

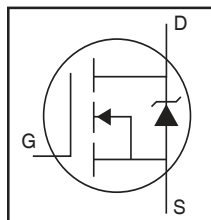
### HEXFET® Power MOSFET

#### Features

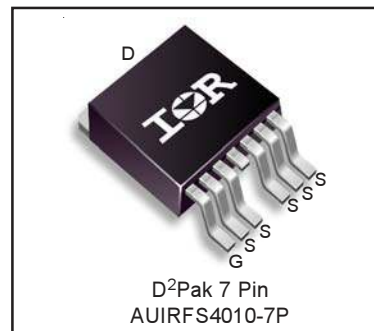
- Advanced Process Technology
- Ultra Low On-Resistance
- Enhanced dV/dT and dI/dT capability
- 175°C Operating Temperature
- Fast Switching
- Repetitive Avalanche Allowed up to T<sub>Jmax</sub>
- Lead-Free, RoHS Compliant
- Automotive Qualified\*

#### 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.



$V_{DSS}$		<b>100V</b>
$R_{DS(on)}$	typ.	<b>3.3mΩ</b>
	max.	<b>4.0mΩ</b>
$I_D$		<b>190A</b>



<b>G</b>	<b>D</b>	<b>S</b>
Gate	Drain	Source

Base Part Number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
AUIRFS4010-7P	D2Pak- 7 Pin	Tube	50	AUIRFS4010-7P
		Tape and Reel Left	800	AUIRFS4010-7TRL
		Tape and Reel Right	800	AUIRFS4010-7TRR

#### 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<sub>A</sub>) is 25°C, unless otherwise specified.

	Parameter	Max.	Units
$I_D @ T_C = 25^\circ\text{C}$	Continuous Drain Current, $V_{GS} @ 10\text{V}$	190	A
$I_D @ T_C = 100^\circ\text{C}$	Continuous Drain Current, $V_{GS} @ 10\text{V}$	130	
$I_{DM}$	Pulsed Drain Current ①	740	
$P_D @ T_C = 25^\circ\text{C}$	Maximum Power Dissipation	380	W
	Linear Derating Factor	2.5	W/°C
$V_{GS}$	Gate-to-Source Voltage	± 20	V
$E_{AS}$	Single Pulse Avalanche Energy (Thermally Limited) ②	330	mJ
$I_{AR}$	Avalanche Current ①	See Fig. 14, 15, 22a, 22b	A
$E_{AR}$	Repetitive Avalanche Energy ①		mJ
dv/dt	Peak Diode Recovery ③	26	V/ns
$T_J$	Operating Junction and	-55 to + 175	°C
$T_{STG}$	Storage Temperature Range		
	Soldering Temperature, for 10 seconds (1.6mm from case)	300	

#### Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case ③④	—	0.40	°C/W
$R_{\theta JA}$	Junction-to-Ambient (PCB Mount) ⑦	—	40	

HEXFET® is a registered trademark of International Rectifier.

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

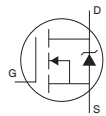
**Static Electrical Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)**

	Parameter	Min.	Typ.	Max.	Units	Conditions
V <sub>(BR)DSS</sub>	Drain-to-Source Breakdown Voltage	100	—	—	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA
ΔV <sub>(BR)DSS</sub> /ΔT <sub>J</sub>	Breakdown Voltage Temp. Coefficient	—	0.11	—	V/°C	Reference to 25°C, I <sub>D</sub> = 5mA <sup>①</sup>
R <sub>DS(on)</sub>	Static Drain-to-Source On-Resistance	—	3.3	4.0	mΩ	V <sub>GS</sub> = 10V, I <sub>D</sub> = 110A <sup>④</sup>
V <sub>GS(th)</sub>	Gate Threshold Voltage	2.0	—	4.0	V	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250μA
g <sub>fs</sub>	Forward Transconductance	210	—	—	S	V <sub>DS</sub> = 25V, I <sub>D</sub> = 110A
R <sub>G</sub>	Internal Gate Resistance	—	2.1	—	Ω	
I <sub>DSS</sub>	Drain-to-Source Leakage Current	—	—	20	μA	V <sub>DS</sub> = 100V, V <sub>GS</sub> = 0V
		—	—	250		V <sub>DS</sub> = 100V, V <sub>GS</sub> = 0V, T <sub>J</sub> = 125°C
I <sub>GSS</sub>	Gate-to-Source Forward Leakage	—	—	100	nA	V <sub>GS</sub> = 20V
	Gate-to-Source Reverse Leakage	—	—	-100		V <sub>GS</sub> = -20V

