

## 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 AUIPS2041(R)(L) 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 5A. 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

Rds(on)	130mΩ (max.)
Vclamp	68V
Ishutdown	5A (typ.)

### Packages

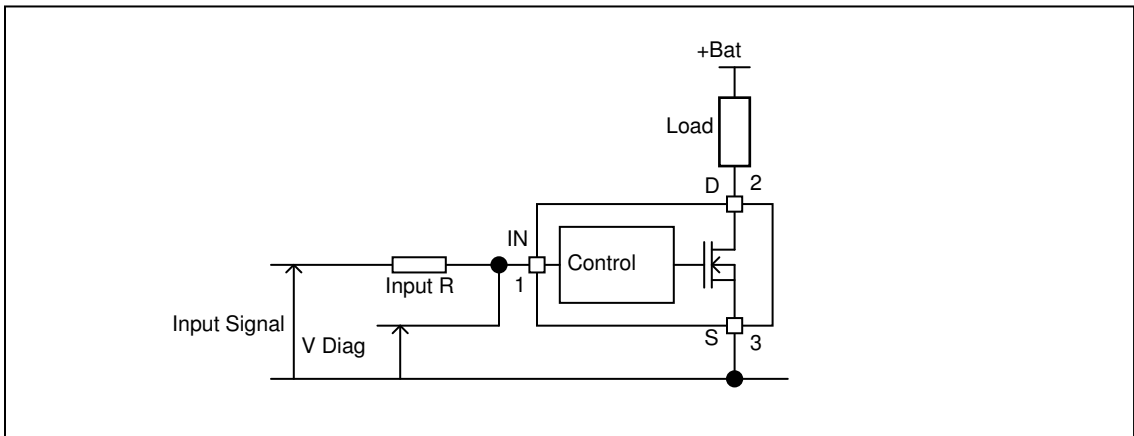


DPak  
AUIPS2041R



SOT223  
AUIPS2041L

### Typical Connection



**Qualification Information†**

<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)
		SOT223-3L	MSL2, 260 °C <sup>†††</sup> (per IPC/JEDEC J-STD-020)
<b>ESD</b>	Machine Model	Class M4 (+/-450V) (per AEC-Q100-003)	
	Human Body Model	Class H3A (+/4500V) (per AEC-Q100-002)	
	Charged Device Model	Class C4 (+/-900V) (per AEC-Q100-011)	
<b>IC Latch-Up Test</b>		ClassII, Level A (per AEC-Q100-004)	
<b>RoHS Compliant</b>		Yes	

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

†† Exceptions to AEC-Q100 requirements are noted in the qualification report.

††† 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 cont.</sub>	Max diode continuous current (limited by thermal dissipation) R <sub>th</sub> =125°C/W	—	1.4	A
P <sub>d</sub>	Maximum power dissipation (internally limited by thermal protection) R <sub>th</sub> =125C°/W	—	1	W
T <sub>j max.</sub>	Max. storage & operating temperature junction temperature	-40	150	°C

## Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Units
R <sub>th1</sub>	Thermal resistance junction to ambient IPS2041L	100	—	°C/W
R <sub>th2</sub>	Thermal resistance junction to ambient with 1" square footprint	50	—	
R <sub>th1</sub>	Thermal resistance junction to ambient IPS2041R D-Pak std. footprint	70	—	
R <sub>th2</sub>	Thermal resistance junction to ambient IPS2041R D-Pak 1" sqr. footprint	50	—	
R <sub>th3</sub>	Thermal resistance junction to case IPS2041R D-Pak	4	—	

## 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> =100 °C/W	—	1.4	A
R <sub>in</sub>	Recommended resistor in series with IN pin to generate a diagnostic	0.5	5	kΩ
Max L	Max recommended load inductance (including line inductance) (1)	—	10	mH
Max. t <sub>rise</sub>	Max. input rising time	—	1	μs

(1) Higher inductance is possible if maximum load current is limited - see figure 11

## Static Electrical Characteristics

$T_j = -40..150^{\circ}\text{C}$ ,  $V_{cc}=14\text{V}$  (unless otherwise specified), typical value are given for  $T_j=25^{\circ}\text{C}$

