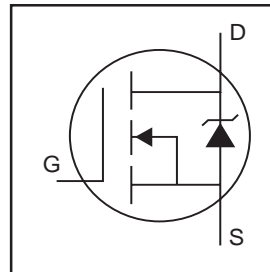


**Features**

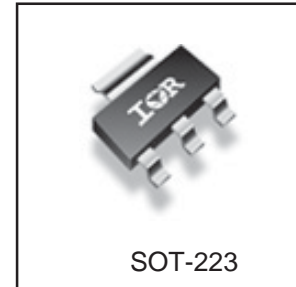
- Advanced Process Technology
- Ultra Low On-Resistance
- 150°C Operating Temperature
- Fast Switching
- Repetitive Avalanche Allowed up to Tjmax
- Lead-Free



$V_{DSS} = 55V$
$R_{DS(on)} = 60m\Omega$
$I_D = 5.0A$

**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 150°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.



**Absolute Maximum Ratings**

	Parameter	Max.	Units
$I_D @ T_A = 25^\circ C$	Continuous Drain Current, $V_{GS} @ 10V$ (Silicon Limited) ⑦	5.0	A
$I_D @ T_A = 70^\circ C$	Continuous Drain Current, $V_{GS} @ 10V$ ⑦	4.0	
$I_{DM}$	Pulsed Drain Current ①	40	
$P_D @ T_A = 25^\circ C$	Power Dissipation ②	2.8	
$P_D @ T_A = 25^\circ C$	Power Dissipation ③	1.0	W
	Linear Derating Factor ②	0.02	W/°C
$V_{GS}$	Gate-to-Source Voltage	$\pm 16$	V
$E_{AS}$ (Thermally limited)	Single Pulse Avalanche Energy ②	21	mJ
$E_{AS}$ (Tested)	Single Pulse Avalanche Energy Tested Value ⑥	38	
$I_{AR}$	Avalanche Current ①	See Fig.12a, 12b, 15, 16	A
$E_{AR}$	Repetitive Avalanche Energy ⑤		mJ
$T_J$	Operating Junction and	-55 to + 150	°C
$T_{STG}$	Storage Temperature Range		

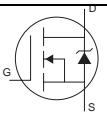
**Thermal Resistance**

	Parameter	Typ.	Max.	Units
$R_{\theta JA}$	Junction-to-Ambient (PCB mount, steady state) ⑦	—	45	°C/W
$R_{\theta JA}$	Junction-to-Ambient (PCB mount, steady state) ⑧	—	120	

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

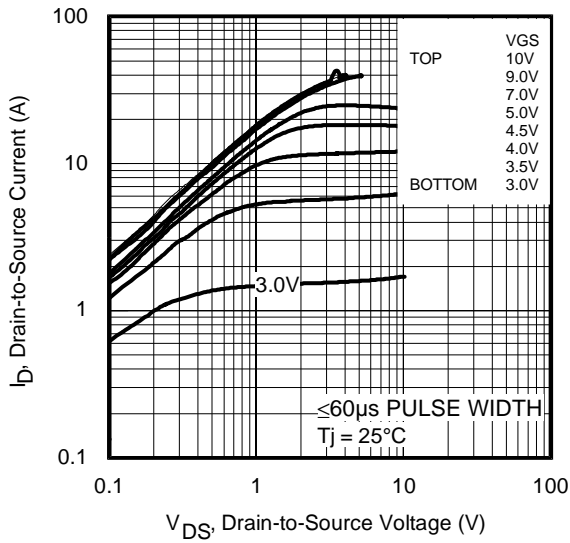
	Parameter	Min.	Typ.	Max.	Units	Conditions
V <sub>(BR)DSS</sub>	Drain-to-Source Breakdown Voltage	55	—	—	V	V <sub>GS</sub> = 0V, I <sub>D</sub> = 250μA
ΔV <sub>(BR)DSS</sub> /ΔT <sub>J</sub>	Breakdown Voltage Temp. Coefficient	—	0.049	—	V/°C	Reference to 25°C, I <sub>D</sub> = 1mA
R <sub>DS(on)</sub>	Static Drain-to-Source On-Resistance	—	48	60	mΩ	V <sub>GS</sub> = 10V, I <sub>D</sub> = 3.0A ③
		—	—	80		V <sub>GS</sub> = 5.0V, I <sub>D</sub> = 3.0A ③
		—	—	100		V <sub>GS</sub> = 4.5V, I <sub>D</sub> = 3.0A ③
V <sub>GS(th)</sub>	Gate Threshold Voltage	1.0	—	3.0	V	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250μA
g <sub>fs</sub>	Forward Transconductance	7.5	—	—	S	V <sub>DS</sub> = 25V, I <sub>D</sub> = 3.0A
I <sub>DSS</sub>	Drain-to-Source Leakage Current	—	—	20	μA	V <sub>DS</sub> = 55V, V <sub>GS</sub> = 0V
		—	—	250		V <sub>DS</sub> = 55V, V <sub>GS</sub> = 0V, T <sub>J</sub> = 125°C
I <sub>GSS</sub>	Gate-to-Source Forward Leakage	—	—	200	nA	V <sub>GS</sub> = 16V
	Gate-to-Source Reverse Leakage	—	—	-200		V <sub>GS</sub> = -16V
Q <sub>g</sub>	Total Gate Charge	—	7.0	11	nC	I <sub>D</sub> = 3.0A
Q <sub>gs</sub>	Gate-to-Source Charge	—	1.5	—		V <sub>DS</sub> = 44V
Q <sub>gd</sub>	Gate-to-Drain ("Miller") Charge	—	4.0	—		V <sub>GS</sub> = 5.0V ③
t <sub>d(on)</sub>	Turn-On Delay Time	—	8.6	—	ns	V <sub>DD</sub> = 28V
t <sub>r</sub>	Rise Time	—	33	—		I <sub>D</sub> = 3.0A
t <sub>d(off)</sub>	Turn-Off Delay Time	—	20	—		R <sub>G</sub> = 56 Ω
t <sub>f</sub>	Fall Time	—	15	—		V <sub>GS</sub> = 5.0V ③
C <sub>iss</sub>	Input Capacitance	—	380	—	pF	V <sub>GS</sub> = 0V
C <sub>oss</sub>	Output Capacitance	—	66	—		V <sub>DS</sub> = 25V
C <sub>rss</sub>	Reverse Transfer Capacitance	—	36	—		f = 1.0MHz
C <sub>oss</sub>	Output Capacitance	—	220	—		V <sub>GS</sub> = 0V, V <sub>DS</sub> = 1.0V, f = 1.0MHz
C <sub>oss</sub>	Output Capacitance	—	53	—		V <sub>GS</sub> = 0V, V <sub>DS</sub> = 44V, f = 1.0MHz
C <sub>oss eff.</sub>	Effective Output Capacitance	—	93	—		V <sub>GS</sub> = 0V, V <sub>DS</sub> = 0V to 44V ④

