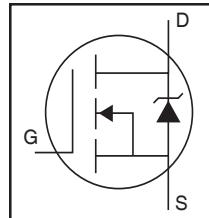


**AUIRLS3036**  
HEXFET® Power MOSFET

**Features**

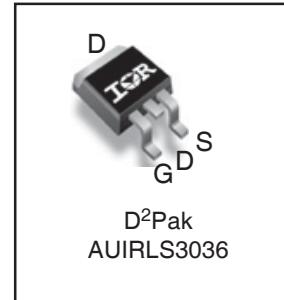
- Advanced Process Technology
- Ultra Low On-Resistance
- Dynamic dv/dt Rating
- 175°C Operating Temperature
- Fast Switching
- Repetitive Avalanche Allowed up to Tjmax
- Lead-Free, RoHS Compliant
- Automotive Qualified \*



<b>V<sub>DSS</sub></b>	<b>60V</b>
<b>R<sub>DS(on)</sub> typ.</b>	<b>1.9mΩ</b>
<b>max.</b>	<b>2.4mΩ</b>
<b>I<sub>D</sub> (Silicon Limited)</b>	<b>270A<sup>①</sup></b>
<b>I<sub>D</sub> (Package Limited)</b>	<b>195A</b>

**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.



<b>G</b>	<b>D</b>	<b>S</b>
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<sub>A</sub>) is 25°C, unless otherwise specified.

<b>Symbol</b>	<b>Parameter</b>	<b>Max.</b>	<b>Units</b>
I <sub>D</sub> @ T <sub>C</sub> = 25°C	Continuous Drain Current, V <sub>GS</sub> @ 10V (Silicon Limited)	270 <sup>①</sup>	A
I <sub>D</sub> @ T <sub>C</sub> = 100°C	Continuous Drain Current, V <sub>GS</sub> @ 10V (Silicon Limited)	190	
I <sub>D</sub> @ T <sub>C</sub> = 25°C	Continuous Drain Current, V <sub>GS</sub> @ 10V (Package Limited)	195	
I <sub>DM</sub>	Pulsed Drain Current ②	1100	
P <sub>D</sub> @ T <sub>C</sub> = 25°C	Maximum Power Dissipation	380	W
	Linear Derating Factor	2.5	W/°C
V <sub>GS</sub>	Gate-to-Source Voltage	±16	V
E <sub>AS</sub>	Single Pulse Avalanche Energy (Thermally Limited) ③	290	mJ
I <sub>AR</sub>	Avalanche Current ②	See Fig. 14, 15, 22a, 22b	A
E <sub>AR</sub>	Repetitive Avalanche Energy ⑩		mJ
dv/dt	Peak Diode Recovery ④	8.0	V/ns
T <sub>J</sub>	Operating Junction and	-55 to + 175	°C
T <sub>STG</sub>	Storage Temperature Range		
	Soldering Temperature, for 10 seconds (1.6mm from case)		

**Thermal Resistance**

<b>Symbol</b>	<b>Parameter</b>	<b>Typ.</b>	<b>Max.</b>	<b>Units</b>
R <sub>0JC</sub>	Junction-to-Case ⑨ ⑪	—	0.40	°C/W
R <sub>0JA</sub>	Junction-to-Ambient (PCB Mount, 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 @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)DSS}$	Drain-to-Source Breakdown Voltage	60	—	—	V	$V_{GS} = 0V, I_D = 250\mu\text{A}$
$\Delta V_{(BR)DSS}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	0.061	—	V/ $^\circ\text{C}$	Reference to $25^\circ\text{C}, I_D = 5\text{mA}$
$R_{DS(on)}$	Static Drain-to-Source On-Resistance	—	1.9	2.4	$\text{m}\Omega$	$V_{GS} = 10V, I_D = 165\text{A}$ ⑤
		—	2.2	2.8		$V_{GS} = 4.5V, I_D = 140\text{A}$ ⑤
$V_{GS(th)}$	Gate Threshold Voltage	1.0	—	2.5	V	$V_{DS} = V_{GS}, I_D = 250\mu\text{A}$
$g_{fs}$	Forward Transconductance	340	—	—	S	$V_{DS} = 10V, I_D = 165\text{A}$
$R_{G(int)}$	Internal Gate Resistance	—	2.0	—	$\Omega$	
$I_{DSS}$	Drain-to-Source Leakage Current	—	—	20	$\mu\text{A}$	$V_{DS} = 60V, V_{GS} = 0V$
		—	—	250		$V_{DS} = 60V, V_{GS} = 0V, T_J = 125^\circ\text{C}$
$I_{GSS}$	Gate-to-Source Forward Leakage	—	—	100	$\text{nA}$	$V_{GS} = 16V$
	Gate-to-Source Reverse Leakage	—	—	-100		$V_{GS} = -16V$

Dynamic Electrical Characteristics @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
$Q_g$	Total Gate Charge	—	91	140	nC	$I_D = 165\text{A}$
$Q_{gs}$	Gate-to-Source Charge	—	31	—		$V_{DS} = 30V$
$Q_{gd}$	Gate-to-Drain ("Miller") Charge	—	51	—		$V_{GS} = 4.5V$ ⑤
$Q_{sync}$	Total Gate Charge Sync. ( $Q_g - Q_{gd}$ )	—	40	—		$I_D = 165\text{A}, V_{DS} = 0V, V_{GS} = 4.5V$
$t_{d(on)}$	Turn-On Delay Time	—	66	—	ns	$V_{DD} = 39V$
$t_r$	Rise Time	—	220	—		$I_D = 165\text{A}$
$t_{d(off)}$	Turn-Off Delay Time	—	110	—		$R_G = 2.1\Omega$
$t_f$	Fall Time	—	110	—		$V_{GS} = 4.5V$ ⑤
$C_{iss}$	Input Capacitance	—	11210	—	pF	$V_{GS} = 0V$
$C_{oss}$	Output Capacitance	—	1020	—		$V_{DS} = 50V$
$C_{rss}$	Reverse Transfer Capacitance	—	500	—		$f = 1.0\text{MHz}$
$C_{oss}$ eff. (ER)	Effective Output Capacitance (Energy Related)	—	1430	—		$V_{GS} = 0V, V_{DS} = 0V$ to $48V$ ⑦
$C_{oss}$ eff. (TR)	Effective Output Capacitance (Time Related)	—	1880	—		$V_{GS} = 0V, V_{DS} = 0V$ to $48V$ ⑥