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Rds(on)	ON state resistance $T_j=25^{\circ}\text{C}$	—	100	130	mΩ	$V_{in}=5\text{V}$ , $I_{ds}=1\text{A}$
	ON state resistance $T_j=150^{\circ}\text{C}$ (2)	—	180	240		
Idss1	Drain to source leakage current	—	0.01	1	μA	$V_{cc}=14\text{V}$ , $T_j=25^{\circ}\text{C}$
Idss2	Drain to source leakage current	—	0.04	2		$V_{cc}=50\text{V}$ , $T_j=25^{\circ}\text{C}$
V clamp1	Drain to source clamp voltage 1	63	68	—	V	$I_d=20\text{mA}$ See fig. 3 & 4
V clamp2	Drain to source clamp voltage 2	—	68	75		$I_d=1\text{A}$
Vin clamp	IN to source pin clamp voltage	5.5	6.2	7.5		$I_{in}=1\text{mA}$
Vth	Input threshold voltage	1.1	2	2.8		$I_d=50\text{mA}$
Iin, on	ON state IN positive current	10	40	80	μA	$V_{in}=5\text{V}$
Iin, off	OFF state IN positive current ( after protection latched )	120	250	350		

## Switching Electrical Characteristics

$T_j = -40..150^{\circ}\text{C}$ ,  $V_{cc}=14\text{V}$ , Resistive load=10Ω,  $R_{input}=50\Omega$ ,  $V_{in}=5\text{V}$ , typical value are given for  $T_j=25^{\circ}\text{C}$

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Tdon	Turn-on delay time to 20%	0.25	1.3	4	μs	See figure 2
Tr	Rise time 20% to 80%	0.1	0.9	2		
Tdoff	Turn-off delay time to 80%	1	3	8		
Tf	Fall time 80% to 20%	0.1	0.6	3		
Eon + Eoff	Turn on and off energy	—	12	—	μJ	

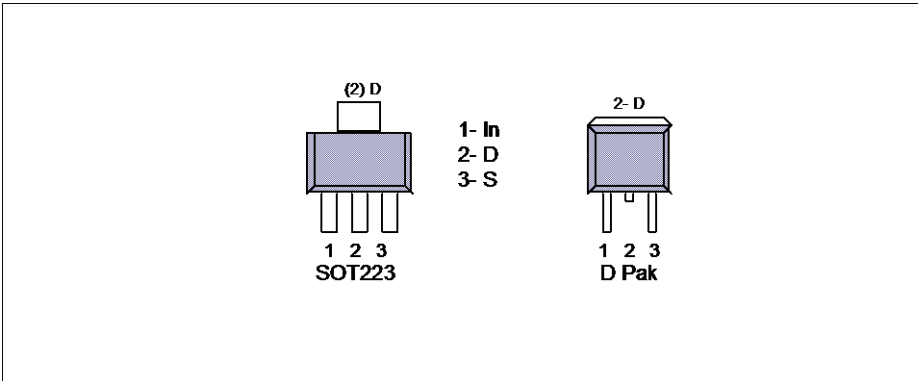
## Protection Characteristics

$T_j = -40..150^{\circ}\text{C}$ ,  $V_{cc}=14\text{V}$  (unless otherwise specified), typical value are given for  $T_j=25^{\circ}\text{C}$

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Tsd	Over temperature threshold	150(2)	165	—	$^{\circ}\text{C}$	See figure 1
Isd	Over current threshold	4	5.5	7.5	A	$T_j=25..150^{\circ}\text{C}$ see fig 1
		3.6	6	8		$T_j = -40^{\circ}\text{C}$
Vreset	IN protection reset threshold	0.9	1.6	2	V	
Treset	Time to reset protection	15	50	500	μs	$V_{in}=0\text{V}$

