

## INTELLIGENT POWER LOW SIDE SWITCH

### Features

- Over temperature shutdown
- Over current shutdown
- Active clamp
- Low current & logic level input
- ESD protection
- Optimized Turn On/Off for EMI
- Diagnostic on the input current

### Description

The AUIPS2031R is a three terminal Intelligent Power Switch (IPS) that features a low side MOSFET with over-current, over-temperature, ESD protection and drain to source active clamp. This device offers protections and the high reliability required in harsh environments. The switch provides efficient protection by turning OFF the power MOSFET when the temperature exceeds 165°C or when the drain current reaches 15A. The device restarts once the input is cycled. A serial resistance connected to the input provides the diagnostic. The avalanche capability is significantly enhanced by the active clamp and covers most inductive load demagnetizations.

### Product Summary

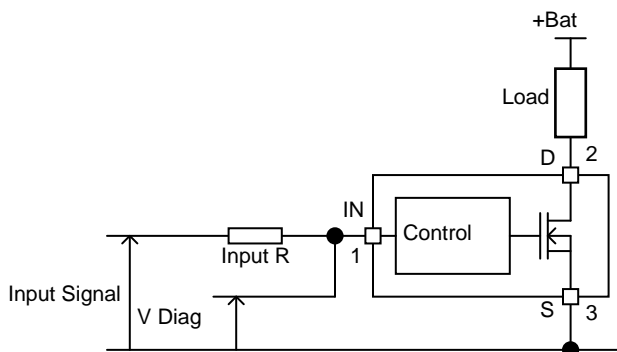
$R_{ds(on)}$	60m $\Omega$ (max.)
$V_{clamp}$	68V
$I_{shutdown}$	10A (min.)

### Packages



DPak  
AUIPS2031R

### Typical Connection



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

<b>Qualification Level</b>		Automotive (per AEC-Q100 <sup>††</sup> )	
		Comments: This family of ICs has passed an Automotive qualification. IR's Industrial and Consumer qualification level is granted by extension of the higher Automotive level.	
<b>Moisture Sensitivity Level</b>		DPAK-3L	MSL1, 260°C (per IPC/JEDEC J-STD-020)
<b>ESD</b>	Machine Model	Class M3 (+/-400V) (per AEC-Q100-003)	
	Human Body Model	Class H1C (+/-2000V) (per AEC-Q100-002)	
	Charged Device Model	Class C4 (+/-1000V) (per AEC-Q100-011)	
<b>IC Latch-Up Test</b>		Class II, Level A (per AEC-Q100-004)	
<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-Q100 requirements are noted in the qualification report.

<sup>†††</sup> Higher MSL ratings may be available for the specific package types listed here. Please contact your International Rectifier sales representative for further information.

## Absolute Maximum Ratings

Absolute maximum ratings indicate sustained limits beyond which damage to the device may occur. (T<sub>j</sub>= -40°C..150°C, V<sub>cc</sub>=6..50V unless otherwise specified).

Symbol	Parameter	Min.	Max.	Units
V <sub>ds</sub>	Maximum drain to source voltage	-0.3	60	V
V <sub>in</sub>	Maximum input voltage	-0.3	6	V
I <sub>sd</sub> cont.	Max diode continuous current (limited by thermal dissipation) R <sub>th</sub> =50°C/W	—	2.5	A
P <sub>d</sub>	Maximum power dissipation (internally limited by thermal protection) R <sub>th</sub> =50°C/W	—	2.5	W
T <sub>j</sub> max.	Maximum operating junction temperature	-40	150	°C
	Maximum storage temperature	-55	150	

## Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Units
R <sub>th1</sub>	Thermal resistance junction to ambient IPS2031R D-Pak std. footprint	70	—	°C/W
R <sub>th2</sub>	Thermal resistance junction to ambient IPS2031R D-Pak 1" sqr. footprint	50	—	
R <sub>th3</sub>	Thermal resistance junction to case IPS2031R D-Pak	2.5	—	

## Recommended Operating Conditions

These values are given for a quick design. For operation outside these conditions, please consult the application notes.

