International
IOR Rectifier

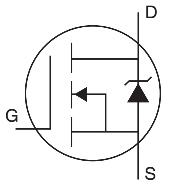
AUTOMOTIVE GRADE

AUIRF1405ZS-7P

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
- Automotive Qualified *



S (Pin 2, 3, 5, 6, 7)
G (Pin 1)

$V_{DSS} = 55V$

$R_{DS(on)} = 4.9m\Omega$

$I_D = 120A$

D^2Pak 7 Pin

Description

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 a wide variety of applications.

Base Part Number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
AUIRF1405ZS-7P	D2Pak- 7 Pin	Tube	50	AUIRF1405ZS-7P
		Tape and Reel Left	800	AUIRF1405ZS-7TRL

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)	150	A
I_D @ T_C = 100°C	Continuous Drain Current, V_{GS} @ 10V (See Fig. 9)	100	
I_D @ T_C = 25°C	Continuous Drain Current, V_{GS} @ 10V (Package Limited)	120	
I_{DM}	Pulsed Drain Current ①	590	
P_D @T_C = 25°C	Maximum Power Dissipation	230	W
	Linear Derating Factor	1.5	W/°C
V_{GS}	Gate-to-Source Voltage	± 20	V
E_{AS}	Single Pulse Avalanche Energy (Thermally Limited) ②	250	mJ
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)	

Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case⑦	——	0.65	°C/W
$R_{\theta JA}$	Junction-to-Ambient (PCB Mount, steady state) ⑥⑦	——	40	

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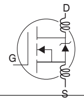
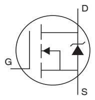
*Qualification standards can be found at http://www.irf.com/

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
$\Delta BV_{DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	0.054	—	V/°C	Reference to 25°C, I_D = 1mA
$R_{DS(on)}$ SMD	Static Drain-to-Source On-Resistance	—	3.7	4.9	mΩ	V_{GS} = 10V, I_D = 88A ③
$V_{GS(th)}$	Gate Threshold Voltage	2.0	—	4.0	V	V_{DS} = V_{GS}, I_D = 150μA
gfs	Forward Transconductance	108	—	—	S	V_{DS} = 10V, I_D = 88A
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	—	150	230	nC	I_D = 88A
Q_{gs}	Gate-to-Source Charge	—	37	—		V_{DS} = 44V
Q_{gd}	Gate-to-Drain ("Miller") Charge	—	64	—		V_{GS} = 10V ③
$t_{d(on)}$	Turn-On Delay Time	—	16	—	ns	V_{DD} = 28V
t_r	Rise Time	—	140	—		I_D = 88A
$t_{d(off)}$	Turn-Off Delay Time	—	170	—		R_G = 5.0Ω
t_f	Fall Time	—	130	—		V_{GS} = 10V ②
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	—	5360	—	pF	V_{GS} = 0V
C_{oss}	Output Capacitance	—	1310	—		V_{DS} = 25V
C_{rss}	Reverse Transfer Capacitance	—	340	—		ƒ = 1.0MHz, See Fig. 5
C_{oss}	Output Capacitance	—	6080	—		V_{GS} = 0V, V_{DS} = 1.0V, ƒ = 1.0MHz
C_{oss}	Output Capacitance	—	920	—		V_{GS} = 0V, V_{DS} = 44V, ƒ = 1.0MHz
C_{oss} eff.	Effective Output Capacitance	—	1700	—		V_{GS} = 0V, V_{DS} = 0V to 44V

Diode Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
I_S	Continuous Source Current (Body Diode)	—	—	150	A	MOSFET symbol showing the
I_{SM}	Pulsed Source Current (Body Diode) ①	—	—	590		integral reverse p-n junction diode. 
V_{SD}	Diode Forward Voltage	—	—	1.3	V	T_J = 25°C, I_S = 88A, V_{GS} = 0V ③
t_{rr}	Reverse Recovery Time	—	63	95	ns	T_J = 25°C, I_F = 88A, V_{DD} = 28V
Q_{rr}	Reverse Recovery Charge	—	160	240	nC	di/dt = 100A/μs ③

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=0.064mH, R_G = 25Ω, I_{AS} = 88A, 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 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 of approximately 90°C.