## Diode Characteristics

Symbol	Parameter	Min.	Typ.	Max.	Units	Conditions
$I_s$	Continuous Source Current (Body Diode)	—	—	270①	A	MOSFET symbol showing the integral reverse p-n junction diode.
		—	—	—		
$I_{SM}$	Pulsed Source Current (Body Diode) ③	—	—	1100	ns	$T_J = 25^\circ\text{C}, I_s = 165\text{A}, V_{GS} = 0V$ ⑤
		—	—	—		
$V_{SD}$	Diode Forward Voltage	—	—	1.3	V	$T_J = 25^\circ\text{C}, I_s = 165\text{A}, V_{GS} = 0V$ ⑤
		—	—	—		
$t_{rr}$	Reverse Recovery Time	—	62	—	ns	$T_J = 25^\circ\text{C} V_R = 51V,$ $T_J = 125^\circ\text{C} I_F = 165\text{A}$
		—	66	—		
$Q_{rr}$	Reverse Recovery Charge	—	310	—	nC	$T_J = 25^\circ\text{C}$ $T_J = 125^\circ\text{C}$ di/dt = $100\text{A}/\mu\text{s}$ ⑤
		—	360	—		
$I_{RRM}$	Reverse Recovery Current	—	4.4	—	A	$T_J = 25^\circ\text{C}$
$t_{on}$	Forward Turn-On Time	Intrinsic turn-on time is negligible (turn-on is dominated by LS+LD)				

## Notes:

- ① Calculated continuous current based on maximum allowable junction temperature. Bond wire current limit is 195A. Note that current limitation arising from heating of the device leads may occur with some lead mounting arrangements.
- ② Repetitive rating; pulse width limited by max. junction temperature.
- ③ Limited by  $T_{Jmax}$ , starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.021\text{mH}$   $R_G = 25\Omega$ ,  $I_{AS} = 165\text{A}$ ,  $V_{GS} = 10V$ . Part not recommended for use above this value.
- ④  $I_{SD} \leq 165\text{A}$ ,  $di/dt \leq 430\text{A}/\mu\text{s}$ ,  $V_{DD} \leq V_{(BR)DSS}$ ,  $T_J \leq 175^\circ\text{C}$ .
- ⑤ Pulse width  $\leq 400\mu\text{s}$ ; duty cycle  $\leq 2\%$ .
- ⑥  $C_{oss}$  eff. (TR) is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .
- ⑦  $C_{oss}$  eff. (ER) is a fixed capacitance that gives the same energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 80%  $V_{DSS}$ .
- ⑧ When mounted on 1" square PCB (FR-4 or G-10 Material). For recommended footprint and soldering technique refer to application note # AN- 994 techniques refer to application note #AN-994.
- ⑨  $R_{\theta}$  is measured at  $T_J$  approximately  $90^\circ\text{C}$ .
- ⑩ Limited by  $T_{Jmax}$ , see Fig. 14, 15, 22a, 22b for typical repetitive avalanche performance.
- ⑪  $R_{\theta JC}$  value shown is at time zero.

**Qualification Information<sup>†</sup>**

		Automotive (per AEC-Q101) <sup>††</sup>	
<b>Qualification Level</b>		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>		D <sup>2</sup> Pak	MSL1
<b>ESD</b>	Machine Model	Class M4 (+/- 800V) <sup>†††</sup> AEC-Q101-002	
	Human Body Model	Class H3A (+/- 6000V) <sup>†††</sup> AEC-Q101-001	
	Charged Device Model	Class C5 (+/- 2000V) <sup>†††</sup> AEC-Q101-005	
<b>RoHS Compliant</b>		Yes	

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

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

<sup>†††</sup> Highest passing voltage.

