

Qualification Information[†]

Qualification Level		Automotive (per AEC-Q100 ^{††})	
		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.	
Moisture Sensitivity Level		D2PAK-5L	MSL1, 260°C (per IPC/JEDEC J-STD-020)
		TO-220	Not applicable (non-surface mount package style)
		DPAK-5L	MSL1, 260°C (per IPC/JEDEC J-STD-020)
ESD	Machine Model	Class M2 (+/-150V) ^{†††} (per AEC-Q100-003)	
	Human Body Model	Class H1C (+/-1500V) ^{†††} (per AEC-Q100-002)	
	Charged Device Model (DPAK,D2PAK)	Class C4 (+/-900V) ^{†††} (per AEC-Q100-011)	
	Charged Device Model (TO220)	Class C3B (+/-750V) ^{†††} (per AEC-Q100-011)	
IC Latch-Up Test		Class II, Level A (per AEC-Q100-004)	
RoHS Compliant		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.

††† Passing voltage level

Absolute Maximum Ratings

Absolute maximum ratings indicate sustained limits beyond which damage to the device may occur. All voltage parameters are referenced to Ground lead. T_j= -40°C..150°C, V_{cc}=6..35V (unless otherwise specified).

Symbol	Parameter	Min.	Max.	Units
V _{out}	Maximum output voltage	V _{cc} -35	V _{cc} +0.3	V
V _{offset}	Maximum logic ground to load ground offset	V _{cc} -35	V _{cc} +0.3	
V _{in}	Maximum input voltage	-0.3	5.5	
V _{cc} max.	Maximum V _{cc} voltage	—	36	
V _{cc} cont.	Maximum continuous V _{cc} voltage	—	28	
V _{cc} sc.	Maximum V _{cc} voltage with short circuit protection	—	30	mA
I _{in} max.	Maximum I _N current	-3	10	
I _{dg} max.	Maximum diagnostic output current	-3	10	
V _{dg}	Maximum diagnostic output voltage	-0.3	5.5	V
P _d	Maximum power dissipation (internally limited by thermal protection)	—	—	W
	R _{th} =5°C/W AUIPS6031	—	25	
	R _{th} =40°C/W AUIPS6031S 1" sqrt. footprint	—	3.1	
	R _{th} =50°C/W AUIPS6031R 1" sqrt. footprint	—	2.5	
T _j max.	Max. storage & operating temperature junction temperature	-40	150	°C

Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Units
R _{th1}	Thermal resistance junction to ambient AUIPS6031 TO220 free air	50	—	°C/W
R _{th2}	Thermal resistance junction to case AUIPS6031 TO220	3.8	—	
R _{th1}	Thermal resistance junction to ambient AUIPS6031S D ² Pak std. footprint	60	—	
R _{th2}	Thermal resistance junction to ambient AUIPS6031S D ² Pak 1" sqrt. footprint	40	—	
R _{th3}	Thermal resistance junction to case AUIPS6031S D ² Pak	3.8	—	
R _{th1}	Thermal resistance junction to ambient AUIPS6031R D-Pak std. footprint	70	—	
R _{th2}	Thermal resistance junction to ambient AUIPS6031R D-Pak 1" sqrt. footprint	50	—	
R _{th3}	Thermal resistance junction to case AUIPS6031R D-Pak	3.8	—	

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 _{IH}	High level input voltage	4	5.5	A
V _{IL}	Low level input voltage	0	0.9	
I _{out}	Continuous drain current, T _{ambient} =85°C, T _j =125°C, V _{in} =5V	—	—	
	R _{th} =5°C/W AUIPS6031	—	8.9	
	R _{th} =40°C/W AUIPS6031S 1" sqrt. footprint	—	3.1	kΩ
	R _{th} =50°C/W AUIPS6031R 1" sqrt. footprint	—	2.8	
R _{in}	Recommended resistor in series with I _N pin	4	10	
R _{dgs}	Recommended resistor in series with DG pin for reverse battery protection	4	20	kHz
R _{dg}	Recommended pull-up resistor for DG	4	20	
R _{ol}	Recommended pull-up resistor for open load detection	5	100	
F max.	Max. switching frequency	—	2.5	

Static Electrical Characteristics

T_j=-40°C..150°C, V_{cc}=6..28V (unless otherwise specified), typical values are given for V_{cc}=14V and T_j=25°C