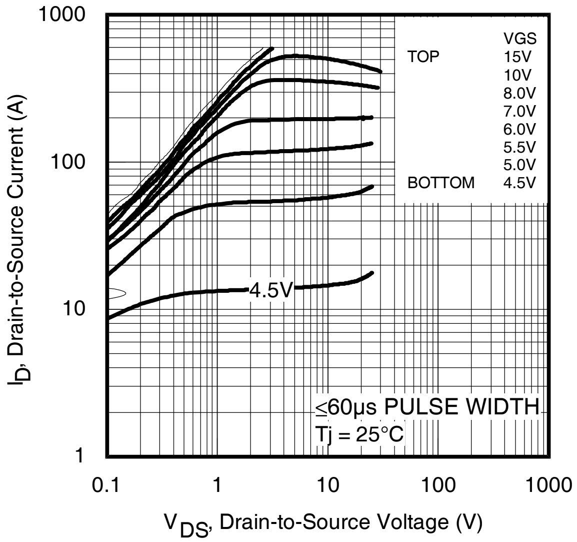


Fig 1. Typical Output Characteristics

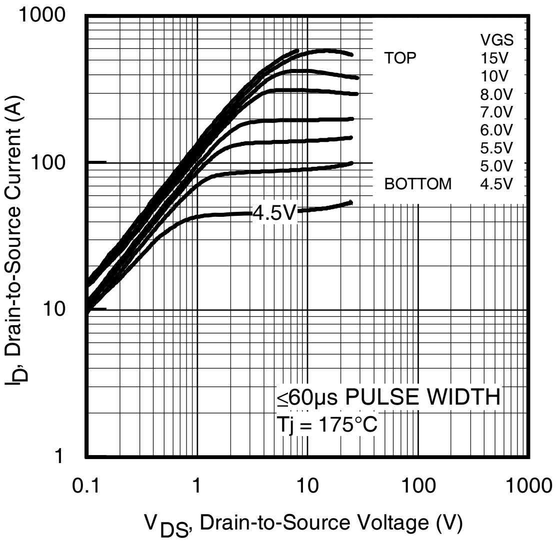


Fig 2. Typical Output Characteristics

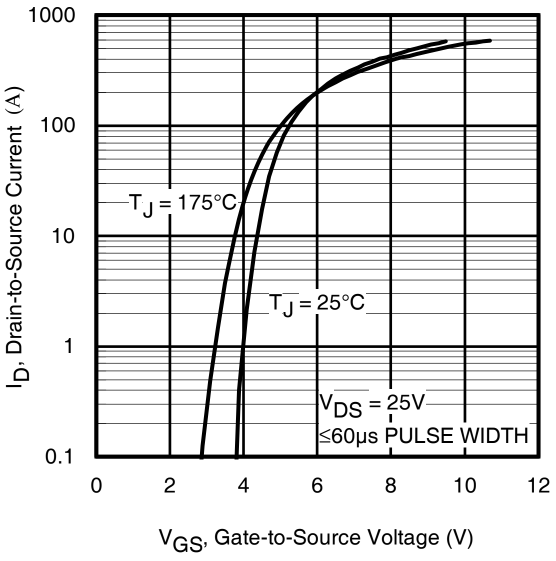


Fig 3. Typical Transfer Characteristics

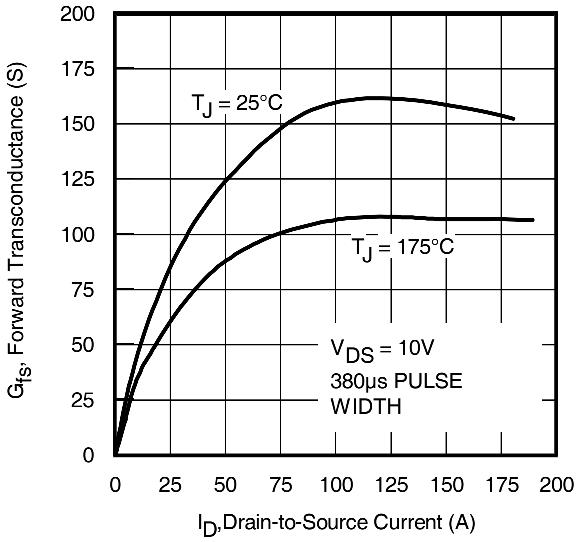