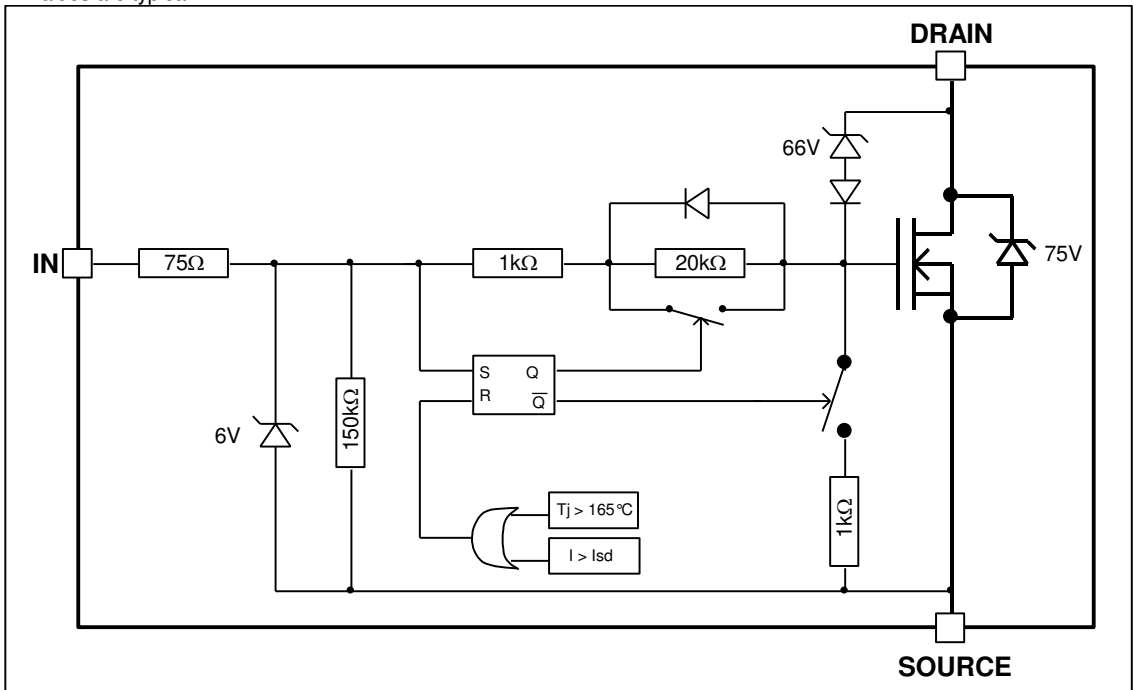
(2) Guaranteed by design

## Lead Assignments



## Functional Block Diagram

All values are typical



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

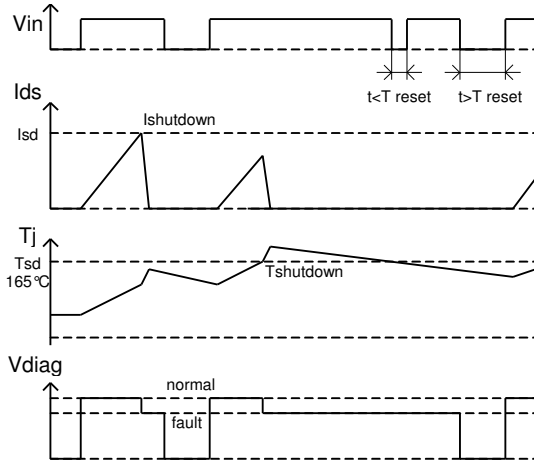


Figure 1 – Timing diagram

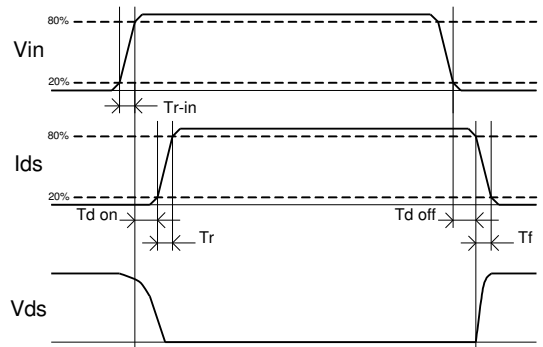


Figure 2 – IN rise time & switching definitions

