Ω ④⑦
L_S	Internal Source Inductance	–––	7.5	–––	nH	Between lead, and center of die contact
C_{iss}	Input Capacitance	–––	7360	–––	pF	V_{GS} = 0V
C_{oss}	Output Capacitance	–––	1680	–––		V_{DS} = 25V
C_{rss}	Reverse Transfer Capacitance	–––	240	–––		ƒ = 1.0 MHz, See Fig. 5 ⑦
C_{oss}	Output Capacitance	–––	6630	–––		V_{GS} = 0V, V_{DS} = 1.0V, ƒ = 1.0MHz
C_{oss}	Output Capacitance	–––	1490	–––		V_{GS} = 0V, V_{DS} = 32V, ƒ = 1.0MHz
C_{oss} eff.	Effective Output Capacitance (Time Related)	–––	1540	–––		V_{GS} = 0V, V_{DS} = 0V to 32V

Diode Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
I_S	Continuous Source Current (Body Diode)	–––	–––	162⑥	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I_{SM}	Pulsed Source Current (Body Diode) ②	–––	–––	650	A	
V_{SD}	Diode Forward Voltage	–––	–––	1.3	V	T_J = 25°C, I_S = 95A, V_{GS} = 0V ④
t_{rr}	Reverse Recovery Time	–––	71	110	ns	T_J = 25°C, I_F = 95A
Q_{rr}	Reverse Recovery Charge	–––	180	270	nC	di/dt = 100A/µs ④⑦
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 Starting T_J = 25°C, L = 0.12mH R_G = 25Ω, I_{AS} = 95A. (See Figure 12)

③ $I_{SD} \leq$ 95A, di/dt ≤ 150A/µs, $V_{DD} \leq V_{(BR)DSS}$, $T_J \leq$ 175°C.

④ Pulse width ≤ 300µs; 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 Calculated continuous current based on maximum allowable junction temperature. Package limitation current is 75A.

⑦ Use IRF1404 data and test conditions.

⑧ 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_θ is measured at T_J approximately 90°C.

Qualification Information†

<table>
<tr><td rowspan="2">Qualification Level</td><td colspan="3">Automotive
(per AEC-Q101) ††</td></tr>
<tr><td colspan="3">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">Moisture Sensitivity Level</td><td></td><td>D2Pak</td><td>MSL1</td></tr>
<tr><td></td><td>TO-262</td><td>N/A</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 H2 (+/- 4000V)†††
AEC-Q101-001</td></tr>
<tr><td>Charged Device Model</td><td colspan="2">Class C5 (+/- 1125V)†††
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.

††† Highest passing voltage.