Fig 4. Typical Forward Transconductance vs. Drain Current

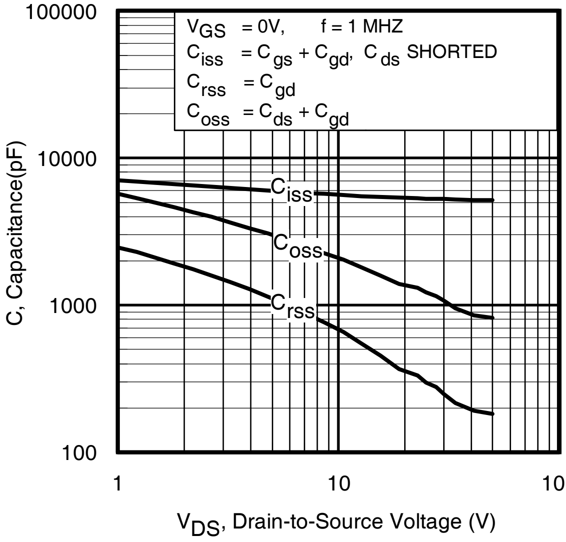


Fig 5. Typical Capacitance vs. Drain-to-Source Voltage

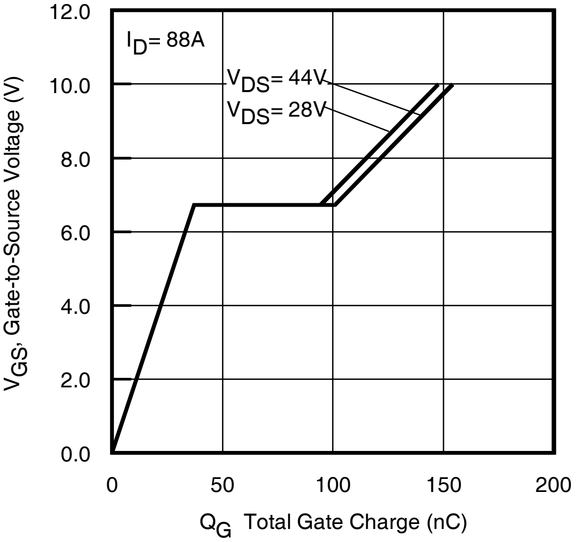


Fig 6. Typical Gate Charge vs. Gate-to-Source Voltage

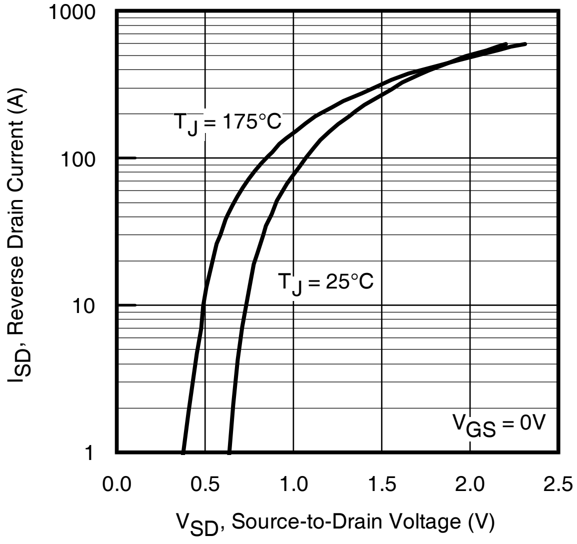