## Source-Drain Ratings and Characteristics

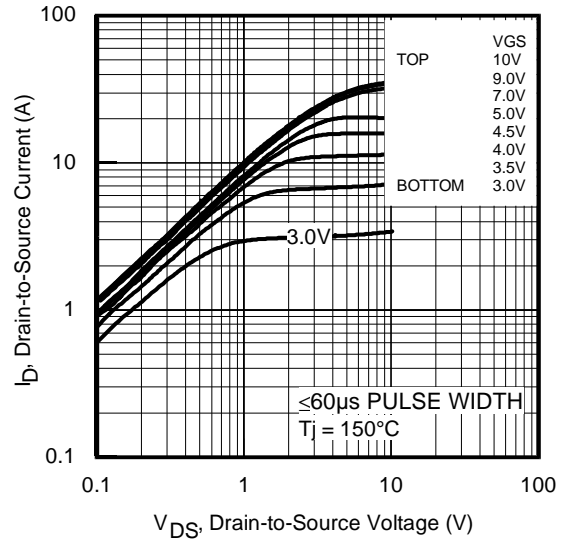
	Parameter	Min.	Typ.	Max.	Units	Conditions
I <sub>S</sub>	Continuous Source Current (Body Diode)	—	—	5.0	A	MOSFET symbol showing the integral reverse p-n junction diode.
I <sub>SM</sub>	Pulsed Source Current (Body Diode) ①	—	—	40		
V <sub>SD</sub>	Diode Forward Voltage	—	—	1.3	V	T <sub>J</sub> = 25°C, I <sub>S</sub> = 3.0A, V <sub>GS</sub> = 0V ②
t <sub>rr</sub>	Reverse Recovery Time	—	15	23	ns	T <sub>J</sub> = 25°C, I <sub>F</sub> = 3.0A, V <sub>DD</sub> = 28V
Q <sub>rr</sub>	Reverse Recovery Charge	—	9.1	14	nC	di/dt = 100A/μs ③
t <sub>on</sub>	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by LS+LD)				