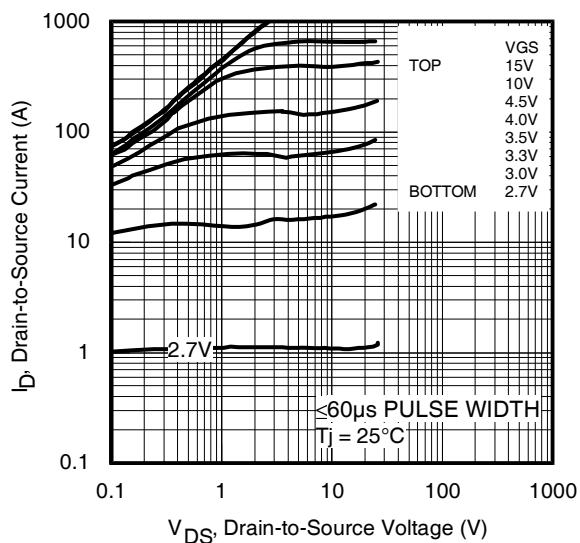


Fig 1. Typical Output Characteristics

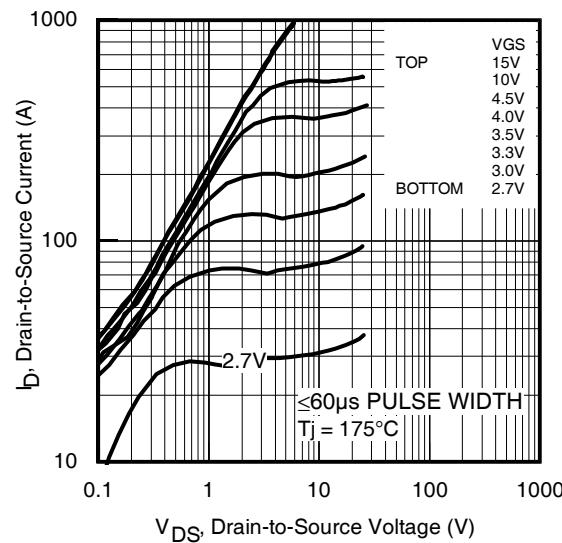


Fig 2. Typical Output Characteristics

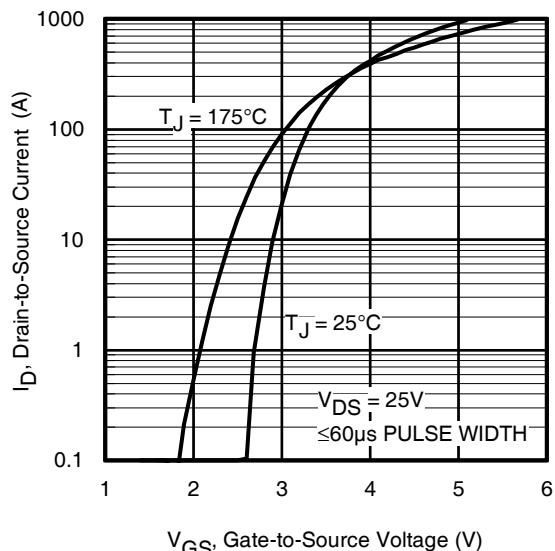


Fig 3. Typical Transfer Characteristics

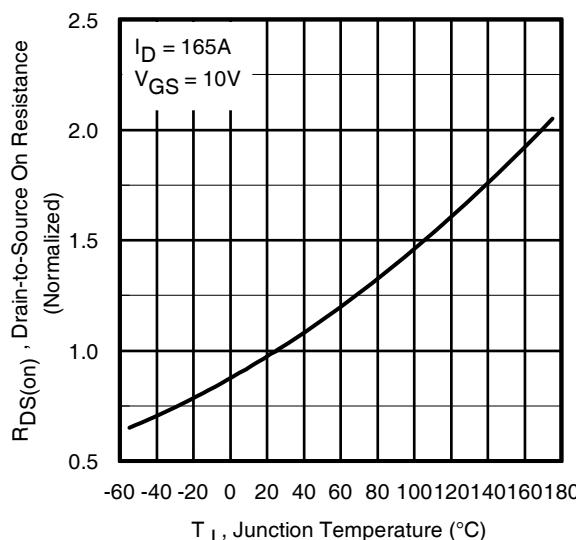


Fig 4. Normalized On-Resistance vs. Temperature

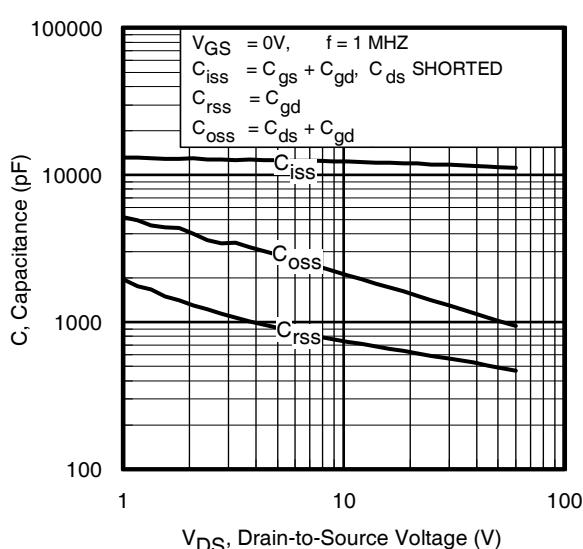


Fig 5. Typical Capacitance vs. Drain-to-Source Voltage

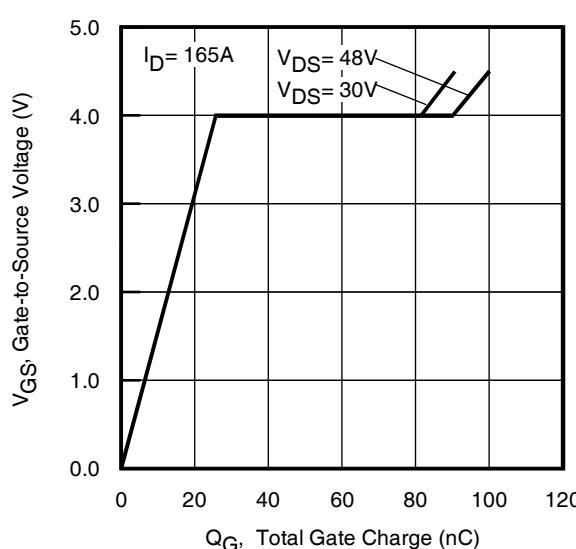
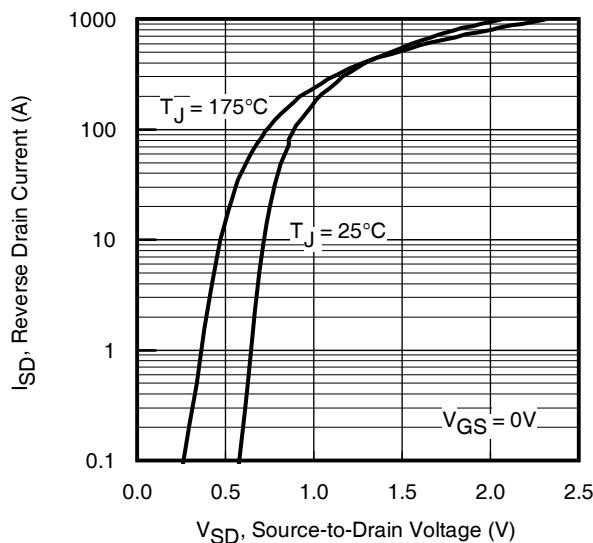
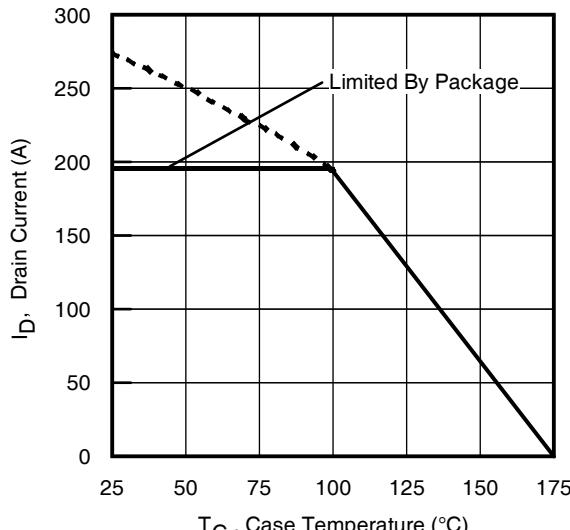