Fig 7. Typical Source-Drain Diode Forward Voltage

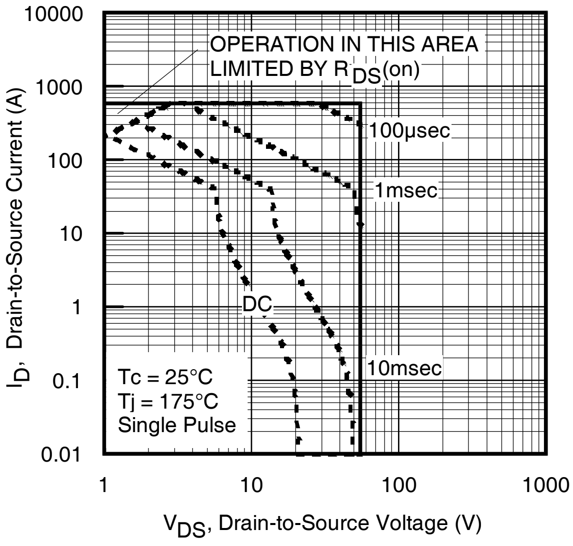


Fig 8. Maximum Safe Operating Area

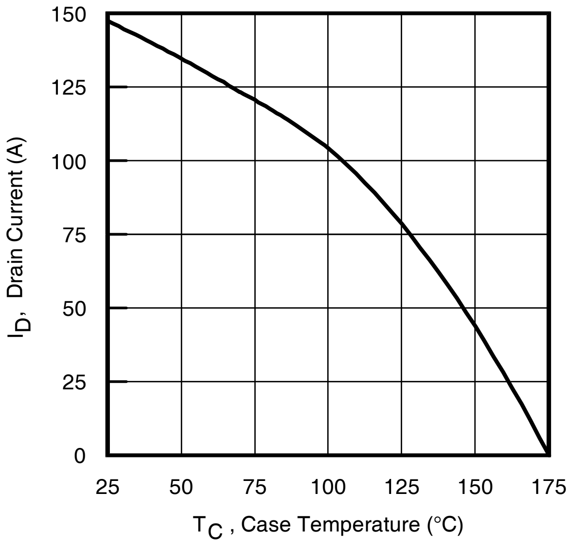


Fig 9. Maximum Drain Current vs. Case Temperature

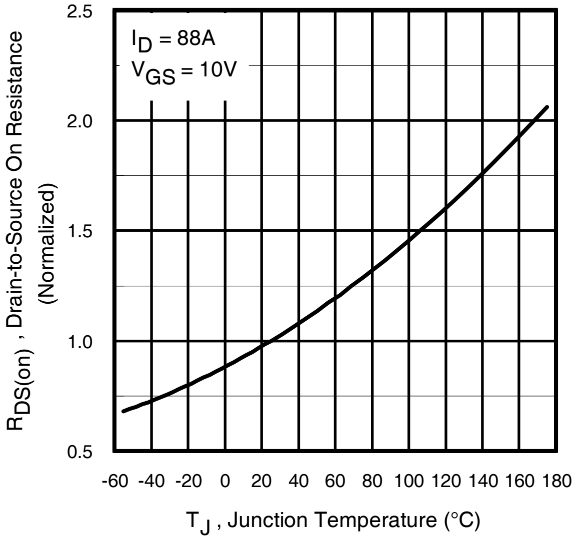
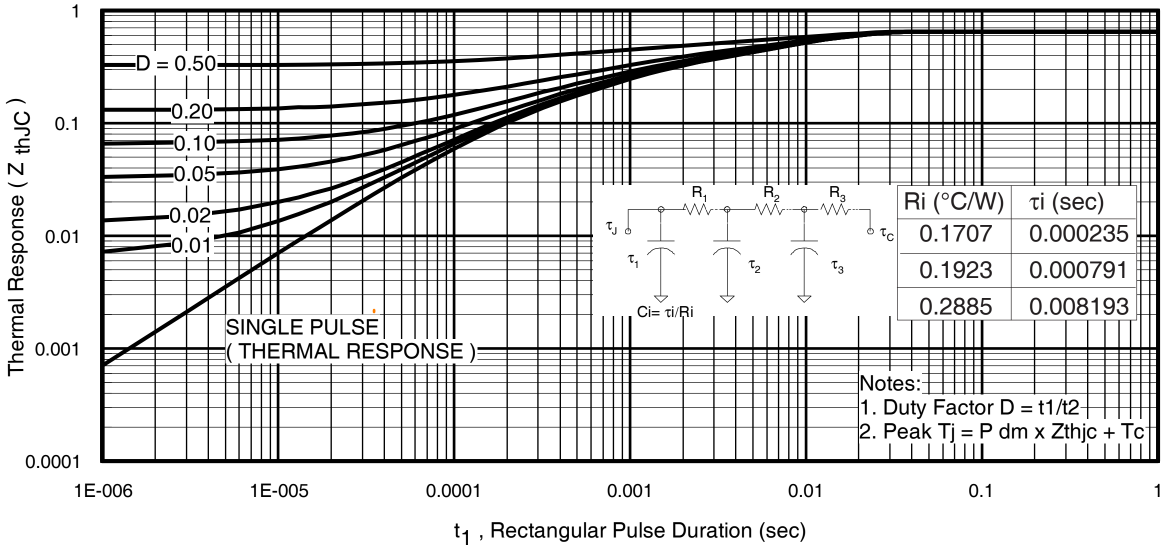