### Notes:

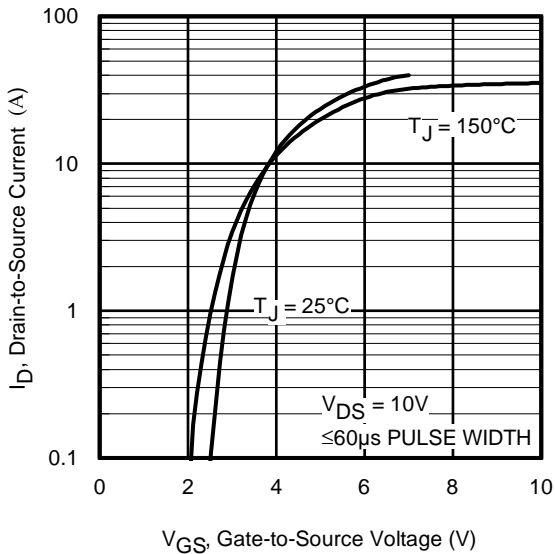
- ① Repetitive rating; pulse width limited by max. junction temperature. (See fig. 11).
- ② Limited by T<sub>Jmax</sub>, starting T<sub>J</sub> = 25°C, L = 4.8mH  
R<sub>G</sub> = 25Ω, I<sub>AS</sub> = 3.0A, V<sub>GS</sub> = 10V.  
Part not recommended for use above this value.
- ③ Pulse width ≤ 1.0ms; duty cycle ≤ 2%.
- ④ C<sub>oss eff.</sub> 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>.
- ⑤ Limited by T<sub>Jmax</sub>, see Fig.12a, 12b, 15, 16 for typical repetitive avalanche performance.
- ⑥ This value determined from sample failure population. 100% tested to this value in production.
- ⑦ When mounted on 1 inch square copper board.
- ⑧ When mounted on FR-4 board using minimum recommended footprint.



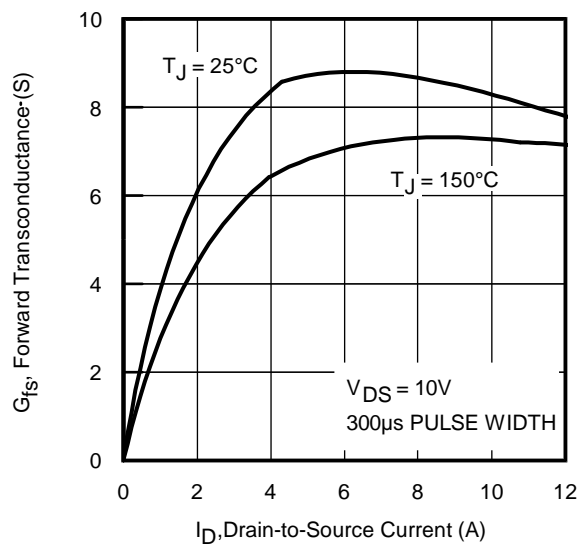
**Fig 1.** Typical Output Characteristics