Symbol	Parameter	Min.	Max.	Units
V <sub>IH</sub>	High level input voltage	4	5.5	
V <sub>IL</sub>	Low level input voltage	0	0.5	
I <sub>ds</sub>	Continuous drain current, T <sub>ambient</sub> =85°C, T <sub>j</sub> =125°C, V <sub>in</sub> =5V, R <sub>th</sub> =70°C/W	—	2.3	A
R <sub>in</sub>	Recommended resistor in series with IN pin	0.5	1.5	kΩ
	Input signal voltage=5V (1) Input signal voltage=4V (1)	0.5	1	
Max. t <sub>rise</sub>	Max. input signal rising time (from 10% to 90%)(2)	—	0.5	μs

(1) Input signal of the pulse generator not the voltage on the IN pin of the device. Do not connect any other component on the input.

(2) Max. t<sub>rise</sub> is for the input signal of the pulse generator not on the IN pin voltage of the device

## Static Electrical Characteristics

$T_j = -40..150^{\circ}\text{C}$ ,  $V_{cc} = 6..50\text{V}$  (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Rds(on)	ON state resistance $T_j = 25^{\circ}\text{C}$	—	45	60	m $\Omega$	$V_{in} = 5\text{V}$ , $I_{ds} = 5\text{A}$
	ON state resistance $T_j = 150^{\circ}\text{C}$	—	80	110		
I <sub>dss1</sub>	Drain to source leakage current	—	0.1	1	$\mu\text{A}$	$V_{cc} = 14\text{V}$ , $V_{in} = 0\text{V}$ , $T_j = 25^{\circ}\text{C}$
I <sub>dss2</sub>	Drain to source leakage current	—	0.15	2		$V_{cc} = 50\text{V}$ , $V_{in} = 0\text{V}$ , $T_j = 25^{\circ}\text{C}$
V <sub>clamp1</sub>	Drain to source clamp voltage 1	63	68	—	V	$I_d = 20\text{mA}$ See fig. 3 & 4
V <sub>clamp2</sub>	Drain to source clamp voltage 2	—	68	75		$I_d = 1\text{A}$
V <sub>in clamp</sub>	IN to source pin clamp voltage	5.5	6.2	7.5		$I_{in} = 1\text{mA}$
V <sub>th</sub>	Input threshold voltage	1.1	2	2.8		$I_d = 200\text{mA}$
I <sub>in, on</sub>	ON state IN positive current	10	40	80	$\mu\text{A}$	$V_{in} = 5\text{V}$
I <sub>in, off</sub>	OFF state IN positive current ( after protection latched )	120	250	350		

## Switching Electrical Characteristics

$V_{cc} = 28\text{V}$ , Resistive load =  $10\Omega$ ,  $R_{input} = 50\Omega$ ,  $V_{in} = 5\text{V}$ ,  $T_j = 25^{\circ}\text{C}$

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
T <sub>don</sub>	Turn-on delay time to 20%	0.5	2	5	$\mu\text{s}$	See figure 2
T <sub>r</sub>	Rise time 20% to 80%	0.2	1.4	3		
T <sub>doff</sub>	Turn-off delay time to 80%	3	8	12		
T <sub>f</sub>	Fall time 80% to 20%	0.2	1.4	3		
E <sub>on</sub> + E <sub>off</sub>	Turn on and off energy	—	110	—	$\mu\text{J}$	

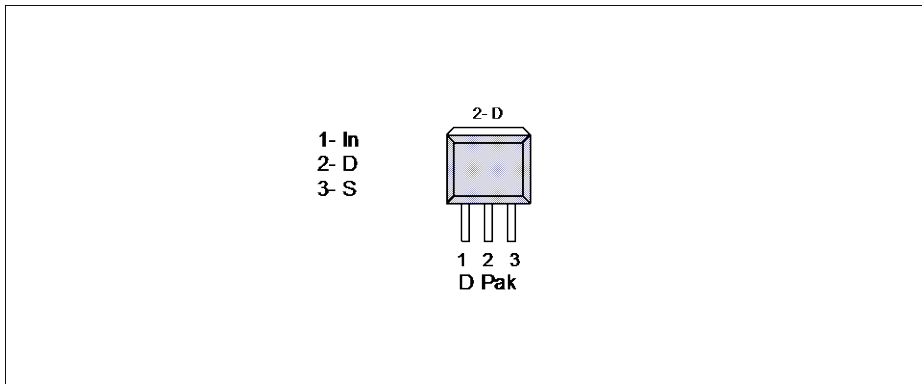
## Protection Characteristics

$T_j = -40..150^{\circ}\text{C}$ ,  $V_{cc} = 6..50\text{V}$  (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
T <sub>sd</sub>	Over temperature threshold	150(2)	165	—	$^{\circ}\text{C}$	See figure 1
I <sub>sd</sub>	Over current threshold	10	15	20	A	See figure 1
V <sub>reset</sub>	IN protection reset threshold	0.9	1.6	2	V	
T <sub>reset</sub>	Time to reset protection	15	50	500	$\mu\text{s}$	$V_{in} = 0\text{V}$ , $T_j = 25^{\circ}\text{C}$