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
R _{ds(on)}	ON state resistance T _j =25°C	—	46	60	mΩ	V _{in} =5V, I _{out} =5A
	ON state resistance T _j =150°C	—	83	100		V _{in} =5V, I _{out} =5A
	ON state resistance T _j =25°C, V _{cc} =6V	—	55	70		V _{in} =5V, I _{out} =2.5A
	ON state resistance during reverse battery T _j =25°C	—	60	80		V _{cc} -Gnd=-14V
V _{cc op.}	Operating voltage range	6	—	28	V	
V clamp 1	V _{cc} to Out clamp voltage 1	37	39	43		I _{out} =30mA
V clamp 2	V _{cc} to Out clamp voltage 2	—	40	—		I _{out} =4A (see Fig. 1)
I _{cc Off}	Supply current when Off and V _{out} connected to ground with R<4Ω	—	4	9	μA	V _{in} =0V, V _{out} =0V, T _j =25°C, V _{cc} =14V
I _{cc On}	Supply current when On	—	2.2	5	mA	V _{in} =5V, V _{cc} =14V
V _{ih}	Input high threshold voltage	—	2.5	3	V	
V _{il}	Input low threshold voltage	1.5	2	—		
I _{n hyst.}	Input hysteresis	0.2	0.5	1		
I _{in On}	Input current when device is On	—	40	100	μA	V _{in} =5V
I _{dg}	Dg leakage current	—	0.1	10		V _{dg} =5V
V _{dg}	Low level DG voltage	—	0.25	0.4	V	I _{dg} =1.6mA

Switching Electrical Characteristics

V_{cc}=14V, Resistive load=6Ω, V_{in}=5V, T_j=-40°C..150°C, typical values are given for T_j=25°C

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
T _{don}	Turn-on delay time	—	8	25	μs	see Fig. 3
Tr1	Rise time to V _{out} =V _{cc} -5V	—	5	20		
Tr2	Rise time to V _{out} =0.9 x V _{cc}	—	8	35		
dV/dt (On)	Turn On dV/dt	—	1.5	—	V/μs	
E _{On}	Turn On energy	—	150	—	μJ	
T _{doff}	Turn-off delay time	—	20	45	μs	
T _f	Fall time to V _{out} =0.1 x V _{cc}	—	9	30	μs	
dV/dt (Off)	Turn Off dV/dt	—	3	—	V/μs	
E _{Off}	Turn Off energy	—	65	—	μJ	

Protection Characteristics

T_j = -40°C..150°C, V_{cc} = 6..28V (unless otherwise specified), typical values are given for V_{cc} = 14V and T_j = 25°C

Symbol	Parameter	Min.	Typ.	Max.	Units	Test Conditions
I _{lim}	Internal current limit	10	16	23	A	V _{out} = 0V, T _j = 25°C
T _{sd} +	Over temperature high threshold	150(1)	165	—	°C	See fig. 2
T _{sd} -	Over temperature low threshold	—	158	—		
V _{sc}	Short-circuit detection voltage(2)	2	3	4	V	
UV+	Under voltage protection V _{cc} going up	—	5	6.2		
UV-	Under voltage protection V _{cc} going down	—	4.5	5.8		
VOL Off	Open load detection threshold	2	3	4		
I _{OL} On	Open load detection threshold	0.15	0.4	0.65	A	T _j = -40..25°C
		0.15	0.4	0.55		T _j = 25..150°C

(1) Guaranteed by design

(2) Reference to V_{cc}

True Table

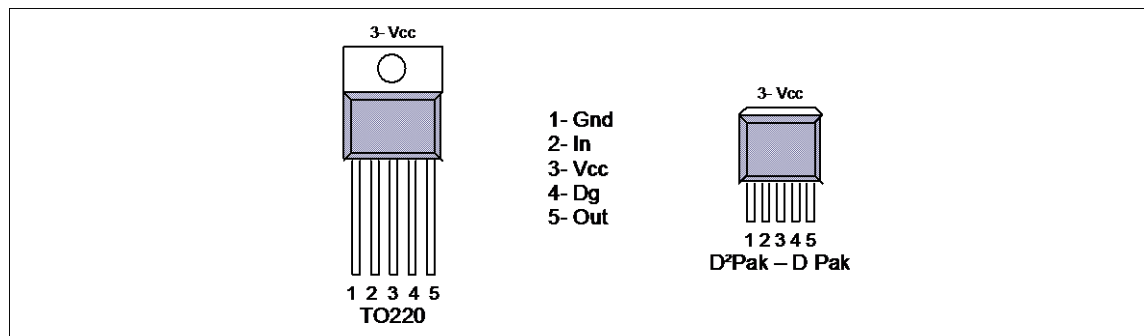
Operating Conditions	IN	OUT	DG
Normal	H	H	H
Normal	L	L	H
Open Load	H	H	L
Open Load (3)	L	H	L
Short circuit to Gnd	H	L	L
Short circuit to Gnd	L	L	H
Short circuit to V _{cc}	H	H	L (4)
Short circuit to V _{cc} (5)	L	H	L
Over-temperature	H	L	L
Over-temperature	L	L	H

(3) With a pull-up resistor connected between the output and V_{cc}.

(4) V_{ds} lower than 10mV.