**Fig 2.** Typical Output Characteristics

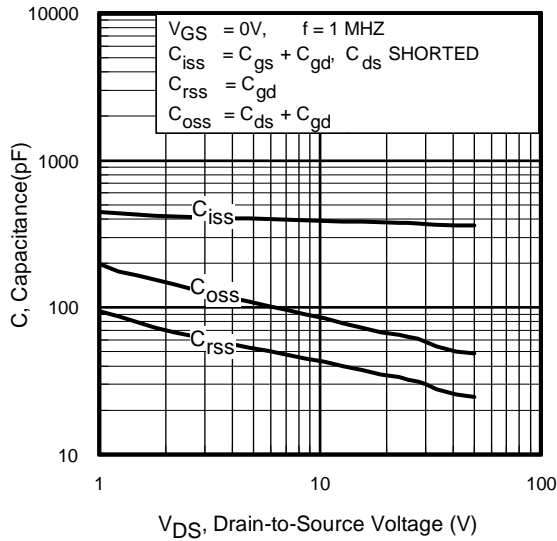


**Fig 3.** Typical Transfer Characteristics

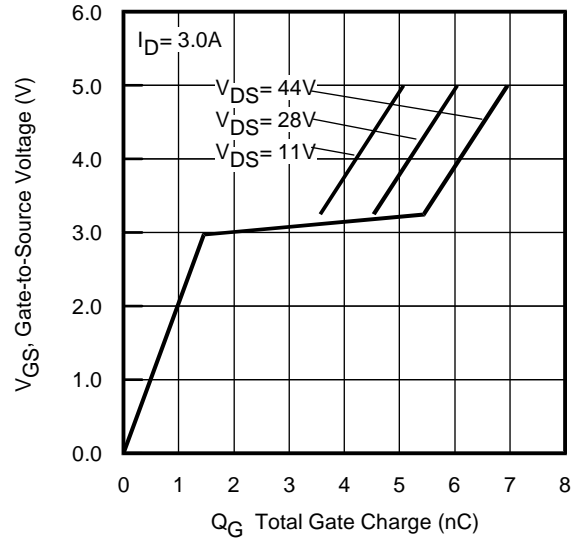


**Fig 4.** Typical Forward Transconductance vs. Drain Current

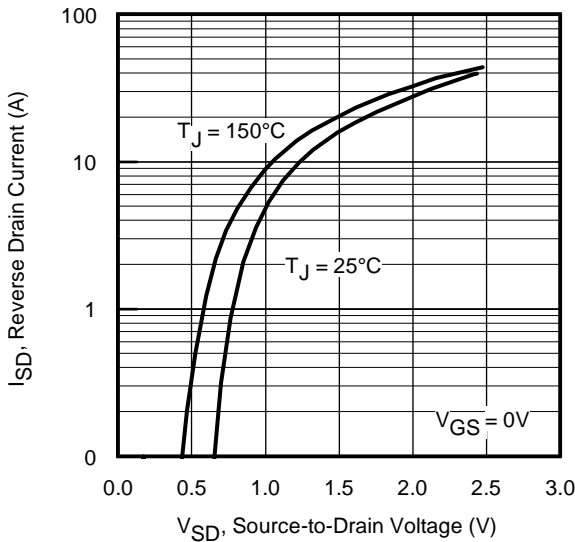
# IRLL024ZPbF



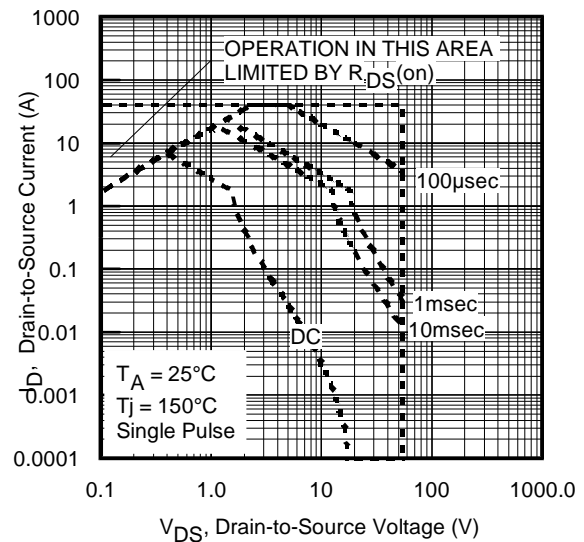
**Fig 5.** Typical Capacitance vs. Drain-to-Source Voltage



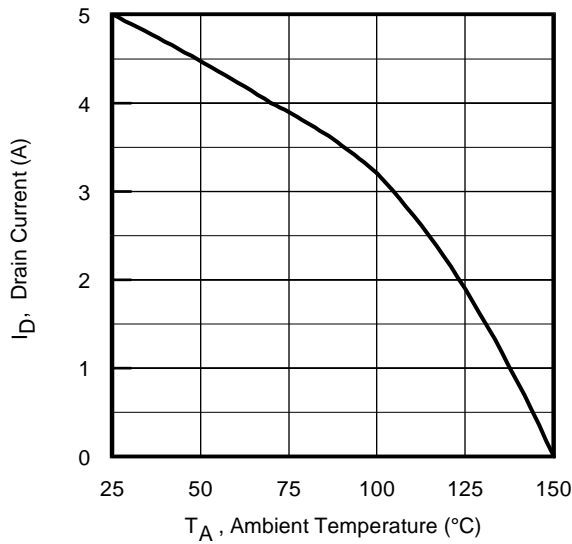
**Fig 6.** Typical Gate Charge vs. Gate-to-Source Voltage



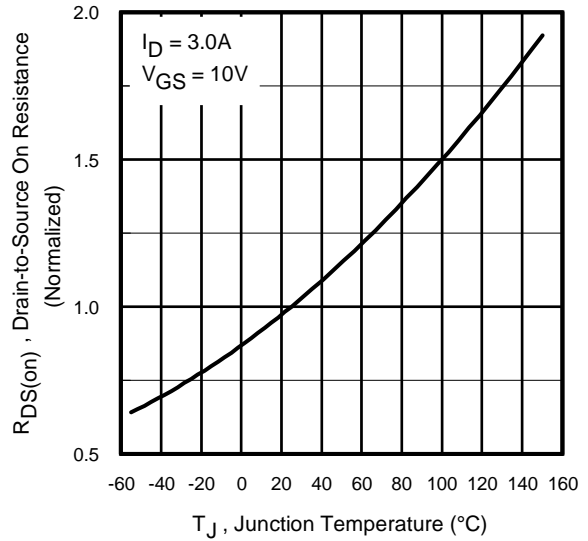
**Fig 7.** Typical Source-Drain Diode Forward Voltage