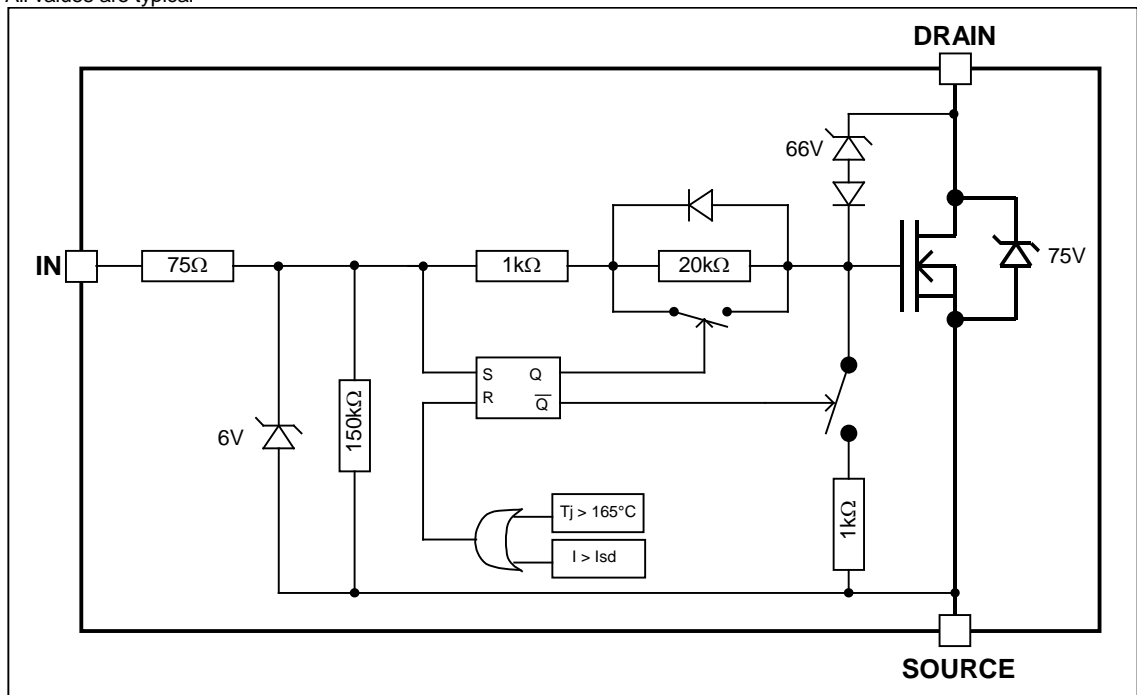
(2) Guaranteed by design

## Lead Assignments



## Functional Block Diagram

All values are typical



All curves are typical values. Operating in the shaded area is not recommended.