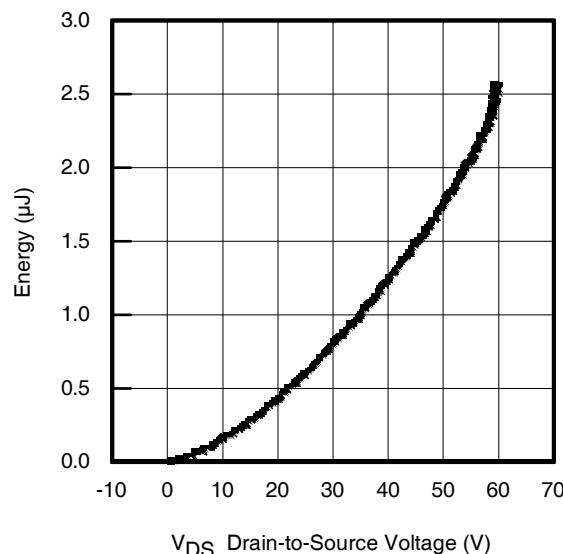
Fig 6. Typical Gate Charge vs. Gate-to-Source Voltage



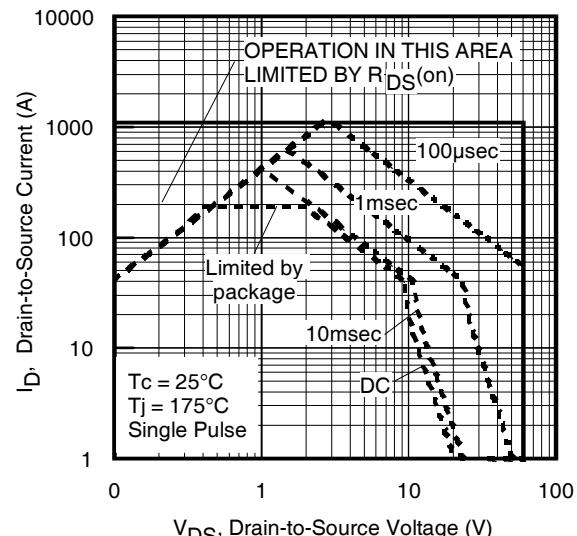
**Fig 7.** Typical Source-Drain Diode Forward Voltage



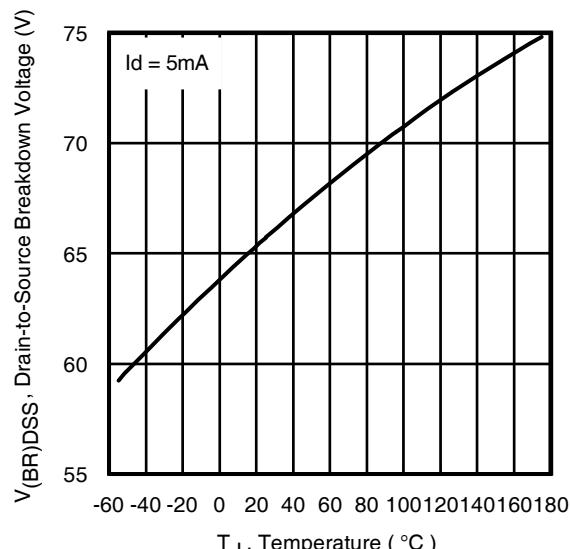
**Fig 9.** Maximum Drain Current vs. Case Temperature