**Dynamic Electrical Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)**

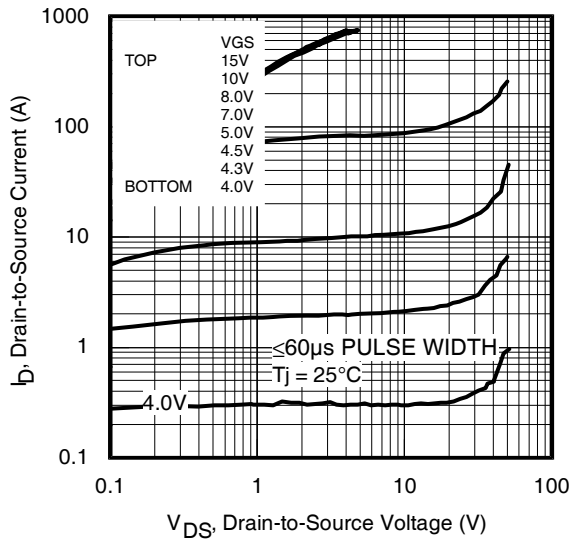
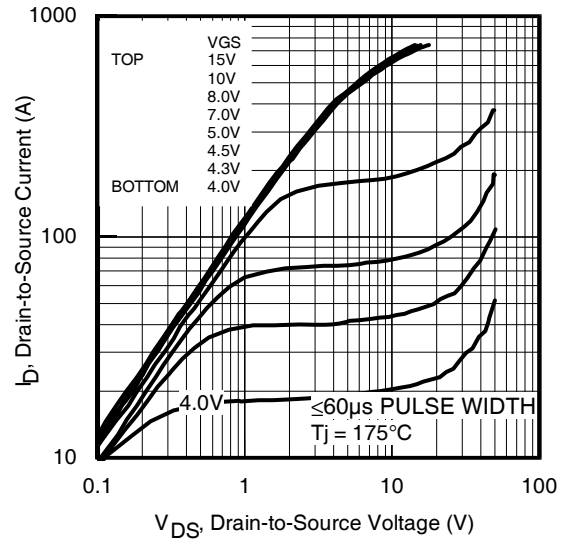
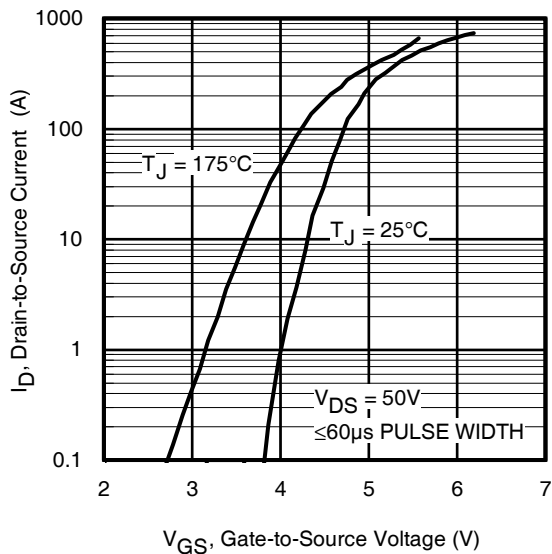
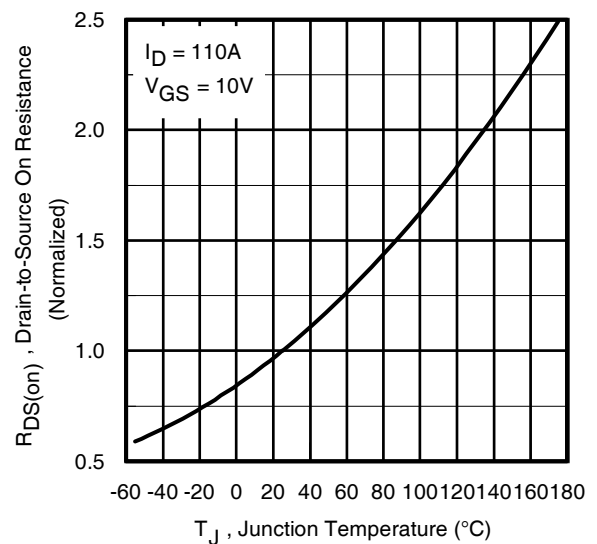
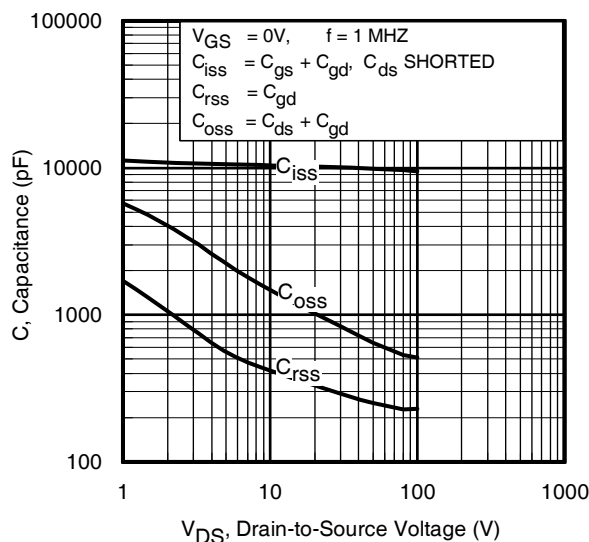
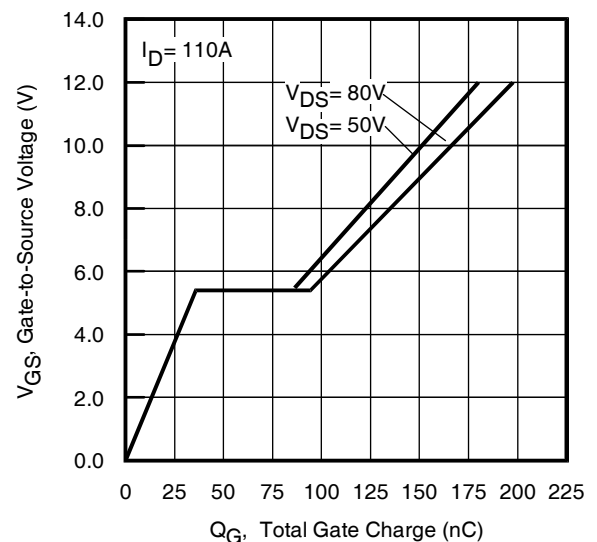
	Parameter	Min.	Typ.	Max.	Units	Conditions
Q <sub>g</sub>	Total Gate Charge	—	150	230	nC	I <sub>D</sub> = 110A
Q <sub>gs</sub>	Gate-to-Source Charge	—	36	—		V <sub>DS</sub> = 50V
Q <sub>gd</sub>	Gate-to-Drain ("Miller") Charge	—	48	—		V <sub>GS</sub> = 10V <sup>④</sup>
Q <sub>sync</sub>	Total Gate Charge Sync. (Q <sub>g</sub> - Q <sub>gd</sub> )	—	102	—		I <sub>D</sub> = 110A, V <sub>DS</sub> = 0V, V <sub>GS</sub> = 10V
t <sub>d(on)</sub>	Turn-On Delay Time	—	19	—	ns	V <sub>DD</sub> = 65V
t <sub>r</sub>	Rise Time	—	56	—		I <sub>D</sub> = 110A
t <sub>d(off)</sub>	Turn-Off Delay Time	—	100	—		R <sub>G</sub> = 2.7Ω
t <sub>f</sub>	Fall Time	—	48	—		V <sub>GS</sub> = 10V <sup>④</sup>
C <sub>iss</sub>	Input Capacitance	—	9830	—	pF	V <sub>GS</sub> = 0V
C <sub>oss</sub>	Output Capacitance	—	650	—		V <sub>DS</sub> = 50V
C <sub>rss</sub>	Reverse Transfer Capacitance	—	260	—		f = 1.0MHz
C <sub>oss</sub> eff. (ER)	Effective Output Capacitance (Energy Related) <sup>⑥</sup>	—	730	—		V <sub>GS</sub> = 0V, V <sub>DS</sub> = 0V to 80V <sup>⑥</sup>
C <sub>oss</sub> eff. (TR)	Effective Output Capacitance (Time Related) <sup>⑤</sup>	—	740	—		V <sub>GS</sub> = 0V, V <sub>DS</sub> = 0V to 80V <sup>⑥</sup>