Fig 10. Normalized On-Resistance vs. Temperature



Ri (°C/W)	τi (sec)
0.1707	0.000235
0.1923	0.000791
0.2885	0.008193

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

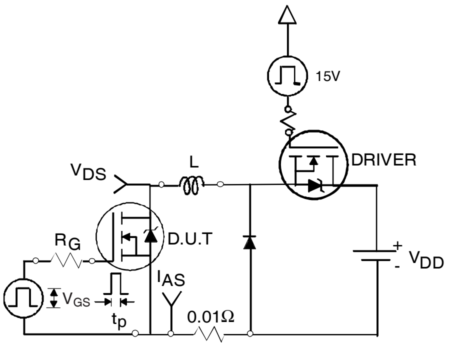


Fig 12a. Unclamped Inductive Test Circuit

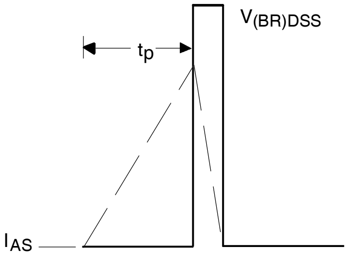


Fig 12b. Unclamped Inductive Waveforms

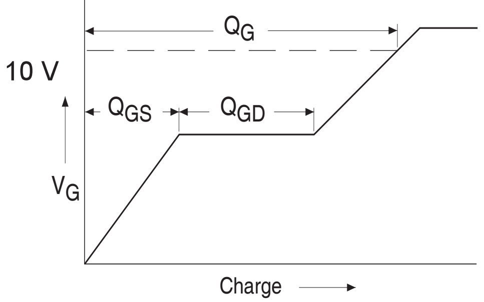


Fig 13a. Basic Gate Charge Waveform

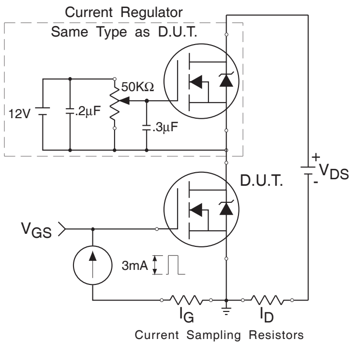