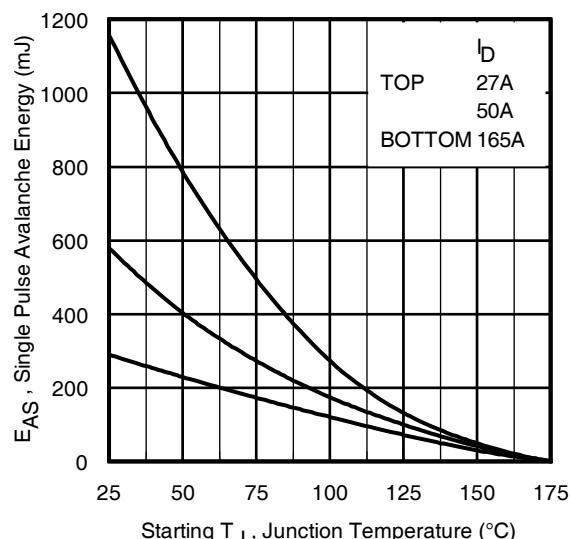
**Fig 11.** Typical Coss Stored Energy



**Fig 8.** Maximum Safe Operating Area



**Fig 10.** Drain-to-Source Breakdown Voltage



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

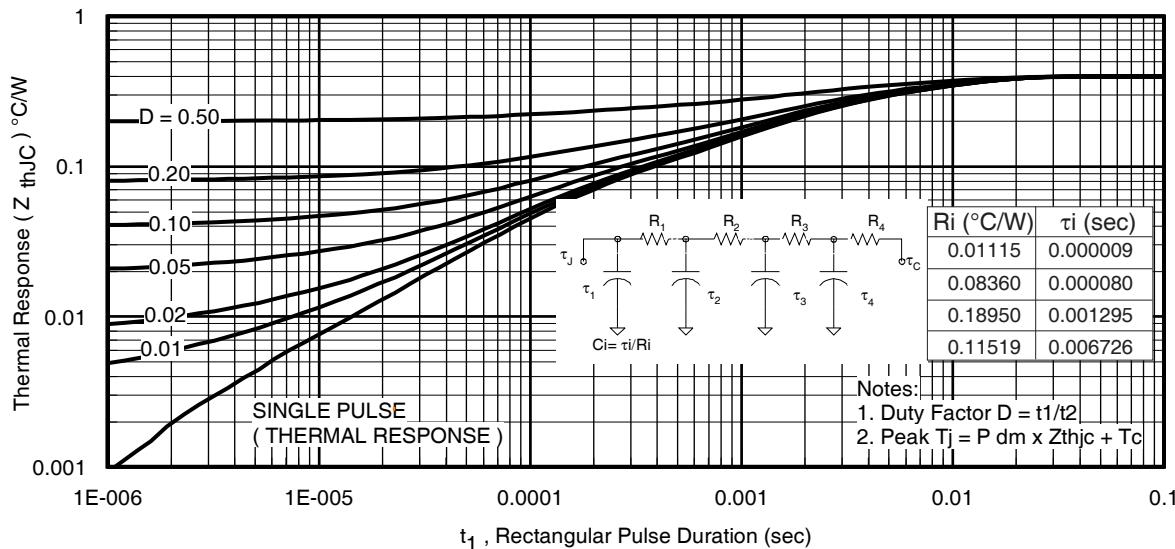


Fig 13. Maximum Effective Transient Thermal Impedance, Junction-to-Case

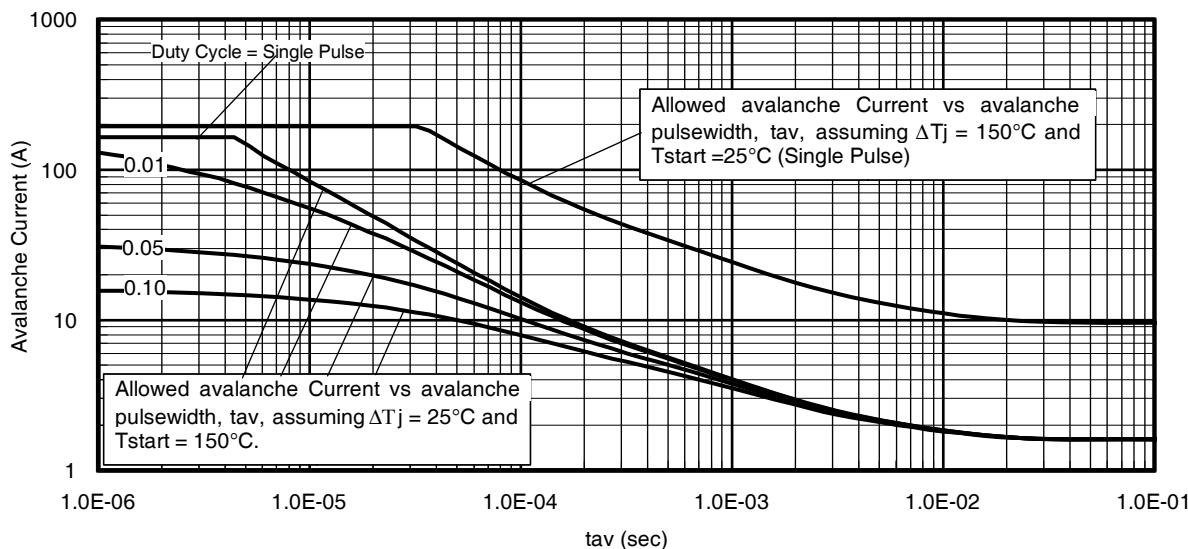


Fig 14. Typical Avalanche Current vs. Pulsewidth

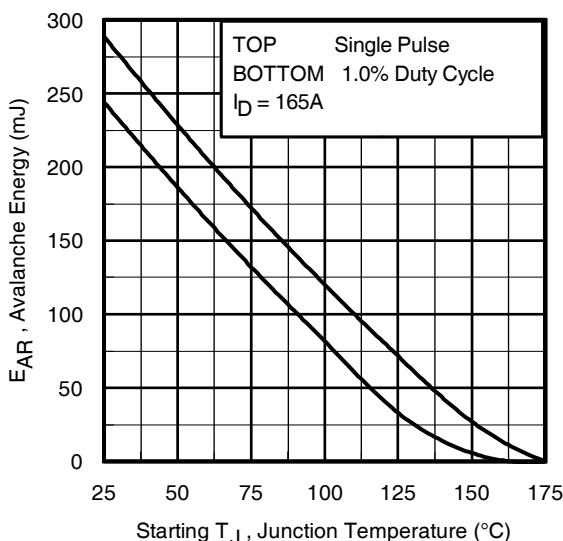


Fig 15. Maximum Avalanche Energy vs. Temperature

**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 16a, 16b.
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