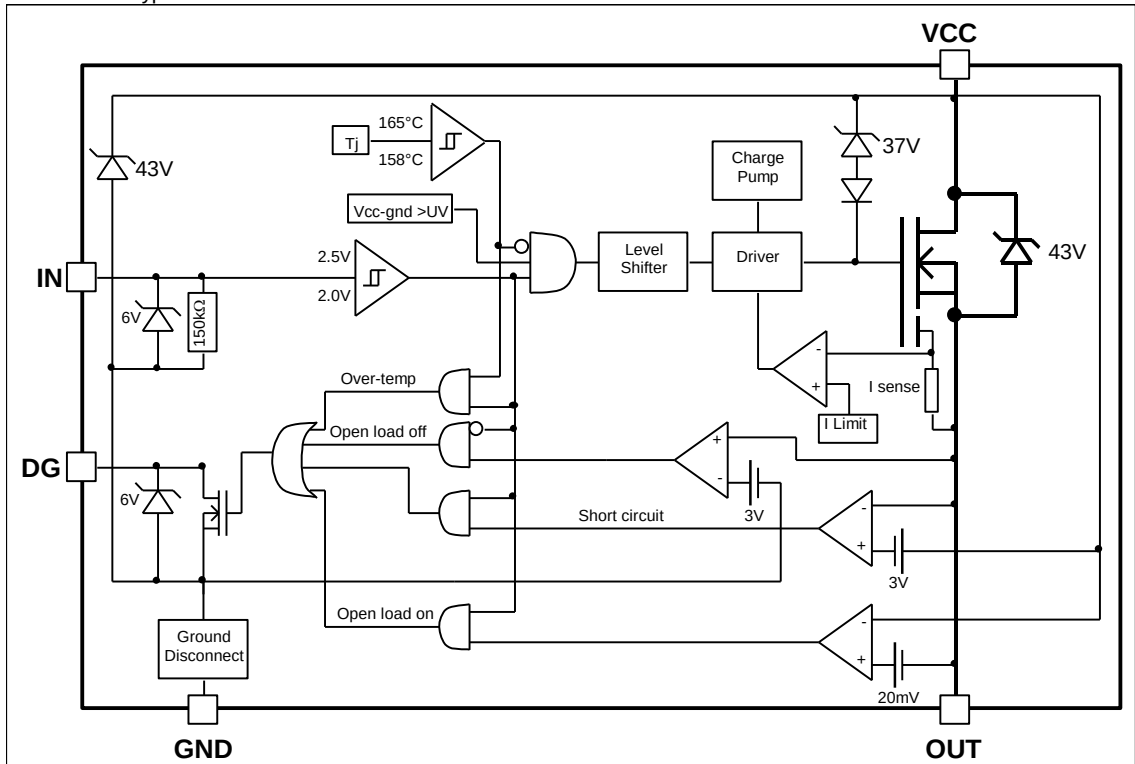
(5) Without a pull-up resistor connected between the output and V_{cc}.