Fig 13b. Gate Charge Test Circuit

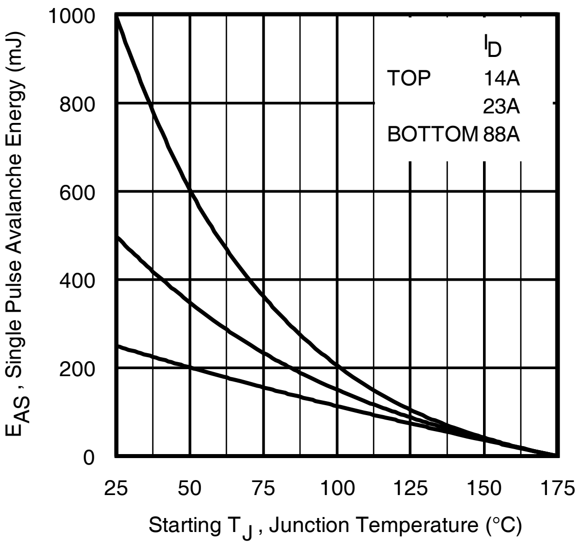


Fig 12c. Maximum Avalanche Energy vs. Drain Current

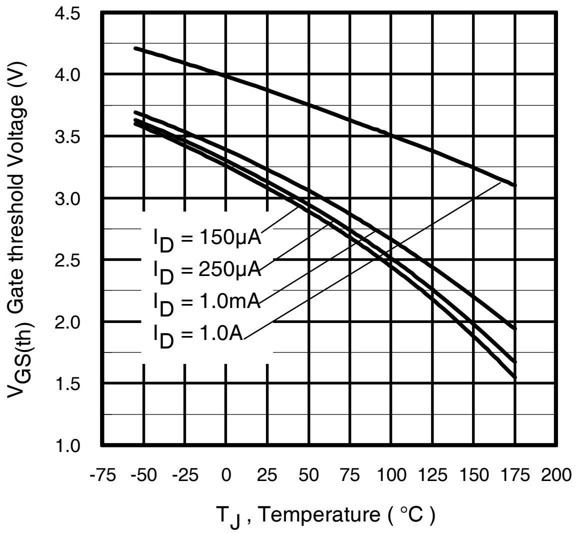


Fig 14. Threshold Voltage vs. Temperature

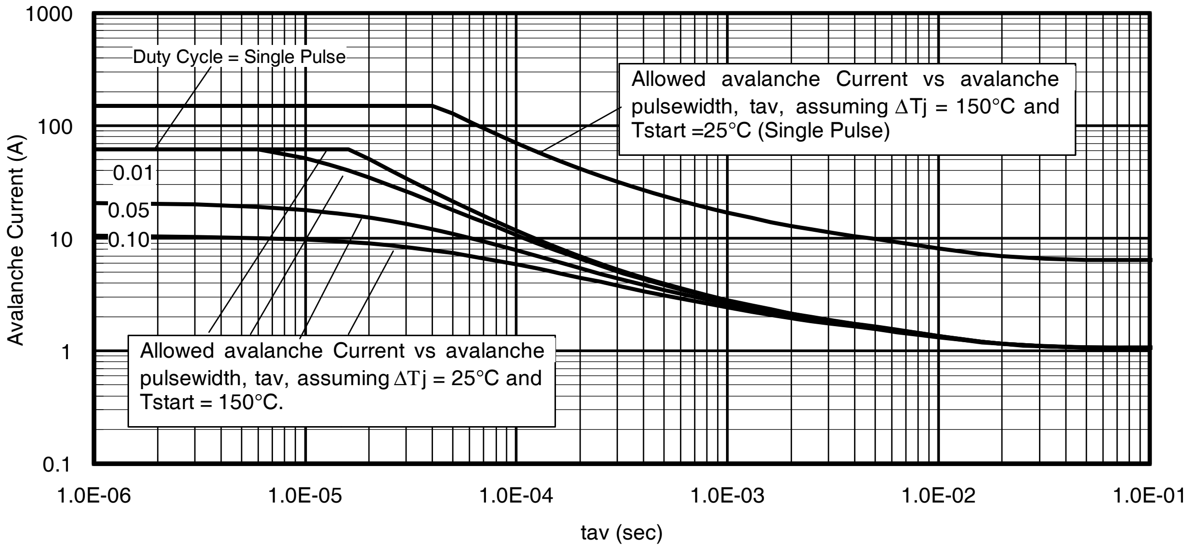


Fig 15. Typical Avalanche Current vs.Pulsewidth

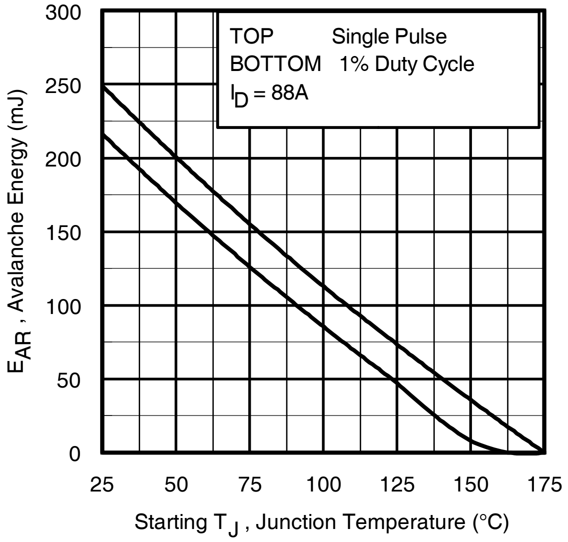
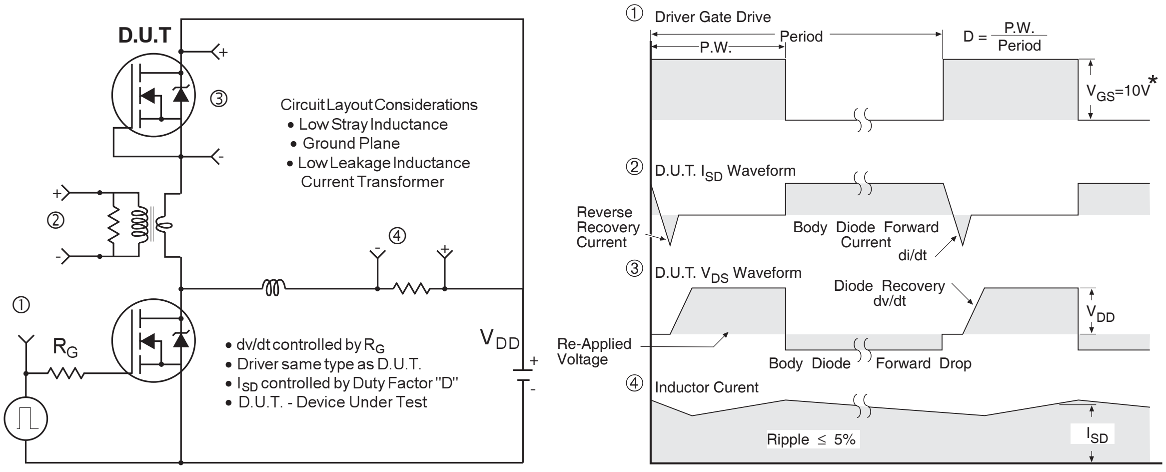


Fig 16. Maximum Avalanche Energy vs. Temperature

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)