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

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

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

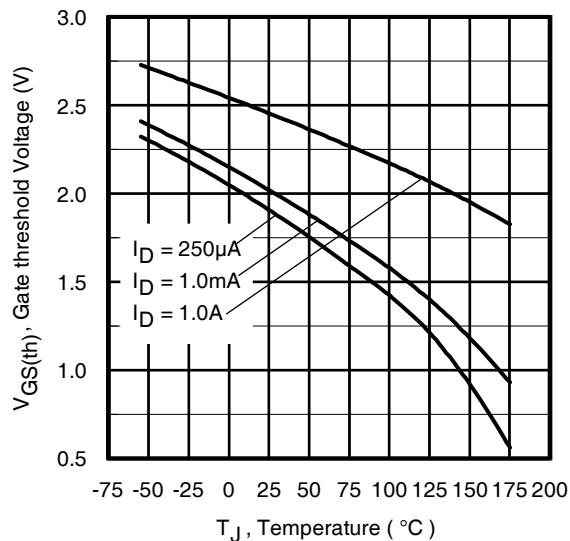


Fig. 16. Threshold Voltage vs. Temperature

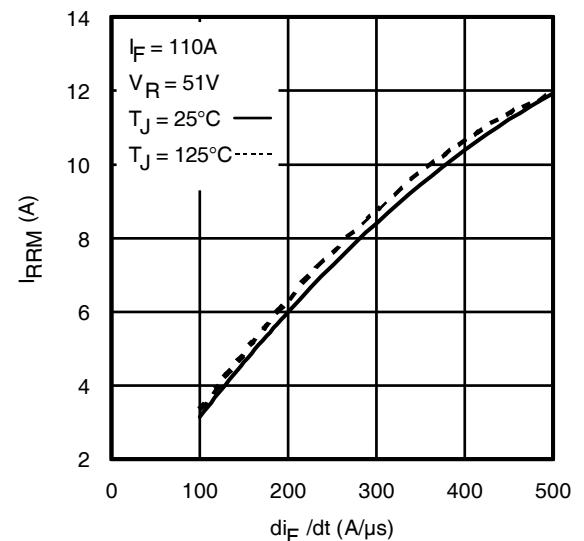


Fig. 17 - Typical Recovery Current vs.  $di_f/dt$

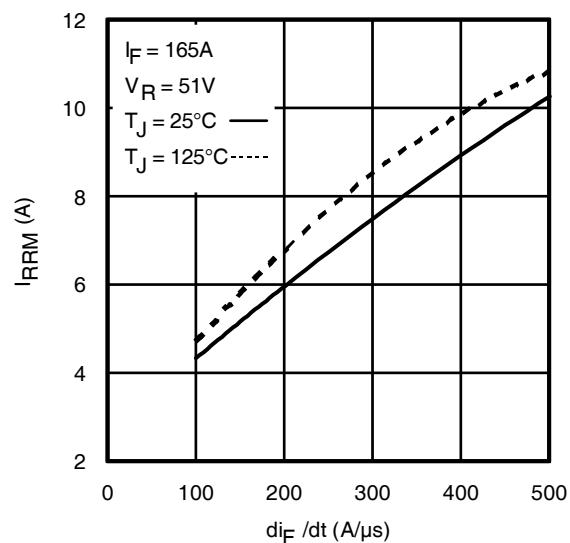


Fig. 18 - Typical Recovery Current vs.  $di_f/dt$

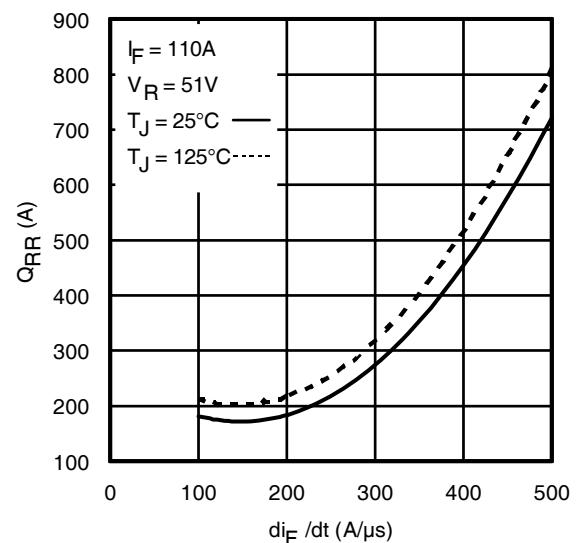


Fig. 19 - Typical Stored Charge vs.  $di_f/dt$

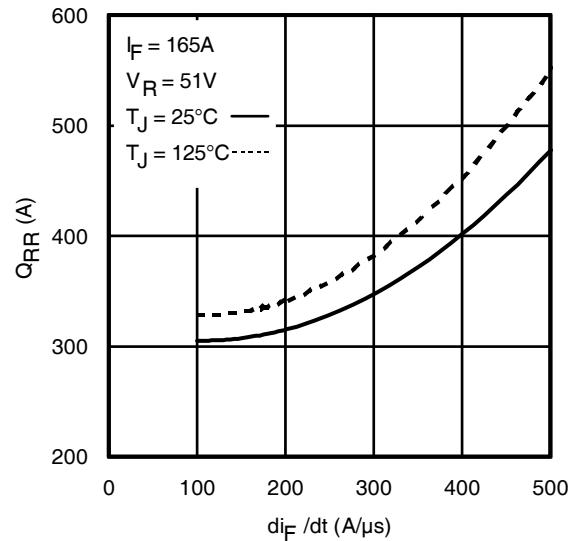
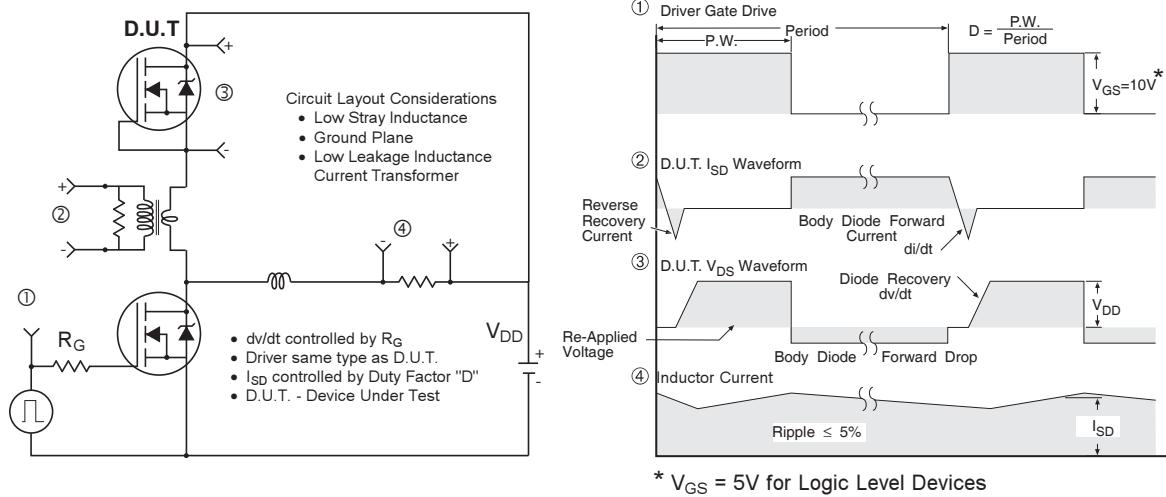
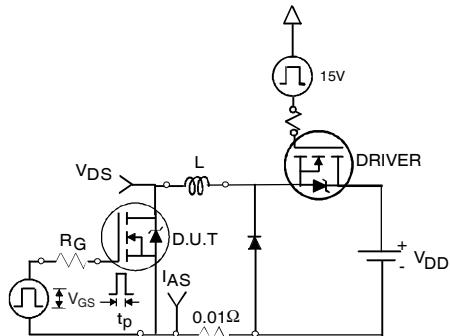