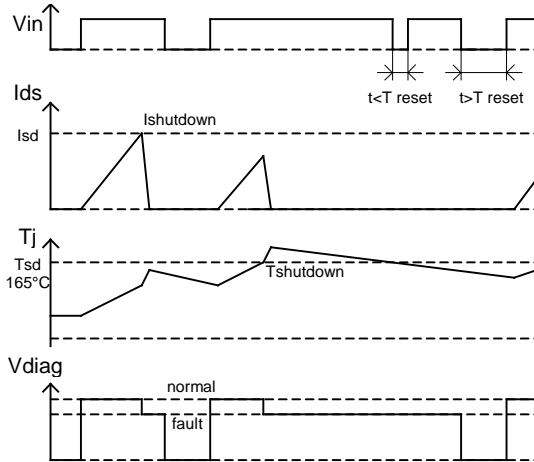


Figure 1 – Timing diagram

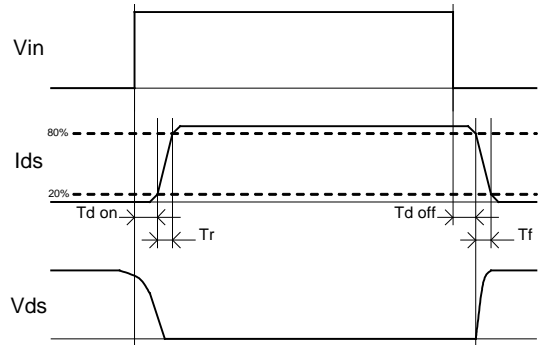


Figure 2 – IN rise time & switching definitions

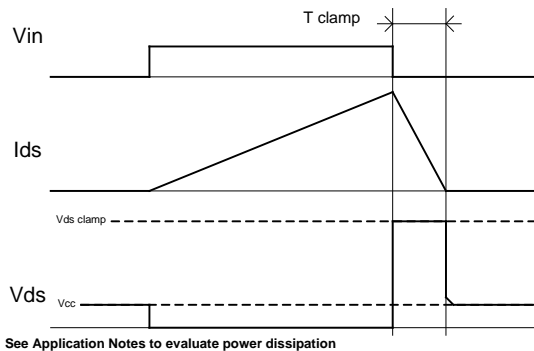


Figure 3 – Active clamp waveforms

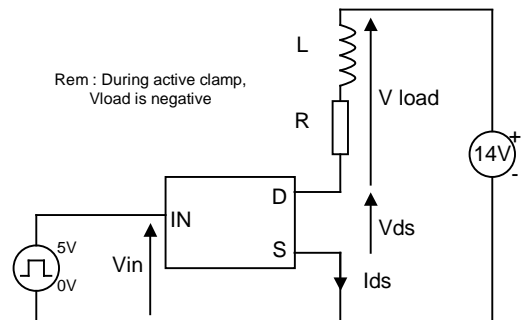
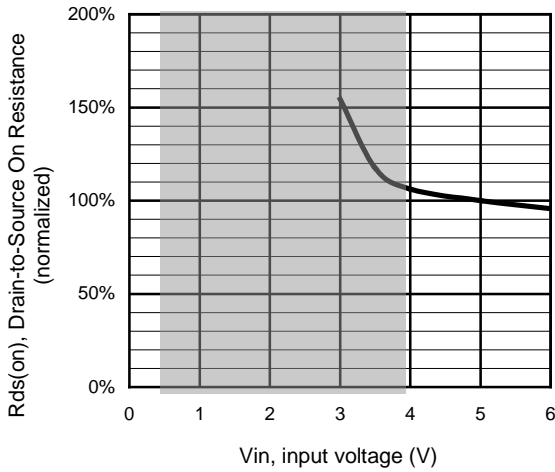
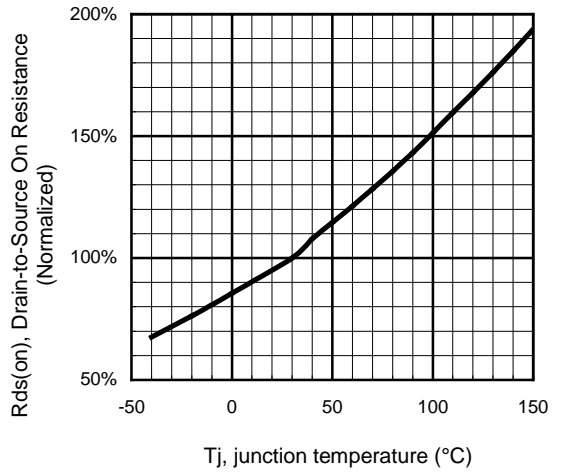
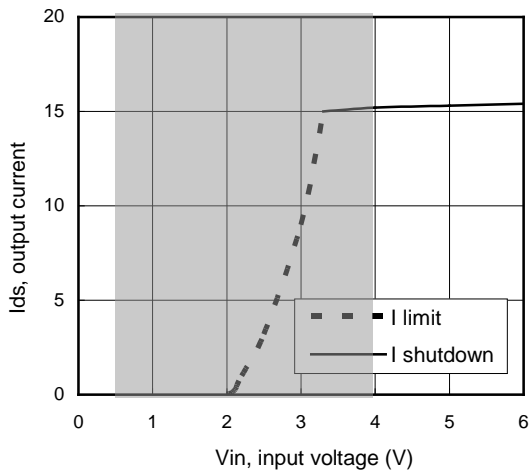
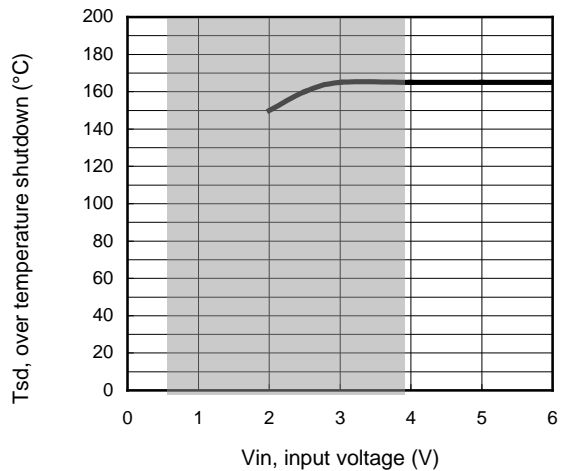
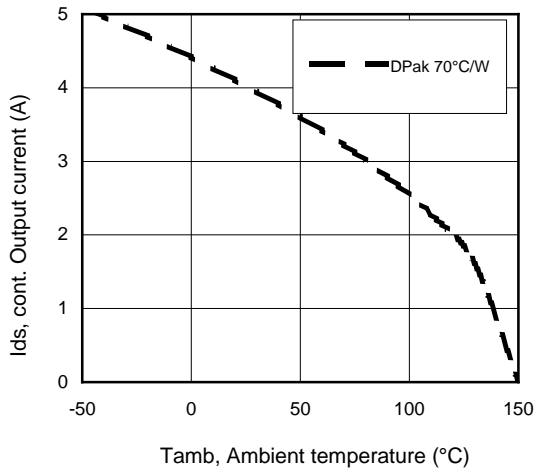
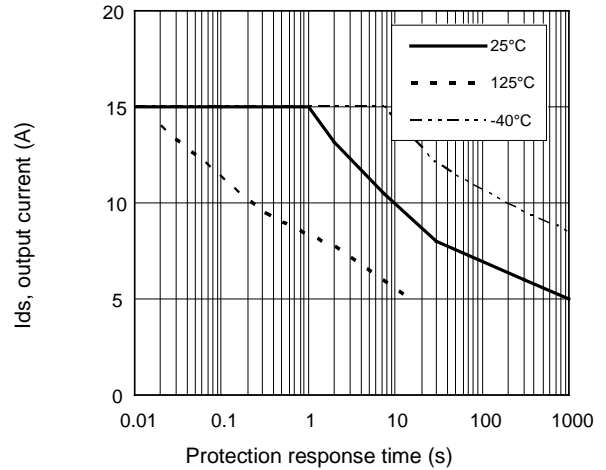