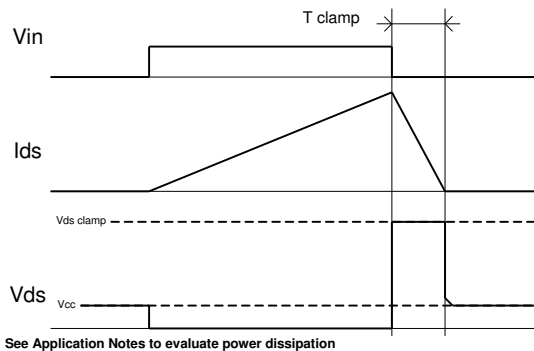


Figure 3 – Active clamp waveforms

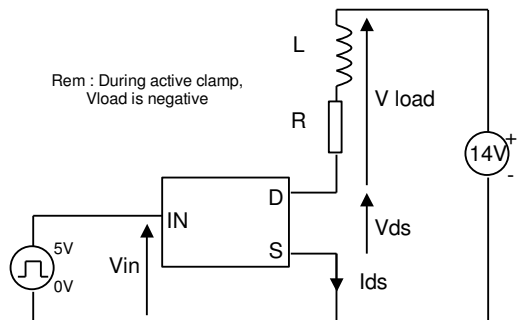
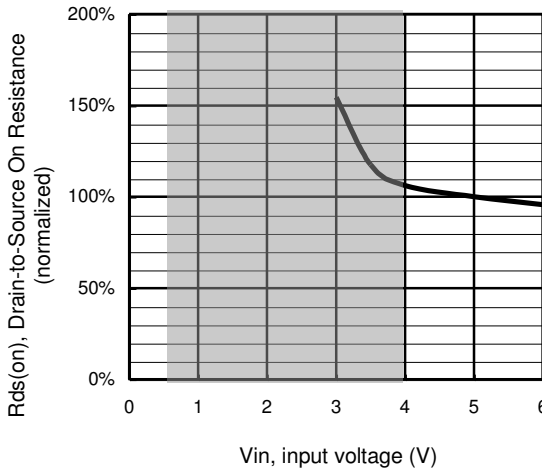
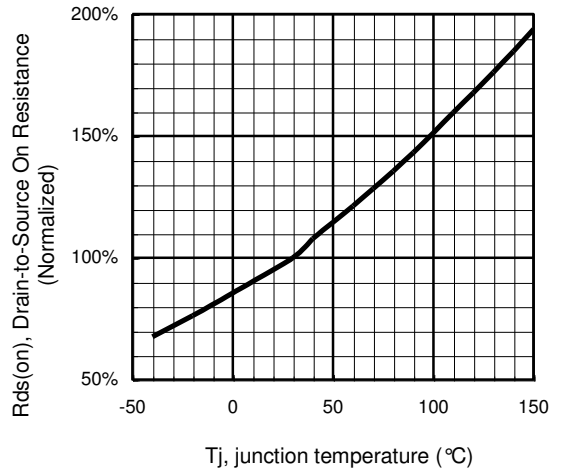


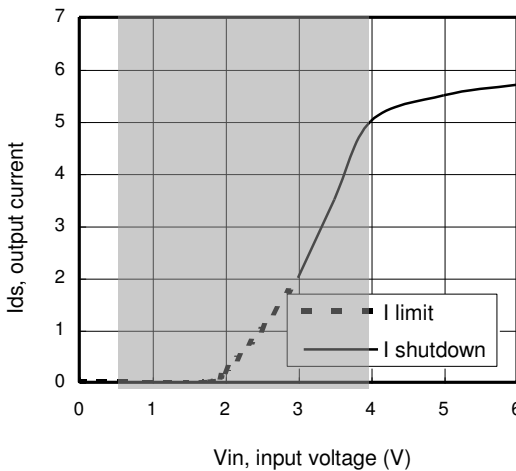
Figure 4 – Active clamp test circuit



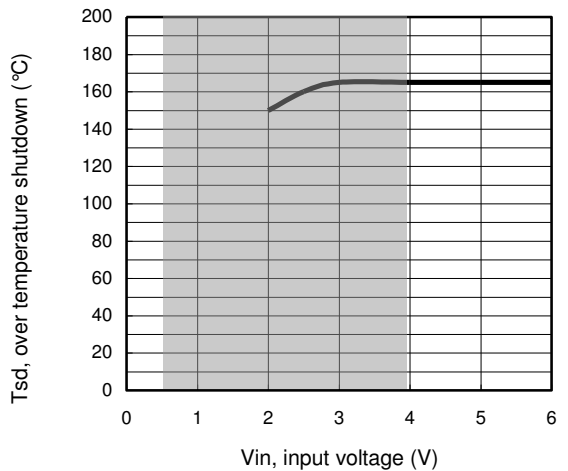
**Figure 5 – Normalized Rds(on) (%) Vs Input voltage (V)**