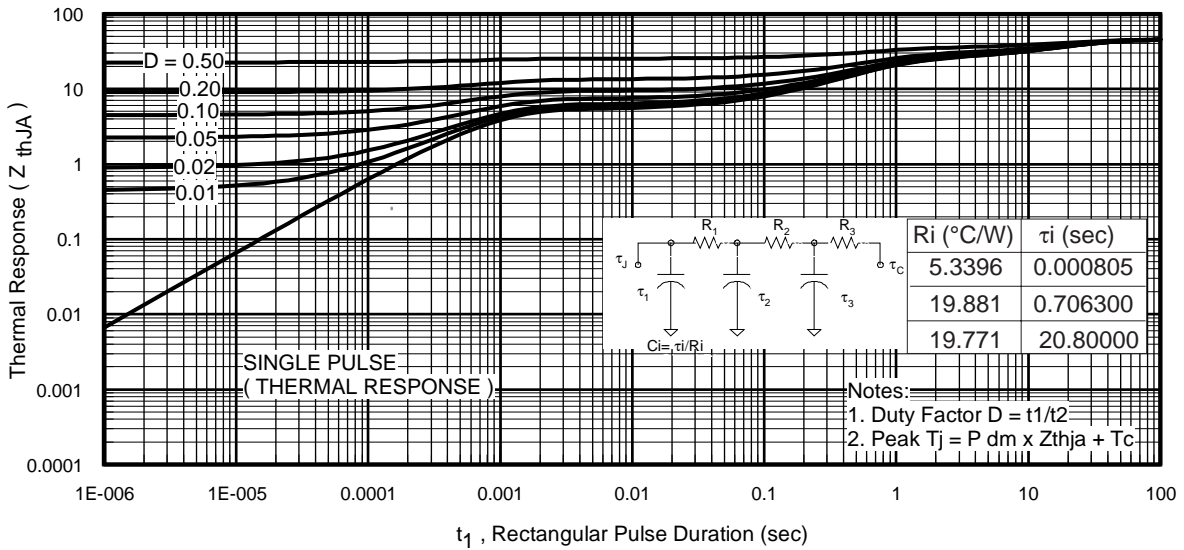
**Fig 8.** Maximum Safe Operating Area



**Fig 9.** Maximum Drain Current vs. Ambient Temperature



**Fig 10.** Normalized On-Resistance vs. Temperature



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

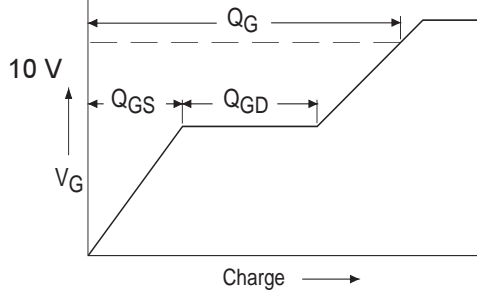
# IRLL024ZPbF



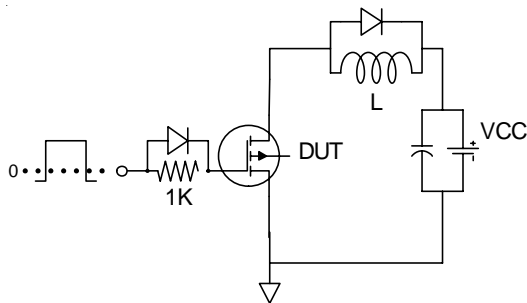
**Fig 12a.** Unclamped Inductive Test Circuit



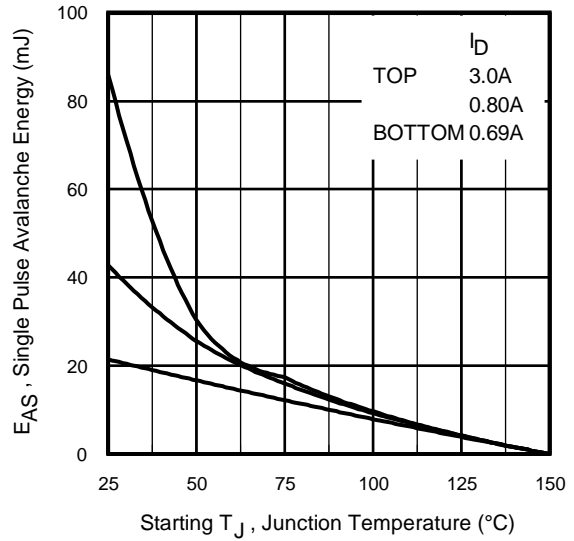
**Fig 12b.** Unclamped Inductive Waveforms