Figure 4 – Active clamp test circuit

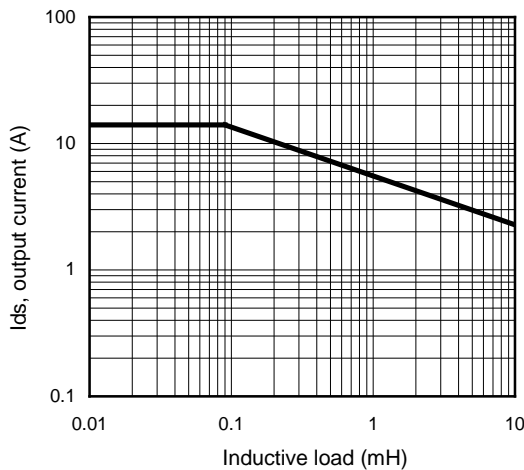

**Figure 5 – Normalized Rdson (%) Vs Input voltage (V)**

**Figure 6 - Normalized Rdson (%) Vs Tj (°C)**

**Figure 7 – Current limitation and current shutdown Vs Input voltage (V)**

**Figure 8 – Over temperature shutdown (°C) Vs input voltage (V)**



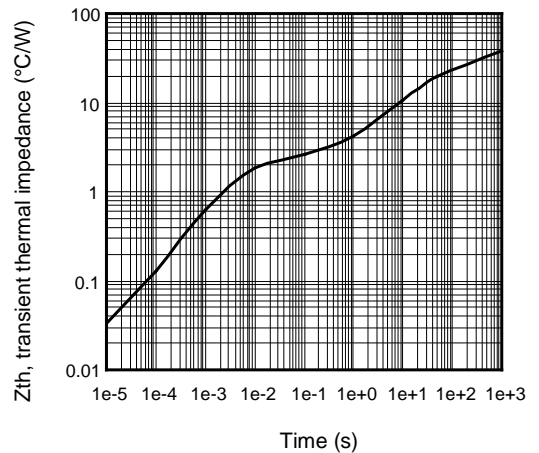
**Figure 9 – Max. continuous output current (A) Vs Ambient temperature (°C)**