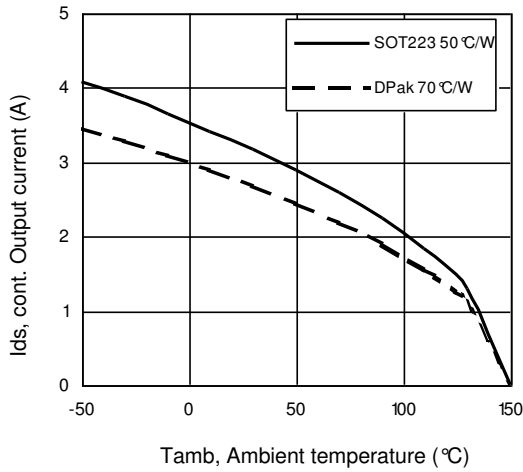
**Figure 6 - Normalized Rds(on) (%) Vs Tj (°C)**



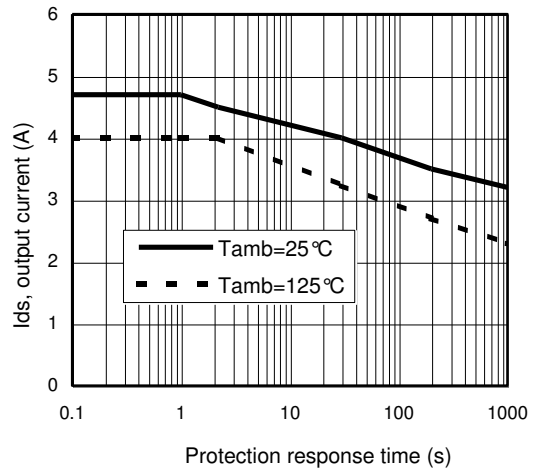
**Figure 7 – Current limitation and current shutdown Vs Input voltage (V)**



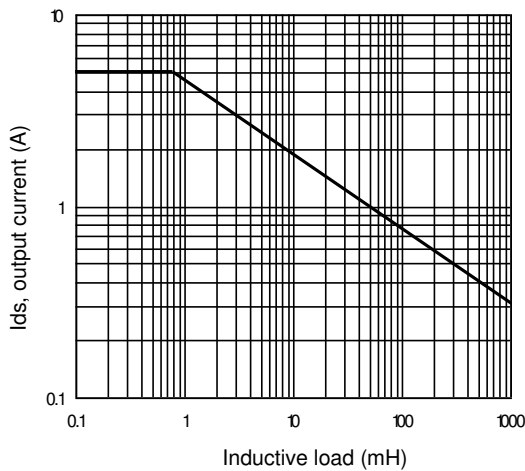
**Figure 8 – Over temperature shutdown (°C) Vs input voltage (V)**



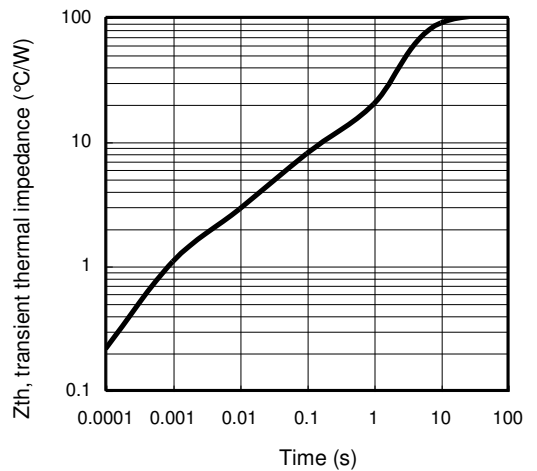
**Figure 9 – Max. continuous output current (A) Vs Ambient temperature (°C)**



