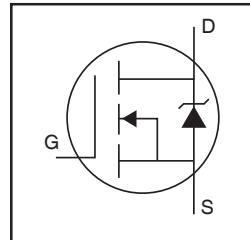


## Features

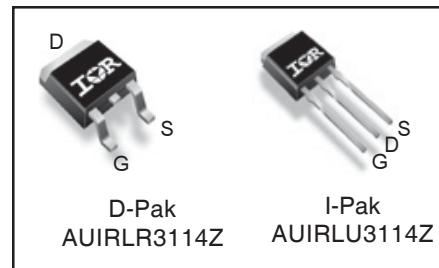
- Advanced Process Technology
- Ultra Low On-Resistance
- 175°C Operating Temperature
- Fast Switching
- Repetitive Avalanche Allowed up to  $T_{jmax}$
- Logic Level
- Lead-Free, RoHS Compliant
- Automotive Qualified \*



$V_{DSS}$	40V
$R_{DS(on)}$ max @ 10V	4.9mΩ
max @ 4.5V	6.5mΩ
$I_D$ (Silicon Limited)	130A <sup>⑨</sup>
$I_D$ (Package Limited)	42A

## 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 ( $T_A$ ) is 25°C, unless otherwise specified.

	Parameter	Max.	Units
$I_D$ @ $T_C = 25^\circ\text{C}$	Continuous Drain Current, $V_{GS}$ @ 10V (Silicon Limited)	130 <sup>⑨</sup>	A
$I_D$ @ $T_C = 100^\circ\text{C}$	Continuous Drain Current, $V_{GS}$ @ 10V (Silicon Limited)	89 <sup>⑨</sup>	
$I_D$ @ $T_C = 25^\circ\text{C}$	Continuous Drain Current, $V_{GS}$ @ 10V (Package Limited)	42	
$I_{DM}$	Pulsed Drain Current <sup>①</sup>	500	
$P_D$ @ $T_C = 25^\circ\text{C}$	Power Dissipation	140	W
	Linear Derating Factor	0.95	W/°C
$V_{GS}$	Gate-to-Source Voltage	±16	V
$E_{AS}$ (Thermally limited)	Single Pulse Avalanche Energy <sup>②</sup>	130	mJ
$E_{AS}$ (Tested)	Single Pulse Avalanche Energy Tested Value <sup>⑥</sup>	260	
$I_{AR}$	Avalanche Current <sup>①</sup>	See Fig.12a, 12b, 15, 16	
$E_{AR}$	Repetitive Avalanche Energy <sup>⑤</sup>	mJ	
$T_J$	Operating Junction and	-55 to + 175	°C
$T_{STG}$	Storage Temperature Range		
	Soldering Temperature, for 10 seconds		
		300(1.6mm from case)	

## Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case <sup>⑧</sup>	—	1.05	°C/W
$R_{\theta JA}$	Junction-to-Ambient (PCB mount) <sup>⑦</sup>	—	40	
$R_{\theta JA}$	Junction-to-Ambient	—	110	

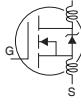
HEXFET® is a registered trademark of International Rectifier.

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

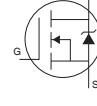
Static Electrical Characteristics @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(\text{BR})\text{DSS}}$	Drain-to-Source Breakdown Voltage	40	—	—	V	$V_{\text{GS}} = 0\text{V}$ , $I_D = 250\mu\text{A}$
$\Delta V_{(\text{BR})\text{DSS}}/\Delta T_J$	Breakdown Voltage Temp. Coefficient	—	0.032	—	V/ $^\circ\text{C}$	Reference to $25^\circ\text{C}$ , $I_D = 1\text{mA}$
$R_{\text{DS}(\text{on})}$	Static Drain-to-Source On-Resistance	—	3.9	4.9	$\text{m}\Omega$	$V_{\text{GS}} = 10\text{V}$ , $I_D = 42\text{A}$ ③
		—	5.2	6.5		$V_{\text{GS}} = 4.5\text{V}$ , $I_D = 42\text{A}$ ③
$V_{\text{GS}(\text{th})}$	Gate Threshold Voltage	1.0	—	2.5	V	$V_{\text{DS}} = V_{\text{GS}}$ , $I_D = 100\mu\text{A}$
$g_{\text{fs}}$	Forward Transconductance	98	—	—	S	$V_{\text{DS}} = 10\text{V}$ , $I_D = 42\text{A}$
$I_{\text{DSS}}$	Drain-to-Source Leakage Current	—	—	20	$\mu\text{A}$	$V_{\text{DS}} = 40\text{V}$ , $V_{\text{GS}} = 0\text{V}$
		—	—	250		$V_{\text{DS}} = 40\text{V}$ , $V_{\text{GS}} = 0\text{V}$ , $T_J = 125^\circ\text{C}$
$I_{\text{GSS}}$	Gate-to-Source Forward Leakage	—	—	100	$\text{nA}$	$V_{\text{GS}} = 16\text{V}$
	Gate-to-Source Reverse Leakage	—	—	-100		$V_{\text{GS}} = -16\text{V}$

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

$Q_g$	Total Gate Charge	—	40	56	nC	$I_D = 42\text{A}$
$Q_{\text{gs}}$	Gate-to-Source Charge	—	12	—		$V_{\text{DS}} = 20\text{V}$
$Q_{\text{gd}}$	Gate-to-Drain ("Miller") Charge	—	18	—		$V_{\text{GS}} = 4.5\text{V}$ ③
$t_{\text{d}(\text{on})}$	Turn-On Delay Time	—	25	—	ns	$V_{\text{DD}} = 20\text{V}$
$t_r$	Rise Time	—	140	—		$I_D = 42\text{A}$
$t_{\text{d}(\text{off})}$	Turn-Off Delay Time	—	33	—		$R_G = 3.7\Omega$
$t_f$	Fall Time	—	50	—		$V_{\text{GS}} = 4.5\text{V}$ ③
$L_D$	Internal Drain Inductance	—	4.5	—	nH	Between lead, 6mm (0.25in.) from package and center of die contact
$L_S$	Internal Source Inductance	—	7.5	—		
$C_{\text{iss}}$	Input Capacitance	—	3810	—	pF	$V_{\text{GS}} = 0\text{V}$
$C_{\text{oss}}$	Output Capacitance	—	650	—		$V_{\text{DS}} = 25\text{V}$
$C_{\text{rss}}$	Reverse Transfer Capacitance	—	350	—		$f = 1.0\text{MHz}$
$C_{\text{oss}}$	Output Capacitance	—	2390	—		$V_{\text{GS}} = 0\text{V}$ , $V_{\text{DS}} = 1.0\text{V}$ , $f = 1.0\text{MHz}$
$C_{\text{oss}}$	Output Capacitance	—	580	—		$V_{\text{GS}} = 0\text{V}$ , $V_{\text{DS}} = 32\text{V}$ , $f = 1.0\text{MHz}$
$C_{\text{oss eff.}}$	Effective Output Capacitance	—	820	—		$V_{\text{GS}} = 0\text{V}$ , $V_{\text{DS}} = 0\text{V}$ to $32\text{V}$ ④