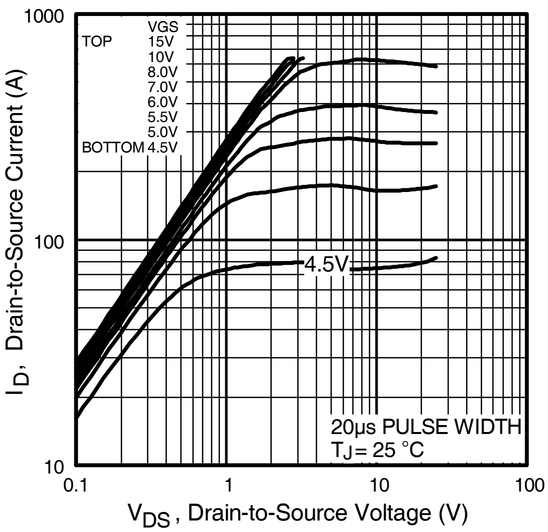


Fig 1. Typical Output Characteristics

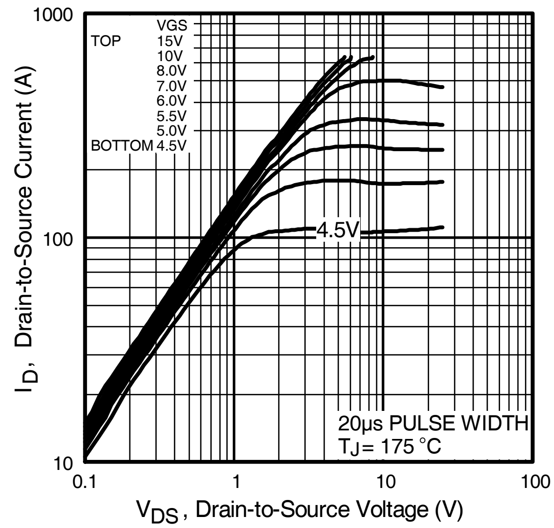


Fig 2. Typical Output Characteristics

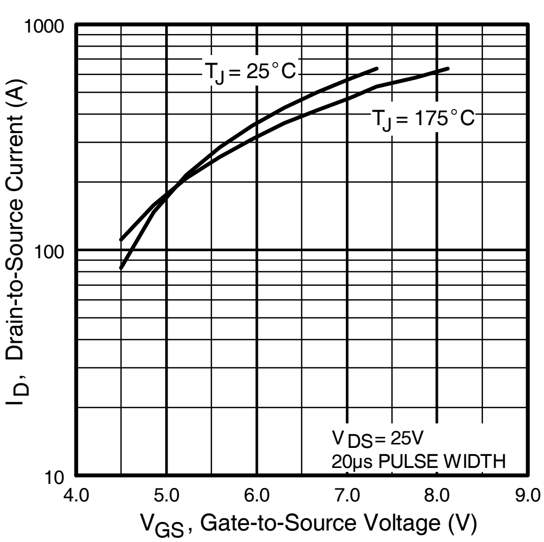


Fig 3. Typical Transfer Characteristics

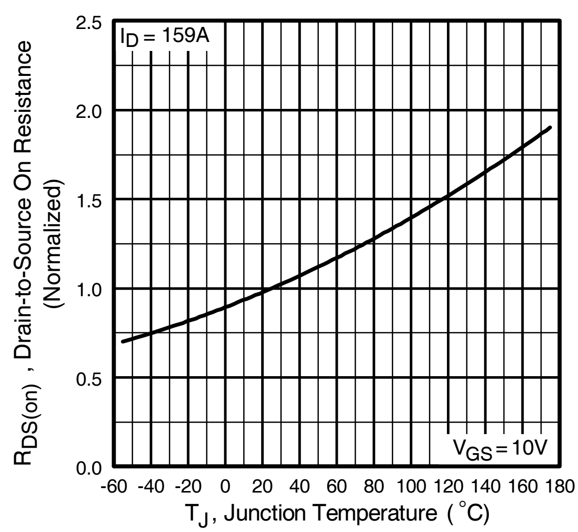


Fig 4. Normalized On-Resistance Vs. Temperature

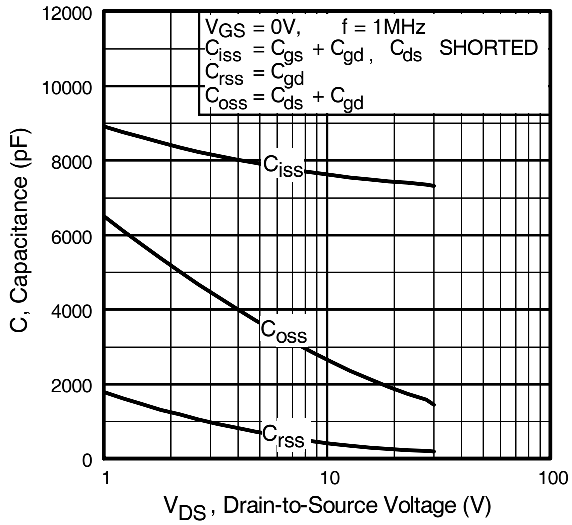