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



* V_{GS} = 5V for Logic Level Devices

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

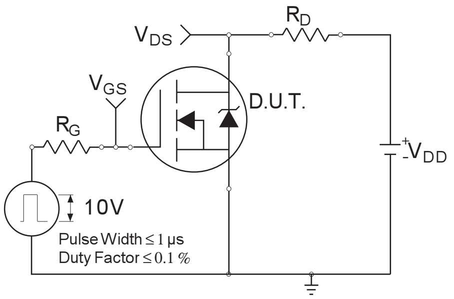


Fig 18a. Switching Time Test Circuit

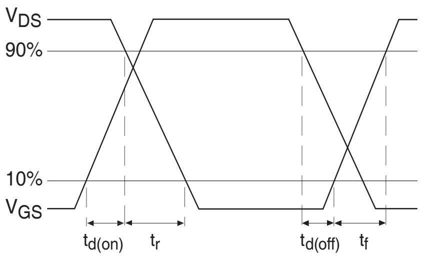
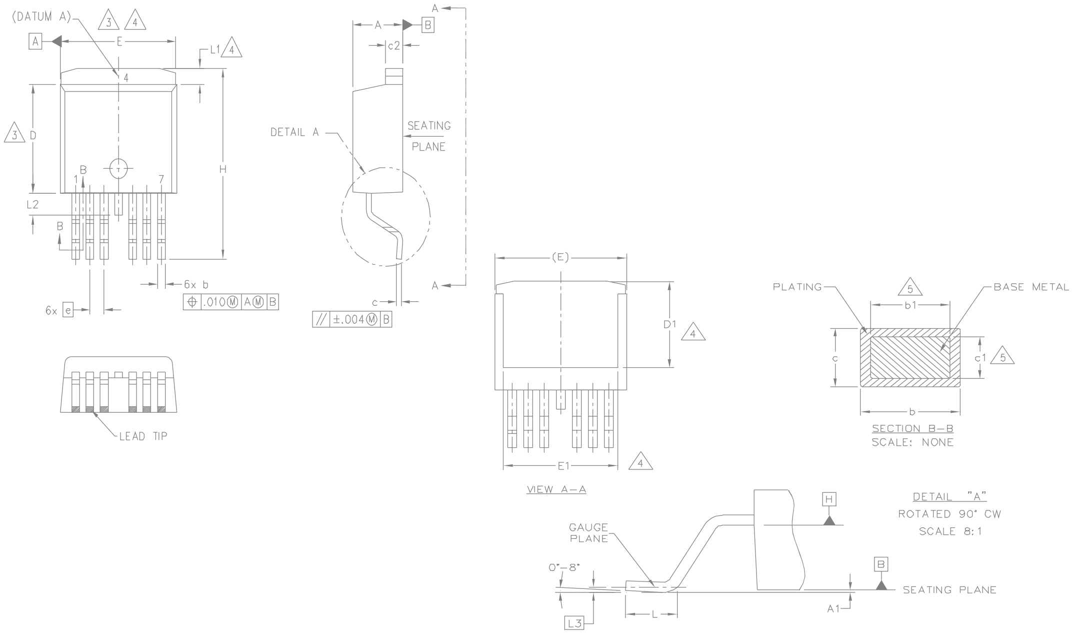


Fig 18b. Switching Time Waveforms

D^{2}Pak - 7 Pin Package Outline

Dimensions are shown in millimeters (inches)



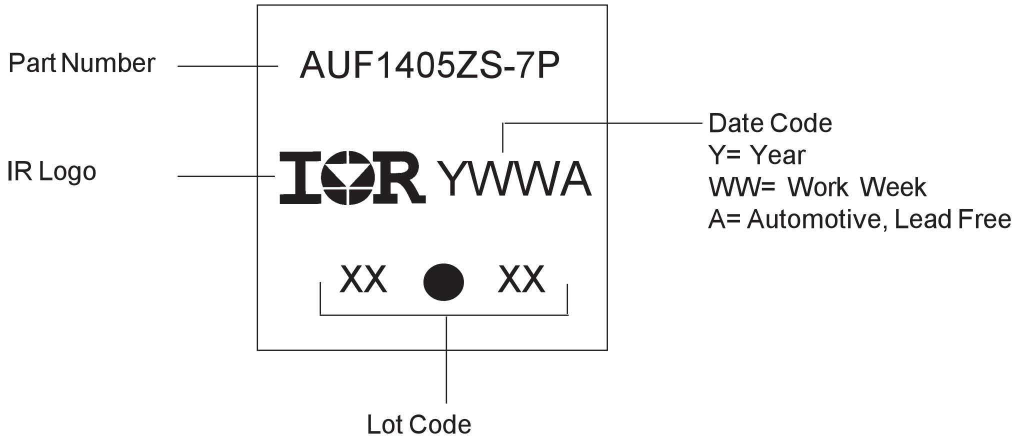
SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	
A1	–	0.254	–	.010	
b	0.51	0.99	.020	.036	
b1	0.51	0.89	.020	.032	5
c	0.38	0.74	.015	.029	
c1	0.38	0.58	.015	.023	5
c2	1.14	1.65	.045	.065	
D	8.38	9.65	.330	.380	3
D1	6.86	7.42	.270	.292	4
E	9.65	10.54	.380	.415	3,4
E1	6.22	8.48	.245	.334	4
e	1.27 BSC		.050 BSC		
H	14.61	15.88	.575	.625	
L	1.78	2.79	.070	.110	
L1	–	1.68	–	.066	4
L2	–	1.78	–	.070	
L3	0.25 BSC		.010 BSC		