## Diode Characteristics

	Parameter	Min.	Typ.	Max.	Units	Conditions
$I_S$	Continuous Source Current (Body Diode)	—	—	42 ⑨	A	MOSFET symbol showing the integral reverse p-n junction diode.
$I_{\text{SM}}$	Pulsed Source Current (Body Diode) ①	—	—	500		
$V_{\text{SD}}$	Diode Forward Voltage	—	—	1.3	V	$T_J = 25^\circ\text{C}$ , $I_S = 42\text{A}$ , $V_{\text{GS}} = 0\text{V}$ ③
$t_{\text{rr}}$	Reverse Recovery Time	—	30	45	ns	$T_J = 25^\circ\text{C}$ , $I_F = 42\text{A}$ , $V_{\text{DD}} = 20\text{V}$
$Q_{\text{rr}}$	Reverse Recovery Charge	—	27	41	nC	$\text{di}/\text{dt} = 100\text{A}/\mu\text{s}$ ③
$t_{\text{on}}$	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 Limited by  $T_{\text{Jmax}}$  starting  $T_J = 25^\circ\text{C}$ ,  $L = 0.15\text{mH}$   $R_G = 25\Omega$ ,  $I_{AS} = 42\text{A}$ ,  $V_{GS} = 10\text{V}$ . Part not recommended for use above this value.
- ③ Pulse width  $\leq 1.0\text{ms}$ ; duty cycle  $\leq 2\%$ .
- ④  $C_{\text{oss eff.}}$  is a fixed capacitance that gives the same charging time as  $C_{\text{oss}}$  while  $V_{\text{DS}}$  is rising from 0 to 80%  $V_{\text{DSS}}$ .
- ⑤ Limited by  $T_{\text{Jmax}}$ , 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" square PCB (FR-4 or G-10 Material).
- ⑧  $R_\theta$  is measured at  $T_J$  approximately  $90^\circ\text{C}$ .
- ⑨ Calculated continuous current based on maximum allowable junction temperature. Package limitation is 42A.

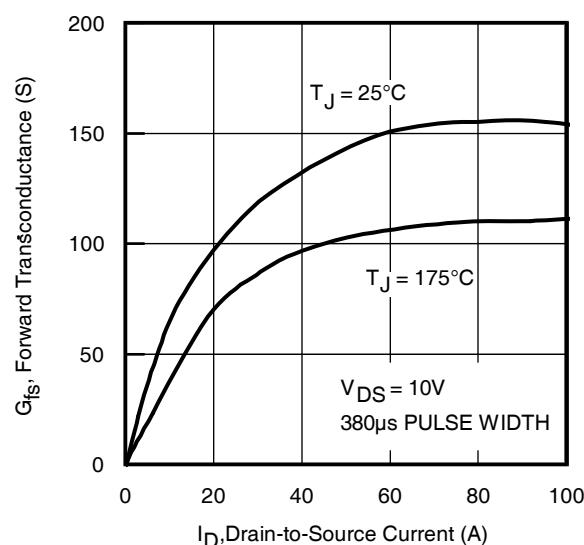
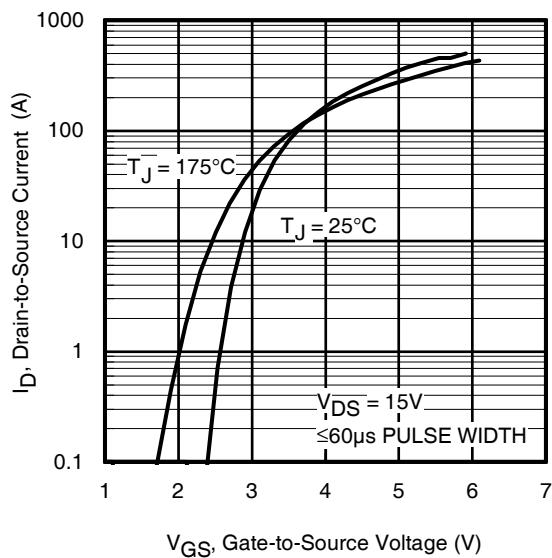
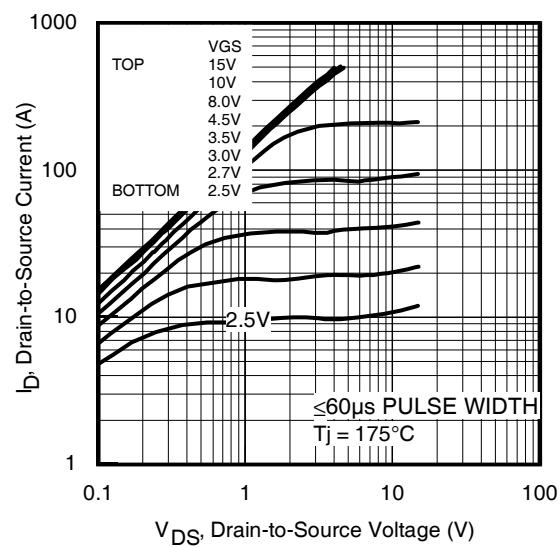
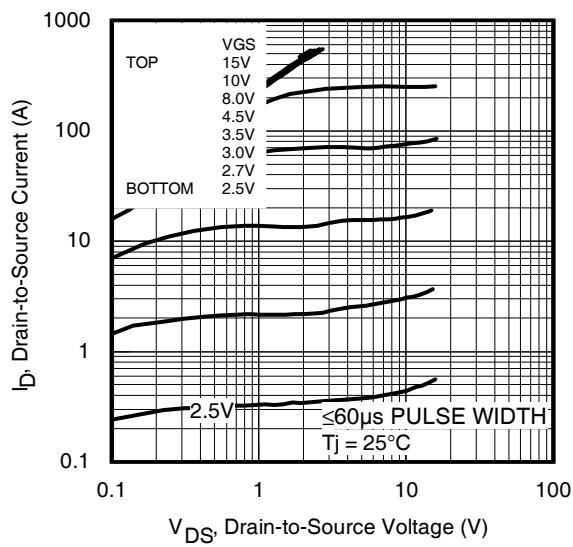
**Qualification Information<sup>†</sup>**