**Figure 10 – Ids (A) Vs over temperature protection response time (s)**



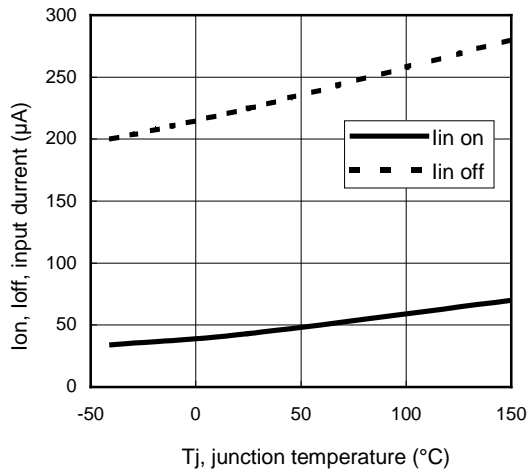
**Figure 11 – Max. output current (A) Vs Inductive load (mH)**



**Figure 12 – Transient thermal impedance (°C/W) Vs time (s)**

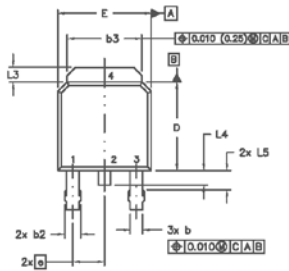
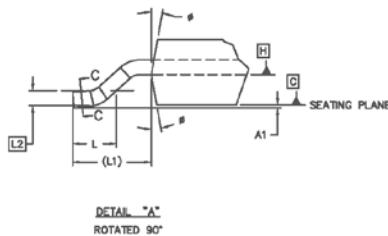
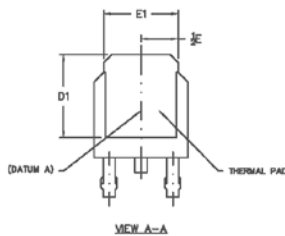
This is for single pulse when  $T_j=165^{\circ}\text{C}$  and for repetitive pulses when  $T_j<115^{\circ}\text{C}$  before turning off.



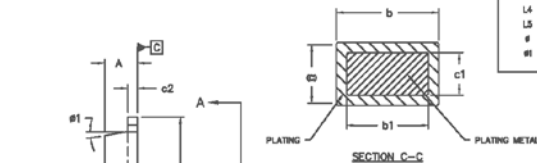


**Figure 13 – Input current (µA) On and Off  
Vs junction temperature (°C)**

## Case outline – Dpak



SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	2.18	2.30	.086	.091	
A1		0.13		.005	
b	0.84	0.89	.033	.035	5
b1	0.84	0.79	.033	.031	5
b2	0.76	1.14	.030	.045	
b3	4.85	5.48	.195	.215	
c	0.48	0.61	.018	.024	5
c1	0.41	0.56	.016	.022	5
e2	.048	0.89	.018	.035	5
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	3.28		.080 BSC		
H	6.40	10.41	.270	.410	
L	1.40	1.78	.055	.070	
L1	2.74 REF.		.100 REF.		
L2	0.81 BSC		.020 BSC		
L3	0.89	1.27	.035	.050	
L4		1.02		.040	
L5	1.14	1.52	.045	.060	3
ø	ø	10°	ø	10°	
ø1	ø	10°	ø	10°	

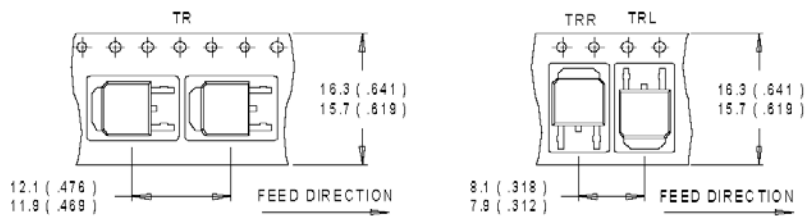


### NOTES:

- 1.0 DIMENSIONING AND TOLERANCING PER ASME Y14.5 M- 1994.
- 2.0 DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
- 3.0 LEAD DIMENSION UNCONTROLLED IN L5
- 4.0 DIMENSION D1 AND E1 ESTABLISH A MINIMUM MOUNTING SURFACE FOR THERMAL PAD.
- 5.0 SECTION C-C DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN .005 [0.127] AND .010 [0.254] FROM THE LEAD TIP.
- 6.0 DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
- 7.0 OUTLINE CONFORMS TO JEDEC OUTLINE TO-252AA.
- 8.0 LEADS AND DRAIN ARE PLATED WITH 100% Sn