**Diode Characteristics**

	Parameter	Min.	Typ.	Max.	Units	Conditions
I <sub>S</sub>	Continuous Source Current (Body Diode)	—	—	186	A	MOSFET symbol showing the integral reverse p-n junction diode. 
I <sub>SM</sub>	Pulsed Source Current (Body Diode) <sup>①</sup>	—	—	740		
V <sub>SD</sub>	Diode Forward Voltage	—	—	1.3	V	T <sub>J</sub> = 25°C, I <sub>S</sub> = 110A, V <sub>GS</sub> = 0V <sup>④</sup>
t <sub>rr</sub>	Reverse Recovery Time	—	60	—	ns	T <sub>J</sub> = 25°C V <sub>R</sub> = 85V,
		—	67	—		T <sub>J</sub> = 125°C I <sub>F</sub> = 110A
Q <sub>rr</sub>	Reverse Recovery Charge	—	150	—	nC	T <sub>J</sub> = 25°C di/dt = 100A/μs <sup>④</sup>
		—	180	—		T <sub>J</sub> = 125°C
I <sub>RRM</sub>	Reverse Recovery Current	—	4.7	—	A	T <sub>J</sub> = 25°C
t <sub>on</sub>	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.
- ② Limited by T<sub>Jmax</sub>, starting T<sub>J</sub> = 25°C, L = 0.052mH  
R<sub>G</sub> = 25Ω, I<sub>AS</sub> = 110A, V<sub>GS</sub> = 10V. Part not recommended for use above this value.
- ③ I<sub>SD</sub> ≤ 110A, di/dt ≤ 1310A/μs, V<sub>DD</sub> ≤ V<sub>(BR)DSS</sub>, T<sub>J</sub> ≤ 175°C.
- ④ Pulse width ≤ 400μs; duty cycle ≤ 2%.
- ⑤ C<sub>oss</sub> eff. (TR) is a fixed capacitance that gives the same charging time as C<sub>oss</sub> while V<sub>DS</sub> is rising from 0 to 80% V<sub>DSS</sub>.
- ⑥ C<sub>oss</sub> eff. (ER) is a fixed capacitance that gives the same energy as C<sub>oss</sub> while V<sub>DS</sub> is rising from 0 to 80% V<sub>DSS</sub>.
- 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<sub>θ</sub> is measured at T<sub>J</sub> approximately 90°C.
- ⑨ R<sub>θJC</sub> value shown is at time zero.