		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>	3L-D PAK	MSL1	
	3L-I-PAK	N/A	
<b>ESD</b>	Machine Model	Class M4(+/- 425V ) <sup>†††</sup> (per AEC-Q101-002)	
	Human Body Model	Class H1C(+/- 2000V ) <sup>†††</sup> (per AEC-Q101-001)	
	Charged Device Model	Class C5(+/- 1125V ) <sup>†††</sup> (per 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 to AEC-Q101 requirements are noted in the qualification report.

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



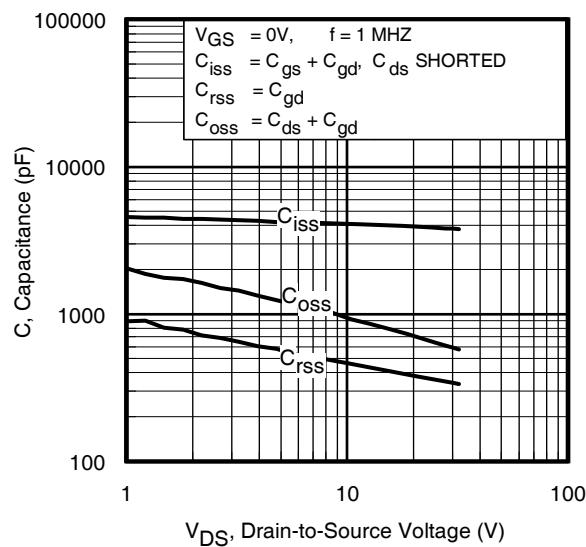


Fig 5. Typical Capacitance vs.  
Drain-to-Source Voltage

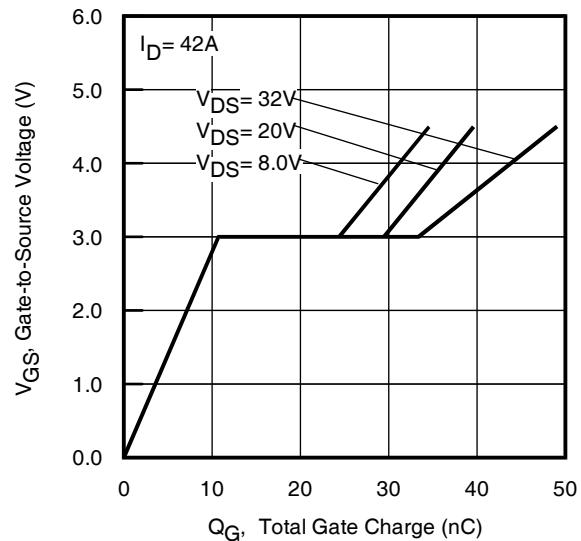


Fig 6. Typical Gate Charge vs.  
Gate-to-Source Voltage

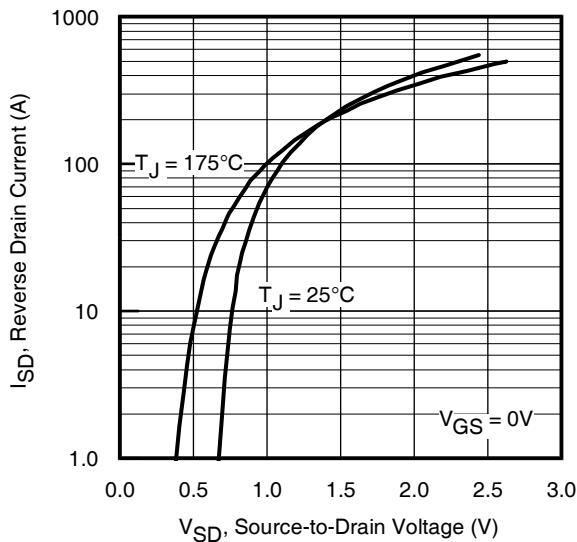


Fig 7. Typical Source-Drain Diode  
Forward Voltage

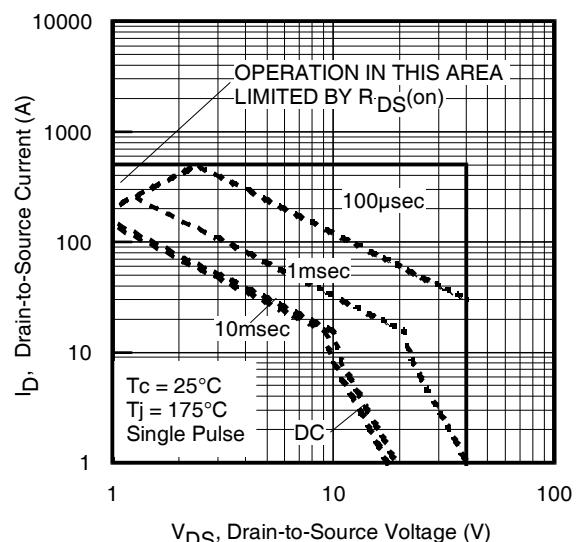
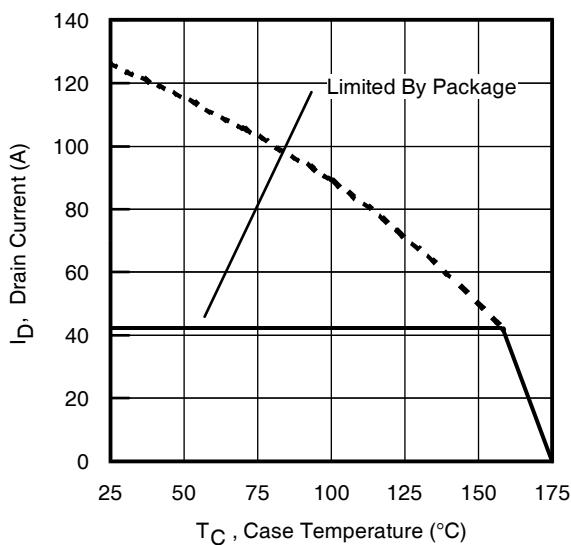
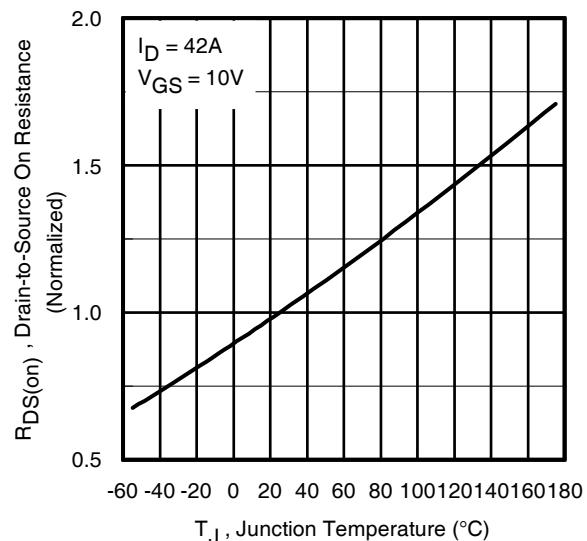