NOTES:

1. DIMENSIONING AND TOLERANCING AS 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–263CB. EXCEPT FOR DIMS. E, E1 & D1.

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

D^{2}Pak - 7 Pin Part Marking Information

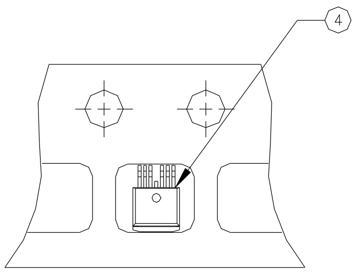


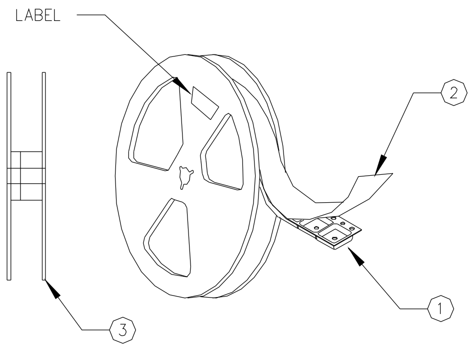
D^{2}Pak - 7 Pin Tape and Reel

NOTES, TAPE & REEL, LABELLING:

1. TAPE AND REEL.
   - 1.1 REEL SIZE 13 INCH DIAMETER.
   - 1.2 EACH REEL CONTAINING 800 DEVICES.
   - 1.3 THERE SHALL BE A MINIMUM OF 42 SEALED POCKETS CONTAINED IN THE LEADER AND A MINIMUM OF 15 SEALED POCKETS IN THE TRAILER.
   - 1.4 PEEL STRENGTH MUST CONFORM TO THE SPEC. NO. 71-9667.
   - 1.5 PART ORIENTATION SHALL BE AS SHOWN BELOW.
   - 1.6 REEL MAY CONTAIN A MAXIMUM OF TWO UNIQUE LOT CODE/DATE CODE COMBINATIONS. REWORKED REELS MAY CONTAIN A MAXIMUM OF THREE UNIQUE LOT CODE/DATE CODE COMBINATIONS. HOWEVER, THE LOT CODES AND DATE CODES WITH THEIR RESPECTIVE QUANTITIES SHALL APPEAR ON THE BAR CODE LABEL FOR THE AFFECTED REEL.

2. LABELLING (REEL AND SHIPPING BAG).
   - 2.1 CUST. PART NUMBER (BAR CODE): IRFXXXXSTRL-7P
   - 2.2 CUST. PART NUMBER (TEXT CODE): IRFXXXXSTRL-7P
   - 2.3 I.R. PART NUMBER: IRFXXXXSTRL-7P
   - 2.4 QUANTITY:
   - 2.5 VENDOR CODE: IR
   - 2.6 LOT CODE:
   - 2.7 DATE CODE:





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

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		7L-D2 PAK	MSL1
ESD	Machine Model	Class M4(425V)[††] (per AEC-Q101-002)	
	Human Body Model	Class H1C(2000V)[††] (per AEC-Q101-001)	
	Charged Device Model	Class C5(1125V)[††] (per AEC-Q101-005)	
RoHS Compliant		Yes	

[†] Qualification standards can be found at International Rectifier's web site: http://www.irf.com/product-info/reliability

[††] Highest passing voltage.

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http://www.irf.com/technical-info/
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Tel: (310) 252-7105

Revision History

Date	Comments
2/27/2015	• Corrected part number for TRL from "AUIRF1405ZS-7PTRL" to "AUIRF1405ZS-7TRL" on page1.