**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**

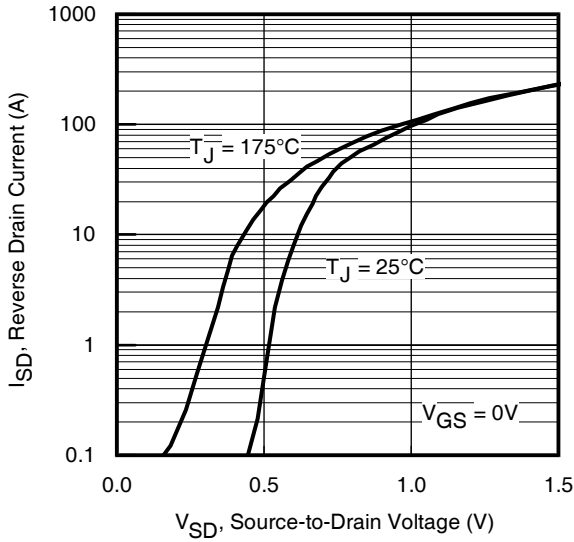


Fig 7. Typical Source-Drain Diode Forward Voltage

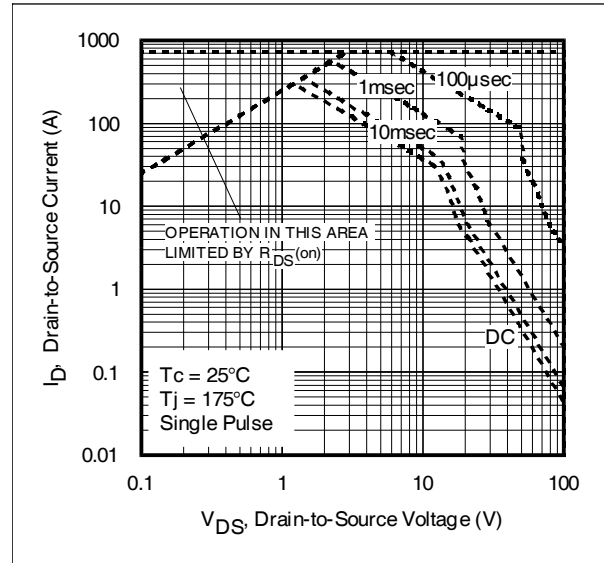


Fig 8. Maximum Safe Operating Area

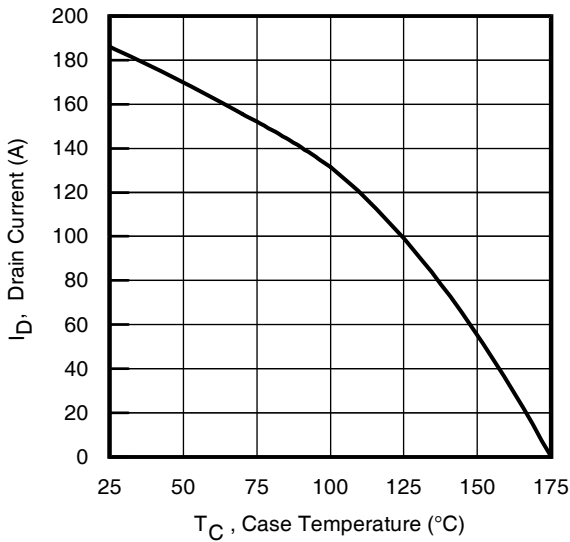


Fig 9. Maximum Drain Current vs. Case Temperature

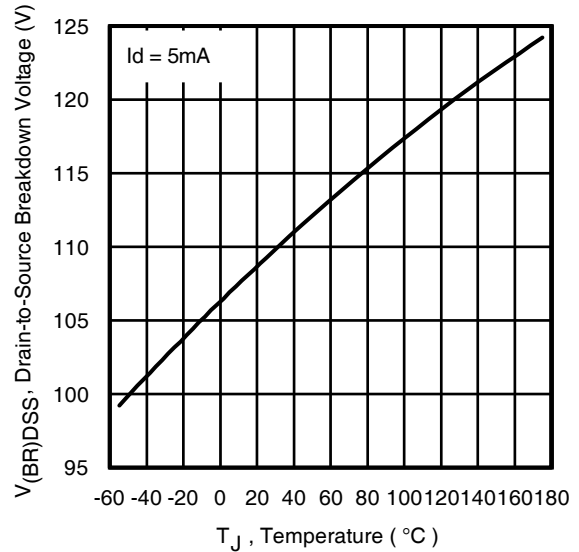


Fig 10. Drain-to-Source Breakdown Voltage

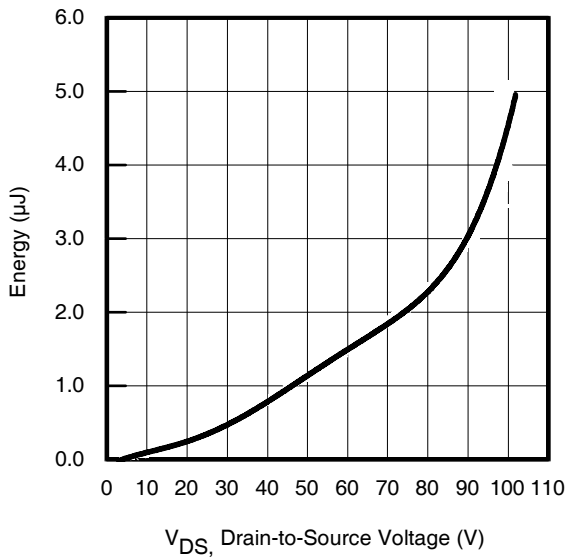


Fig 11. Typical  $C_{OSS}$  Stored Energy

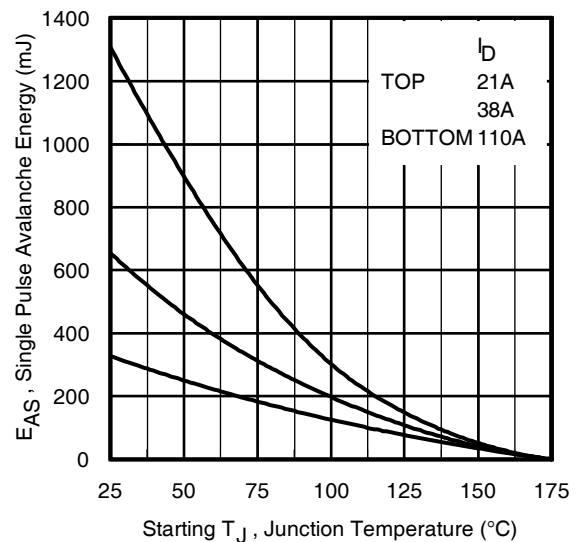


Fig 12. Maximum Avalanche Energy vs. Drain Current

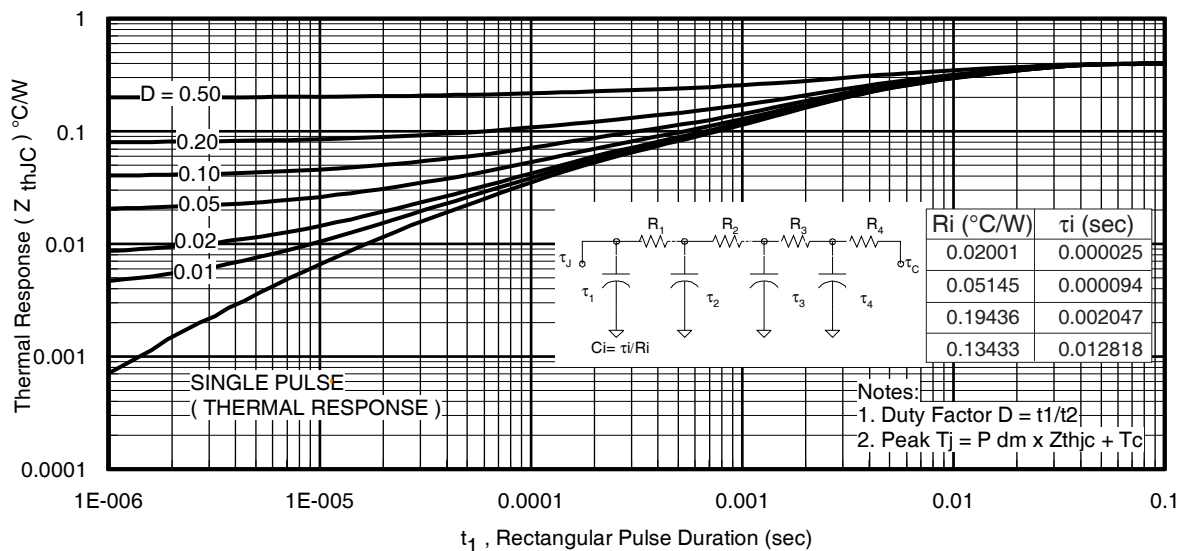


Fig 13. Maximum Effective Transient Thermal Impedance, Junction-to-Case

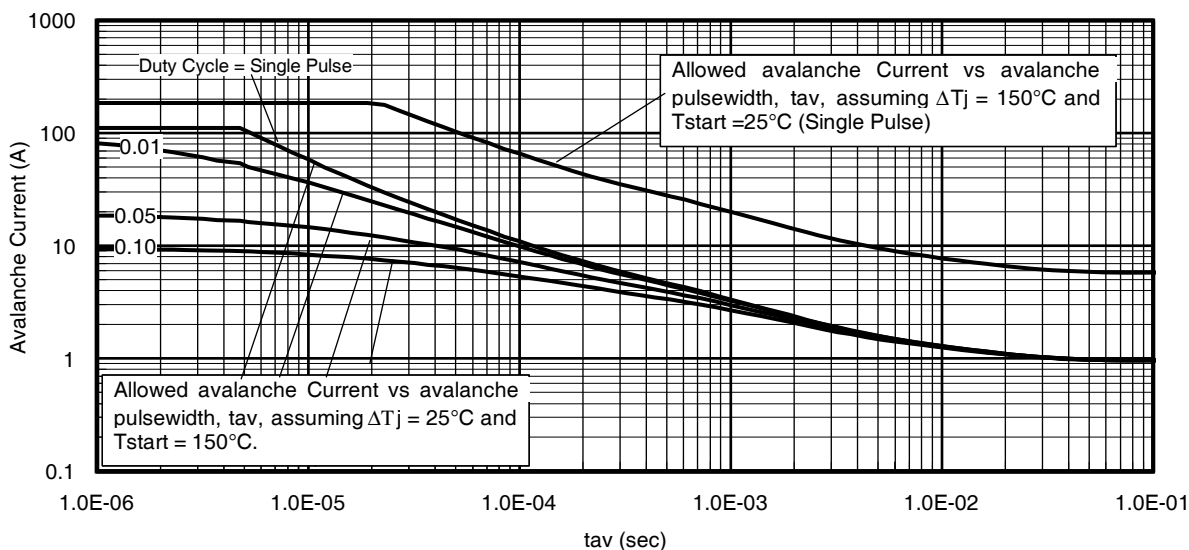
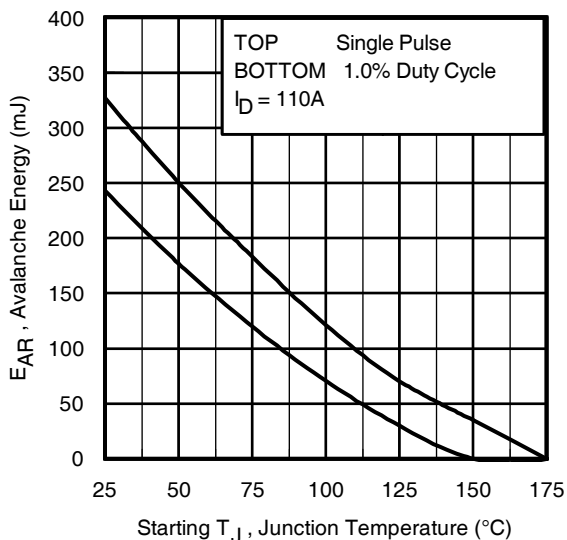


Fig 14. Typical Avalanche Current vs. Pulsewidth