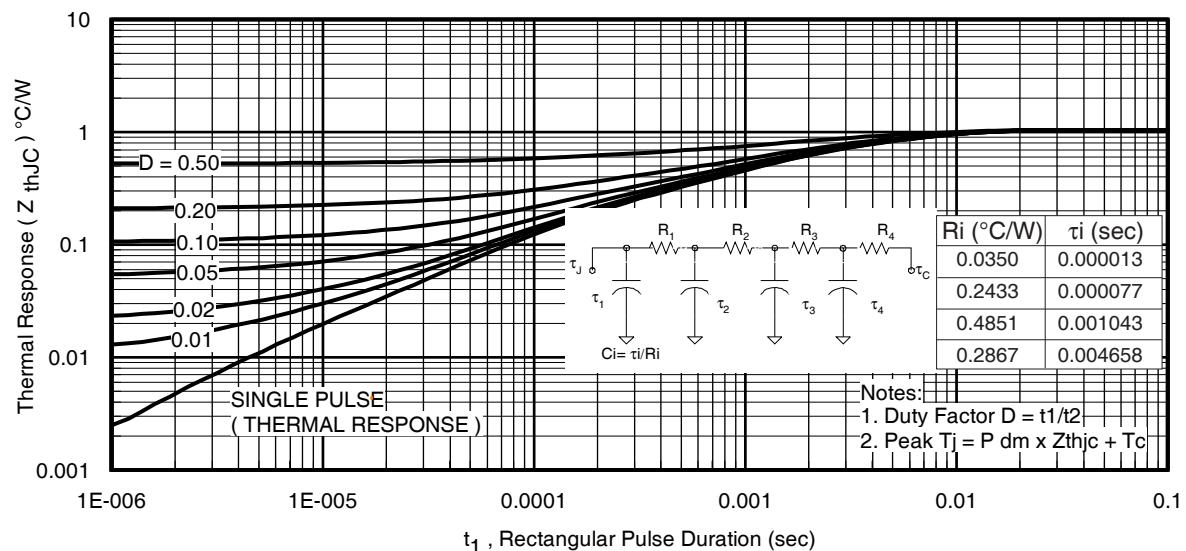
Fig 8. Maximum Safe Operating Area



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



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



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

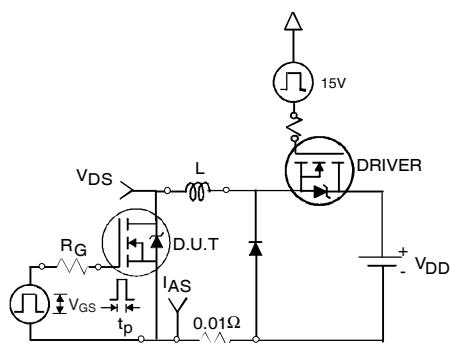


Fig 12a. Unclamped Inductive Test Circuit

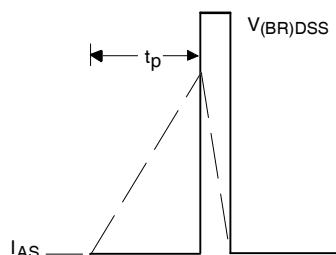


Fig 12b. Unclamped Inductive Waveforms