Lead Assignments



Functional Block Diagram

All values are typical



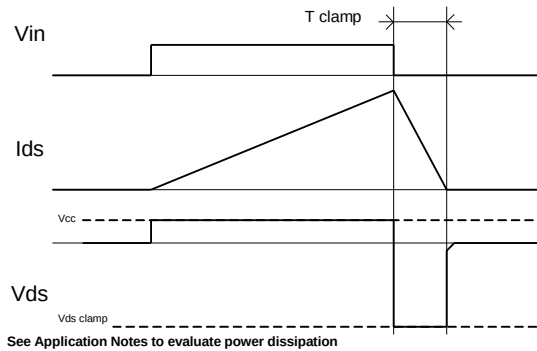


Figure 1 – Active clamp waveforms

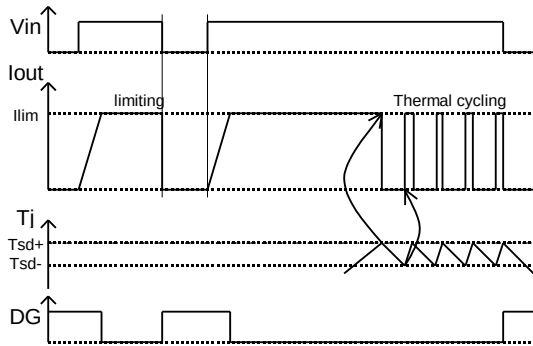


Figure 2 – Protection timing diagram

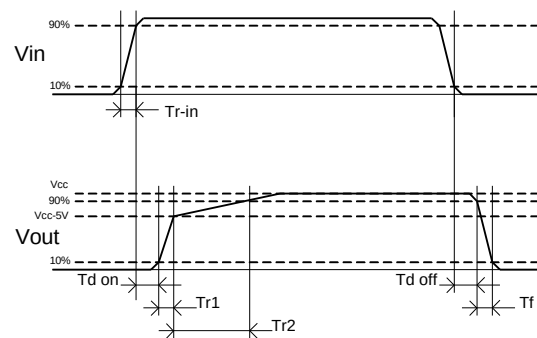


Figure 3 – Switching times definitions

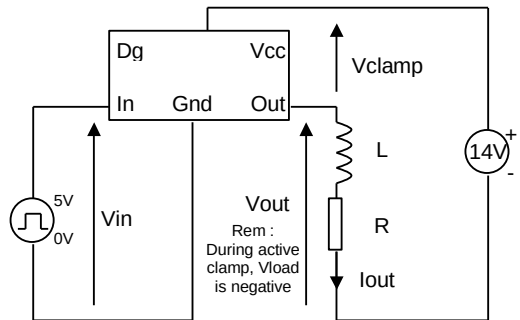


Figure 4 – Active clamp test circuit

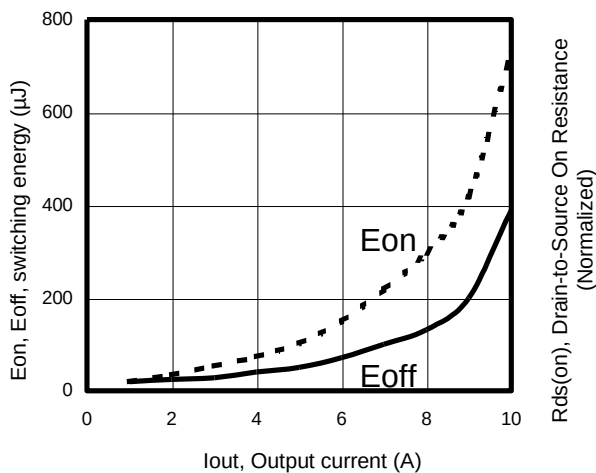


Figure 5 – Switching energy (μJ) Vs Output current (A)

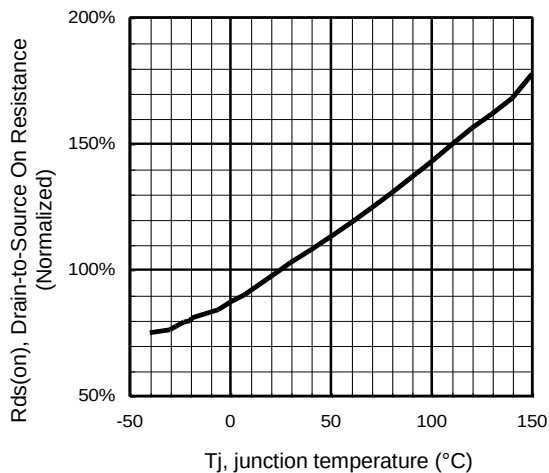


Figure 6 - Normalized $R_{ds(on)}$ (%) Vs T_j ($^{\circ}C$)

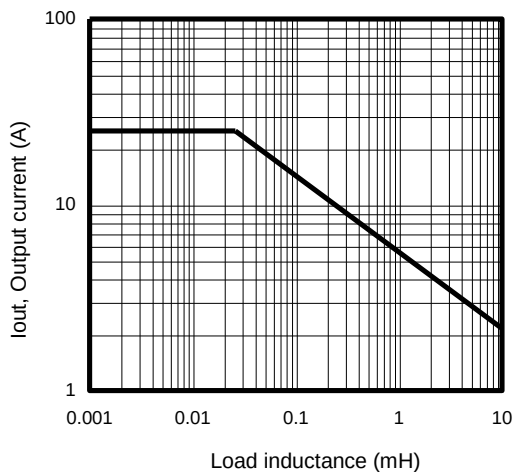


Figure 7 – Max. Output current (A) Vs Load inductance (mH)

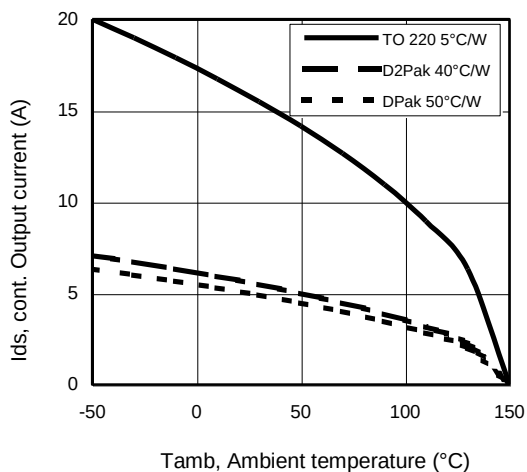


Figure 8 – Max. output current (A) Vs Ambient temperature ($^{\circ}C$)

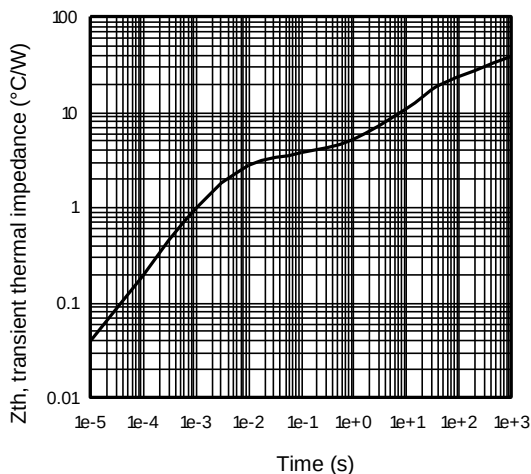


Figure 9 – Transient thermal impedance ($^{\circ}\text{C/W}$) Vs time (s)