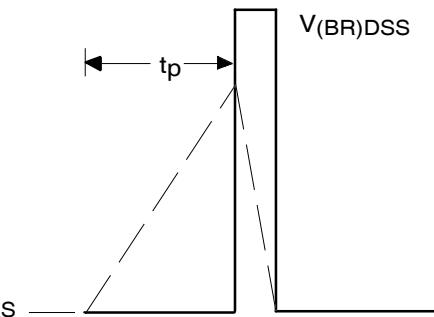
Fig. 20 - Typical Stored Charge vs.  $di_f/dt$



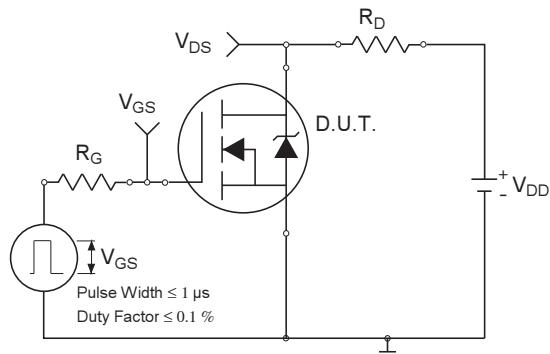
**Fig 21.** Peak Diode Recovery  $dv/dt$  Test Circuit for N-Channel HEXFET® Power MOSFETs



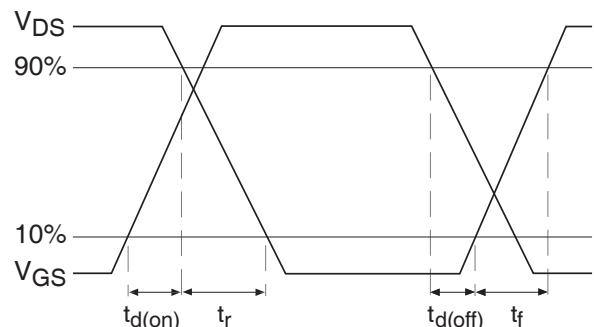
**Fig 22a.** Unclamped Inductive Test Circuit



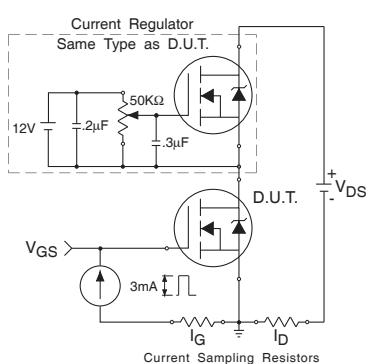
**Fig 22b.** Unclamped Inductive Waveforms



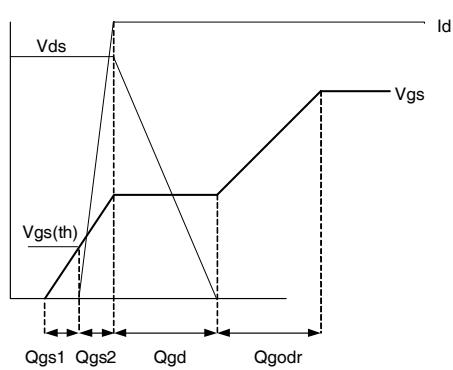
**Fig 23a.** Switching Time Test Circuit



**Fig 23b.** Switching Time Waveforms

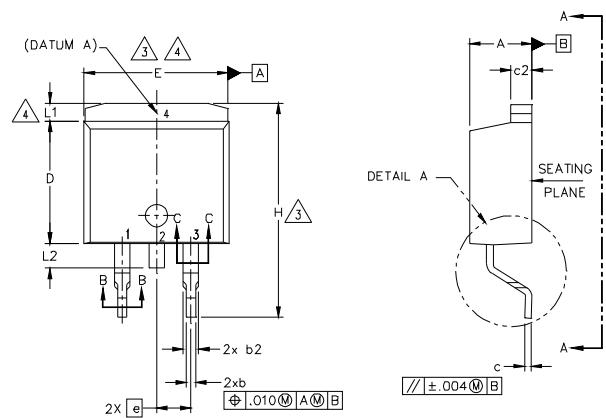


**Fig 24a.** Gate Charge Test Circuit



**Fig 24b.** Gate Charge Waveform

D<sup>2</sup>Pak 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	0.00	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		
L2	1.27	1.78	—	.070		
L3	0.25	BSC	.010	BSC		
L4	4.78	5.28	.188	.208		

LEAD ASSIGNMENTS

DIODES

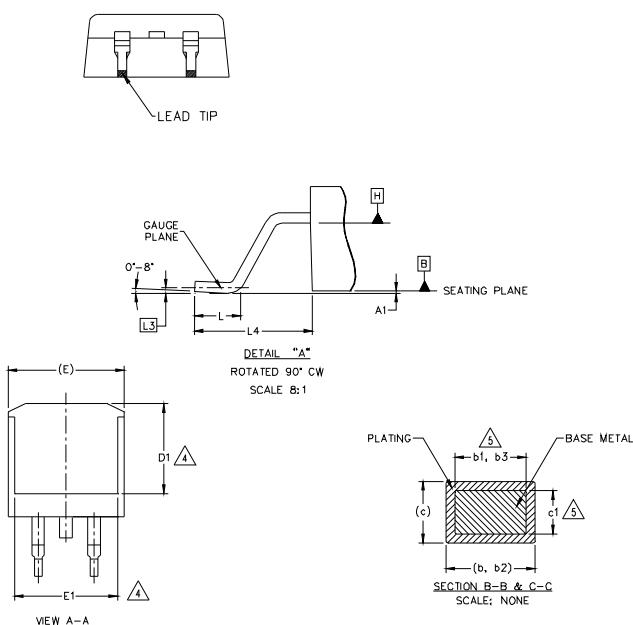
1. ANODE (TWO DIE) / OPEN (ONE DIE)  
2, 4. CATHODE  
3. ANODE