Fig 5. Typical Capacitance Vs. Drain-to-Source Voltage

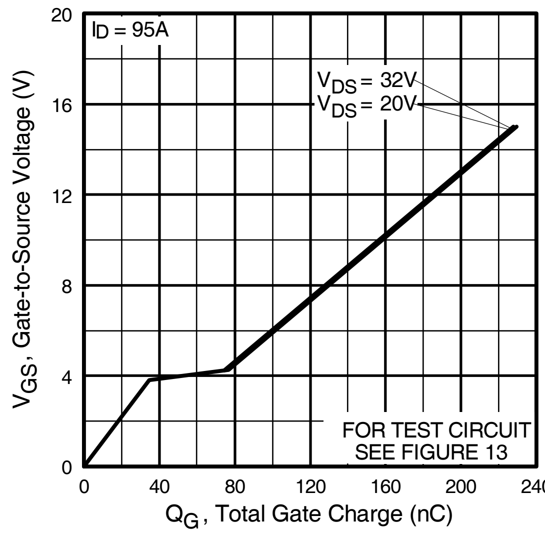


Fig 6. Typical Gate Charge Vs. Gate-to-Source Voltage

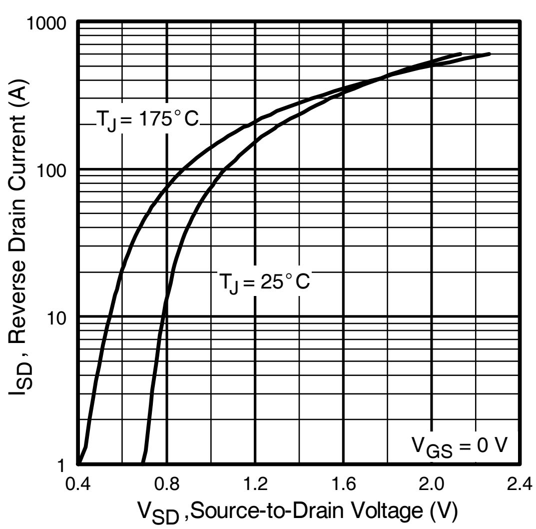


Fig 7. Typical Source-Drain Diode Forward Voltage

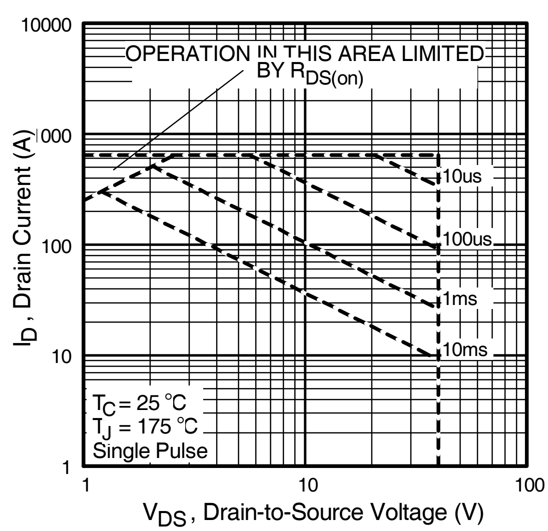


Fig 8. Maximum Safe Operating Area

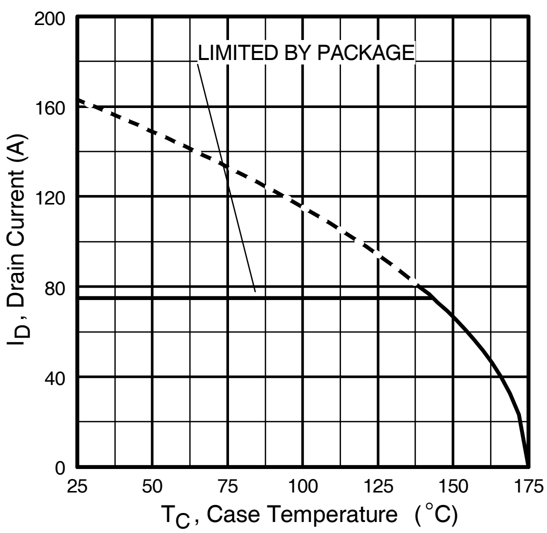


Fig 9. Maximum Drain Current Vs. Case Temperature