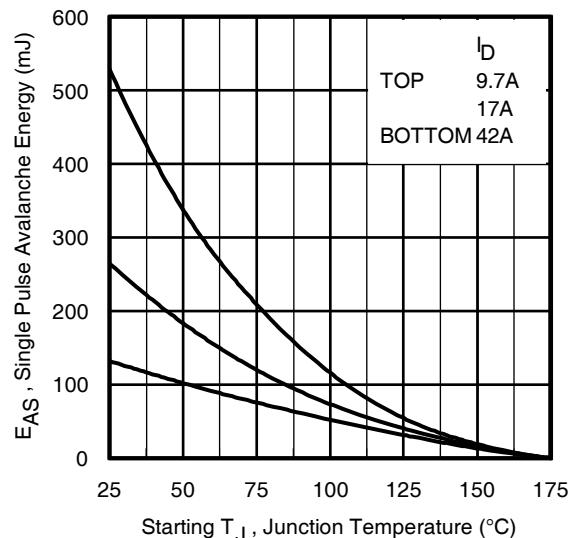


Fig 12c. Maximum Avalanche Energy vs. Drain Current

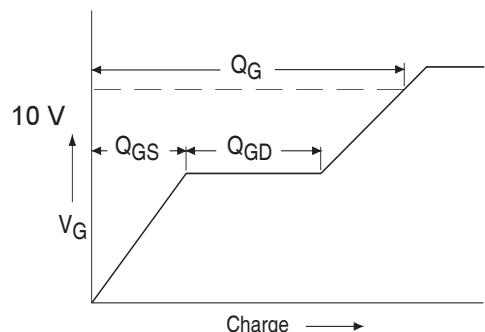


Fig 13a. Basic Gate Charge Waveform

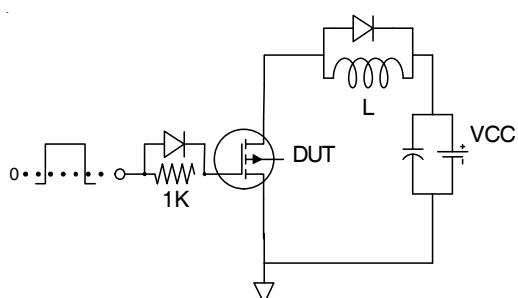


Fig 13b. Gate Charge Test Circuit

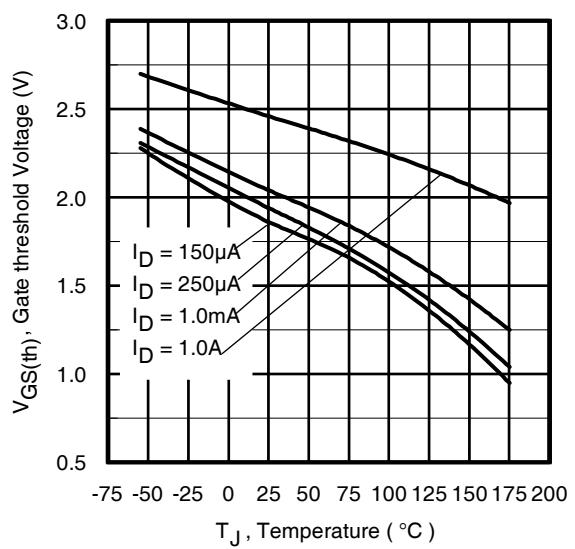


Fig 14. Threshold Voltage vs. Temperature

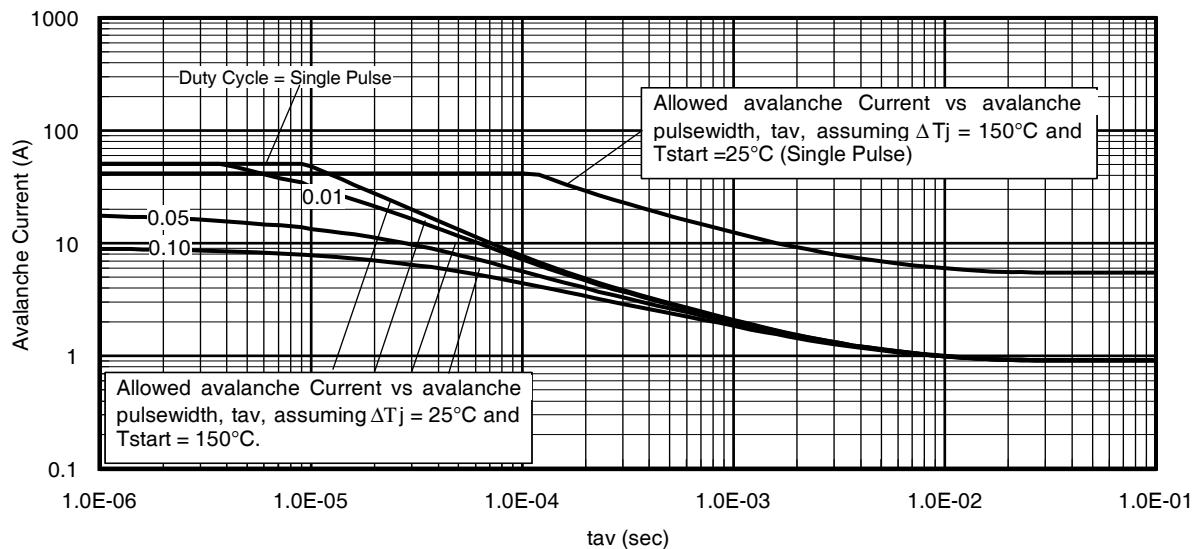
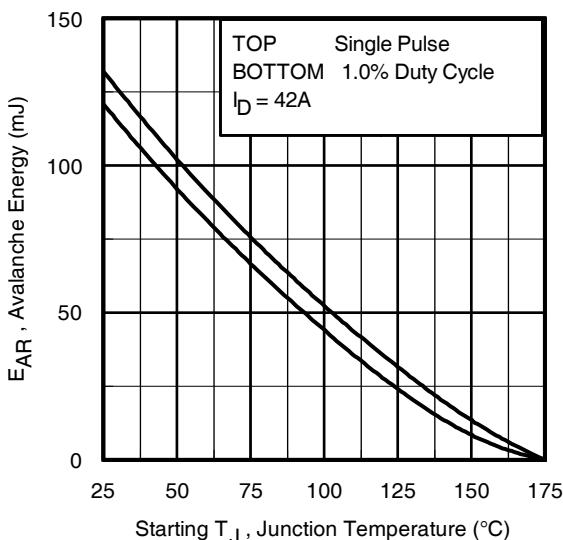