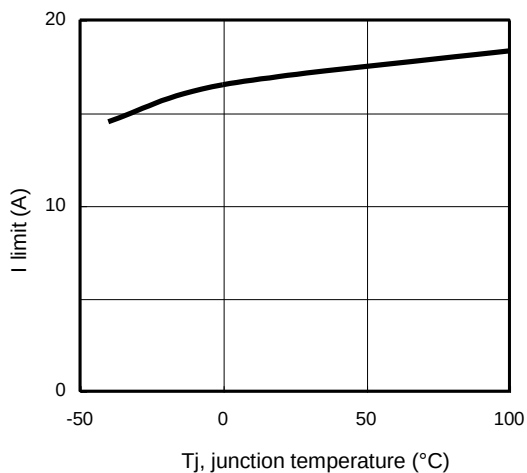


Figure 10 – I_{limit} (A) Vs junction temperature ($^{\circ}\text{C}$)

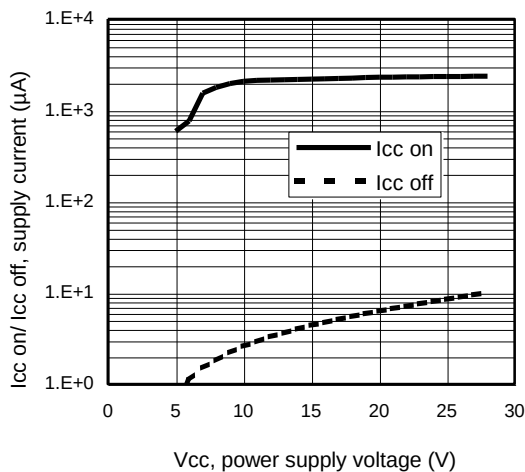


Figure 11 – $I_{cc\ on}/ I_{cc\ off}$ (μA) Vs V_{cc} (V)*

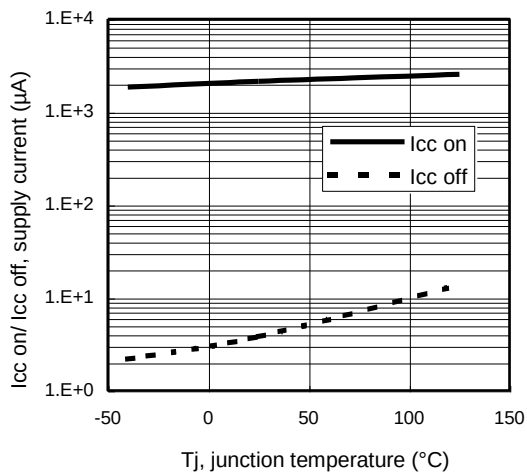
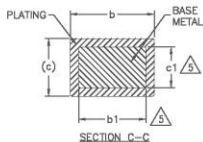
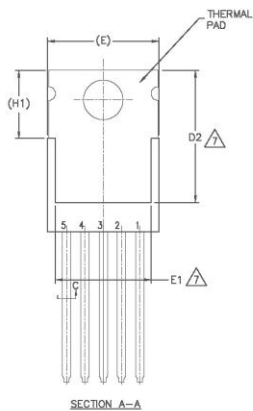
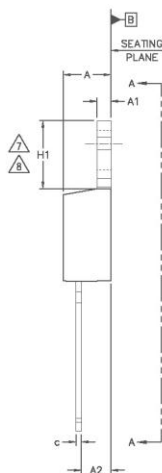
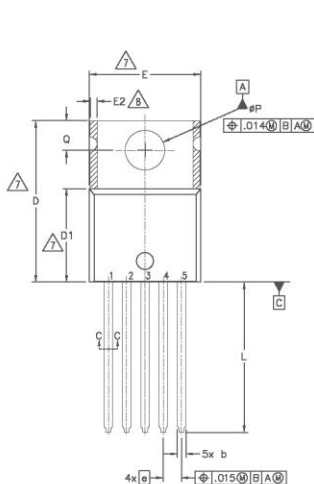


Figure 12 – $I_{cc\ on}/ I_{cc\ off}$ (μA) Vs T_j ($^{\circ}\text{C}$)*

* V_{out} connected to ground with $R < 4\Omega$

Case Outline - TO220 (5 leads)