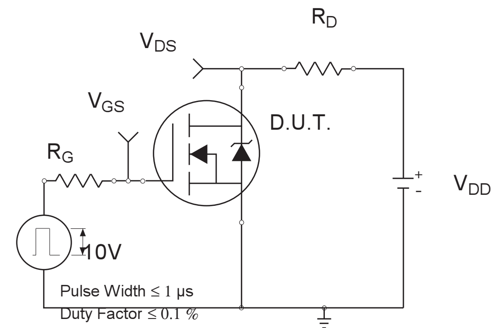


Fig 10a. Switching Time Test Circuit

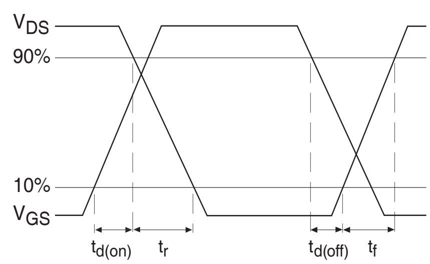


Fig 10b. Switching Time Waveforms

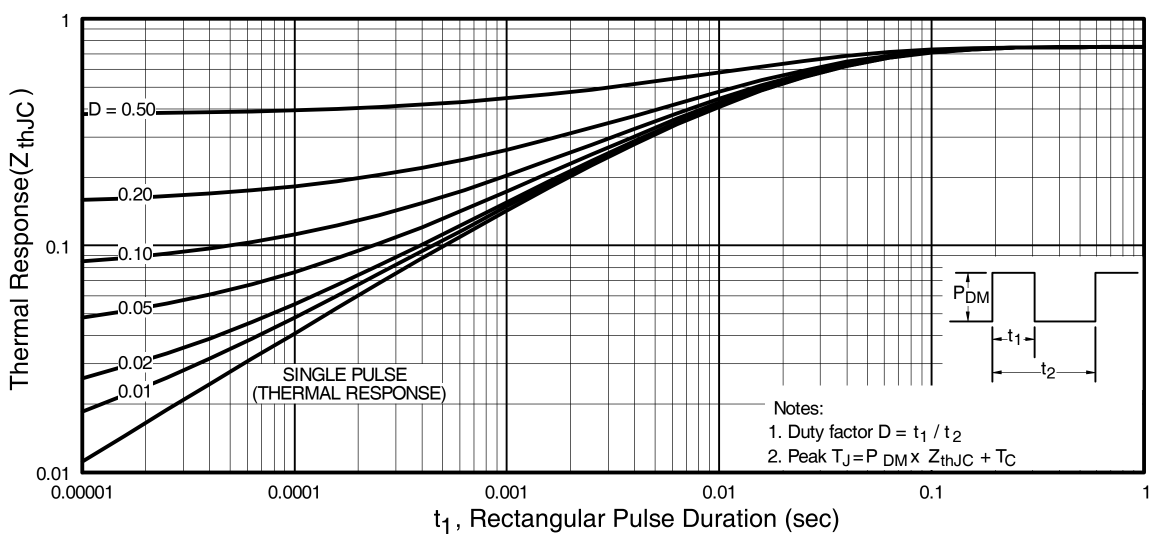


Fig 11. Maximum Effective Transient Thermal Impedance, Junction-to-Case

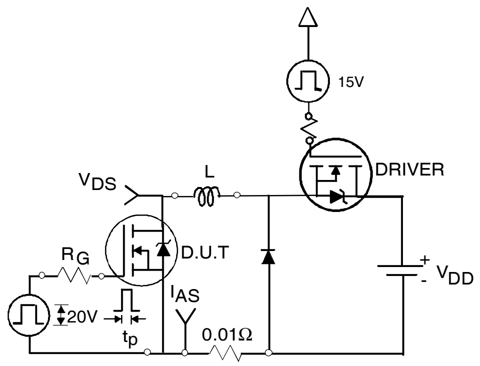


Fig 12a. Unclamped Inductive Test Circuit

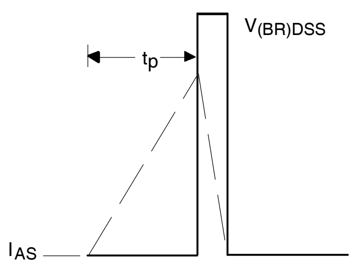