**Notes on Repetitive Avalanche Curves , Figures 14, 15:**  
 (For further info, see AN-1005 at [www.irf.com](http://www.irf.com))

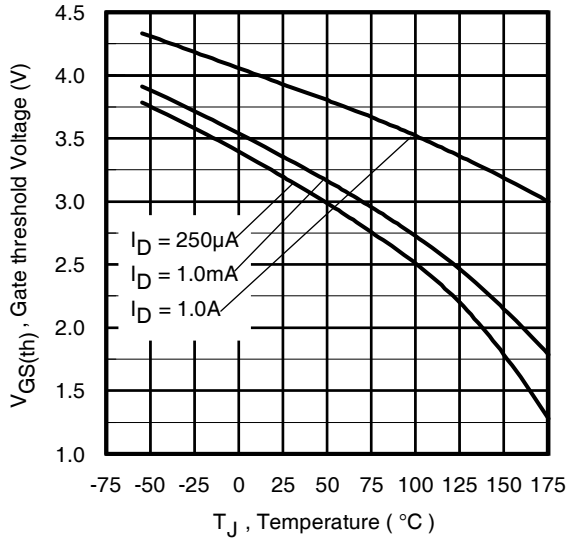
1. Avalanche failures assumption:  
 Purely a thermal phenomenon and failure occurs at a temperature far in excess of  $T_{jmax}$ . This is validated for every part type.
2. Safe operation in Avalanche is allowed as long as  $T_{jmax}$  is not exceeded.
3. Equation below based on circuit and waveforms shown in Figures 22a,22b.
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.  $\Delta T$  = Allowable rise in junction temperature, not to exceed  $T_{jmax}$  (assumed as 25°C in Figure 14, 15).  
 $t_{av}$  = Average time in avalanche.  
 $D$  = Duty cycle in avalanche =  $t_{av} \cdot f$   
 $Z_{thJC}(D, t_{av})$  = Transient thermal resistance, see Figures 13)