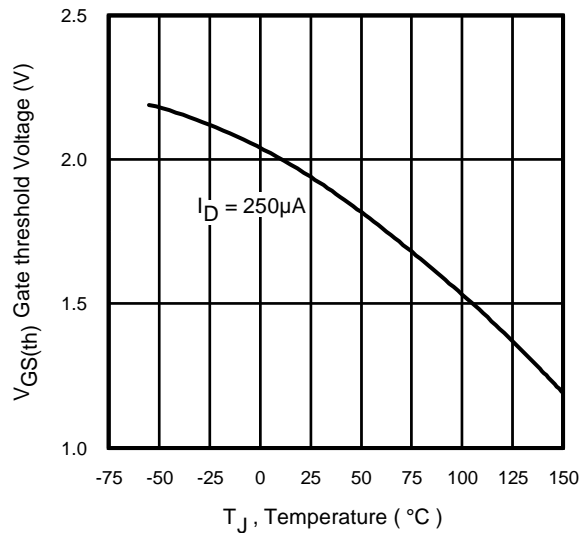
**Fig 13a.** Basic Gate Charge Waveform



**Fig 13b.** Gate Charge Test Circuit



**Fig 12c.** Maximum Avalanche Energy vs. Drain Current



**Fig 14.** Threshold Voltage vs. Temperature

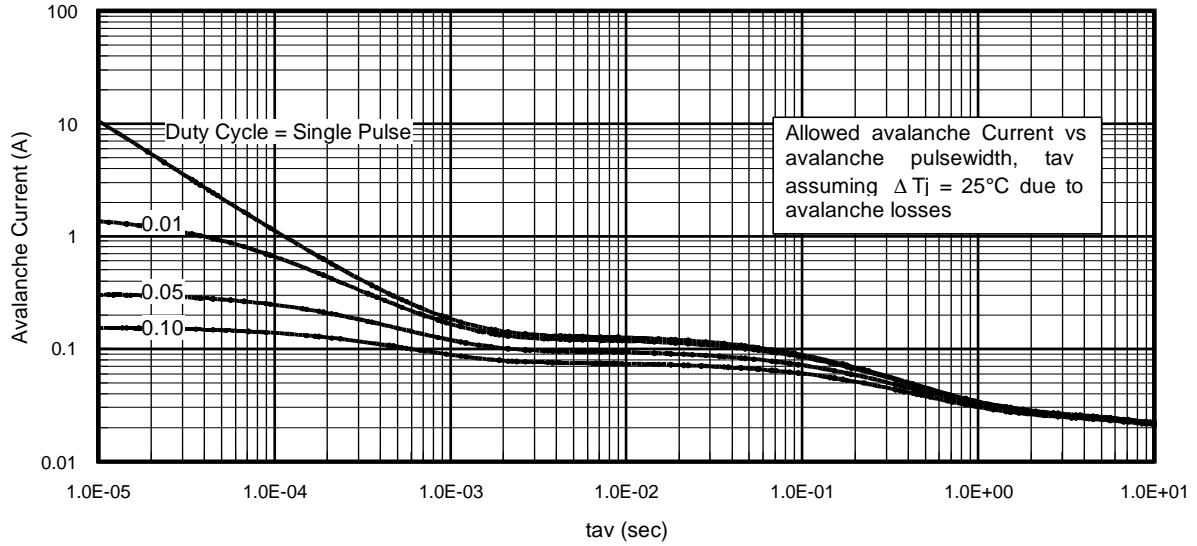


Fig 15. Typical Avalanche Current vs.Pulsewidth

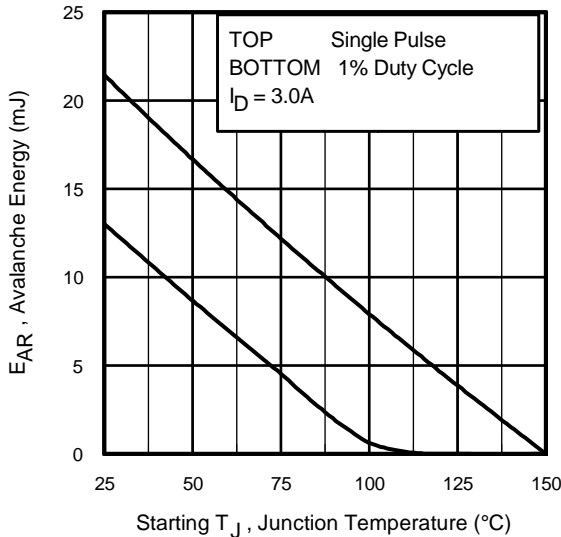


Fig 16. Maximum Avalanche Energy vs. Temperature

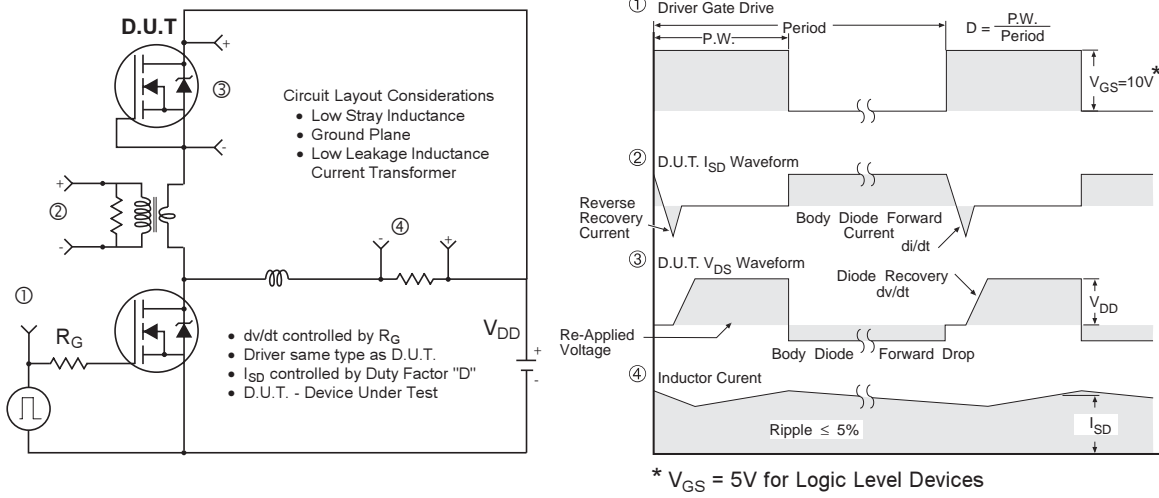