Fig 12b. Unclamped Inductive Waveforms

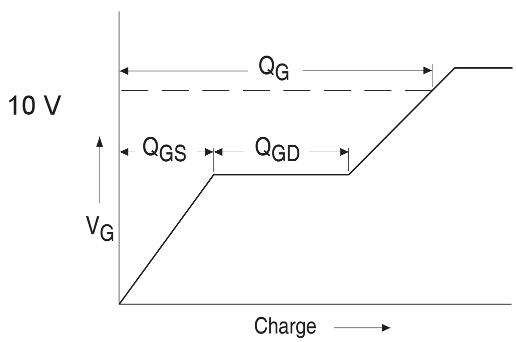


Fig 13a. Basic Gate Charge Waveform

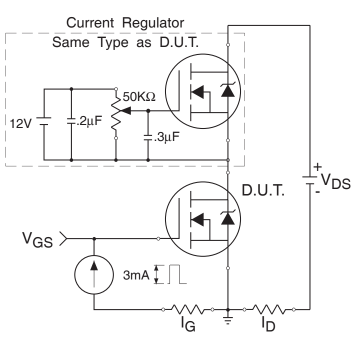


Fig 13b. Gate Charge Test Circuit

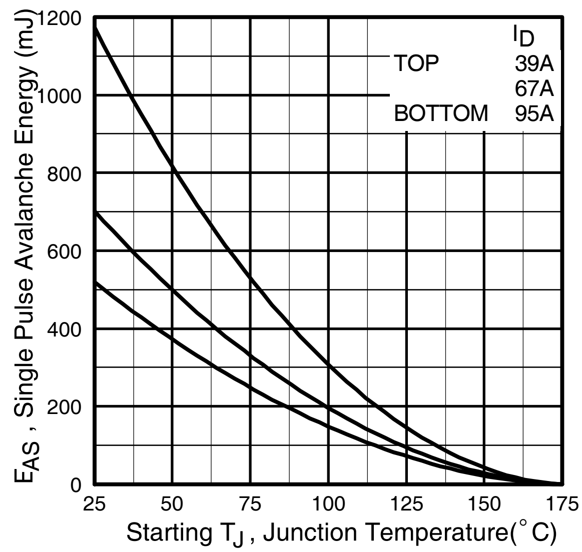


Fig 12c. Maximum Avalanche Energy Vs. Drain Current

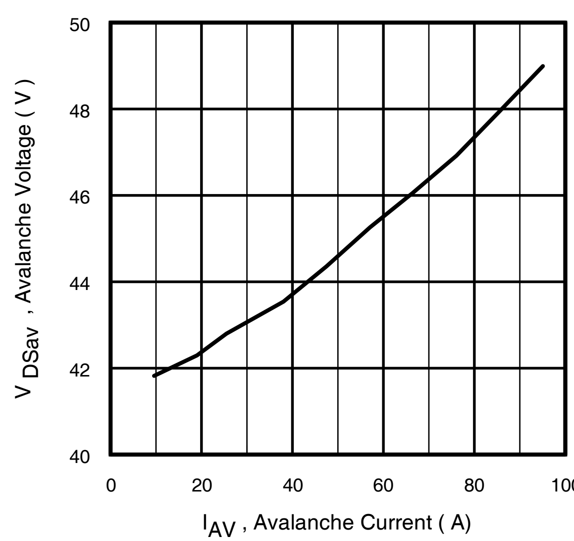
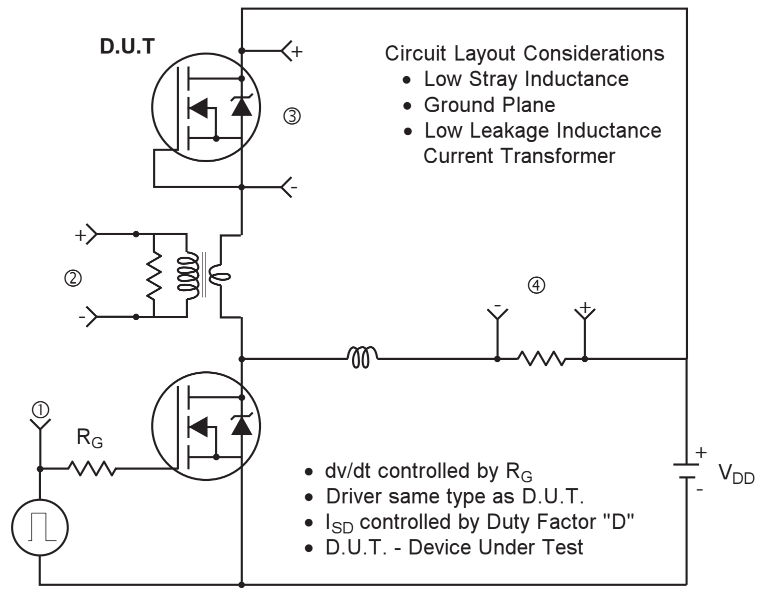