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

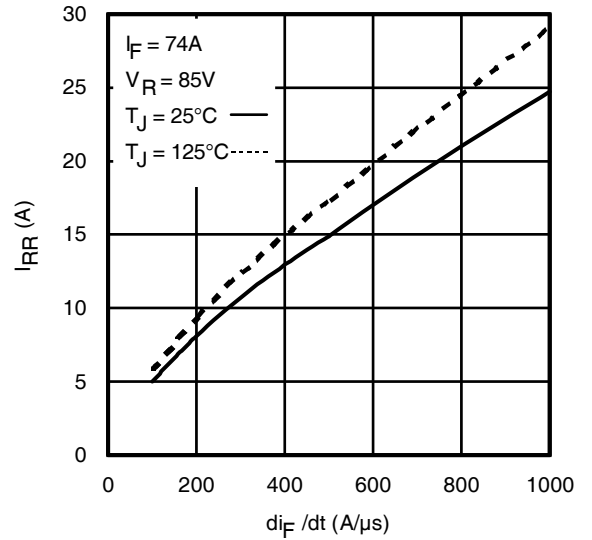
$$I_{av} = 2\Delta T / [1.3 \cdot BV \cdot Z_{th}]$$

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

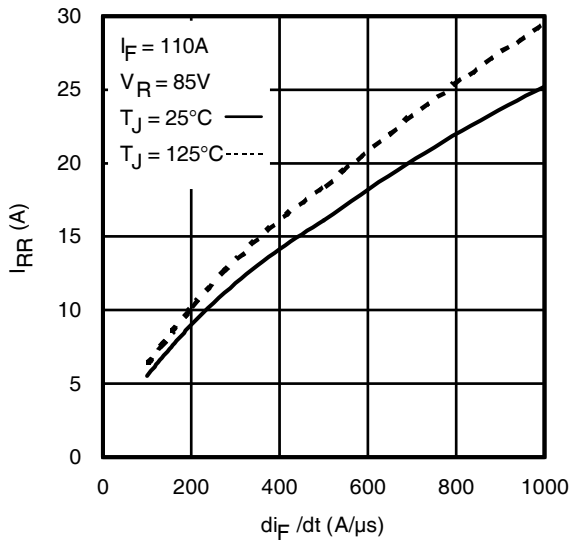
Fig 15. Maximum Avalanche Energy vs. Temperature



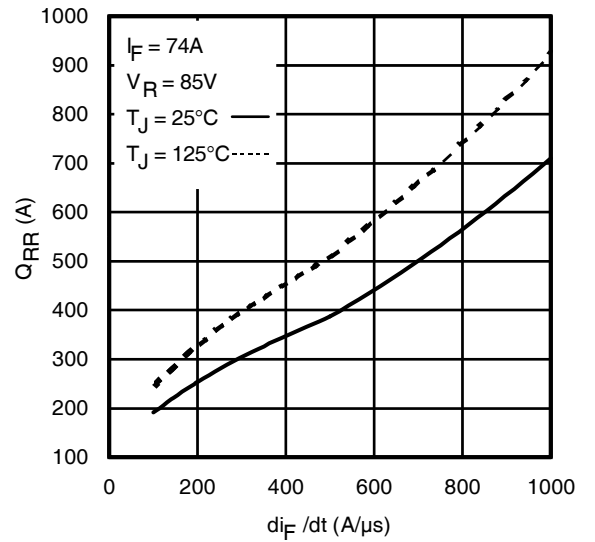
**Fig 16.** Threshold Voltage vs. Temperature



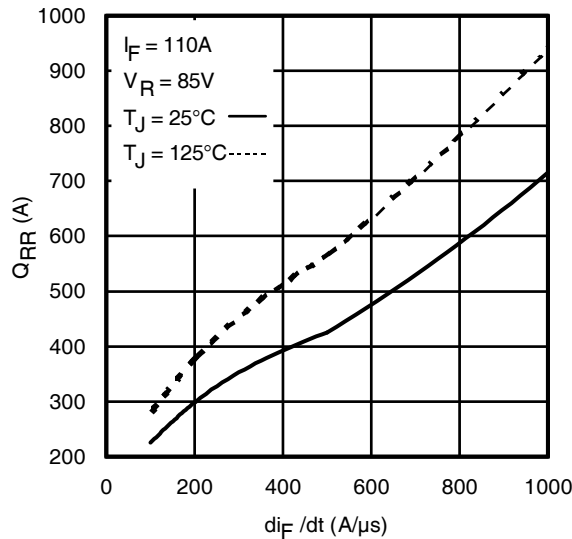
**Fig. 17 -** Typical Recovery Current vs.  $di_F/dt$



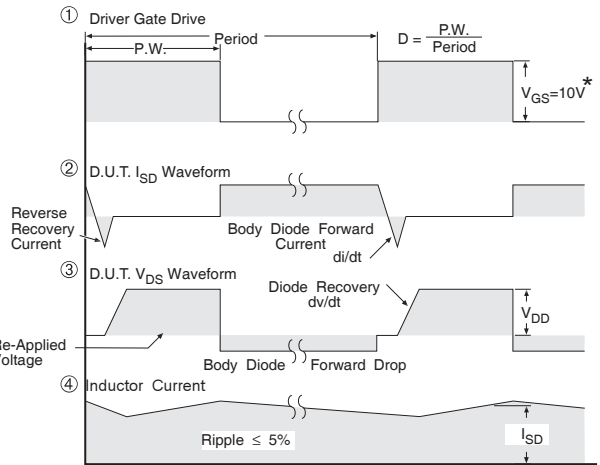
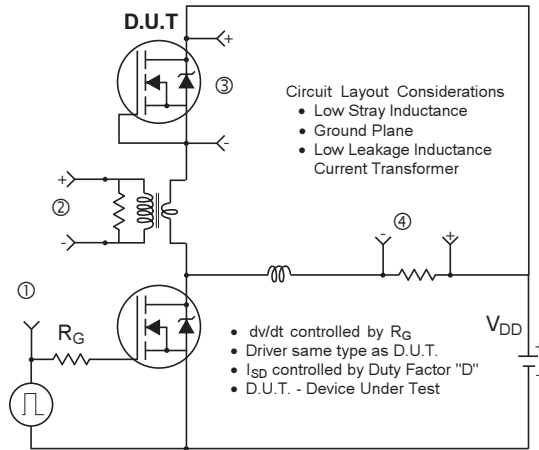
**Fig. 18 -** Typical Recovery Current vs.  $di_F/dt$