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

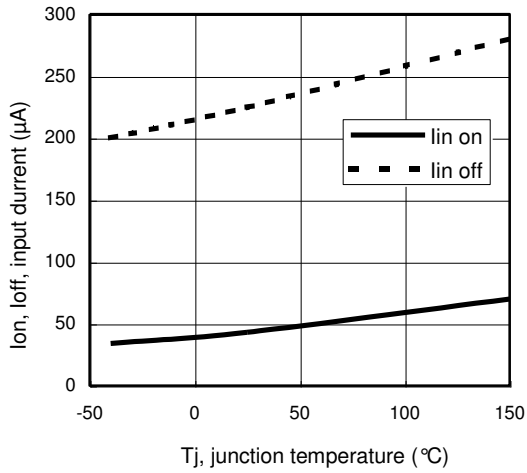


**Figure 11 – Max. output current (A) Vs Inductive load (mH)**



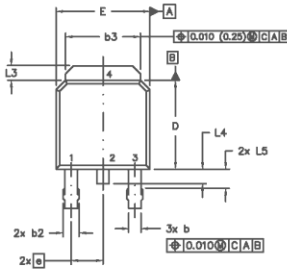
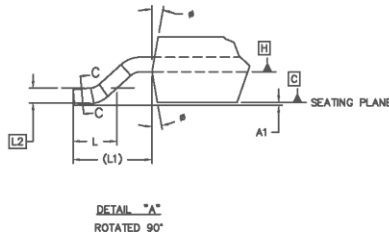
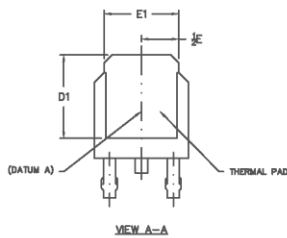
**Figure 12 – Transient thermal impedance (°C/W) Vs time (s)**



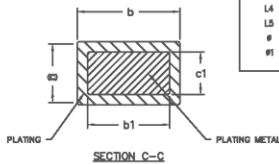
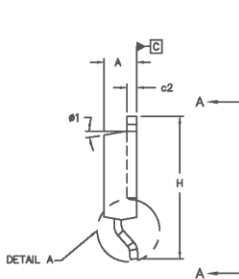


**Figure 13 – Input current (µA) On and Off  
Vs junction temperature (°C)**

## Case outline – Dpak - Automotive Q100 PbF MSL1 qualified



SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	2.18	2.39	.088	.094	
A1		0.13		.005	
b	0.64	0.89	.025	.035	5
b1	0.64	0.76	.025	0.030	5
b2	0.78	1.14	.030	.045	
b3	4.65	5.46	.185	.215	
c	0.48	0.61	.018	.024	5
c1	0.41	0.56	.016	.022	5
c2	.048	0.89	.018	.035	5
D	5.97	6.22	.235	.245	6
D1	3.21	-	.205	-	4
E	6.35	6.73	.250	.265	6
E1	4.32	-	.170	-	4
e	2.28		.090 BSC		
H	6.40	10.41	.270	.410	
L	1.40	1.78	.055	.070	
L1	2.74 REF.		.108 REF.		
L2	Ø.01 BSC		.020 BSC		
L3	0.89	1.27	.035	.050	
L4		1.02		.040	
L5	1.14	1.52	.045	.060	
Ø	0"	10"	0"	10"	
Ø1	0"	15"	0"	15"	3

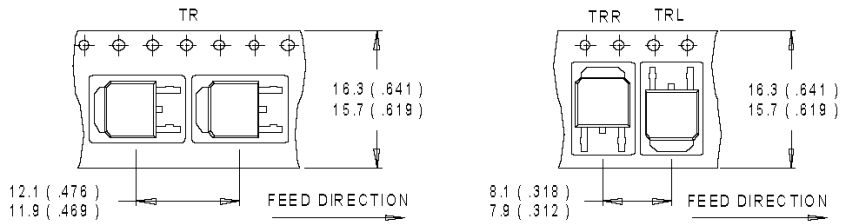


**NOTES:**

- 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 [0.2540] 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