Fig 12d. Typical Drain-to-Source Voltage Vs. Avalanche Current

Peak Diode Recovery dv/dt Test Circuit



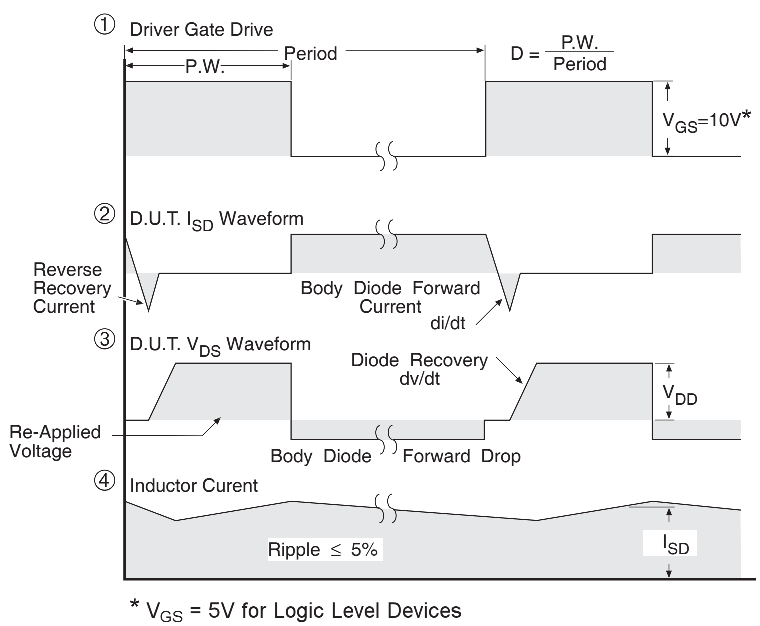
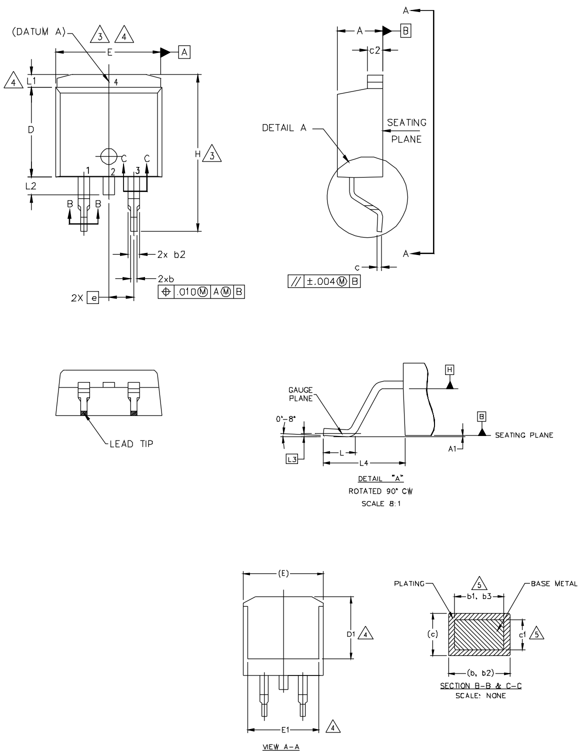