**Fig. 19 -** Typical Stored Charge vs.  $di_F/dt$

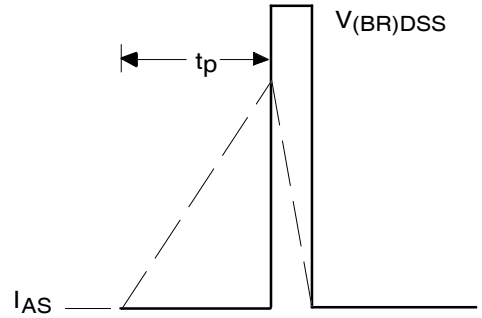
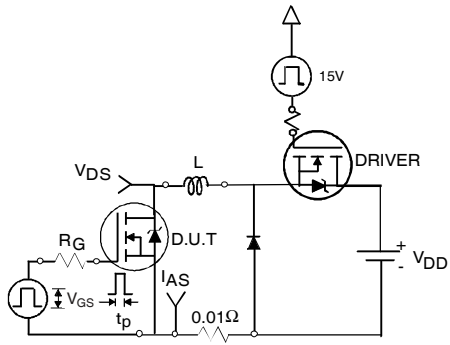


**Fig. 20 -** Typical Stored Charge vs.  $di_F/dt$



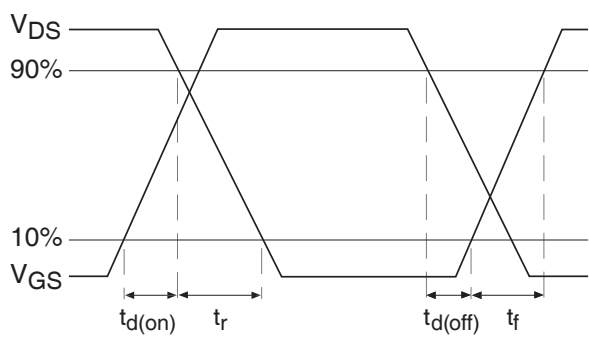
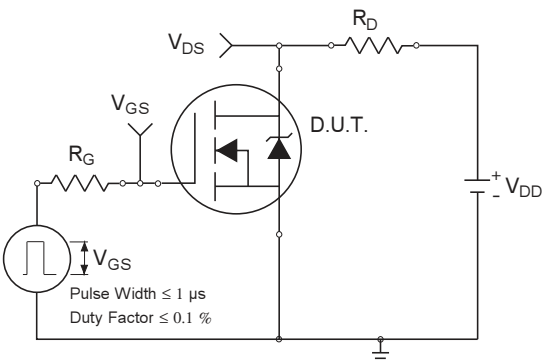
\*  $V_{GS} = 5V$  for Logic Level Devices

**Fig 21. Peak Diode Recovery dv/dt Test Circuit for N-Channel HEXFET® Power MOSFETs**



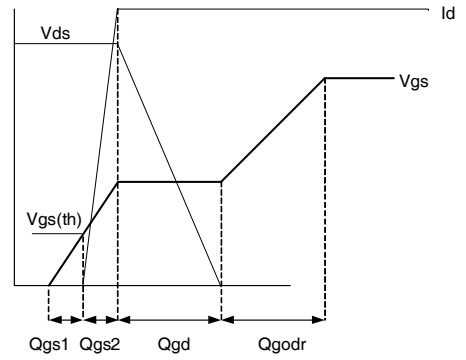
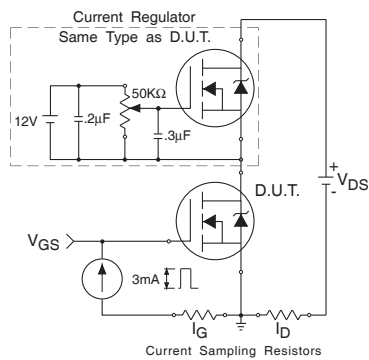
**Fig 22a. Unclamped Inductive Test Circuit**