Fig 15. Typical Avalanche Current vs.Pulsewidth

Fig 16. Maximum Avalanche Energy  
vs. Temperature

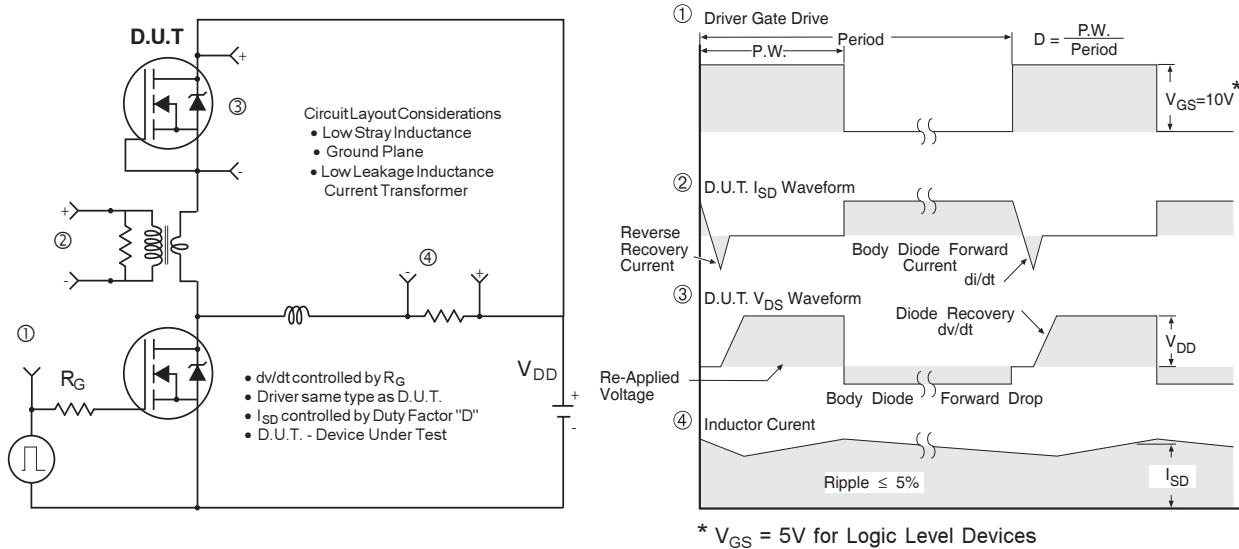
Notes on Repetitive Avalanche Curves , Figures 15, 16:  
(For further info, see AN-1005 at [www.irf.com](http://www.irf.com))

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 neither  $T_{jmax}$  nor  $I_{av}$  (max) is exceeded.
3. Equation below based on circuit and waveforms shown in Figures 12a, 12b.
4.  $P_D \text{ (ave)} = \text{Average power dissipation per single avalanche pulse.}$
5.  $BV = \text{Rated breakdown voltage (1.3 factor accounts for voltage increase during avalanche).}$
6.  $I_{av} = \text{Allowable avalanche current.}$
7.  $\Delta T = \text{Allowable rise in junction temperature, not to exceed } T_{jmax} \text{ (assumed as 25°C in Figure 15, 16).}$   
 $t_{av} = \text{Average time in avalanche.}$   
 $D = \text{Duty cycle in avalanche} = t_{av} \cdot f$   
 $Z_{thJC}(D, t_{av}) = \text{Transient thermal resistance, see figure 11)$

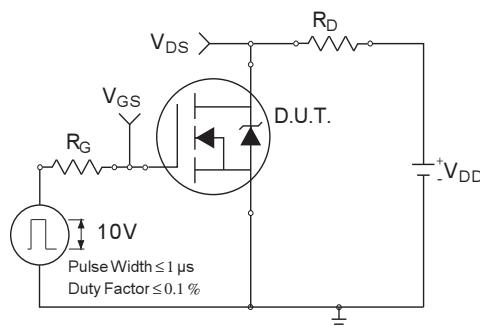
$$P_D \text{ (ave)} = 1/2 ( 1.3 \cdot BV \cdot I_{av} ) = \Delta T / Z_{thJC}$$

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

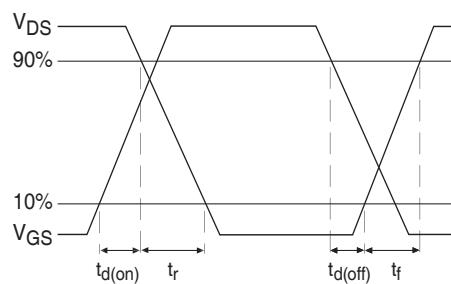
$$E_{AS \text{ (AR)}} = P_D \text{ (ave)} \cdot t_{av}$$



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



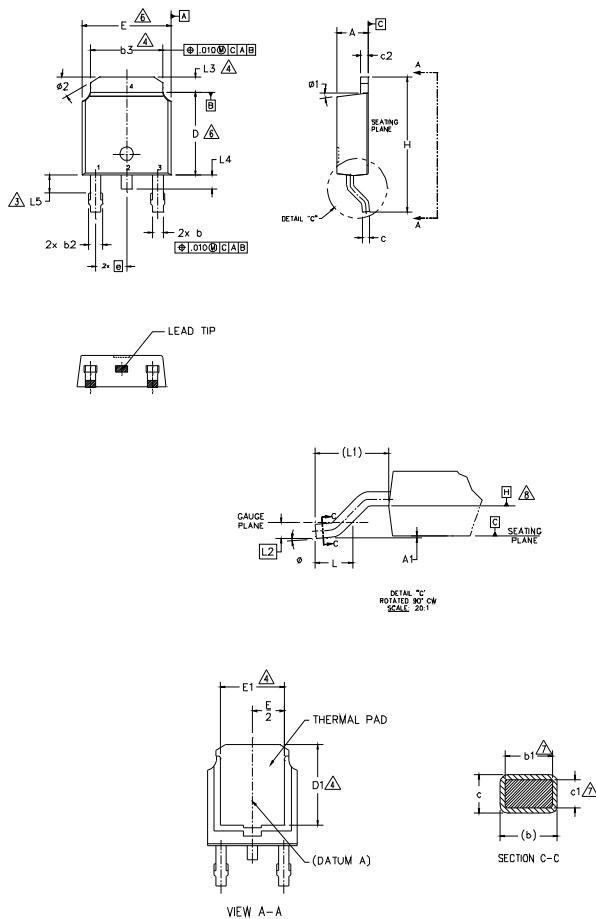
**Fig 18a.** Switching Time Test Circuit



**Fig 18b.** Switching Time Waveforms

## D-Pak (TO-252AA) Package Outline

Dimensions are shown in millimeters (inches)



## NOTES:

- 1. - DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
- 2. - DIMENSION ARE SHOWN IN INCHES [MILLIMETERS].
- 3. - LEAD DIMENSION UNCONTROLLED IN L5.
- 4. - DIMENSION D1, E1, L3 & b3 ESTABLISH A MINIMUM MOUNTING SURFACE FOR THERMAL PAD.
- 5. - SECTION C-C DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN .005 AND 0.10 [0.13 AND 0.25] FROM THE LEAD TIP.
- 6. - DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005 [0.13] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
- 7. - DIMENSION b1 & c1 APPLIED TO BASE METAL ONLY.
- 8. - DATUM A & B TO BE DETERMINED AT DATUM PLANE H.
- 9. - OUTLINE CONFORMS TO JEDEC OUTLINE TO-252AA.