Fig 14. For N-channel HEXFET® Power MOSFETs

D^{2}Pak (TO-263AB) 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

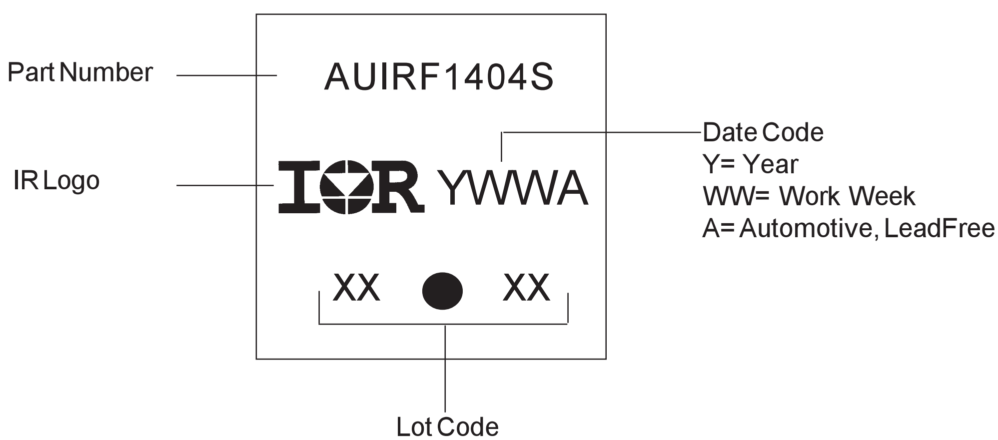
1.– GATE
2, 4.– COLLECTOR
3.– EMITTER

DIODES

1.– ANODE *
2, 4.– CATHODE
3.– ANODE

* PART DEPENDENT.

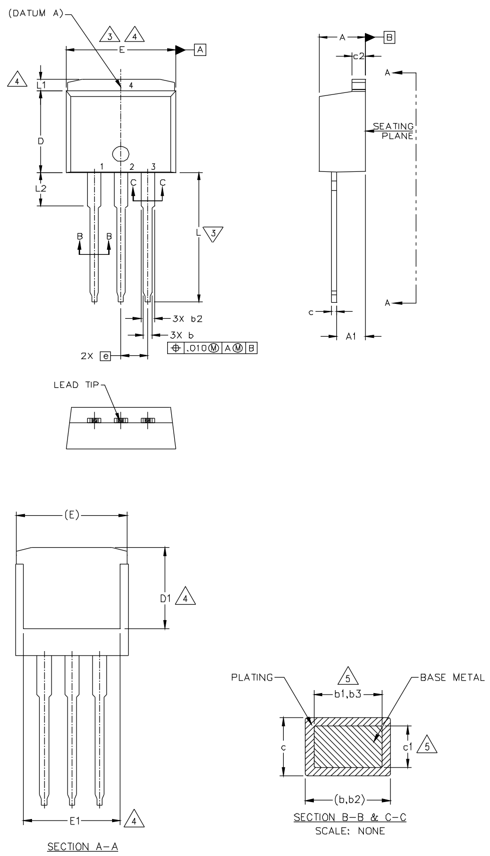
D^{2}Pak (TO-263AB) Part Marking Information



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

TO-262 Package Outline

Dimensions are shown in millimeters (inches)



SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	
A1	2.03	3.02	.080	.119	
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		
L	13.46	14.10	.530	.555	
L1	—	1.65	—	.065	4
L2	3.56	3.71	.140	.146	

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. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.
5. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
6. CONTROLLING DIMENSION: INCH.
7.- OUTLINE CONFORM TO JEDEC TO-262 EXCEPT A1(max.), b(min.) AND D1(min.) WHERE DIMENSIONS DERIVED THE ACTUAL PACKAGE OUTLINE.