**Fig 22b. Unclamped Inductive Waveforms**



**Fig 23a. Switching Time Test Circuit**

**Fig 23b. Switching Time Waveforms**

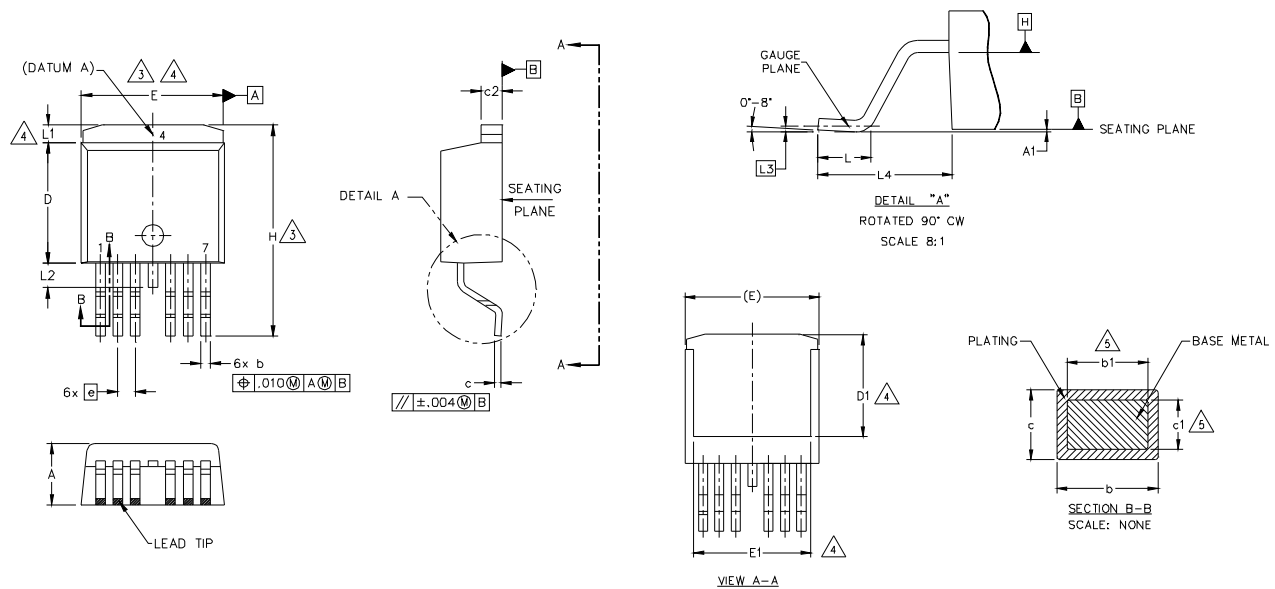


**Fig 24a. Gate Charge Test Circuit**

**Fig 24b. Gate Charge Waveform**

# D<sup>2</sup>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	5
A1	-	0.254	-	.010	
b	0.51	0.99	.020	.036	
b1	0.51	0.89	.020	.032	
c	0.38	0.74	.015	.029	
c1	0.38	0.58	.015	.023	
c2	1.14	1.65	.045	.065	
D	8.38	9.65	.330	.380	
D1	6.86	-	.270	-	
E	9.65	10.67	.380	.420	
E1	6.22	-	.245	-	
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		
L4	4.78	5.28	.188	.208	

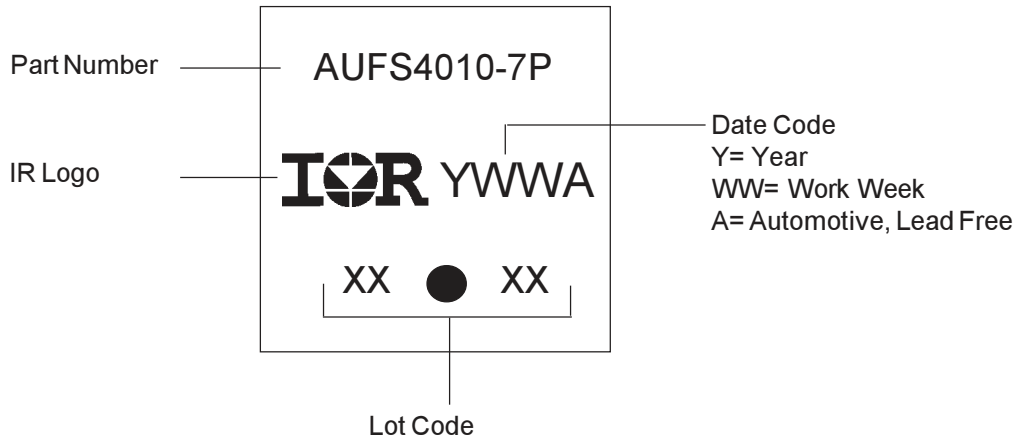
**NOTES:**

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.

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



## D<sup>2</sup>Pak - 7 Pin Part Marking Information



## D<sup>2</sup>Pak - 7 Pin Tape and Reel

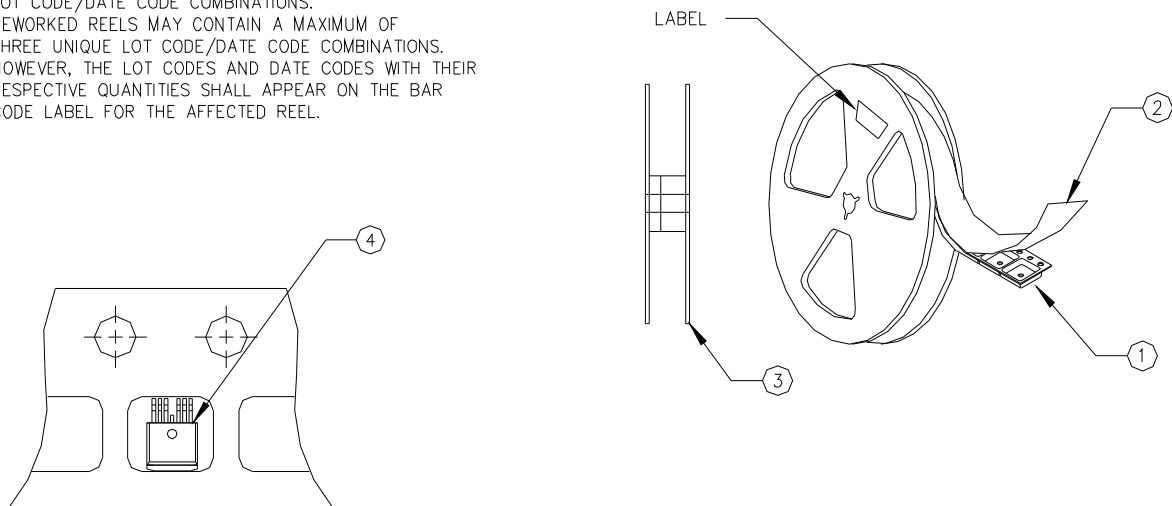
### NOTES, TAPE & REEL, LABELLING:

#### 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<sup>†</sup>

<b>Qualification Level</b>		Automotive (per AEC-Q101) <sup>††</sup>	
		Comments: This part number(s) passed Automotive qualification. IR's Industrial and Consumer qualification level is granted by extension of the higher Automotive level.	
<b>Moisture Sensitivity Level</b>		7L-D2 PAK	MSL1
<b>ESD</b>	Machine Model	Class M4(+/- 800V) <sup>†††</sup> (per AEC-Q101-002)	
	Human Body Model	Class H3A(+/- 6000V) <sup>†††</sup> (per AEC-Q101-001)	
	Charged Device Model	Class C5(+/- 2000V) <sup>†††</sup> (per AEC-Q101-005)	
<b>RoHS Compliant</b>		Yes	

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

†† Exceptions (if any) to AEC-Q101 requirements are noted in the qualification report.

††† Highest passing voltage

**IMPORTANT NOTICE**

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**Revision History**

Date	Comments
3/10/2014	<ul style="list-style-type: none"> <li>• Updated fig.8 SOA curve on page 5</li> <li>• Updated data sheet with new IR corporate template</li> </ul>