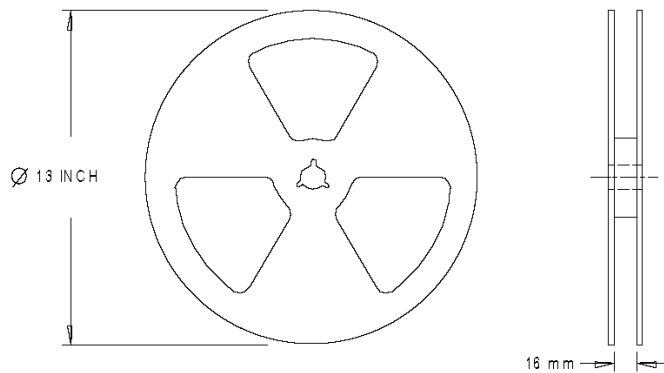
## Tape & Reel – Dpak

Dimensions are shown in millimeters (inches)



**NOTES :**

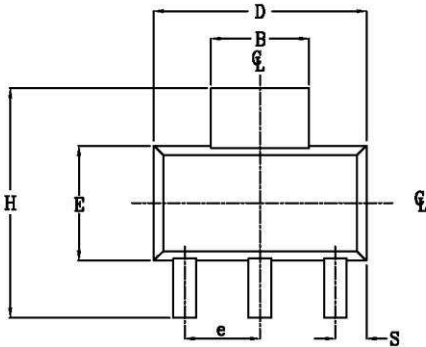
1. CONTROLLING DIMENSION : MILLIMETER.
2. ALL DIMENSIONS ARE SHOWN IN MILLIMETERS ( INCHES ).
3. OUTLINE CONFORMS TO EIA-481 & EIA-541.



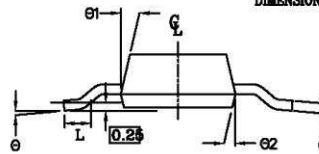
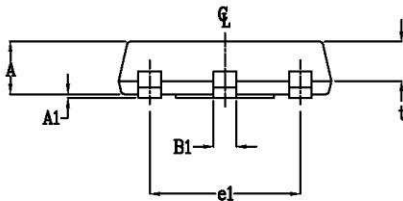
**NOTES :**

1. OUTLINE CONFORMS TO EIA-481.

## Case Outline - SOT-223 - Automotive Q100 PbF MSL2 qualified



POS	MILLIMETERS		INCHES	
	MAX	MIN	MAX	MIN
A	1.70	1.50	.067	.060
A1	0.10	0.02	.004	.0008
B	3.15	2.95	.124	.116
B1	0.85	0.65	.033	.026
C	0.35	0.25	.014	.010
D	6.70	6.30	.264	.248
e	2.30 NOM		.0905 NOM	
e1	4.60 NOM		.181 NOM	
E	3.70	3.30	.146	.130
H	7.30	6.70	.287	.264
S	1.05	0.85	.041	.033
t	1.30	1.10	.051	.043
∅	10° MAX		10° MAX	
∅1	16°	10°	16°	10°
∅2	16°	10°	16°	10°
L	0.75 MIN		0.0295 MIN	

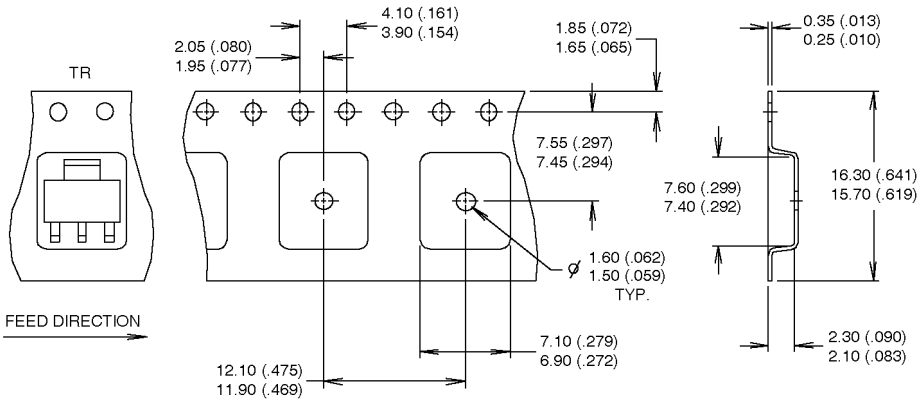


NOTE:  
 1. PACKAGE OUTLINE EXCLUSIVE OF ANY MOLD FLASHES DIMENSION.  
 2. PACKAGE OUTLINE EXCLUSIVE OF BURR DIMENSION.