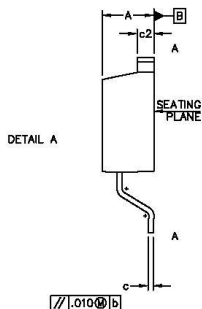
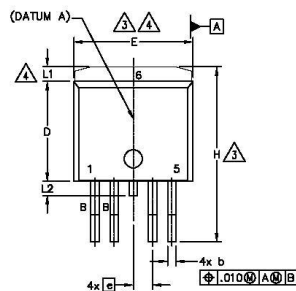
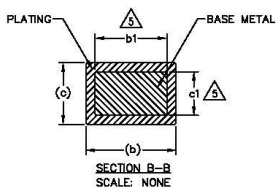
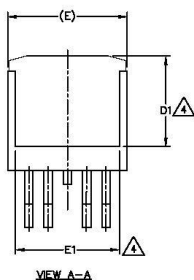
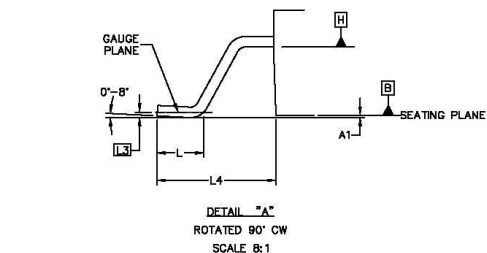


SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	3.56	4.83	.140	.190	
A1	0.51	1.40	.020	.055	
A2	2.03	2.92	.080	.115	
b	0.64	0.89	.025	.035	5
b1	0.64	0.84	.025	.033	
c	0.36	0.61	.014	.024	
c1	0.36	0.56	.014	.022	5
D	14.22	16.51	.560	.650	4
D1	8.38	9.02	.330	.355	
D2	11.68	12.88	.460	.507	7
E	9.65	10.67	.380	.420	4,7
E1	6.86	8.89	.270	.350	7
E2	—	0.76	—	.030	8
e	1.70 BSC		.067 BSC		
H1	5.84	6.86	.230	.270	7,8
L	12.70	14.73	.500	.580	
W	3.53	3.73	.139	.147	
Q	2.54	3.05	.100	.120	

NOTES:

- 1.— DIMENSIONING AND TOLERANCING AS PER ASME Y14.5 M— 1994.
- 2.— DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
- 3.— LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
- 4.— DIMENSION D, D1 & 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.
- 5.— DIMENSION b1 & c1 APPLY TO BASE METAL ONLY.
- 6.— CONTROLLING DIMENSION : INCHES.
- 7.— THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS E,H1,D2 & E1.
- 8.— DIMENSION E2 X H1 DEFINE A ZONE WHERE STAMPING AND SINGULATION IRREGULARITIES ARE ALLOWED.
- 9.— OUTLINE CONFORMS TO JEDEC TO-220, EXCEPT A2 (max.) AND D2 (min.) WHERE DIMENSIONS ARE DERIVED FROM THE ACTUAL PACKAGE OUTLINE.
- 10.— LEADS AND DRAIN ARE PLATED WITH 100% Sn

Case Outline D2PAK - 5 Leads

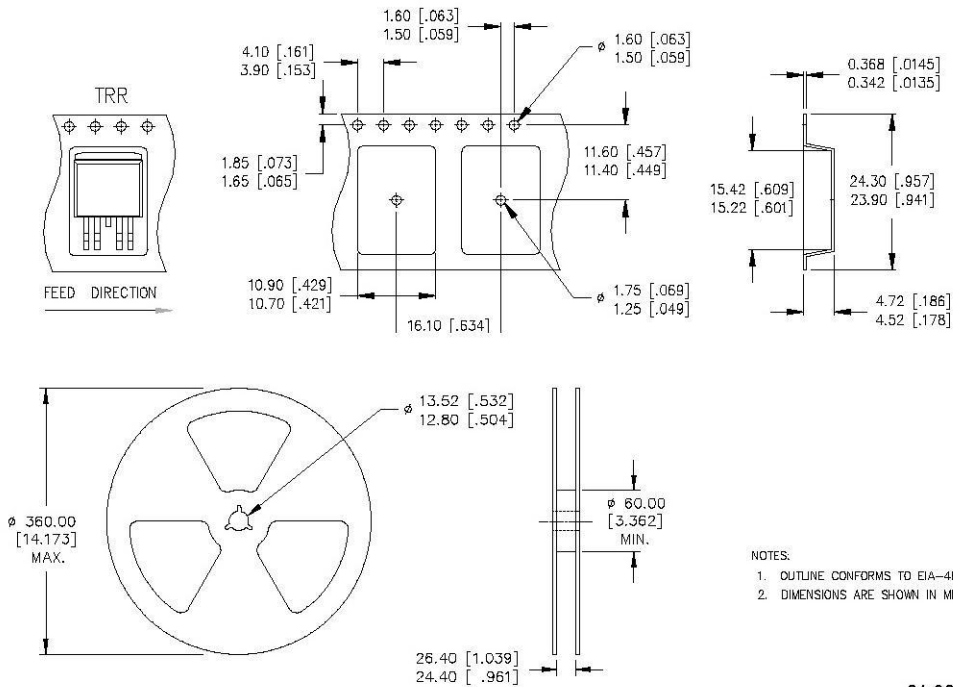


NOTES:

1. DIMENSIONING AND TOLERANCING AS 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 [0.005"] 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-263BA.
9. LEADS AND DRAIN ARE PLATED : 100% Sn

SYM BO L	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	4
A1	—	0.254	—	.010	
b	0.51	0.89	.020	.039	
b1	0.51	0.89	.020	.035	4
c	0.38	0.74	.015	.029	
c1	0.38	0.58	.015	.023	
c2	1.14	1.65	.045	.065	3
D	8.38	9.65	.330	.380	
D1	6.86	—	.270	—	
E	9.65	10.67	.380	.420	3
E1	6.22	—	.245	—	
e	1.70	BSC	.067	BSC	
H	14.61	15.88	.575	.625	
L	1.78	2.79	.070	.110	
L1	—	1.68	—	.066	
L2	—	1.78	—	.070	
L3	0.25	BSC	.010	BSC	
L4	4.78	5.28	.188	.208	

Tape & Reel D2PAK - 5 Leads

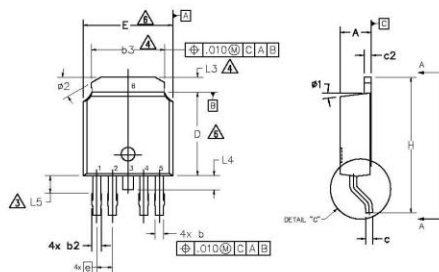
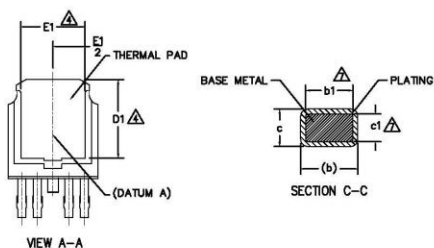
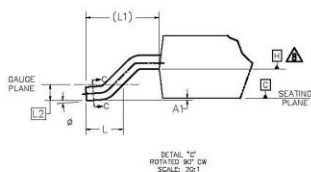


NOTES:

1. OUTLINE CONFORMS TO EIA-481 & EIA-541.
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].

01-3071 00 / 01-3072 00

Case Outline DPAK - 5 Leads



SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	2.18	2.39	.086	.094	2
A1	—	0.13	—	.005	
b	0.56	0.79	.022	.031	2
b1	.056	0.74	.022	.029	
b2	0.65	0.89	.026	.035	2
b3	4.95	5.46	.195	.215	
c	0.46	0.61	.018	.024	2
c1	0.41	0.56	.016	.022	
c2	0.46	0.89	.018	.035	3
D	5.97	6.22	.235	.245	
D1	5.21	—	.205	—	3
E	6.35	6.73	.250	.265	
E1	4.32	—	.170	—	3
e	1.14 BSC		.045 BSC		
H	9.40	10.41	.370	.410	3
L	1.40	1.78	.055	.070	
L1	2.74 BSC		.108 REF.		3
L2	0.51 BSC		.020 BSC		
L3	0.89	1.27	.035	.050	3
L4	—	1.02	—	.040	
L5	1.14	1.52	.045	.060	3
ø	0"	10"	0"	10"	
ø1	0"	15"	0"	15"	3
ø2	28"	32"	28"	32"	

NOTES:

- 1.— DIMENSIONING AND TOLERANCING AS PER ASME Y14.5M-1994
- 2.— DIMENSIONS 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-252.
- 10.— LEADS AND DRAIN ARE PLATED WITH 100% Sn

The technical drawing consists of two views of a mechanical component.

Top View (Left):

- A vertical shaft-like feature with a diameter dimension of 0.30 ± 0.05 .
- A fillet radius at the base labeled "0.3 R MAX".
- Two horizontal dimensions from the centerline are labeled K_0 and K_1 , with a circled "C" next to K_1 .

Side View (Right):

- The overall length of the part is 2.0 .
- A central section has a width of 4.0 .
- A hole or feature on the left has a diameter of 1.5 ± 0.1 DIA.
- The distance from the left edge to the start of the main body is 1.2 .
- The main body features three rectangular sections, each containing a circular feature.
- The distance between the centers of the first and second rectangular sections is 5.5 .
- The distance from the right edge of the last rectangular section to the right end of the part is 1.75 .
- The total width of the part is labeled W .
- Section lines A-A are indicated across the part.
- A note "SEE NOTE 6" points to a specific feature.
- A fillet radius at the bottom right corner is labeled "0.5 R. TYP."
- Other labels include P_1 , A_o , B_o , and circled "C"s.