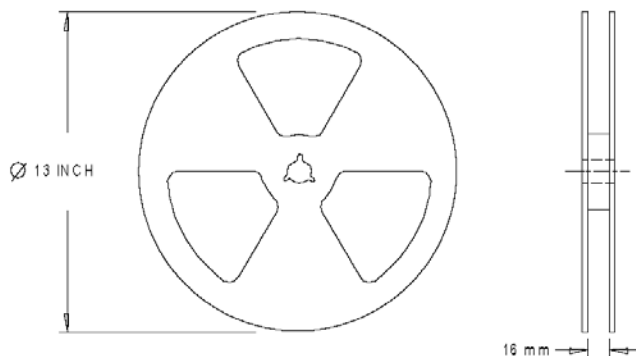
## Tape & Reel – Dpak

Dimensions are shown in millimeters (inches)



### NOTES:

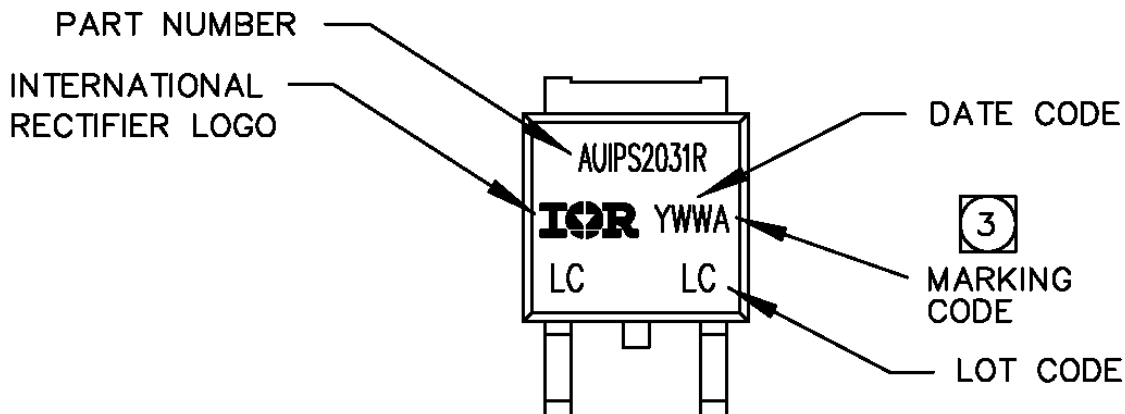
1. CONTROLLING DIMENSION : MILLIMETER.
2. ALL DIMENSIONS ARE SHOWN IN MILLIMETERS ( INCHES ).
3. OUTLINE CONFORMS TO EIA-481 & EIA-541.



### NOTES:

1. OUTLINE CONFORMS TO EIA-481.

## Part Marking Information



## Ordering Information

Base Part Number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIPS2031R	D-Pak-5-Lead	Tube	75	AUIPS2031R
		Tape and reel	2000	AUIPS2031RTR
		Tape and reel left	3000	AUIPS2031RTRL
		Tape and reel right	3000	AUIPS2031RTRR

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**WORLD HEADQUARTERS:**

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Tel: (310) 252-7105

## Revision History

Revision	Date	Notes/Changes
A4	March, 25 <sup>th</sup> , 2010	Add tri-temp ds
A5	May, 10 <sup>th</sup> 2010	Update before qual
A6	November, 17 <sup>th</sup> 2010	Final release
A7	December, 7 <sup>th</sup> 2010	Remove ESD section page3
A8	December, 9 <sup>th</sup> 2010	Update qual page
B	June, 21 <sup>st</sup> 2012	Update storage temperature
C	December, 3 <sup>rd</sup> 2012	Update switching losses Add a note figure 11
D	April, 18 <sup>th</sup> 2013	Update Recommended Input resistor

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