**Notes on Repetitive Avalanche Curves , Figures 15, 16:**  
(For further info, see AN-1005 at [www.irf.com](http://www.irf.com))

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 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.  $\Delta T$  = 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)

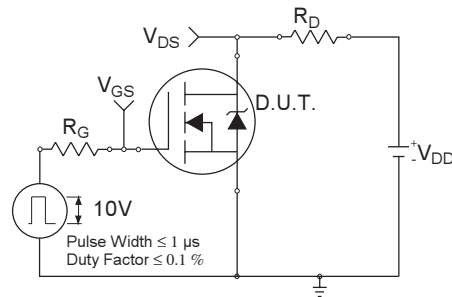
$$P_{D(ave)} = 1/2 ( 1.3 \cdot BV \cdot I_{av} ) = \Delta T / Z_{thJC}$$

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

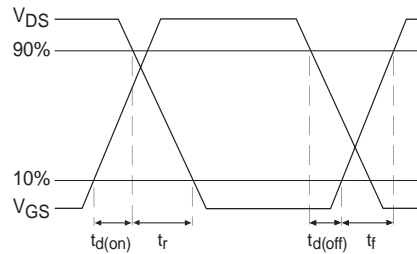
$$E_{AS(AR)} = P_{D(ave)} \cdot t_{av}$$