LEAD ASSIGNMENTS

IGBTs, CoPACK

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

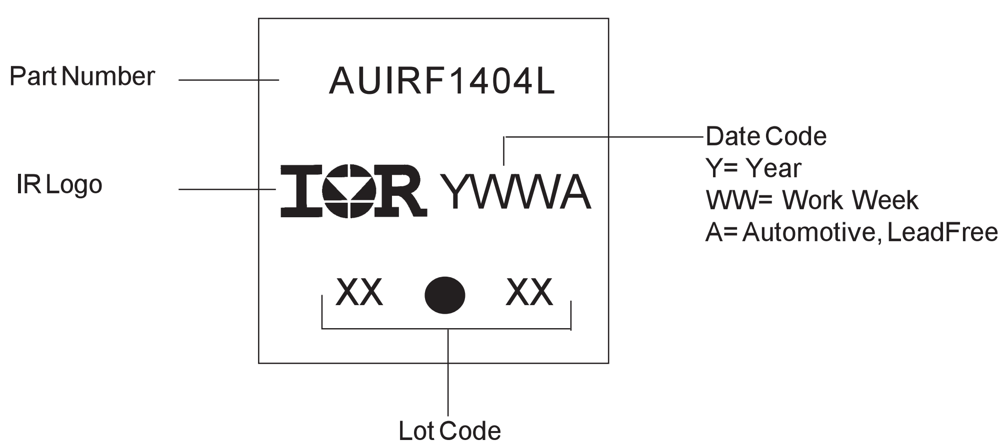
HEXFET

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

DIODES

1.- ANODE (TWO DIE) / OPEN (ONE DIE)
2, 4.- CATHODE
3.- ANODE

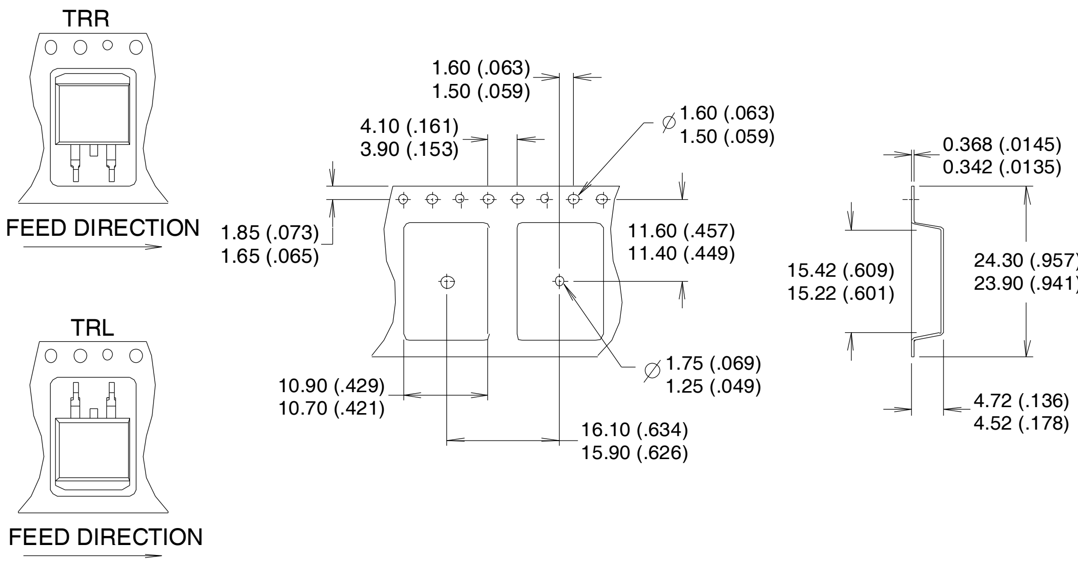
TO-262 Part Marking Information

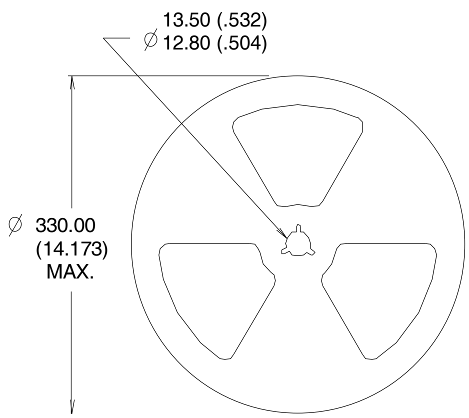


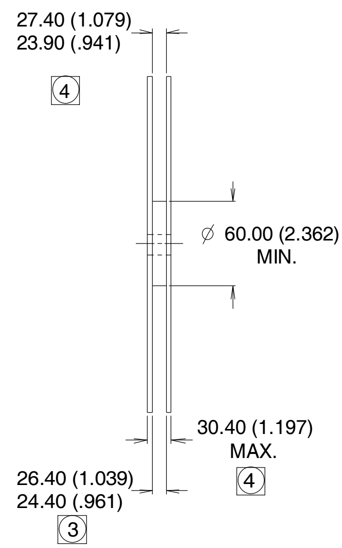
Note: For the most current drawing please refer to IR website at http://www.irf.com/package/

D²Pak (TO-263AB) Tape & Reel Information

Dimensions are shown in millimeters (inches)







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

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

Ordering Information

Base part number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIRF1404S	D2Pak	Tube	50	AUIRF1404S
		Tape and Reel Left	800	AUIRF1404STRL
		Tape and Reel Right	800	AUIRF1404STRR
AUIRF1404L	TO-262	Tube	50	AUIRF1404L

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For technical support, please contact IR’s Technical Assistance Center
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