HEXFET

IGBTs, CoPACK

1. GATE  
2, 4. DRAIN  
3. SOURCE

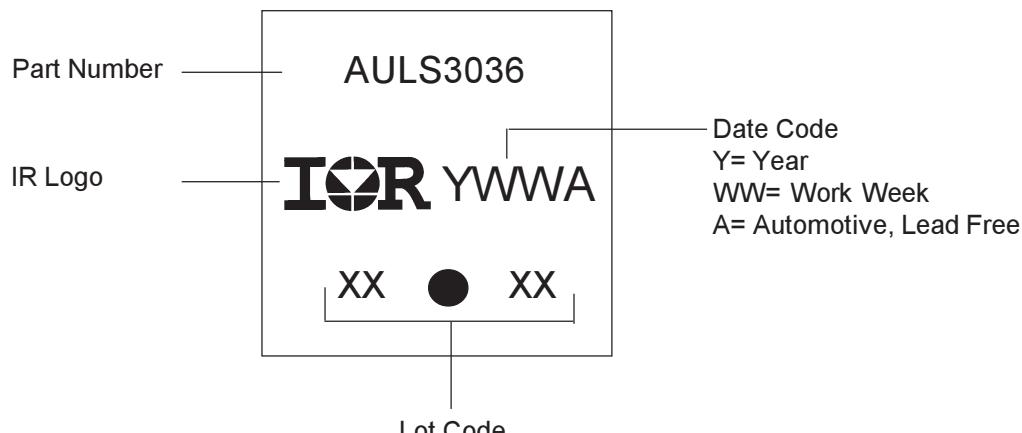
1. GATE  
2, 4. COLLECTOR  
3. Emitter

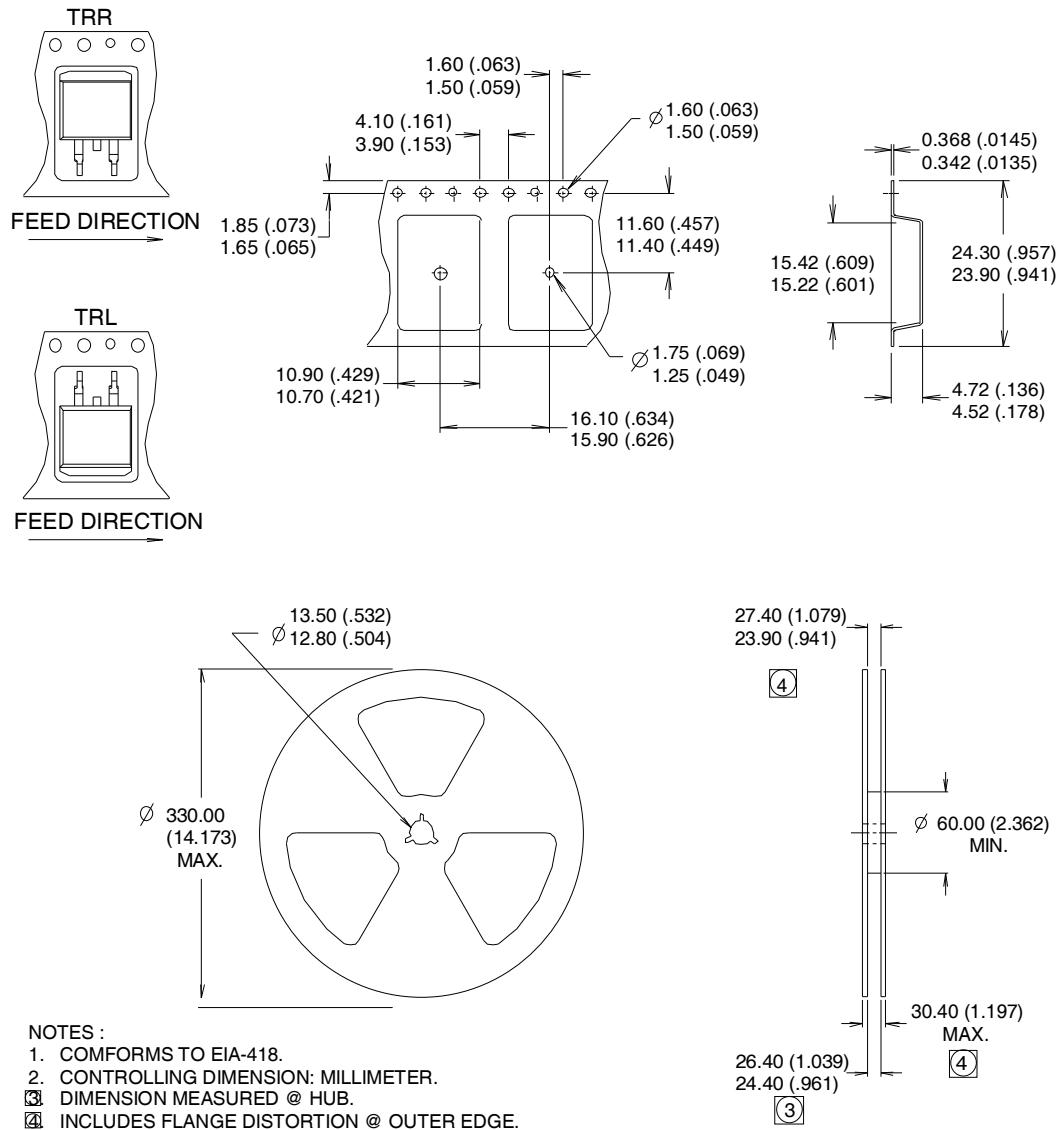


NOTES:

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.

D<sup>2</sup>Pak Part Marking Information



D<sup>2</sup>Pak Tape & Reel Information

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	
AUIRLS3036	D2Pak	Tube	50	AUIRLS3036
		Tape and Reel Left	800	AUIRLS3036TRL
		Tape and Reel Right	800	AUIRLS3036TRR

**IMPORTANT NOTICE**

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