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



**Fig 18a. Switching Time Test Circuit**

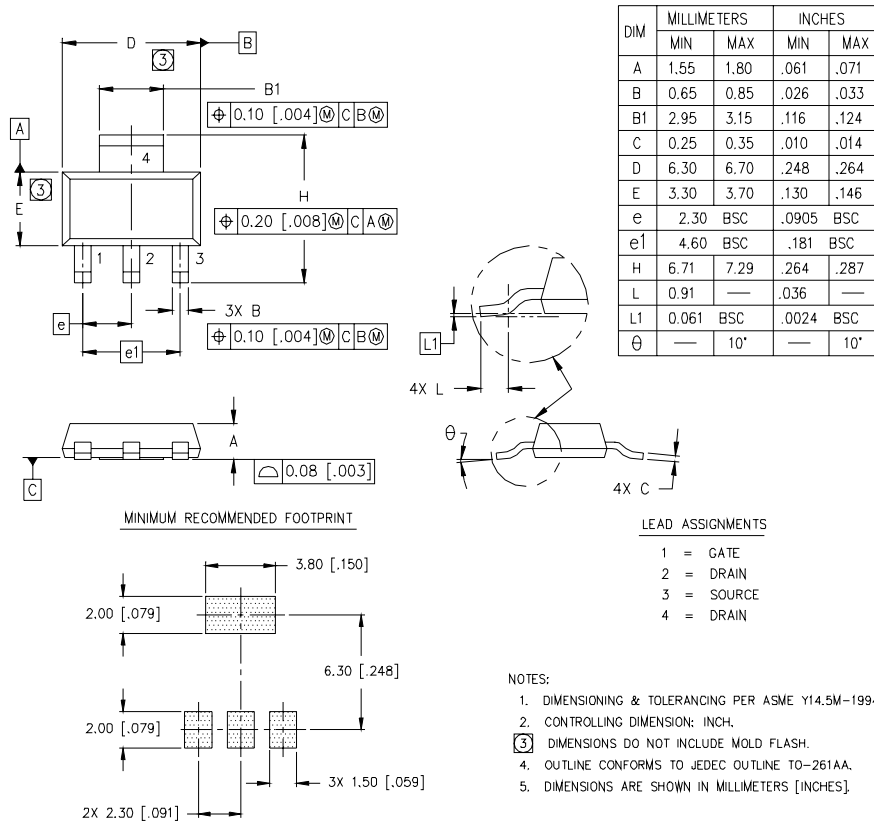


**Fig 18b. Switching Time Waveforms**



## SOT-223 (TO-261AA) Package Outline

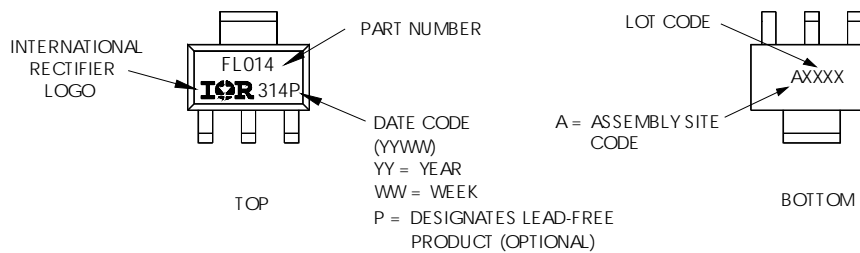
Dimensions are shown in millimeters (inches)



## SOT-223 (TO-261AA) Part Marking Information

### HEXFET PRODUCT MARKING

EXAMPLE: THIS IS AN IRFL014

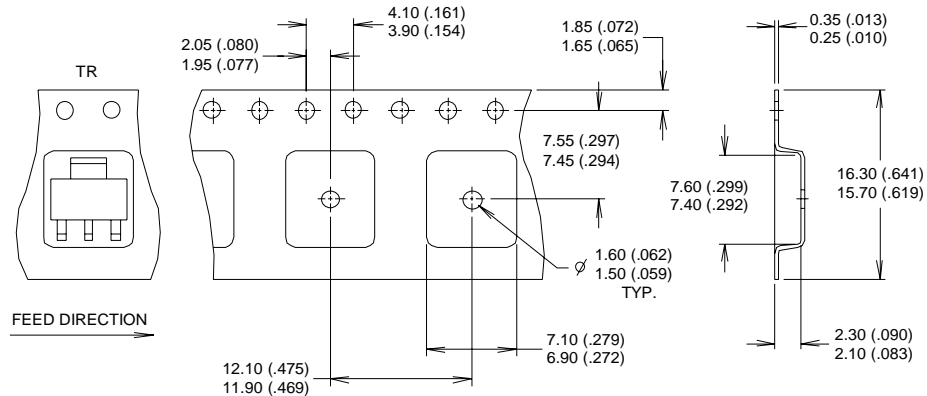


# IRLL024ZPbF

International  
**IR** Rectifier

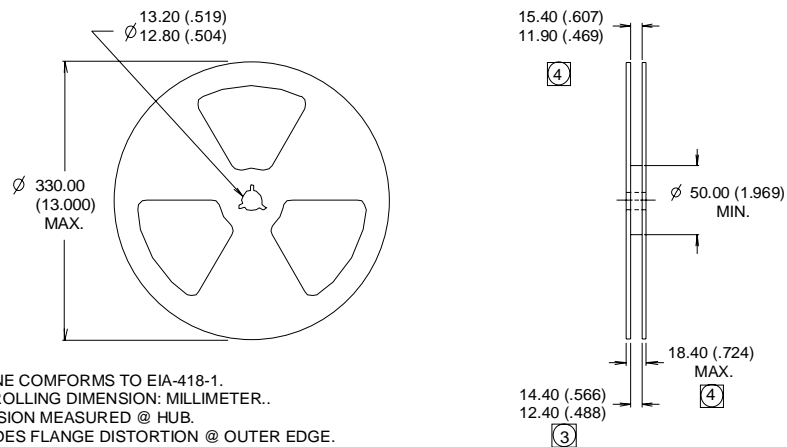
## SOT-223 (TO-261AA) Tape & Reel Information

Dimensions are shown in millimeters (inches)



### NOTES :

1. CONTROLLING DIMENSION: MILLIMETER.
2. OUTLINE CONFORMS TO EIA-481 & EIA-541.
3. EACH  $\phi$ 330.00 (13.00) REEL CONTAINS 2,500 DEVICES.



### NOTES :

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

Data and specifications subject to change without notice.  
This product has been designed for the Automotive [Q101] market.  
Qualification Standards can be found on IR's Web site.

International  
**IR** Rectifier

**IR WORLD HEADQUARTERS:** 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105  
TAC Fax: (310) 252-7903

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