SYMBOL	DIMENSIONS				NOTES	
	MILLIMETERS		INCHES			
	MIN.	MAX.	MIN.	MAX.		
A	2.18	2.39	.086	.094		
A1	—	0.13	—	.005		
b	0.64	0.89	.025	.035		
b1	0.65	0.79	.025	.031	7	
b2	0.76	1.14	.030	.045		
b3	4.95	5.46	.195	.215	4	
c	0.46	0.61	.018	.024		
c1	0.41	0.56	.016	.022	7	
c2	0.46	0.89	.018	.035		
D	5.97	6.22	.235	.245	6	
D1	5.21	—	.205	—	4	
E	6.35	6.73	.250	.265	6	
E1	4.32	—	.170	—	4	
e	2.29	BSC	.090	BSC		
H	9.40	10.41	.370	.410		
L	1.40	1.78	.055	.070		
L1	2.74	BSC	.108	REF.		
L2	0.51	BSC	.020	BSC		
L3	0.89	1.27	.035	.050	4	
L4	—	1.02	—	.040		
L5	1.14	1.52	.045	.060	3	
Ø	0"	10"	0"	10"		
Ø1	0"	15"	0"	15"		
Ø2	25"	35"	25"	35"		

## LEAD ASSIGNMENTS

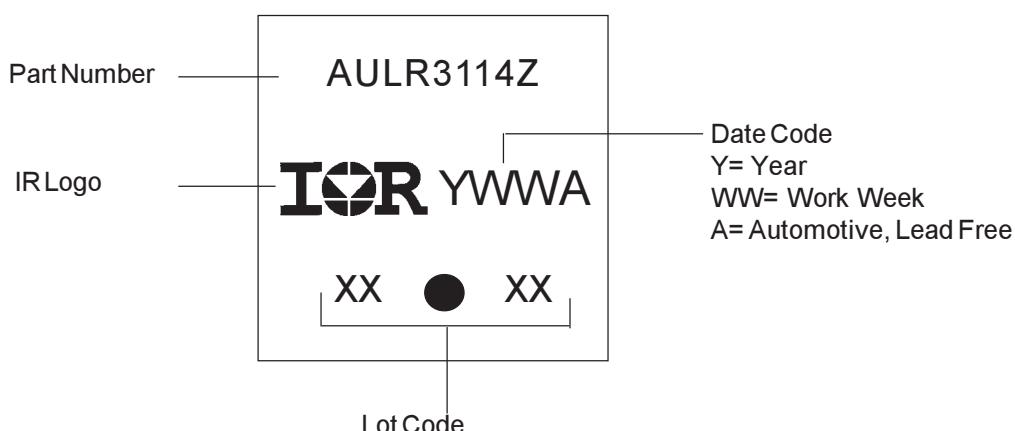
## HEXFET

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

IGBT & CoPAK

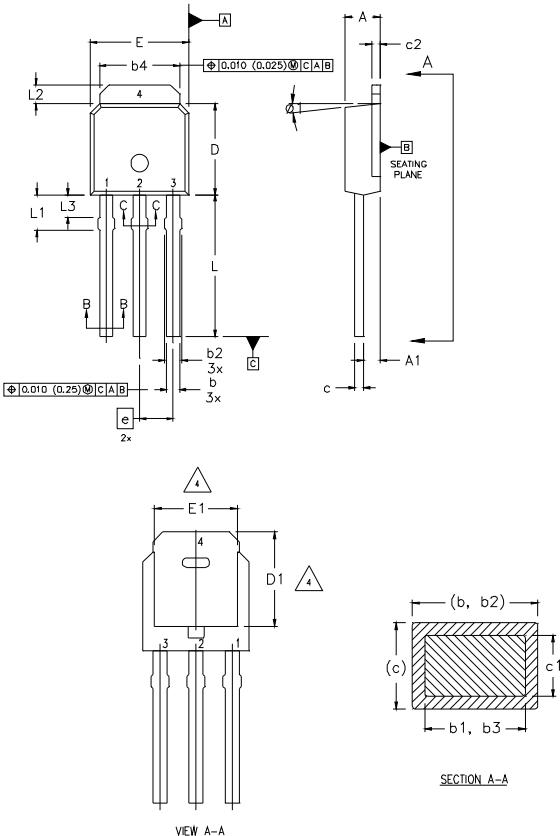
1. - GATE
2. - COLLECTOR
3. - Emitter
4. - COLLECTOR

## D-Pak (TO-252AA) Part Marking Information



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

I-Pak (TO-251AA) Package Outline ( Dimensions are shown in millimeters (inches)



NOTES:

- 1 DIMENSIONING AND TOLERANCING PER ASME Y14.5 M- 1994.
- 2 DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
- 3 DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
- 4 THERMAL PAD CONTOUR OPTION WITHIN DIMENSION b4, L2, E1 & D1.
- 5 LEAD DIMENSION UNCONTROLLED IN L3.
- 6 DIMENSION b1, b3 APPLY TO BASE METAL ONLY.
- 7 OUTLINE CONFORMS TO JEDEC OUTLINE TO-251AA.
- 8 CONTROLLING DIMENSION : INCHES.