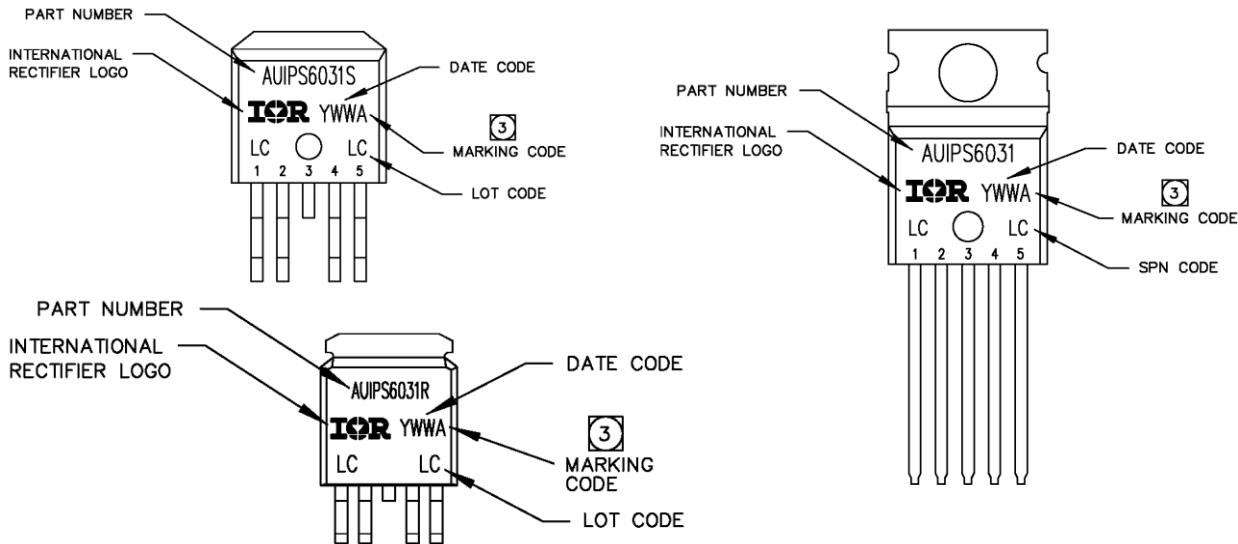
Cross-Section A-A:

This cross-section shows the internal profile of the part. It includes a central bore and various internal features corresponding to the external geometry shown in the side view.

1. 10 SPROCKET HOLE PUNCH CUMULATIVE TOLERANCE ± 0.02
2. CAMBER NOT TO EXCEED 1mm in 100mm
3. MATERIAL: CONDUCTIVE BLACK POLYSTYRENE
4. A_0 AND B_0 MEASURED ON A PLANE 0.3mm ABOVE THE BOTTOM OF THE POCKET
5. K_0 MEASURED FROM A PLANE ON THE INSIDE BOTTOM OF THE POCKET TO THE TOP SURFACE OF THE CARRIER
6. POCKET POSITION RELATIVE TO THE SPROCKET HOLE MEASURED AS TRUE POSITION OF POCKET, NOT POCKET HOLE
7. VENDOR: (OPTIONAL)
8. MUST ALSO MEET REQUIREMENTS OF EIA STANDARD #EIA-481A, TAPING OF SURFACE-MOUNT COMPONENTS FOR AUTOMATIC PLACEMENT.
9. TOLERANCE TO BE MANUFACTURER STANDARD
10. SURFACE RESISTIVITY OF MOLDED MATL: MUST MEASURE LESS THAN OR EQUAL TO 10^4 OHMS PER SQUARE, MEASURED IN ACCORDANCE TO PROCEDURE GIVEN IN ASTM D-257 & ASTM D-991 (REF. C-9000 SPEC.)
11. TOTAL LENGTH PER REEL MUST BE 79 METERS
12. © CRITICAL DIMENSION

Ao = 10.5 mm
 Bo = 7.0 mm
 Ko = 2.8 mm
 K1 = 2.4 mm
 F = 7.5 mm
 P1 = 12.0 mm
 W = 16.0 ± .3 mm

Part Marking Information



Ordering Information

Base Part Number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIPS6031	TO220-5-Leads	Tube	50	AUIPS6031
AUIPS6031S	D2-Pak-5-Leads	Tube	50	AUIPS6031S
		Tape and reel left	800	AUIPS6031STRL
		Tape and reel right	800	AUIPS6031STRR
AUIPS6031R	D-Pak-5-Leads	Tube	75	AUIPS6031R
		Tape and reel	2000	AUIPS6031RTR
		Tape and reel left	3000	AUIPS6031RTRL
		Tape and reel right	3000	AUIPS6031RTRR

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For technical support, please contact IR's Technical Assistance Center
<http://www.irf.com/technical-info/>

WORLD HEADQUARTERS:

101 N Sepulveda Blvd., El Segundo, California 90245
Tel: (310) 252-7105

Revision History

Revision	Date	Notes/Changes
B	September, 12th 2011	AU release
C	May 15, 2012	Add the test condition for the ICC (off) parameters