Leads and drain are plated with 100% Sn

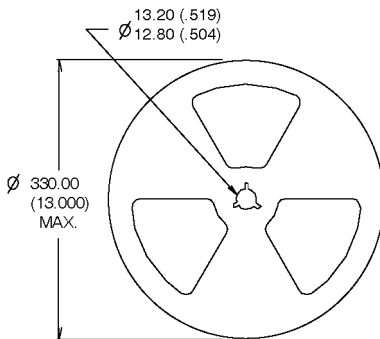
## Tape & Reel - SOT-223

Dimensions are shown in millimeters (inches)



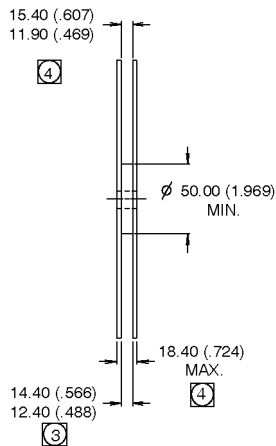
**NOTES:**

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

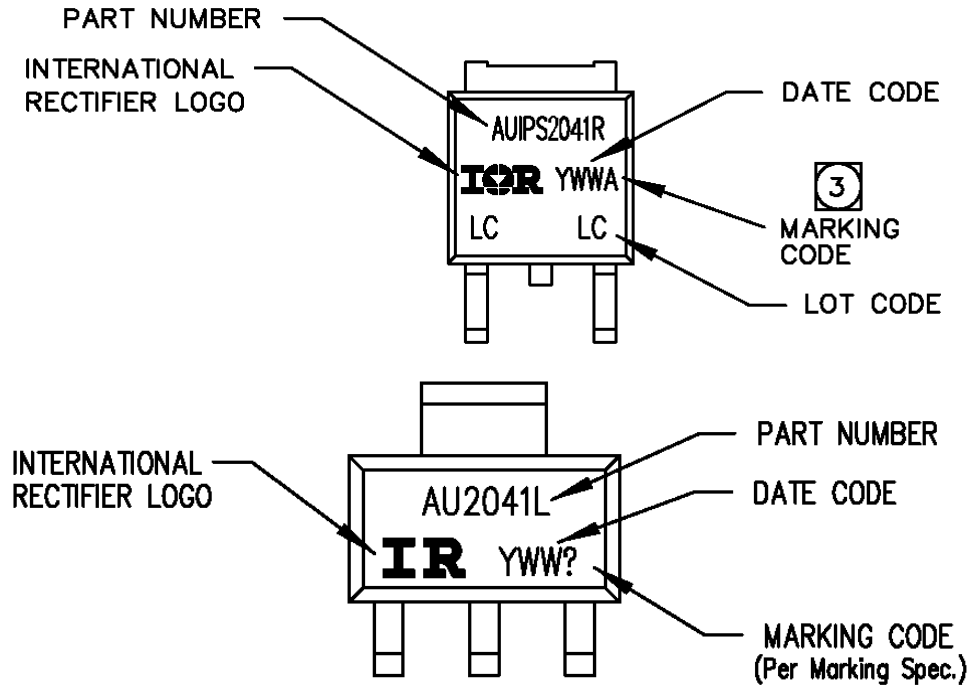


**NOTES:**

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



## Part Marking Information



## Ordering Information

Base Part Number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIPS2041L	D-Pak-5-Lead	Tube	75	AUIPS2041R
		Tape and reel	2000	AUIPS2041RTR
		Tape and reel left	3000	AUIPS2041RTRL
		Tape and reel right	3000	AUIPS2041RTRR
AUIPS2041L	SOT223	Tube	80	AUIPS2041L
		Tape and reel	2500	AUIPS2041LTR

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For technical support, please contact IR's Technical Assistance Center

<http://www.irf.com/technical-info/>

**WORLD HEADQUARTERS:**

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Tel: (310) 252-7105

**Revision History**

<b>Revision</b>	<b>Date</b>	<b>Notes/Changes</b>
C	26/02/2009	AU number update / OV removed
D	09/12/2010	Final release
E	14/03/2011	Update part marking
F	November, 14 <sup>th</sup> 2011	Update T&R SOT223
G	May 9 <sup>th</sup> , 2012	Update the component number of the SOT223 tube