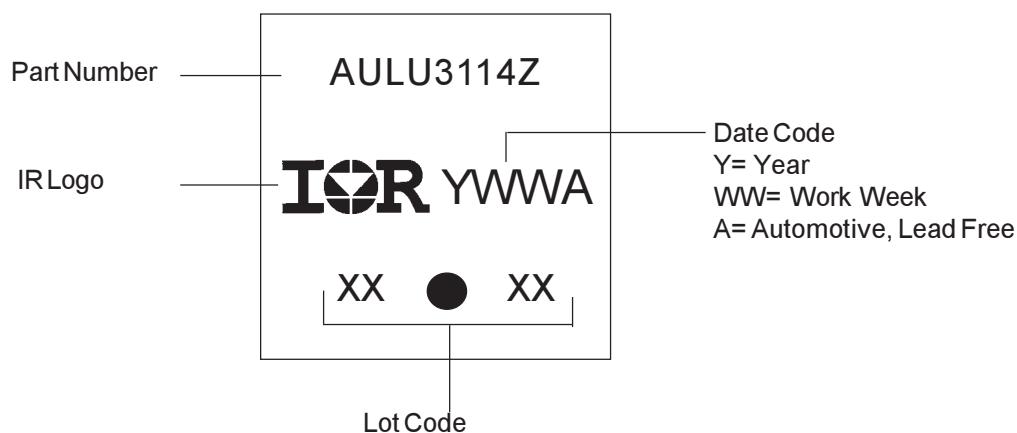
LEAD ASSIGNMENTS

HEXFET

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

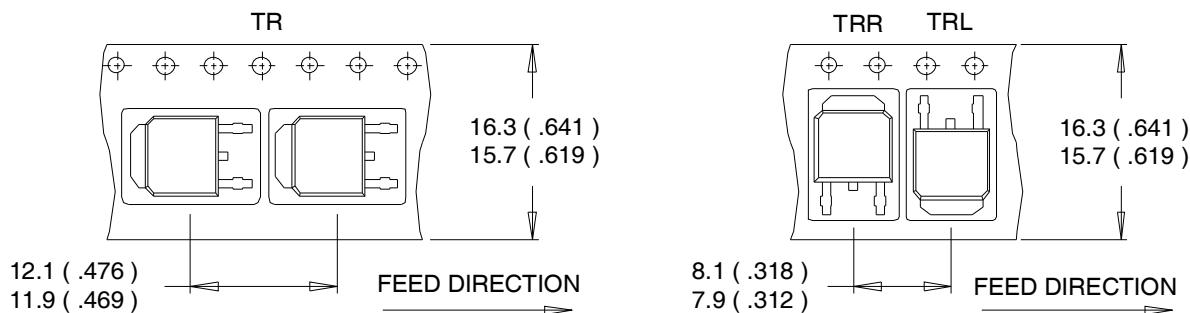
SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	2.18	2.39	0.086	.094	
A1	0.89	1.14	0.035	0.045	
b	0.64	0.89	0.025	0.035	
b1	0.64	0.79	0.025	0.031	4
b2	0.76	1.14	0.030	0.045	
b3	0.76	1.04	0.030	0.041	
b4	5.00	5.46	0.195	0.215	4
c	0.46	0.61	0.018	0.024	
c1	0.41	0.56	0.016	0.022	
c2	.046	0.86	0.018	0.035	
D	5.97	6.22	0.235	0.245	3, 4
D1	5.21	—	0.205	—	4
E	6.35	6.73	0.250	0.265	3, 4
E1	4.32	—	0.170	—	4
2.29		0.090 BSC			
L	8.89	9.60	0.350	0.380	
L1	1.91	2.29	0.075	0.090	
L2	0.89	1.27	0.035	0.050	4
L3	1.14	1.52	0.045	0.060	5
Ø1	0"	15"	0"	15"	

I-Pak (TO-251AA) Part Marking Information



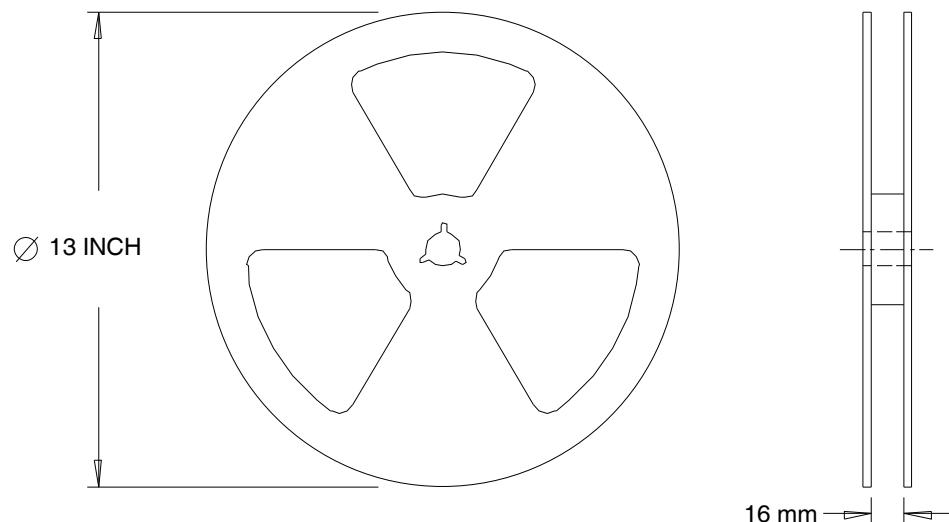
## D-Pak (TO-252AA) Tape &amp; Reel Information

Dimensions are shown in millimeters (inches)



## NOTES :

1. CONTROLLING DIMENSION : MILLIMETER.
2. ALL DIMENSIONS ARE SHOWN IN MILLIMETERS ( INCHES ).
3. OUTLINE CONFORMS TO EIA-481 & EIA-541.



## NOTES :

1. OUTLINE CONFORMS TO EIA-481.

### Ordering Information

Base part	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUICLR3114Z	DPak	Tube	75	AUICLR3114Z
		Tape and Reel	2000	AUICLR3114ZTR
		Tape and Reel Left	3000	AUICLR3114ZTRL
		Tape and Reel Right	3000	AUICLR3114ZTRR
AUICLU3114Z	IPak	Tube	75	AUICLU3114Z

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